



**LUND UNIVERSITY**  
School of Economics and Management

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# **To Be Smart or To Be Alone?**

## **Exploring return on investment and problems in smart city**

Master thesis 15 HEC, course INFM10 in Information Systems  
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# To Be Smart or To Be Alone?

## Exploring return on investments and problems in smart city

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Abstract:

The European Nations foresees a growing population and a trending urbanization which, pose significant health, environmental and social concerns. Municipal decision makers attempt to leverage the smart city concept as a means to maintain the prepossessed living standard in the city because they cannot manage the radical change themselves. However, the smart city concept force municipalities outside their comfort zone and into new collaborations between internal organizations as well as external partnerships with universities, citizen and industries. The new collaborations are riddled with problems that hamper smart city advancements and convolute return on investment. This thesis attempts to further the discussion on return on investment and expose the most predominant problems in smart city initiatives from the municipal decision makers' perspective in mid-sized European cities.

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# 1 Introduction

The European Nations declare that approximately half of the world's population is living in cities and this number is anticipated to continuously grow to sixty percentages in 2030 (Vlacheas et al., 2013). This trending urbanization already poses significant health and environmental concerns for urban living such as: waste management, air pollution, traffic congestions and scarcity of resources. Additionally, aging technical and physical city infrastructure inadequately supports the anticipated growth in population.

Observed from a competitive lens, cities with increasing urbanization are advised to redevelop their infrastructure to compete globally. Competitive cities produce a desirable place for educated and skilled citizens to live and work as well as attracting growing industries to leverage continued external investment and a robust tax base. (Chourabi et al., 2012). Harrison et al. (2010) argue that sustained or enhanced quality of life can be achieved through advances in city services and resources which are fundamental in competition between cities.

However, these challenges necessitate that municipalities do more with less due to limited financial-, environmental- and human resources (Naphade et al., 2011). These challenges prompt cities across the globe to study smarter ways to manage them while striving towards more sustainable and liveable cities leveraged by information communication systems (ICT), these cities are commonly labelled smart city (Chourabi et al., 2012). The integration between thirty different city agencies and coherent information systems allowed Rio de Janeiro to analyse historical data and pre-emptively prevent car accidents, traffic congestions and keeping the city operational and safe during environmental hazards (Singer, 2012).

In another example, Bloomberg reports that “The Edge” was recently finalized in the Netherlands and is praised as the smartest building in the world (Randall, 2015). The building facilitates 28,000 sensors all connected to a central dashboard which allows The Edge to track energy usage, lighting and heating to suit individuals' personal preferences. Abundant amounts of energy is generated through solar panels, water systems store hot water during summers to use during winters and entire sections of the building are shut off during less busy days which yield a sustainability score above 98 percentages according to British rating agency (Randall, 2015).

The opportunities and incentives to leverage a smart city in order to combat challenges with increased urbanization are evident. Less evident is the anticipated return of investment (ROI) in smart city. ROI for smart cities concerns multiple levels in the short term, such as operational efficiency, increased productivity or energy savings (Harrison et al., 2010). In a longer time span, cities may value their brand reputation, strategic positioning, impact on society and public safety (ibid).

However, the smart city concept is complex and still emerging (Chourabi et al., 2012) which arguably complicates accurate calculations of return on investment. Large volumes of investments required in concert with long term delays to maturity constitutes two out of many barriers to financing smart cities, according to recent research conducted by the European Commission (Ferrer et al., 2013). Furthermore, municipal leaders experience difficulties in map-

ping quantifiable factors to measure, and the limited demonstrators commonly lack the scalability to have actual impacts on the economy (Cosgrave et al., 2013). Manville et al. (2014) accentuates that it is especially difficult to monetize societal oriented initiatives such as smart city which may explain the difficulties in measuring the return on investment.

The desirable returns on investments range from cost reducing incentives to public safety, which convolutes prioritizations for transforming cities and it all comes with a hefty price tag that underscores the importance of allocating scarce resources accurately. It could also be argued that the difficulties in discussing or measuring return on investment as expressed in literature accentuates the need for further research.

Moreover, smart city initiatives are riddled with problems and challenges to overcome in order to reap the benefits of smart city investments. One of the predominant challenges is how to achieve a strategic alignment between the key stakeholders of smart city development; people, technology and institutions (Nam and Pardo, 2011a). Problems in smart city initiatives range from technical to governance to managerial challenges (Ojo et al., 2014).

Issues such as stakeholder and citizen participation (Ibid), interoperability of systems (Nam and Pardo, 2011b) as well as privacy and security concerns (Kitchin, 2014a) are common difficulties. These problems debatably convolute and hinder cost efficient ROI which are important considerations for all smart city stakeholders and holds especially true for governmental institutions, such as the municipality, that has to allocate scarce resources in smarter ways in order to tackle the growing urbanization.

## 1.1 Purpose

The purpose of this study is to advance the discussion on return on investment in addition to exposing the most predominant problems with smart city initiatives from the municipal perspective in mid-sized European cities. To support this discussion, a brief review of the understanding behind the concept smart city help shape the foundation to further debate return on investment and experienced problems. The study may serve as fundament for primarily municipal, but also other smart city stakeholders, to make more accurate decisions to combat future problems in pursuit of desirable impacts.

## 1.2 Research Questions

- What return on investment do municipal decision makers hope to achieve with smart city?
- What are the most predominant challenges in a smart city from the municipal decision maker's perspective?

### 1.3 Disposition

The thesis is divided into four overarching chapters. This initial chapter contains introductory elements to project the problem area and accentuate the need for further investigation regarding return on investments and challenges with smart city initiatives. Henceforth follows the chapter of methodologies used in conducting this research. The methodology chapter attempts to preserve a high degree of traceability and covers the research approach and an in-depth argumentation of selected literature which concludes with a theoretical model based on 63 studied articles.

The following chapter reviews the targeted literature sample regarding return on investment and problems in smart city. The fourth chapter synthesises the empirical data which is subsequently analysed and contrasted with the literature review. The thesis concludes with a reflective discussion of noteworthy findings which are ultimately summarized in a compact form.

### 1.4 Delimitation

This thesis attempts to determine the level of returns which arguably serves as an indicator for priority, although, verifying bankability and cost-benefit ratio with respect to the real needs extends past the scope of this paper.

This research is not trying to associate a particular set of problems in search of a specific return on investment. For example, this thesis will not claim that interoperability in between information systems is the most predominant challenge when striving towards societal sustainability.

## 2 Method

Providing transparency and traceability of the research process is important in order to achieve high reliability. Therefore, this chapter will thoroughly present the overall research design that has guided this study. The chapter begins with a short presentation of the pre-study that preceded this research followed by a discussion of the research design and the epistemological assumptions, methodological considerations as well as key decisions taken regarding the research process. Then follows a systematic presentation of how the literature review was conducted as well as how the theoretical framework was developed. The second part of the chapter reports on how the empirical data was collected and analysed as well as discussion regarding quality and ethics.

### 2.1 Pre-study

In parallel to defining the rough outlines about smart city, we co-led a pre-study about the smart city concept together with another research team from the department of informatics in Lund's University. The pre-study set out to investigate city needs in addition to map smart city solutions. The study spanned across Europe on the behalf of a European consortium of companies and governmental institutions in search of solutions to tackle current and future challenges with growing urbanization. Countries were selected based on five overarching motives.

Initially, the pre-study honed in on Europe in hopes of higher probability of finding interview objects and on the assumption that European countries are more cooperative. Secondly, only mid-sized cities with a population between 100.000 – 500.000 were targeted. Thirdly, only cities that have smart city related initiatives were considered in order to draw from first-hand experience. Fourthly, cities with smart city initiatives that had a wide impact on the city as a whole were prioritized rather than cities that, for instance, considered themselves a smart city because they measure energy consumption in a few selected private residents. Lastly, solutions operating in solitude without connection to network in order to share and aggregate data were excluded. This weeding generated interviews with 32 municipal decision makers in 25 different cities throughout eleven countries.

The research team emphasized interview questions with technical inclination in addition to probing questions in pursuit of determining the city needs. Such questions would undoubtedly reveal interesting findings; however, broader questions were favoured in order to determine complexities with smart city initiatives from a more holistic perspective. This research served as a pre-study to this succeeding master thesis and a wider perspective was advocated with the intention of drilling deeper into interesting difficulties that may have been overlooked otherwise with narrow questions. Three overarching questions were therefore added to their interview guide prior to conducting the 32 interviews. They were: 1) what is smart city to you? 2) what are the predominant challenges with smart city initiatives? and 3) what do you hope to achieve with smart city?

Henceforth, all conducted interviews were assembled in an excel document in order to compare and contrast answers in search of reoccurring difficulties with smart city initiatives that were deemed interesting to further pursuit with the master thesis. Questions and answers that were frequently left out or often incomplete were coloured red and not further examined due to the limited deduction that could be considered from insufficient answers. On the contrary, questions with rich volume and exemplifications were coloured green and further studied. This procedure is further illustrated in Exhibit 1 which can be found in the appendix.

A multitude of interesting findings emerged after carefully studying and discussing all green coloured answers. For instance, municipal decision makers wanted to be associated with smart city but lack any plan to realize it which may be explained by the absence of an explicit and transparent end goal. Furthermore, a large sample of the interviewed cities claim that measuring success is crucial to smart city development, however, hardly any of the interviewees actually actively measure and monitor smart city progression. Additionally, smart city is leveraged through multiple internal as well as external stakeholders who experienced difficulties to collaborate due to conflicting interest, budget and lack of individual incentive.

From a general standpoint, it could be argued that municipal decision makers embark upon the smart city hysteria with a rather uncritical mind-set with limited considerations of prominent risks or what they hope to achieve with the smart city initiative. This proved an interesting eye-opener and acted as a springboard for the two main considerations in this paper: to identify the most predominant problems in smart city initiatives in addition to further the discussion on what return cities hope to achieve with their smart city investments.

## 2.2 Research Design

According to Yin (2003), research design is the logic, or structure of the research, a logical plan for getting from here to there. The research method refers to the strategies that implement the design. Similarly, Recker (2012) states that research methodology is equal to the strategy of the techniques used to answer the research question. There are many choices to take and several decisions to be made concerning research design (Recker, 2012). Not in the least questions of epistemological assumptions about the problem area in the study and the corresponding adherence to a research paradigm but also more specifically about the method of choice.

In this study smart city is investigated from the municipal point of view with the purpose of exploring experienced problems and expected return on investments with smart city initiatives. However, municipals will arguably have different conceptions of smart city similarly to the ambiguity of the concept in the literature. What is considered as a problem or an expected return on investment is most likely dependent upon both individual and local experience as well as the perceived definition of smart city among cities and the people managing the smart city initiatives. Therefore, this study starts from an assumption that the experience of problems and expected returns from smart city is dependent upon different real-life social contexts.

This arguably calls for an interpretative approach which is based on the assumption that the reality is social and non-objective, or singular, since it is shaped by human experience and social settings as debated by (Bhattacharjee, 2012). With an interpretivist approach, the studied phenomenon is interpreted through a sense-making process instead of a hypothesis testing

process. Such an approach will be fruitful for this study since it aims to identify and understand the problems and expectations experienced by municipal decision makers in their smart city initiatives in a real-life social context. Similarly, this is also referred to by Goldkuhl (2012) as “an understanding through processes of interpretation” (Goldkuhl, 2012, p.4). Moreover, Bhattacharjee (2012) assert that interpretivism has a number of attractive features such as being helpful for theory development in areas with scarce available theory as well as the study of real-life social contexts. This claim further strengthens the decision to employ an interpretivist position in this study since the problem area lacks coherent theories and experience of problems and expected return of smart city initiatives are arguably best investigated in their social real-life context.

### 2.2.1 Methodological considerations

Methodology is a strategic choice of how to best answer the research question and Recker (2012) points out that research methodology goes hand in hand with the development of research design. This study starts from an interpretative position and advances an exploratory approach due to the mainly un-researched problem area of the research. The expected outcome of the study is descriptive in nature with an ambition to deliver new insight and increased understanding of the problems and expected returns from smart city initiatives. Given these design decisions it was decided that it was best to adopt a qualitative method conferring to the research design decisions in Recker (2012) shown in the picture below.

**Table 3.1** Research design decisions (Adapted from [38])

Spectrum	One end of continuum		Other end of continuum
Method	Qualitative	vs.	Quantitative
Aim	Exploratory	vs.	Explanatory
Boundary	Case	vs.	Statistical
Setting	Field	vs.	Laboratory
Timing	Cross-sectional	vs.	Longitudinal
Outcome	Descriptive	vs.	Causal
Ambition	Understanding	vs.	Designing

Figure 1: Research design decisions (Recker, 2012).

According to Recker (2012), qualitative methods offer an effective way to assist researchers in order to understand phenomena in context and are also ideal for studying social, cultural, or political aspects of a phenomenon. He comments that:

“Qualitative methods often consist of interpretive research in which researchers develop interpretations of the data they collect and analyse, often in the form of suggested conceptualizations of theories about the phenomenon of study.” (Recker, 2012, p.89)

Qualitative methods are attractive as a source of well-grounded, rich description and explanation of processes occurring in local contexts (Miles and Huberman, 1984) and as a useful method in exploratory studies with new phenomenon not yet fully understood and well researched (Recker, 2012). This indicates a promising approach for this study since it starts from an interpretivist and exploratory position seeking insight of the experience from smart city initiatives, which is arguably highly contextual.

Moreover, this study could also benefit from collecting quantitative data. It was considered that quantitative measures would usefully supplement and extend the qualitative data by ex-

panding the target sample which would strengthen the generalizability of the results. This is also accentuated by Bhattacharjee (2012) who commends that interpretive research should attempt to gather both qualitative and quantitative data of the phenomenon researched. For instance, a survey questionnaire could provide many more pieces to the puzzle, i.e. the complete understanding of the problems and the expected return on investments cities encounter its smart city initiatives.

Furthermore, Bhattacharjee (2012) suggests that survey questionnaires are ideally suited for large populations that could not easily be investigated with methods directly involving the researcher. However, despite the obvious advantages of quantitative data collection, the limitations of this study would not allow for both quantitative and qualitative data collection. Interviews were chosen as the primary data collection method due to its strengths of directly targeting the unit of analysis and the research topic providing first hand insightful data (Paré, 2004).

### 2.3 Selecting Theoretical Model

Two potential paths were deemed suitable prior to studying the available academic literature. The first option was to research widely used information system theories in search for already established frameworks or theories that fit this thesis. This option could potentially free up time to conduct more extensive empirical data gathering. Additionally, models and frameworks that are tested and evaluated by antecedent researchers arguably provide a more consistent and reliable approach in contrast to developing new and unproven model from the ground up. Notably, applying an existent model could steer away from a genuinely explorative approach towards theory testing and evaluating.

The second option sets out to build a theoretical framework from the ground up based on an extensive literature review. In contrast to using an existing model, a newly developed theoretical framework allows in-depth customization to fit this thesis more appropriately and would initially be entirely explorative in order to reveal new central patterns and nuances not covered in existing models. Consequently, a new model does not have the privilege to be evaluated and tested prior to this research which presumably calls for further adjustments subsequent to publishing this paper. Furthermore, building new models arguably consumes more time in contrast to borrowing existing ones.

The site [is.theorizeit.org](http://is.theorizeit.org) was used in search for developed theoretical models to suit this thesis. The site offers summarizations on widely used theories applied in the field of information systems research. [is.theorizeit.org](http://is.theorizeit.org) is an on-going project at the University of Colorado and the IS PhD preparation program and henceforth used in this thesis as the primary source in pursuit of preferable models and frameworks. The top ten most revisited information systems theories in 2014 were extracted to an excel document from the site and further examined to determine their relevancy to this research. This filter framed ten theories that debatably are the most probable to suit any information system research. Theories below the top ten have a lower popularity percentage than 3.7 percentage and hence not likely to suit this particular study and therefore not further examined.

The ten theories were then listed within the excel document and attained an indicatory application degree correspondingly that ranged from irrelevant-limited-partly-mostly-fully. Respective theory was also left a brief motivational argument associated to the given application

degree to support each decision. An extraction of the compilation can be seen in Table 1 below as well as in its entirety in the appendix.

For instance, the second most predominant IS theory, social network theory, achieved the application degree: low, and was left with the coherent motivation: social network theory views social relationships in terms of nodes and ties. This theory focuses on nodes and links in order to leverage node size, density as well as link strength. This theory is determined to have a low applicable degree in this thesis because it does not encompass social, cultural or organizational aspects that help build a smart city. To some extent, it could be debated that increased numbers of nodes could further leverage smart city collaboration and enable synergies as seen within the mobile ecosystem (Constantinou and Vakulenko, 2014), however, that association is rather distant and hence determined as not applicable in this research.

In another example, the most predominant IS theory, institutional theory, was examined and attained the application degree: partly, and was left with the following motivation: institutional theory attends to the deeper and more resilient aspects of social structure. This theory is debatably applicable to some degree since it covers an institutional perspective and, internal as well as external stakeholders ultimately determine if the new changes are used or not, as further discussed in chapter 3, literature review. However, the institutional theory will be excluded in this particular thesis because it centres on institutional emergence, conformity, conflict, change, isomorphism which does not encompass a technical perspective. Nor does it frame any variables similar to return on investments or otherwise and hence incorporates a too narrow scope.

Conclusively, two out of the ten investigated IS theories were deemed irrelevant to this thesis due to the absence of social, technological and organizational standpoints that are pivotal components in a smart city, as further elaborated upon in the literature review. Six out of the ten inquires could merely be applied to a limited degree.

Several theories touch upon technical, economic, organizational or social aspects that are all present in the smart city concept, however, none of which encompass for all or at least, several perspectives in uniformity which may result in a fragmented output that merely frames predominant problems from a limited set of variables. Municipal decision makers co-create services and more efficient procedures with industries, universities and citizens with the support of technology, social and physical infrastructure to combat problems that stem from an increased urbanization. Hence, models that hones in on a single perspective risk not covering problems that stem from a more holistic view.

Lastly, two theories were partly applicable to this thesis because they incorporated a broader standpoint. For example, the socio-technical theory centres on a fit between the technical subsystem and the social subsystem. These systems together make up an organization to make predictions of the impact of technology on business efficiency and productivity. The level of

**Table 1. Top 10 Information Systems Theories 2014**

#	Theory	Applicable degree	Motive
1	Institutional theory	Limited	Institutional theory attends to the deeper and more resilient aspects of social structure. This theory is debatably applicable to some degree since internal as well as external stakeholders ultimately determine if the new changes are used or not. However, this theory will be excluded in this particular thesis because it centres on institutional emergence, conformity, conflict, change, isomorphism which does not encompass a technical perspective. Nor does it frame any variables similar to return on investments or otherwise and hence surrounding a too narrow scope.
2	Social network theory	Irrelevant	Social network theory views social relationships in terms of nodes and ties. This theory focus on nodes and links in order to leverage node size, density as well as link strength. This theory is determined to have a low applicable degree in this thesis because it does not encompass social, cultural or organizational aspects that help build a smart city. To some extent, it could be debated that increased numbers of nodes could further leverage smart city collaboration and enable synergies as seen within the mobile ecosystem (Constantinou and Vakulenko, 2014), however, that association is determined farfetched and hence not applicable in this research.
3	Contingency theory	Partly	This theory claims that optimal organizational leadership style is contingent upon various internal and external constraints. The theory considers efficiency and organizational performance and evaluates its influence on strategy, technology, task, organizational size, structure, and culture. The theory does not stray too far off this particular thesis, however, it addresses these variables from an individual and firm perspective which lack educational institutions and governmental institutions. Furthermore, the framework results in organizational performance in terms of financial achievement and volume which is merely one of several potential outcomes with smart city.

analysis hones in on the organization, its employees and its environment which arguably address a multitude of challenges that are evident in smart city initiatives.

However, this model steers away from exploring problems and desirable impacts with smart city that has not been sufficiently exposed which may limit the exposure of new findings. Furthermore, the municipal standpoint debatably values different aspects than organizations which complicates the applicability of this theory. It could be argued that a mixture of two or several theories would form a suitable theoretical model in this paper.

Although, due to the overall low degree of applicability in addition to the emphasis on exploration to uncover significant problems and impacts with smart city that has not been adequately addressed today, no theory was deemed suitable. It is possible that an appropriate theoretical framework already exists which could have been identified with a more thorough review, however, this research advocates to build a theoretical framework from the ground up based on the results of this theory review.

## 2.4 Selecting Literature: Return on Investment

An extensive literature review was conducted in order to find or build a theoretical framework applicable to return on investments or impacts of smart city. Lund's University online library, LUBsearch, was used as the primary source in search of academic literature in addition to complimentary publications from Google scholar. Initially, the search included all publications on LUBsearch that had *smart city* in the title which generated 4,176 results. Four thousand publications are not a manageable amount for two researchers to undertake within the limited timeframe and the probability that the publications are relevant to this study were estimated to be low which suggested that further segmentation was needed.

In addition to searching for smart city in the title, the wording *return on investment* was added and was required to occur in the abstract. This filter resulted in four publications relevant to this research. The scarce available body of literature on return on investment in the smart city domain suggests to us that either return on investment is not applicable to smart city or that the return on investment may be overwhelmingly difficult to discuss due to smart city complexity. A widened perspective was needed to better understand the literature scarcity which advocated wordings with a broader implication.

Instead of filtering on only return on investment in the abstract, *cost benefit*, *evaluation* and *value* was applied to encompass the widened perspective which yielded 180 results. 139 of the 180 publications were generated by the word *value* which could indicate that smart city is still fussy and hence quantifiable and concrete terms such as return on investment and cost-benefit are replaced with vaguer terms such as value. Moreover, another filter containing the words *opportunities* + *smart city* in the title generated 50 additional results to further cover the vagueness concerning ROI in smart city.

The abstracts of the total of 230 publications were carefully read and the article body was further skimmed through if needed in order to determine its relevance to this research. The majority of articles were excluded based on three reasons. Firstly, articles concerning too specific or in-depth technical discussions were not considered relevant in answering the research question. Articles such as: *A Computational Architecture Based on RFID Sensors for Traceability in Smart Cities* (Mora-Mora et al., 2015) were therefore excluded. Secondly, irrelevant perspectives such as; mobile operators, diverged from the municipal perspective and therefore contributed less to this specific context. However, it could be argued that mobile operators play an important role in enabling smart cities through ICT infrastructure and hence influence the perceived return on investment. This study recognizes that smart cities are built upon collaboration between university, governmental institutions, industries and citizens but is exclusively examining the phenomena from the municipal standpoint to reduce the scope and noise in an attempt to generate findings that are applicable for someone rather than no one. Thirdly, articles that merely mention the key search words without further elaboration were excluded based on the reasoning that they lack an argumentative foundation to build theory upon.

This weeding left 41 articles. Authors anticipated return on investment; value propositions, cost benefit, evaluations and opportunities were examined individually. 41 articles were read through in their entirety and 22 of them were determined relevant to this research based on previous reasoning. The perceived value proposition that smart city attempts to achieve was extracted to an excel document and categorized based on value domain to reveal patterns.

An example of an extracted value proposition may be; "*Smart city centric strategies are expected to comprise solutions to sustainable environment and urban life*" (Zhang et al., 2013,

p.1) which would be categorized in two value domains; *sustainable environment* and *improved urban life*. Despite minor variations only four desirable impacts were frequently reoccurring throughout the targeted literature sample; economic sustainability, environmental sustainability, social sustainability and improved liveability.

Convincing similarities are evident when further examining the understanding behind liveability and social sustainability. Ricciardi et al. (2013) in concert with Giffinger and Gudrun (2010) describe liveability as improved quality of life through crucial needs such as; education, healthcare, security, social inclusion, environmental quality, family support, etcetera that may be measured in a multitude of ways.

Analogous, if not equivalent, factors help define social sustainability. Social sustainability concerns assets that accommodate social services, such as; education, healthcare and public spaces in addition to intellectual capital and social capital (Nam and Pardo, 2011b). Giffinger and Gudrun (2010) include environmental quality as one factor when determining improved quality of life. However, environmental quality will be extracted from the perception of liveability and improved quality of life in this thesis to further distinguish between environmental and social sustainability. Therefore, the understanding of improved liveability, higher quality of life and social sustainability are henceforth aggregated into the word social sustainability, separated from environmental factors.

Additionally, a complementary search was conducted on Google Scholar to strengthen the theoretical sample with articles that were not registered in LUBsearch. A less fine grained selection process was conducted due to limited search and segmentation options in Google Scholar. Importantly, the key search words were the same; return on investment, cost benefit, value, evaluation or opportunities, all in conjunction with the word: smart city. The title and abstract of the top 30 articles were examined and considered based on their relevancy which generated another eight articles and formed a total of 30 relevant publications.

Economic growth and economic sustainability was perceived as one of the three most reoccurring end goals with smart city initiatives. Economic incentives through cost reduction and value propositions occurred as a prominent return on smart city investment in 19 out of the 30 articles. Economic incentives predominantly occurred in conjunction with environmental and social sustainability, although few articles argue exclusively for economic encouragements. The ones that did were oftentimes supported by marketing and research firms. Similarly, environmental sustainability occurred 19 times throughout the selected sample. Most of which transpired with economic and social sustainability, however, environmental sustainability was more frequently occurring in isolation in comparison to the other perceived impacts.

Evidently, the environmental considerations oftentimes intend to decrease natural deterioration, reduce energy usage and pollution. Moreover, social sustainability occurred 20 times and hence occurs slightly more than the other two. That being said, social sustainability debatably does not hold a greater value in comparison and merely got higher occurrence weight due to the aggregation described above. The word encompasses a wide definition and hence frames a variety of social impacts.

<b>Table 2. Literature Review: Returns on Smart City Investments</b>					
#	Authors	Impacts			
		ECO	ENV	SOC	OTR
1	Abil and Sunil (2014) FRPT- Software Snapshot. 7/13/2014, p2	x		x	
2	Accenture. Business wire (2011)	x	x	x	
3	Bifulco, Tregua, Amitrano and D'Auria (2015)	x	x	x	
4	Brauer et al. (2015)		x		
5	Christopoulou, Ringas and Garofalaki (2014)	x	x	x	
6	Cosgrave, Arbuthnot and Tryfonas (2013)				x
7	Dameri and Rosenthal-Sabroux (2014)		x		
8	Ferrer (2013)	x	x	x	
9	FRPT (2014) - Telecom Snapshot. 10/19/2014, p9-10		x		
10	Galdon-clavell (2013)	x	x	x	
11	Gartner (2015)	x			
12	Giffinger and Gudrun (2010)		x	x	
13	Girard (2013)				x
14	Hara, Nagao, Hanno and Nakamura (2016)	x	x	x	
15	Harrison et al. (2010)	x	x	x	
16	Ielite, Olevsky and Safiulins (2015)		x		
17	Kraus, Richter, Papagiannidis and Durst (2015)				x
18	Lekamge and Marasinghe (2013)	x	x	x	
19	Manville et al. (2014)	x	x	x	
20	Mayangsari and Novani (2015)	x		x	
21	Molinari (2012)	x		x	
22	Murray, Minevich and Abdoullaev (2012)	x		x	
23	Pan, Lin, Chuang, and Yu-Chia Kao (2011)		x	x	
24	Perevezentsev (2014)	x			
25	Popescu, (2015)	x			
26	Příbyl and Horák (2015)	x	x	x	
27	Reid et al. (2010)			x	
28	Shahrokni, Arman, Lazarevic, Nilsson and Brandt (2015)	x	x	x	
29	Zhang, Huang, Zhu and Qiu (2013)		x	x	
30	Zygiaris (2013)	x	x	x	
	<b>Sum weight:</b>	<b>19</b>	<b>19</b>	<b>20</b>	<b>3</b>

Apart from few variances, labelled as OTR in Table 2; economic, environmental and social sustainability are the predominant end goals with smart city initiatives with uniformly distributed weight. When further contemplating on the reason behind the evenly distributed weight, it is rather evident that most authors accounted for in this literature review primarily cite the same few sources.

Caragliu et al. (2011) are perhaps the most frequently cited author in describing smart city as a concept and what it attempts to achieve. This may suggest that smart city as a concept is in fact, not fragmented to scholars but rather unified on an abstract or holistic level. In contrast, it could arguably suggest that researchers do not adequately question the definition and purpose due to a high level of contextualization which spawn multitudes of fragmented interpretations of the concept.

## 2.5 Selecting Literature: Problems and Challenges with Smart City

In similar fashion, a systematic literature review was conducted with the purpose of developing a theoretical model to help identify the most frequent problems and challenges experienced in smart city initiatives. Lund's University online library, LUBsearch was used as the primary search engine for academic literature. Since LUBsearch contain publications from multiple disciplines the literature review included publications from different research fields as suggested by Webster and Watson (2002).

An initial search with the keyword *smart city* returned over 15 000 hits. This was of course an unmanageable number of articles and it did not lead to articles dealing specifically with problems. In order to further specify the search and segment down to the articles specifically dealing with problems, the keywords *problems*, *challenges*, *risks* and *issues* were added to the search. In addition, the filter setting was adjusted to include journals, conference proceedings as well as books.

Since smart city is an emerging concept and the publications on smart city has increased exponentially during the last years (Cocchia, 2014) the time span was set to include literature from 2011. Moreover, since the aim of the literature review was to identify the most predominant problems in smart city initiatives, and the fact that most initiatives have been deployed the last couple of years (ibid) further strengthened the decision to delimit the literature search to the timespan 2011-2016.

With this configuration the search returned over 1700 publications. It was apparent that a more detailed search strategy was needed that would yield a more manageable literature volume. Along with the initial keywords, the search engine was filtered to only include *smart city* in the title and the following keywords was added: *problems*, *challenges*, *risks* and *issues*. This returned 477 results, although a quick overview of the 50 first hits suggested that further segmentation was needed. In addition to the previous filter settings used, the search was adjusted to only include searching in the abstract with the keywords which returned 374 results. These 374 publications were then reviewed with the aim of identifying passages and themes related to problems in smart city.

However, despite the segmentation and filtering process, still a daunting amount of literature remained. It was self-evident that it was hard to find publications that specifically deal with problems in a more general smart city context. In an attempt to further segment the literature, publications with a too narrow outlook, for example problems in a specific smart city system, were disregarded since the problems highlighted were not applicable to the more general smart city context of existing smart city initiatives. An example of such an article is: *An accelerated-time simulation for traffic flow in a smart city* by Galán-García et al. (2014). The work in this article mainly focuses on presenting a new model for accelerated-time simulations for traffic flow within smart city traffic management. The smart city scope in this thesis is broad and includes all the different smart city domains. Therefore, articles such as this one was disregarded because challenges anticipated or experience in such a narrow context would arguably be hard to apply to other smart city domains.

Furthermore, some articles were also disregarded because a quick look reviled failures to adhere to basic scientific standards such as using references to back up statements. This raised concerns about quality and rigor of the articles. An example of this is: *Application of Privacy Impact Assessment in the Smart City* by Seto (2015). The introduction chapter in this article

do not include a single reference and makes bold statements regarding risks in smart cities. This was enough to deem it as unreliable and it was disregarded.

Other publications were disregarded because they had a pure computer science perspective discussing problems at system architecture level. An example of this is: *Virtual reality platform for smart city based on sensor network and OSG engine* by (Hu et al., 2012) who state that the purpose of their paper is to build a virtual reality system with sensor network, an approach not applicable to the purpose in this research.

After this screening process left 79 publications. Those were carefully read and the outcome of the final review generated 28 articles that deal with a wide range of problems in smart city. In addition to the 28 publications, two more publications were included. The landmark study of European smart city initiatives, *Mapping Smart Cities* by Manville et al. (2014), was included due to the importance of its extensive empirical work with case studies of several European cities and corresponding smart city initiatives. Furthermore, in order to complement the LUBsearch and uphold a more comprehensive literature review, the basket of eight (aisnet.org) was also skimmed for relevant literature, using the search phrase: “*smart city and challenges site:aisnet.org*”. This resulted in an additional article by Ojo et al. (2014).

The final result of the literature review is presented in Table 3 with problems grouped into eight problem categories divided in two main problem domains, technical and non-technical. A further explanation of the reasoning behind the technical and non-technical problem domains follows in chapter 3.2.

**Table 3. Problems Related to Smart City Development**

<b>Non-technical problem domain</b>		<b>Technical problem domain</b>	
Collaboration	[Bakıcı et al., 2013; Breuer et al., 2014; Baccarne et al., 2014; Zanella et al., 2014; Baron., 2012; Van den Bergh and Viaene., 2015; Kitchin, 2014 & 2014b; Carvalho, 2014; Ojo et al., 2014b; Nam and Pardo, 2011; Paskaleva, 2011]	Privacy	[Heo et al., 2014; Buck and While, 2015; Elmaghraby and Losavio, 2014; Theodoridis et al.,2013; Balakrishna, 2012; Kitchin, 2014 & 2014b; Boulos and Al-Shorbaji, 2014; Bianchini and Avila, 2014; Tuballa and Abundo, 2016; DeRen et al., 2015, Khan et al., 2014]
Financial	[Breuer et al., 2014; Vilajosana et al., 2013; Buck and While., 2015; Zanella et al., 2014; Carvalho, 2014; Ojo et al., 2014; Manville et al., 2014; Nam and Pardo, 2011; Ferrer, 2013]	Security	[Heo et al., 2014; Balakrishna, 2012; Piro et al., 2014; Baron, 2012; Boulos and Al-Shorbaji, 2014; Wu et al., 2016; Tuballa and Abundo, 2016; Bianchini and Avila, 2014; Buck and While, 2015]
Governance	[Bakıcı et al., 2013; Lee et al., 2011; Balakrishna, 2012; Baron., 2012; Kitchin, 2014 & 2014b; Hernández-Muñoz et al., 2011; Carvalho, 2014; Lee, J.H., Hancock, M.G. and Hu, M.C., 2014]	Interoperability	[Tuballa and Abundo, 2016; Heo et al., 2014; Villanueva et al., 2013; Theodoridis et al., 2013; Zanella et al., 2014; Bianchini and Avila, 2014]
Contextual	[Mattoni et al., 2015; Bakıcı et al., 2013; Breuer et al., 2014; Letaifa., 2015; Kitchin, 2014 & 2014b; Hernández-Muñoz et al., 2011; Lee, J.H., Hancock, M.G. and Hu, M.C., 2014; Manville et al., 2014]		
Political	[Vilajosana et al., 2013; Buck and While., 2015; Hernández-Muñoz et al., 2011; Carvalho, 2014; Manville et al., 2014; Nam and Pardo, 2011]		

## 2.6 Developing the Problem Framework

As previously mentioned, smart city is a relatively new and emerging concept and the exploration of the literature of problems in smart city initiatives exposed an apparent gap, namely the lack of a coherent theory that explain problems encountered by existing smart city initiatives and how they affect the expected returns of such initiatives. Since the aim of this thesis is to show what return on investment municipal decision makers hope to achieve with smart city initiatives in addition to exposing the most prominent problems in reaching that investment, a theoretical guidance was needed.

In any theory, constructs are the most fundamental component and they typically refer to the properties of things (Recker, 2012). In a theory concerning problems with smart city initiatives, problems themselves constitutes the core constructs. Consequently, the development process of the problem framework (Table 3) followed a series of steps in order to segment and aggregate the identified problems from the literature in an attempt to reach a feasible number of recurrent problems to use in the interviews.

The framework was designed as a bottom-up conceptual analysis as suggested by Bhattacharjee (2012) in order to identify different sets of predictors, in this case problems with smart city transformation, relevant to the problem area. Significant constructs in the literature were put together and the final framework shaped the theoretical foundation for this study's investigation of problems in smart city initiatives.

The segmentation process of extracting problems from the literature followed an operationalization procedure as described by Bhattacharjee (2012). The first step in this process was to extract all the identified problems by each author into an excel sheet (Exhibit 2). At this stage the problem list consisted of 91 listed problems. However, many problems reoccurred frequently, although with different phrasing. This was managed by a classification into problems emerging from a technical perspective (mapped with blue colour) versus a non-technical perspective (mapped with green colour). A further explanation of the reasoning behind these two overarching problem domains follows in chapter 3.

A further segmentation process was conducted in order to reduce redundancy and identify the most frequent mentioned problems. The two overarching problem domains (technical and non-technical) and their corresponding problems were separated into two different excel sheets. All problems were then listed in conjunction with authors and tagged with a label (Exhibit 3 and 4). To give an example of this from the technical problem domain; Buck and While (2015) point to the fact that smart city technologies may encourage increased surveillance. This problem was labelled as *privacy* (Exhibit 5). An example from the non-technical problem domain is accentuated by Bakıcı et al. (2013) who state that creating cross-departmental cooperation and clear definition of roles and responsibilities is a problem thus labelled *collaboration* (Exhibit 6).

The list of the initial 91 problems had been aggregated into 30 problem categories (Collaboration, Financial etcetera) divided under the two overarching problem domains (Non-technical and Technical). Furthermore, the problems were weighted according to occurrences by authors.

<b>Table 4. The Problem Framework</b>	
<b>Non-technical problem domain</b>	<b>Technical problem domain</b>
<p><b>Collaboration</b></p> <ul style="list-style-type: none"> <li>- Weak collaborative engagement with external stakeholders</li> <li>- Weak collaborative engagement with internal stakeholders</li> <li>- The lack of an aligned vision of the city development with external and internal stakeholders</li> <li>- Issues concerning institutional resistance</li> </ul> <p><b>Financial</b></p> <ul style="list-style-type: none"> <li>- Limited funds for smart city initiatives</li> <li>- Difficult to monetize on smart city investments</li> <li>- Large up-front investment</li> <li>- Long term delay before reaching maturity / profitability</li> </ul> <p><b>Governance</b></p> <ul style="list-style-type: none"> <li>- Control creep, the hollowing out of state provided services, widening inequalities and dispossession of land and livelihoods</li> <li>- Formulating the right governance structure given organizational barriers to supporting smart city initiatives</li> </ul> <p><b>Contextual</b></p> <ul style="list-style-type: none"> <li>- Influence of geographical variables, exportation of best practices may not occur easily</li> <li>- Difficult to extend local imitations to multi-city projects due to the localized character of initiatives</li> <li>- The use of canonical examples and one-size fits all narratives</li> </ul> <p><b>Political</b></p> <ul style="list-style-type: none"> <li>- Political uncertainties hampering public and private investments</li> <li>- Political hyper-activism</li> </ul>	<p><b>Security</b></p> <ul style="list-style-type: none"> <li>- Big Data in public clouds brings with it issues relating to security</li> <li>- Challenges of smart city infrastructure integration: Security concerns</li> <li>- Outsourcing of power and control to private sector providers</li> </ul> <p><b>Interoperability</b></p> <ul style="list-style-type: none"> <li>- Issues of service interoperability</li> <li>- Smart city infrastructure integration: system interoperability</li> </ul> <p><b>Privacy</b></p> <ul style="list-style-type: none"> <li>- How to make sense and best use of such 'big data', while preserving citizens' privacy and data security</li> <li>- Key issue relates to the privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens' routines and habits in case of malicious or unintentional data exposure Smart city technologies may encourage increased surveillance</li> </ul>

As an example, in the technical problem domain the problem category *privacy* (Exhibit 5) reoccurred nine times, indicating that this problem was identified in nine publications. The total weight in each problem category was then used as an indication of the significance level of problems based of the reviewed literature.

Finally, out of the 30 problem categories, which were still too many to work with in a theoretical framework, problems with an occurrence of six or more were deemed predominant and hence included in the framework. This resulted in eight problem categories, extracted from the literature, which then formed the basis of the final theoretical problem framework as can be seen in Table 4.

## 2.7 Data Collection

The empirical data in this research was collected using interviews. Interviews are widely used in qualitative research methods and a common way of gathering qualitative data that is particularly useful in studies of socially situated phenomena (Myers and Newman, 2007, Schultze and Avital, 2011) such as smart city. Accounting for the critique by Miles and Huberman (1984) that inferences from qualitative methods are uncertain due to the lack of traceability and established conventions of data collection, this section will explain how the interviews in this study were prepared and carried out. By explicitly showing the procedures, decisions and thought processes guiding the design of the data collection in this work, this study aims to provide the necessary transparency by which other researchers can track down the procedures used to arrive at similar findings (Miles and Huberman, 1984). This is similar to what Bhattacharjee (2012) refer to as confirmability which a criterion for rigor in interpretive research.

Interviews as a data collection technique offer a number of attractive features to this study. It is a personalized way of data collection that enables the researcher to record personal observations and comments (Bhattacharjee, 2012). Also, it has the advantage of precision by focusing directly on the research topic (Paré, 2004). Moreover, it is insightful since it allows the probing of experience from smart city initiatives by engaging participants directly in a conversation with the researchers (ibid). This enables access to deeply contextual and authentic nuanced data (Schultze and Avital, 2011) concerning the problem area in this study.

Depending on the purpose and research design of a study, interviews can be constructed in different ways such as descriptive, exploratory and explanatory. Descriptive interviews are used to generate rich descriptions of phenomenon with the purpose of exploring many different perspectives of the phenomenon with the aim at arriving to a conceptualization or multifaceted description. Exploratory interviews are more generally used to put forward theory contributions and build theories. Since, explanatory interviews typically are used in causal studies; the two previous interview types have guided the development of the interviews in this study. (Recker, 2012).

Myers and Newman (2007) also distinguish three different approaches to interviews: structured-, semi-structured- and group interviews whereas semi-structured are most commonly used in information system research (Recker, 2012). A structured interview follows a strict manuscript that is prepared prior to the interview (Myers and Newman, 2007). This offer little room for improvising during the interview. Hence, this approach was disregarded since the aim of this study is to probe real-life experience and potential new nuances of interesting find-

ings. This will arguably require a more flexible form of inquiry in which new questions can be brought up during the interview as a response to input from the interviewees (Recker, 2012). Therefore, a semi-structured interview approach was adopted. This approach helped form the interview into a conversational procedure. This provided the researchers an opportunity to inject follow-up questions, ask informants to elaborate on something important that was touched upon as well as having a bi-directional discussion between the researcher and the informant (ibid). Furthermore, it helped shape the interview into a guided discussion as proposed by Yin (2003).

Other important considerations that strengthened the decision of using a semi-structured interview process was the comments by Schultze and Avital (2011) who highlight the importance of:

“Providing an explicit framework for guiding the participants to articulate and interpret their experiences: in order to help the interviewee, access their lived experience and reflect on it, effective interviewing methods should provide frameworks that structure the conversation in such a way that guides the interviewee through this introspective journey while honouring his/her freedom of thought and expression. By structuring the interview interaction, such frameworks help the interviewee as well as the researcher surface detail-rich descriptions as well as their significance and meaning in a way that is less likely to be dictated by cultural scripts and established identities. As such, they assist in the generation of rich data as the interviewees are guided in accessing multiple layers of experience” (Schultze and Avital, 2011, p.5).

These suggestions made it clear that a well-crafted interview guide was needed in order to reach a “thick description” of our problem area. The procedure for how this was done will be discussed further in the following section.

## 2.8 The Interview Guide

The interview guide ensures that the interview is held within the limits specified by the problem area which is a safeguard against the 1000-page question by Kvale (1996). Kvale (1996) points out a concern about having too much empirical data should not be experienced after the interviews are conducted. Rather the method of analysis should be planned in advance and be built into the interview situation itself (ibid). Handling this challenge required a clear understanding of the research goal. Therefore, the interview guide was constructed with questions that were closely related to the problem area of the study.

As outlined in previous sections the starting point of this research was the literature review. It exposed the literature gap and served as the basis for development of the theoretical framework. This process followed in close conjunction with the research question. The interview guide (Appendix 3, Table 12) was derived directly from the theoretical framework (section 2.6, Table 4) which secured a strong connection to the problem area thus ensuring that the interview questions would target the research question. The questions were categorized accordingly to the problem categories from the theoretical framework. To give an example, the problem category *Collaboration* in the non-technical problem domain contains four different problems in the framework (Table 5). Those problems were addressed with three different questions (Table 6) in an attempt to expose new, confirm or reject particular problems related to collaboration.

<b>Table 5. Extraction of the Problem Framework</b>	
<b>Non-technical problem domain</b>	<b>Technical problem domain</b>
Collaboration <ul style="list-style-type: none"> <li>- Weak collaborative engagement with external stakeholders</li> <li>- Weak collaborative engagement with internal stakeholders</li> <li>- The lack of an aligned vision of the city development with external and internal stakeholders</li> <li>- Issues concerning institutional resistance</li> </ul>	Security <ul style="list-style-type: none"> <li>- Big Data in public clouds brings with it issues relating to security</li> <li>- Challenges of smart city infrastructure integration: Security concerns</li> <li>- Outsourcing of power and control to private sector providers</li> </ul>

<b>Table 6. Extraction of the Interview Guide</b>	
<b>Non-technical problem domain</b>	<b>Generated Interview Questions</b>
Collaboration <ul style="list-style-type: none"> <li>- Weak collaborative engagement with external stakeholders</li> <li>- Weak collaborative engagement with internal stakeholders</li> <li>- The lack of an aligned vision of the city development with external and internal stakeholders</li> <li>- Issues concerning institutional resistance</li> </ul>	<ul style="list-style-type: none"> <li>- Have you experienced any difficulties in collaborating with internal and external stakeholders? If yes, what would that be?</li> <li>- What is your vision of smart city and what stakeholders does it concern?</li> </ul>

## 2.9 The Interviews

In this study a total of twelve interviews were conducted and carried out with participants from ten cities. This generated around ten hours of interview time with an average duration of 50 minutes. The interviews were conducted via Skype since face-to-face interviews in ten European cities would require time and financial resources which the study could not employ. All interviews were audio-recorded with consent of the participants using a third party application, MP3 Skype recorder that integrated nicely with Skype. Furthermore, the interviewees were asked if they wished to stay anonymous but since all of them agreed to appear with their real name the interviewees were not anonymised. Importantly, quotations were drafted with all the interviewees before officially publishing the thesis.

The interviews were designed to be as open as possible in order to have the participant stepping into the role of “informants” as referred to by Yin (2003). This is described as a state where the participants start to share their own opinions and insight. This way the participants transcend their initial role as respondents thus becoming “informants”. To accomplish this, interviews started with open ended questions: What is smart city to you? What do you hope to achieve with smart city? What challenges or problems have you experienced with smart city? This basic frame was sufficient enough for initiating the participants to access their ex-

periences and reflect upon them. In most interviews, these first questions touched upon several of the most important themes which then could be followed-up during the rest of the conversation.

## 2.10 Target Sample

The unit of analysis in this thesis was extracted based on six levels of segmentation which are illustrated in Figure 1. Initially, a reasoning that smart city concerns urban societies with a population of minimum 150.000 generates roughly 2900 cities throughout the world according to World Atlas 2016 (Statisticbrain.com, 2016). Evidently, conducting interviews with 2900 cities during a few weeks of time for two researchers was not considered a feasible strategy and hence the targeted sample needed further thinning.

Additionally, physical, technological and cultural aspects possibly encompass significant divergence between continents which reduce the research findings' level of applicability. The target sample was further trimmed to European cities because the smart city has gained high popularity on the European continent (Vanolo, 2013) and has the most number of smart cities according a global research study by Neirotti et al. (2014). These preconditions arguably position Europe as a flourishing target sample with a more extensive pool of experience to draw from than other continents. Data obtained from the UN Demographic Yearbook 2009-2010 reveal 468 European cities with 100.000 or more citizens.

This sample was further culled down to mid-sized cities that house 100.000 – 600.000 citizens which generated 199 cities. The reasoning supporting this last segmentation was based on the assumption that mid-sized cities are more inclined to cooperate outside of city borders to collaborate with other cities and external stakeholders which is considered a significant enabler in targeting more holistic economic, social and environmental goals, which is further discussed in chapter 3, Literature Review. The fourth culling was based on the findings in the pre-study conducted prior to this research which outlined 25 European cities with an indication of their smart city maturity level. Ten specific cities were then extracted from those 25 in pursuit of the highest level of smart city maturity in order to learn from interviewees with extensive experience. Additionally, a wider spread of countries throughout Europe was emphasized rather than a collection of cities in few countries to encompass for a more extensive European perspective.

Finally, this research aimed towards one or two municipal decision makers in each targeted city which generated a total of twelve interviewees. The aim towards two interview objects per city is meant to establish a more nuanced reality encompassing two perspectives rather than one. Two perspectives allow the opportunity to encompass for both organizational concerns in addition to technical concerns since it might be difficult to find interviewees that are experienced in both areas.

Moreover, given the scarce timeframe, higher numbers of cities were emphasized in pursuit of a wider European coverage. Conclusively, municipal decision makers in smart city initiatives constitutes the unit of analysis in this thesis which encompass a wide variety of roles such as; project managers, city planners, city CTO, smart city coordinators or other managerial roles within this specific context. Some of the interviewees took part in the pre-study and helpfully participated in this research as well, however, a majority of the interviewees are new contributions in this extensive research.

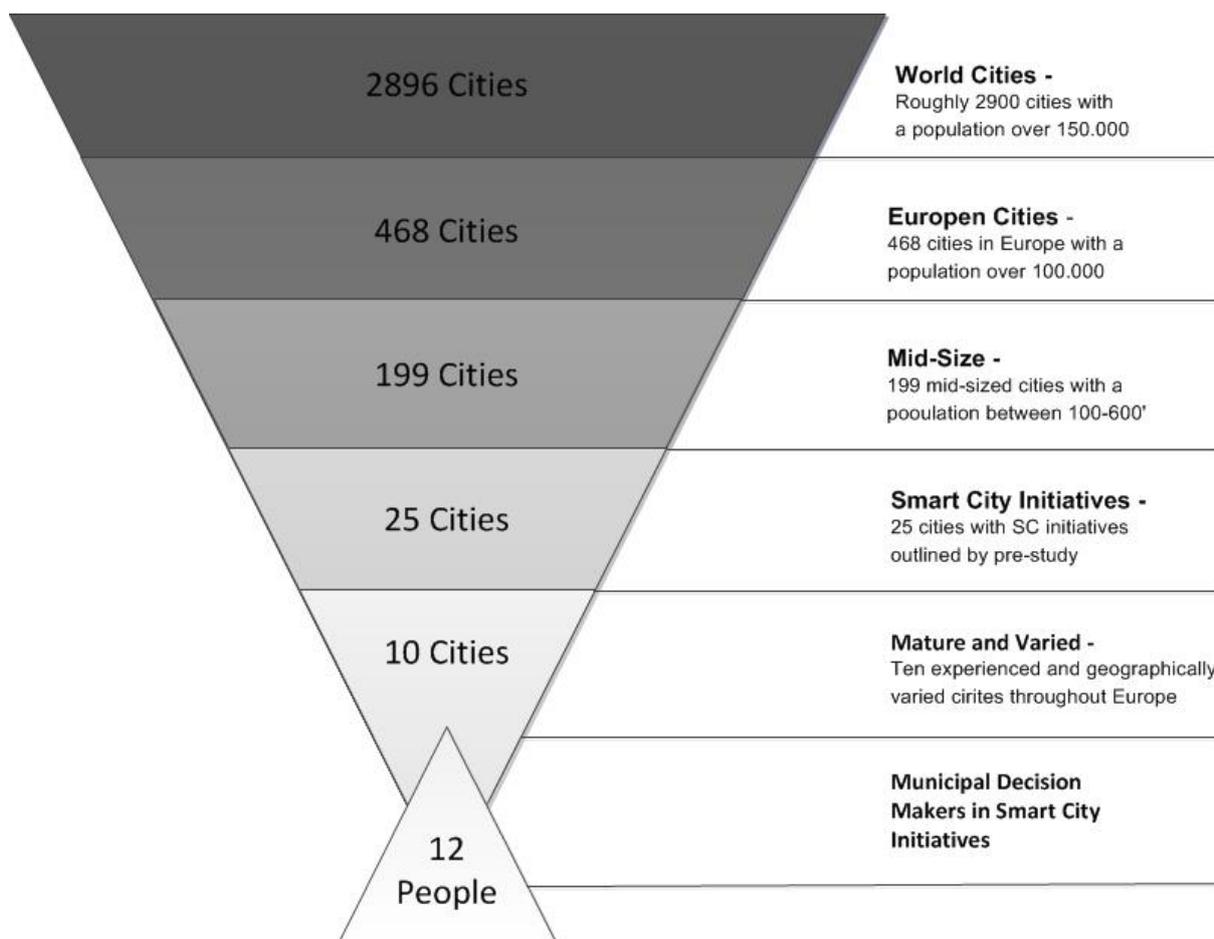


Figure 1. Illustration of the segmentation processes to reach the unit of analysis.

## 2.11 Analytical Method

The data analysis strategy adopted in this study uses both pattern coding as described by Paré (2004) and pattern matching logic as proposed by Yin (2003). Pattern matching is an analytical approach that compares empirically based patterns with predicted ones' expected outcomes as patterns. In the context of this thesis this means matching the empirical findings with the theory that constitutes the problem framework (Table 4). The problem categories (predicted outcomes) in the problem framework were evaluated in contrast to patterns of emergent outcomes from the empirical data, comparing if the originally predicted results (problems in the problem framework) were found and alternative patterns were lacking.

Since the empirical data was collected from multiple locations the study also provided an opportunity to seek rival explanations as patterns; searching if some of the significant explaining conditions were expressed in the empirical findings. In that case the presence of certain explanations excludes the presence of others. The strength with this approach was that the theoretical problem framework was tested and developed under influence from the empirical findings. Moreover, that provided possibilities of repeated comparisons i.e. a theoretical replication across different cities and smart city initiatives making the results stand robustly and thus accounting for external validity of the findings (Yin, 2003). In other words, this approach accounted for transferability that refers to the degree of generalizability of the findings (Bhattacharjee, 2012).

This study started out with an initial set of constructs derived from literature (problem framework) - or expected outcomes in the words of Yin (2003). This made the constructs that were relevant to the emerging theory evident since rigorous empirical research starts off from a strong grounding in related literature to identify appropriate constructs and expose a research gap (Eisenhart and Graebner, 2007). These conducts were also a way to account for researcher bias because regardless of how entangled a researcher is to a certain concept, if it is not supported by the empirical reality, it must be disregarded (Corbin and Strauss, 1990).

In general terms, the development of the problem framework followed the conceptualization procedures as described by Bhattacharjee (2012). Problems in the literature that were found to pertain to the same phenomena were grouped into problem categories. A thorough explanation of the step-by-step process of how this was done as explained in chapter 2.3 to 2.6. Such an conceptualization process is the closest an interpretative study will reach regarding reliability or dependability as argued by Bhattacharjee (2012).

A priori development of constructs from the literature was helpful for outlining the initial design of the problem framework. Furthermore, this procedure was chosen because it was a way of securing the internal validity of the constructs in the study. Developing a preliminary theoretical framework offered some level of triangulation between the literature and the empirical data in order to improve the internal validity and the generalizability of the theory (Eisenhardt, 1989). In the words of Eisenhardt: “When several of these constructs did emerge as related to the decision process, there were strong, triangulated measures on which to ground the emergent theory.” (Eisenhardt, 1989, p.545).

Pattern coding (Paré, 2004) was used when analysing the interview transcriptions to identify themes that conform to the problems in the problem framework in order to reveal patterns and variations that either confirmed or refuted the framework as advocated by Corbin and Strauss (1990). This procedure was useful to achieve data reduction (Paré, 2004) which refers to the process of selecting, focusing, simplifying, abstracting and transforming the data that appear in the interview transcripts (Miles and Huberman, 1984). This procedure is presented in Figure 3 and Figure 4.

The coding scheme was developed by using abbreviations of the problems in the problem framework, for instance: FIN is an abbreviation of Financial and GOV is an abbreviation of Governance. Emerging themes were assigned the code NEW. Every time a theme was identified it was assigned a code and a number in order to strengthen traceability in the transcript as shown in Figure 3 and Figure 4.

Additionally, all the interview transcriptions were aggregated into a table in order to get a complete view of the problem categories in the framework as well as new emerging themes which will be further explored in chapter 4, Empirical findings.

Figure 3. Coding of transcription text.

Birgitte: Because we do not know if we use in the municipality, if we use resources to put, for example from energy data from our platform to make them public available and it costs resources for us to make them ready for that. We don't know always if anything, if they are used, if anyone used them for anything. That's often a challenge because we have a lot of other things to do in the municipality, we have to prioritize. If you do not know what you can benefit from making data available, you would maybe not prioritize it. We often talked about, it's not the one that says that also reaps. We put a lot of efforts in making the data available, but it's not municipality that use the available data. Does it make sense? 9. FIN  
10. COL

Interviewer: It makes sense, yes thank you. I think about covers it for the return on investment questions and I am moving over to the problem-questions. I am going to start off very broad, so what challenges, or rather what would you say are the most predominant challenges with smart city or open data platforms?

Birgitte: It would actually like to answer in ways that cover both smart city and open data work. The most predominant challenge is the new mindset. It's the new way of thinking and that's easy for some but it is difficult for others.

Interviewer: What is the difficulty with this new mindset?

Birgitte: It is for example, its sometimes difficult big organizations like Aarhus municipality and Aarhus region to collaborate in this new form of collaboration; how do you do this? None have done this before. In 2012 when we started, we had two, make it up ourselves and that can be a challenge. 11. GOV

NEW: 7 Hard to Measure  
4 Lack killer case  
3 Insufficient expertise

8 Lack economic B-case

Non-technical problem domain	Technical problem domain
<p><b>Collaboration</b></p> <ul style="list-style-type: none"> <li>Weak collaborative engagement with various stakeholders (external)</li> <li>Local engagement and collaboration across departments (internal)</li> <li>The lack of an aligned vision of the city development</li> </ul> <p><b>Financial</b></p> <ul style="list-style-type: none"> <li>Limited funds for smart city initiatives</li> <li>Difficult to monetize on Smart City Investments</li> <li>Large up-front investment</li> <li>Long term delay before reaching maturity / profitability</li> </ul> <p><b>Governance</b></p> <ul style="list-style-type: none"> <li>Control creep, the hollowing-out of state provided services, widening inequalities and dispossession of land and livelihoods</li> <li>Formulating the right governance structure given organizational barriers to supporting smart city initiatives</li> <li>Issues concerning institutional resistance, how to reach user commitment and consumer engagement? (internal / external)</li> </ul> <p><b>Contextual</b></p> <ul style="list-style-type: none"> <li>Influence of geographical variables, exportation of best practices may not occur easily</li> <li>Difficult to extend local limitations to multi-city projects due to the localized character of initiatives</li> <li>The use of canonical examples and one-size fits all narratives</li> </ul> <p><b>Political</b></p> <ul style="list-style-type: none"> <li>Political uncertainties hampering public and private investments</li> <li>Political hyper-activism</li> </ul>	<p><b>Security</b></p> <ul style="list-style-type: none"> <li>Big Data in public clouds brings with it issues relating to security</li> <li>Challenges of smart city infrastructure integration: Security concerns</li> <li>Outsourcing of power and control to private sector providers</li> </ul> <p><b>Interoperability</b></p> <ul style="list-style-type: none"> <li>Issues of service interoperability</li> <li>Smart city infrastructure integration: system interoperability</li> </ul> <p><b>Privacy</b></p> <ul style="list-style-type: none"> <li>How to make sense and best use of such 'big data', while preserving citizens' privacy and data security</li> <li>Key issue relates to the privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens' routines and habits in case of malicious or unintentional data exposure. Smart city technologies may encourage increased surveillance.</li> </ul>

1 Goal: Indication to societal & environmental

2 Basis: Non-tech 1

3 Measure: # of partnerships/collaboration + # of services based on data, and collect via APP

Figure 4. Mapping of codes to problem framework.

## 2.12 Research Quality

One of the weaknesses identified with qualitative research is often the lack of transparency in the research process for things like the researchers' priori assumptions, criteria, decisions and operations for dealing with and establishing meaningful data (Miles and Huberman, 1984). To ensure research rigor and quality this thesis has set out to thoroughly declare and make transparent all the decisions and procedures guiding the research from start to end.

Generalizability is always a concern in research. There are different ways of ensuring validity in research but the criteria by Yin (2003) to determine the quality of empirical social research - construct validity, internal validity, external validity and reliability – is a feasible way to measure and validate the research validity and reliability.

Construct validity is about how to establish fruitful constructs for the study. To account for this, the literature review of problems and return on investments in smart city followed a systematic procedure as suggested by Webster and Watson (2002) as well as adhered to a methodically operationalization process which has been reported on in chapter 2.6.

Internal validity refers to how the data analysis is done (Yin, 2003). This study has used pattern matching as an analytical method where constructs derived from theory were evaluated and tested against the empirical data. This meant in practise that the theoretical propositions were triangulated against the empirical data, a process that ensures high internal validity according to Eisenhardt (1989) and, Miles and Huberman (1984).

External validity concerns the generalizability of the findings in the study. One way this thesis has managed external validity is by using replication logic (Yin, 2003). This means that the theoretical constructs in the problem framework has been tested against the empirics in several different cities which provides strong support for its validity in a more general context. This is referred to as analytical generalizability by Yin (2003). By including interviewees from ten different cities in Europe the study has also accounted for what Miles and Huberman (1984) call *check for representativeness* which includes increasing the number of cases, in this thesis the number of cities, in the study. This wide-encompassing target sample arguably provides strong arguments to support external validity in this research.

Reliability is achieved when preceding researchers repeat this research and arrive to similar conclusions. This refers to what is mentioned above about being open with intentions, pre-suppositions but most important providing a transparent and thorough documentation of the research process; how the theoretical constructs were extracted and how the data was analysed. Yin (2003) suggest that research should be conducted as if someone were constantly looking over the shoulder of the researcher.

Reliability is also related to quality of the empirical grounding in the theory building process because it is always helpful to prevent confusions by taking on a systematic data collection that is reported with transparent descriptions especially how the theory was inducted from the data (Eisenhart and Graebner, 2007). Since this thesis in detail has reported on both how the literature review and the theoretical framework were developed as well as how the empirical data was analysed it may be argued that this research upholds basic requirement of reliability as it is defined by both Eisenhart and Graebner (2007) and Yin (2003) .

## 2.13 Research Ethics

Ethics refer to the moral distinction between right and wrong (Bhattacharjee, 2012). Throughout a research project like this thesis there are many decisions that have to be balanced against ethical considerations especially concerning data collection and analysis (Recker, 2012). According to Bhattacharjee (2012) every researcher has an ethical obligation to the scientific community to be honest in how data is analysed and reported especially surrounding unexpected or negative findings (ibid).

Since ethical norms may vary depending on cultural and local contexts (Bhattacharjee, 2012) it was decided that this thesis would follow the AIS Code of Research Conduct (Committee, 2014) to act as a common ethical baseline. Especially the first three articles have been carefully taken into consideration since they relate to the respect of the work of others as well as validity and reliability of research; 1) *Do not plagiarize*, 2) *Do not fabricate or falsify data, research procedures, or data analysis*, 3) *Do not use other people's unpublished writings, information, ideas, concepts or data that you may see as a result of processes such as peer review without permission of the author*.

Furthermore, ethical decisions also had to be taken concerning the interviewees and the question of anonymity. Since it is difficult to guarantee full anonymity to interviewees in one-to-one interviews the authors in this study choose to not anonymize the interviewees in the text since all of them were asked and agreed to disclose their full names. In this sense it was good that the interviewees all agreed to disclose their names in the report. However, it was an important ethical principle to guarantee full confidentiality of the data as suggested by Recker (2012), especially during the interview recordings.

Other ethical challenges that had to be managed was related to the interview situation. Interviews are not always open dialogues between egalitarian partners free from structures of dominance but rather a hierarchical and instrumental form of talk. The interviewer is the one who dominates the talk due to the control of the scene setting that is constructed around the researcher's interest which poses risk of inferring researcher biases in the interviews (Brinkmann and Kvale, 2005). This thesis targeted key decision makers in smart cities who are well informed individuals with extensive experience of the context relevant to the problem area in the thesis. That arguably acted as a counterweight to any potential power asymmetries.

Overall, this thesis has the ambition to be as transparent as possible concerning the decisions that has guided the research design by having presented arguments to every decision made in the research process. The authors have also tried to structure the report in such a way that is easy to understand and follow by including tables and figures showing the development of the theoretical framework, the literature review process, the interview guide, the data collection and analysis method as well as the empirical result. Therefore, it is the authors hope that the reader feels confident that sound academic and ethical conduct has been followed.

## 3 Literature Review

In order to understand the context of the research problems this section invites the reader to a theoretical journey that starts from the definition of smart city and different conceptualisations of the concept. Furthermore, the discussion covers the return on investments and problems predominant in the smart city context. The literature review concludes with a short summarization of the key takeaways from this section in order to carry over the essentials into the following chapter, empirical findings.

### 3.1 Smart City

Smart city is a recent term among researchers as well as practitioners and lacks a unified definition (Breuer et al., 2014, Neirotti et al., 2014, Ojo et al., 2014). The term constitutes different terminology, context and meanings throughout the world. The inconsistent use of the term has generated conceptual variants such as; digital and intelligent city (Chourabi et al., 2012) or instrumented and interconnected city (Harrison et al., 2010). The fuzzy understanding expose an evident research gap for future scholars to narrow, however, that gap spans beyond the scope for this study. Consequently, the fragmented understanding is acknowledged and calls for an interpretation of the term in this inquiry in order to extend the discussion to problems and return on investments of smart city.

This study, in concert with Harrison et al. (2010), argues that smart cities entitles cities that connects the physical-, social-, business-, and IT infrastructure to leverage the collective intelligence of the city. The overarching objective aims to “[...] improve operational efficiency and quality of life of a city by building on advances in IT” (Harrison et al., 2010, p.2). Throughout the theoretical research conducted in this study, academic scholars frequently define the fundamental components and the ultimate purpose with smart city (Caragliu et al., 2011, Giffinger and Gudrun, 2010, Washburn et al., 2009), however, few academic papers describe whom it involves.

Leydesdorff and Deakin (2011) apply the triple-helix model to demonstrate that the interactions between government, industry and university generate dynamic spaces within cities where knowledge can be exploited with the aid of ICT. Leydesdorff and Deakin (2011) model convincingly fit Harrison et al. (2010) definition of the concept, however, none of which explicitly account for the civilian perspective.

This study debates that civilians play a central role in enabling smart cities. Dameri and Rosenthal-Sabroux (2014) argue that citizen involvement plays a critical role in both social and technical transformation which both are central to smart city. Citizens are simultaneously producers and consumers of digitally generated information (ibid). Moreover, information security, integrity (Neirotti et al., 2014, Perevezentsev, 2014) and digital divide (Bowerman et al., 2000) among citizens are game-changing factors and important concerns expressed in numerous researches in the smart city setting.

A civilian standpoint is motivated and therefore draws upon Lombardi et al. (2012) work that expands upon the triple-helix model in the context of smart city and added the civil society to the three originating stakeholders. Harrison et al. (2010) in conjunction Lombardi et al. (2012) help explain the definition behind smart city in this paper which consists of three components and four key actors.

The three components being the physical infrastructure, social infrastructure and technology are the essential components to power a smart city initiative which are represented in the inner circle in Figure 5. The four key actors collaborate with said components to combat the problems caused by the increased urbanization, these actors are; government, industries, universities and the civil society which are represented in the outer circle.

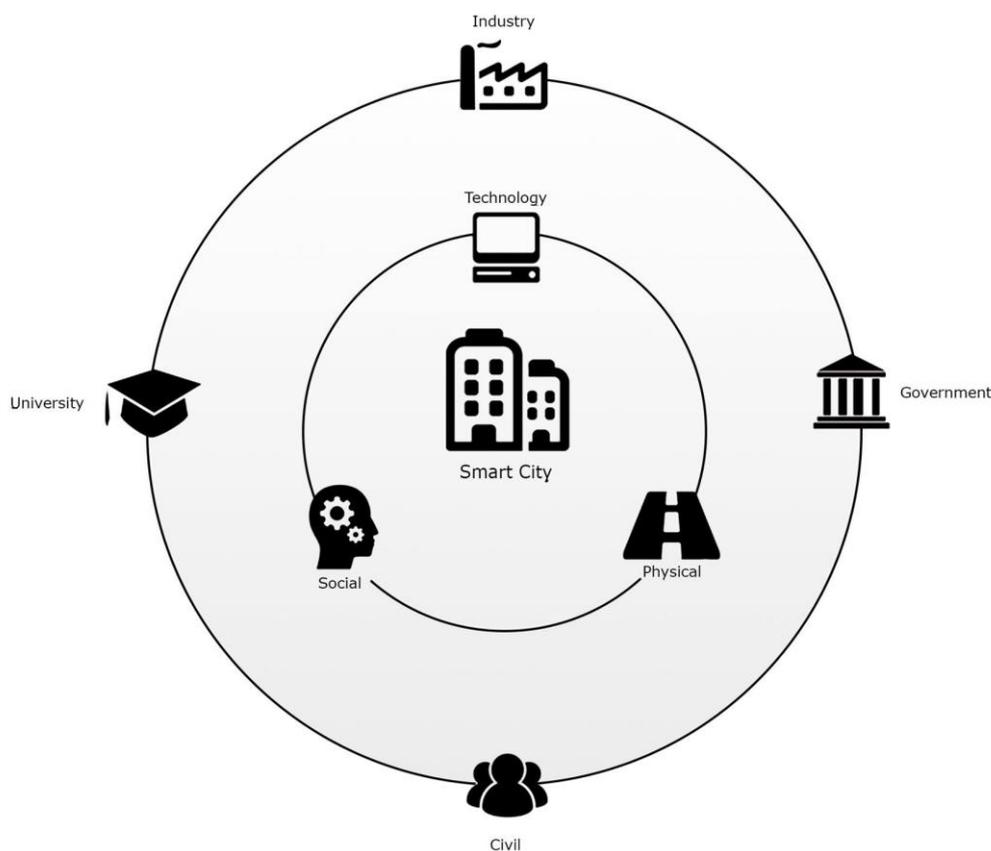


Figure 5. Simplified illustration of the interpretation of smart city in this paper.

Hereinafter follows a clarification of the three components and four key actors, not already mentioned, that together form a smart city. Physical infrastructure encompasses roads, waste disposal, water supplies and power grids to mention a few. Social infrastructure concerns assets that accommodate social services, such as; education, health care and public spaces in addition to intellectual capital and social capital (Nam and Pardo, 2011a).

Notably, an emphasis here lies on the third building block that connects the different spheres with the support of IT infrastructure. Widespread broadband network, wireless networks, fibre optic channels, service-oriented information systems, hotspots etcetera are crucial to leverage the collective intelligence in smart city (Chourabi et al., 2012).

However, technology is not an end in itself but a means to support the integration between the other building blocks in order to achieve the desired goal. Urban planning based on govern-

ance with several stakeholders in addition to institutional preparations is fundamental to success of smart city initiatives (Nam and Pardo, 2011b). Mauser et al. (2013) argue that global sustainability research inquiries “no longer emerge from science alone but in interaction with civil society, governments and other stakeholders” (p3). It is expected to adopt cross border approaches and to connect companies and territories to achieve global sustainability (Attour et al., 2015). In concert with Mauser et al. (2013) and Attour et al. (2015), this thesis argue that the concept of smart city is truly leveraged through different cities in a joint collaboration.

Universities play a central part in enabling smart cities. Industries and municipalities pay close attention to universities that have large IT and economics faculties to exchange ideas and insights in addition to enabling access to IT experts. Universities also work as a platform for network-building which may connect companies and entrepreneurs with scholars to solve urban challenges. (Kraus et al., 2015).

The city government assess the role of project coordinator or rather, innovation broker, in smart city projects by connecting stakeholders and determining the degree of interaction between the other three actors to spur co-creation (Dameri and Rosenthal-Sabroux, 2014). An extensive case study in Europe demonstrates that government and municipalities are predominantly the first movers to implement smart city programs that spans across the entire city.

Dameri and Rosenthal-Sabroux (2014) expands upon this statement and argues that municipalities play a key role in supporting and carrying out decisions as well as strategies concerning smart city. An example of this is Amsterdam where the municipality assumes a leading character. The municipality in Amsterdam applies a top-down approach to implement various smart initiatives throughout the city and guide the various stakeholders towards a unified direction. Although, the scarcity of financial resources for municipalities to drive such strategies demands support from European Union programs as well as the industries, which proceeds the discussion to industries’ role in smart city. (Dameri and Rosenthal-Sabroux, 2014).

Industries provide the development and adaptation of new knowledge or technical platforms to drive smart city transformation (Cooke and De Propris, 2011). Cooke and De Propris (2011) argue that industries contribute to economic growth by leveraging innovation which is a central outcome with smart city initiatives. Caragliu et al. (2011) explain that innovation in smart city is driven by entrepreneurs and products that necessitate a progressively more capable labour force.

Additionally, the pre-study conducted in conjunction with this thesis evidently show that municipalities co-create together with industries because the municipality does not prepossess the human or financial resources needed to manage technical as well as organizational challenges when transforming towards smart city. Based on the pre-study, municipalities oftentimes lend isolated city districts to co-creating industries and entrepreneurs as living-labs. These living-labs allows the partnership to deploy and evaluate pilot projects before scaling up.

Chapter 3.1 key takeaways:

- The smart city concept is leveraged through a collaboration between the three essential building blocks and four actors.
- The thee building blocks constitutes technology, social and physical infrastructure.
- The four actors are identified as municipalities, universities, industries and citizens.
- Collaboration between cities further leverage the smart city concept.

### 3.2 Conceptualizing Smart City

Numerous studies have attempted to synthesize the smart city literature in order to classify the literature as well as conceptualizing smart city (Chourabi et al., 2012, Cocchia, 2014, Gil-Garcia et al., 2015, Meijer and Bolívar, 2015, Nam and Pardo, 2011a, Papa et al., 2015, Yin, 2003). Meijer and Bolívar (2015) divide the literature along three ideal-typical definitions of smart city; technology-centric, human resource-centric and a third combination of the technology and human resource focus. Technology-centric assigns technology as the main definition of a smart city and emphasize the role of technology as the driving force behind the development of the urban system. Human resource-centric does not exclude the role of technology but accentuates *smart people* as fundament to the formation of smart cities. The combined technology and human resource perspective gives emphasis to *smart collaboration* between both technology and smart people as the driving force in smart cities. (Meijer and Bolívar, 2015).

Furthermore, Yin et al. (2015) advance a more technological perspective with a classification of the literature into four categories; technical infrastructure, domain application, system integration and data processing. Technical infrastructure refers to literature that emphasise the technical architecture in a ICT driven intelligent city, operating with real-time data to optimize and improve city services. In the domain application category, smart city is equal to the integration of smart ICT infrastructure with city infrastructure and services.

The literature in the system integration category view smart city as a city consisting of multiple integrated systems in an overall smart city architecture comprising a “system of systems”. The data processing category adhere to literature with a focus on smart city from a big data perspective. However, by only maintaining a constricted ICT perspective, Yin et al. (2015) overlooks major non-technical perspectives in the smart city literature such as the human resource category by Meijer and Bolívar (2015) that includes non-technical factors such as citizens.

Some authors (Chourabi et al., 2012, Galán-García et al., 2014, Nam and Pardo, 2011b) tried to develop new definitions and conceptualizations of smart city. For example, Gil-Garcia et al. (2015) suggest that smart city should be viewed as a socio-technical phenomenon and argue that:

“[...] researchers and practitioners must take a holistic approach and that the conceptualization of smart city needs to include, at its base, technology, management, and policy components.” (Gil-Garcia et al., 2015, p.79).

Similarly, Nam and Pardo (2011b) identify smart city as a city with a commitment to innovation in terms of technology, organisation and policy.

The landmark study by Chourabi et al. (2012) offers a comprehensive literature review of the smart city concept that builds from a plethora of different literature in fields such as e-government, information science, urban studies and public administration. The major contribution of that study to research as well as practitioners is the development of a holistic and at the same time detailed conceptualization of smart city as consisting of eight components: organization, technology, policy, governance, people and communities, infrastructure, natural environment and economy.

Similar to both Meijer and Bolívar (2015) and Chourabi et al. (2012) an even broader perspective has been accentuated by Papa et al. (2015) who found that smart city literature is highly interdisciplinary. The authors conclude that the literature spans across several different disciplines and problem areas. From environmental issues concerning the use of natural resources and energy consumption, to socioeconomic issues and the role of human and social capital as well as institutional aspects and the role of ICT in increasing city decision-making processes. They reach a two-

tier taxonomy of the literature. Firstly, a technology-centric perspective centred on urban physical infrastructure as well as ICT. Secondly, a holistic perspective where smart city is considered as an urban system of interconnected components, both of ICT and non ICT character.

In addition to the taxonomies and definitions of smart city as outlined above, literature also contains some critical voices (Hollands, 2008, Kitchin, 2014b, Thomas et al., 2015, Vanolo, 2013) that accentuates a critical stance towards the smart city concept. The critique surrounds that of anticipated unspoken assumptions and rhetorical aspects of cities labelled as smart (Hollands, 2008) as well as the use smart city as an empty evocative slogan lacking shared and common concepts (Vanolo, 2013).

While some authors highlight that smart city lacks a well-defined core (Hollands, 2008, Vanolo, 2013) others focus on the ambiguities of the adjective smart (Cocchia, 2014). Moreover, Vanolo (2013) point out that the un-uniformity of the smart city concept give smart city advocates opportunities to use the term in ways that support their own agendas. Söderström et al. (2014) goes even further in their critique of smart city by proclaiming it as a dominant corporate vision for the future of cities with the following argument:

“IBM’s storytelling rests on two rhetoric pillars. The first is systems thinking which inscribes it in a techno scientific imagination and provides it with the legitimacy of science. More concretely, it allows the translation of the city into a common language on which the company’s technology can act. The second is a utopian story which recurs to an imaginary of progress, therapy and conversion (if not redemption). Each rhetoric pillar brings different elements to the persuasive power of the smarter cities campaign.” (Söderström et al., 2014, p.316).

In concert with Söderström et al. (2014), Vanolo (2013) comment on the dangers of using unrealistic definitions of smart city: “[...] together with the ideal-type of the smart city, specific objectives, strategies, ideologies and political choices may be presented as ‘natural’ and ‘univocal’ approaches.” (Vanolo, 2013, p.16). This also touches upon the concerns put forward by Kitchin (2014a) of the risks that smart city could lead to a more technocratic form of governance and a shift towards a more neoliberal vision of city management, something that is also acknowledged by Söderström et al. (2014).

However, this thesis will not account for any critical perspectives, nor will it try to come up with a new taxonomy of the literature or developing a new definition of smart city. This thesis is clear on the task of exploring predominant problems as well as anticipated return on investments in smart city initiatives. Therefore, the focal point in the literature review is problems and return on investments in smart city initiatives.

To keep it simple, a dualistic view of the smart city concept is preferred. Henceforth, similar to the taxonomy proposed by Papa et al (2015) this thesis will divide the literature and corresponding problems of smart city initiatives into two domains; *technology centred* and *non-technology centred*. In the technology centred domain, problems are seen as emerging from the use of technology while in the non-technical centred domain organisational problems and problems related to the management of technology are highlighted. The two problem domains has been used in the literature review (Table 3) and the problem framework (Table 4).

Chapter 3.2 key takeaways:

- Smart cities tend to be technology centric, non-technology centric or a mixture of the two.
- Technology centric initiatives first and foremost explore how technology can be utilized to advance the city.
- A non-technology stand point first and foremost explores the municipal needs and then investigate options in order to meet those needs.
- This thesis applies a mixed approach and subdivides problems into technology centred and non-technology centred problem domains.

### 3.3 Return on Investment

The following chapter will cover the anticipated returns of investments from a smart city initiative based on an extensive body of literature. The returns in this chapter do not result in an algorithm that measures and calculates definite return on money spent, but rather a synthesis of what a smart city can hope to achieve. Thereafter, this chapter briefly touches upon financial challenges that hamper more concrete definitions of return on investments. Furthermore, this synthesis with basis in academic literature will serve as fundament to compare and contrast the empirical research. Moreover, the empirical research will expand upon the synthesis by assessing their level of return from a municipal perspective.

Return on investment is the predominant method in measuring performance success based on data to satisfy the taste of numerous stakeholders. ROI is applied to evaluate programs in the private-sector, public-sector and in non-profit organizations. (Phillips and Phillips, 2007). ROI will be applied to some extent in this context to estimate returns of smart city investments. As initially outlined, the investment needed for smart city projects may be significant and often different from traditional investment resources (Ferrer et al., 2013) which consequently leads to questions regarding the returns, such as; what can municipal decision makers hope to achieve with a smart city transformation?

The European Commission proposed a financing model for smart cities which eventually need future research to pinpoint criteria aimed at determining the level of priority and feasibility as well as sustainability of the smart initiatives. Additionally, verifying the bankability and the cost / benefit ratio with respect to the real needs is necessary to invest in smart city projects. (Ferrer et al., 2013). From a financial standpoint, smart city attempts to frame the usual suspects such as; cost reduction, operational efficiency, energy savings and increases productivity (Harrison et al., 2010).

However, the returns of investments in this context spans beyond financial growth. Based on the presumption that an appropriate literature review was conducted prior to writing this chapter, it is safe to say that smart city initiatives expect returns in two additional areas, environmental sustainability (Harrison et al., 2010, Naphade et al., 2011, Zygiaris, 2013) and social sustainability (Harrison et al., 2010, Nam and Pardo, 2011a, Zygiaris, 2013).

In contrast, Giffinger and Gudrun (2010) do not distinguish between social and environmental sustainability in smart cities but rather aggregates similarities between the two into the word; liveability. Considering the multitude of stakeholders involved in a smart city as defined in this thesis, each with their own objective, liveability may be perceived as too general of a term. Hence, municipal decision makers can consider returns on investments in financial growth, environmental sustainability and social sustainability.

### 3.3.1 Economical sustainability

The economic growth opportunities are constantly revisited in academia as well as industrial publications. Creativity and entrepreneurship are stimulated by bringing people together who spur economic activity (Naphade et al., 2011). Market research firm Frost & Sullivan (Perevezentsev, 2014) estimate that the global smart city market will venture into the trillions by 2025 with 26 global smart cities, most of which located in Europe and the United States. Consulting and marketing firms of the like are incentivized to reveal startling market trends with the intention of selling this information and appurtenant services to companies in search of growth opportunities and hence should be taken with a grain of salt.

Moreover, financial growth is enabled by reducing costs and increasing value delivery through the municipal services. Zygiaris (2013) debates that the capacity to leverage more value-adding services and reduce cost stem from the city's ability to utilize real time data from sensors, which is more commonly known as internet of things (IoT). Ericsson (2012) specializes in technical communication infrastructure on a global level and they anticipate fifty billion connected devices by 2020 to leverage a "networked society" (Ericsson 2012). IoT enable reduced cost of energy and real estate maintenance in industrial regions, office parks, shopping mall, airports or seaports (Gartner, 2015, Zygiaris, 2013).

Additional growth opportunities stem from city administration, such as: streamlined management and city utilities, such as: delivering appropriate amounts of water and energy while reducing waste (Zygiaris, 2013). Reducing waste and not excessively spending water and energy resources bring financial incentives to municipalities through reduced costs, although, these procedures could also induce positive impacts to nature which leads this conversation to environmental sustainability.

### 3.3.2 Environmental sustainability

A recent article published in the association for information system (AIS) declare that environmental sustainability as one of the most critical issues across the world and it concerns all inhabitants (Brauer et al., 2015). Brauer et al. (2015) state that the purpose with environmental sustainability is to preserve scarce resources and lower pollution as a means to avert natural degradation. These authors argue that cities massively contribute to degradation through an increase in mobility in addition to energy and water consumption and waste production, hence exposing convincing potential in terms of sustainability (ibid).

Smarter cities are perceived to contribute to environmental sustainability in several ways. Reduced traffic congestions and encouraging public transportation lowers CO<sub>2</sub> emissions. Energy saving solutions such as: smart grids interconnect sensors with supervisory controls to adjust heating ventilation, air conditioning, distribution systems etcetera. For instance, Malta utilizes smart grids to monitor water and power systems in order to reveal water leaks and electricity losses. (Zygiaris, 2013).

Notably, some research debate that environmental sustainability is a problem of global scale rather than municipal. A joint collaboration amongst world leaders without country borders could steer away from city governance that addresses global challenges with local means. Although, that would demand fundamental changes of assumptions, beliefs, values in addition to a deeper understanding of how technology and innovation can leverage environmental sustainability. (Reid et al., 2010). This thesis proceeds with a municipal standpoint, although,

cities looking to transform into smarter cities, particularly in pursuit of environmental sustainability, may want an increased collaboration outside of city and country borders.

### 3.3.3 Social sustainability

Social sustainability or the human dimension according to Nam and Pardo (2011a), concerns the people living in the city. Nam and Pardo (2011a) encapsulate much of what available literature touch upon in this domain and hence will be briefly summarized. The human dimension can be further segmented into four intangible, yet key drivers to smart city: creative-, learning-, humane- and knowledgeable city. Creative city concerns the need for a climate suitable for developing creative class. Creative class is founded by crime-free environments, knowledge networks and human infrastructure, such as: creative occupations and workforce. Creative class also concern social infrastructure which involve available intellectual as well as social capital. (ibid).

Human, as described by Nam and Pardo (2011a) encompass the city's ability to exploit higher educated and more skilled workforces to attract high tech knowledge-sensitive industries. The authors argue that successful cities attract smart people, making smarter cities smarter while the remainders are getting less smart (ibid). Notably, this may fuel the trending urbanization and enhance its perceived problems rather than halting it.

Although, competition between cities to attract citizens through diversity or specialization of economics activity or better utilizing technical asset to spur innovation in cities is nothing new (Feldman and Audretsch, 1999). Additionally, the digital divide (Bowerman et al., 2000) and social inclusion (Giffinger and Gudrun, 2010) already pose significant concern for citizens as well as between municipal units, and smart cities are predominantly enabled through ICT and IoT which may instil digital divide between cities as well. This may concern cities that intend to achieve their goals through collaboration between cities which holds especially true in empowering environmental sustainability, as expressed by Reid et al. (2010).

A learning- and a knowledge city are analogous. The essence of both encompasses a city or a cluster of cities that interlink individuals and the city network to enable learning. The purpose here is to compete on the global knowledge to leverage innovation in an urban context. (Nam and Pardo, 2011a). The democratization of ICT allows citizens, to express important concerns from their lives. Such democratization supports a more intimate relationship between citizens and governmental institutions which leads to new services and tools as a result of co-creation between the two. (Walravens, 2015).

Complementary to the four intangible drivers, social sustainability can be articulated more concretely as well. Smart city can potentially deliver more accurate and more rapid diagnosis in healthcare through the combined intelligence of the people in addition to better data gathering tools (Zygiaris, 2013). Public safety can be increased with the use of real time information to act swiftly to emergencies (ibid) but also leveraged to fight crime (Harrison et al., 2010, Milgram, 2013).

Information gathering and sharing between units and cities help identify the most significant crimes, which may expose better return on investment in the domain of social sustainability. For instance, an attorney in New Jersey uncovered that police divisions were fighting low level criminality just outside the police premises with indifferent outcomes. The combined intelligence of data and people in different police departments suggested cases of state-wide

importance rather than local disturbance, such as political corruption, prosecuting street gangs, firearm and drug trafficking. (Milgram, 2013). Noteworthy, these discoveries strengthen the global standpoint as previously advocated with environmental sustainability. Hence, smart cities could allow municipalities to better allocate resources in order to achieve more, essentially, a better return on investment. Furthermore, in concurrence with proactively fighting crime, the same approach could convincingly be applied in healthcare to prevent diseases with the shared knowledge of people and ICT within and outside city borders.

#### 3.3.4 One rock two birds

Municipalities do not necessarily have to choose one objective over the other. Differentiating objectives between citizens, industries, education and institutional units may conflict with each other, although, fruitful contemporary cities combine multiple visions to create a complete a vision for an urban region (Nam and Pardo, 2011a). The authors concretize this statement by exemplifying: an increase in transportation and accessibility supports economic growth but could be harmful to the environment due to an increase in CO<sub>2</sub> emissions.

The challenge here is to uphold economic growth while simultaneously reducing air pollution. These situations can be solved with decoupling. Decoupling in this context centres on economic-environmental decoupling which means that cities achieves economic growth without an apparent increase of the environmental carbon footprint. That can be accomplished by linking health policies to transportation policies to encourage citizens to change transportation choices without hampering accessibility. (ibid).

#### 3.3.5 The returns of a smart city are concealed

Projects with high social value are difficult to monetize in positive externalities (Lingane and Olsen, 2004) and this is very much the case for smart cities. The anticipated returns of investments are clouded by financial challenges, many of which are outlined by the European Commission (Ferrer et al., 2013). Ferrer et al. (2013) perceive a high risk when investing in innovative solutions. The author does not expand upon this statement, although, previous research argues that innovation is an outcome of complex coordination between technical knowledge and market judgment which is difficult to measure (Landau and Rosenberg, 1986) which may explain the high risk Ferrer et al. (2013) anticipates.

Furthermore, uncertainties in energy price policies and fossil fuels prices conceal the financial return on investment. Thirdly, and perhaps most challenging, are the large volumes of investments required in conjunction with the long-term delays before cities are anticipated to reach maturity or profitability. Attracting capital for large projects with long terms to maturity necessitates the involvement of institutional investors which can be attained if the anticipated credit rating of projects is great. Although, that is highly doubtful to be the circumstance for innovative solutions in smart city. (ibid).

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### Chapter 3.3 key takeaways:

- Smart cities attempt to achieve economic, environmental and social sustainability in order to combat challenges with increased urbanization.
- Successful projects reap benefits in several domains, for example: both economy and environmental sustainability.
- Measuring return on investment is desirable to attract investors, industries and skilful citizens.
- Social and financial complexities conceal quantifiable return on investment.
- Literature incorporates social and environmental aspects into the word liveability. However, this thesis extracts environmental concerns from the word and hereinafter associates liveability with social sustainability.

## 3.4 Problems with Smart City

In recent years, there has been an increasing amount of literature on the smart city concept (Cocchia, 2014). A search on Google Scholar with the keywords “smart city” returns around 2 050 000 results which indicates a substantial body of smart city literature which according to Cocchia (2014) has grown exponentially since 2010. However, the literature is fragmented, especially when it comes to the definition of smart city, which is still ambiguous and inconsistently used (Meijer and Bolívar, 2015).

While the general discussion of smart city may promise many opportunities and benefits as outlined in the introduction chapter, the attention to risks, challenges as well as analysis of problems that cities with smart city initiatives are faced with are less evident in the smart city literature (Bakıcı et al., 2013). Van den Bergh and Viaene (2015) express the need for more empirical research on the experience of existing smart city initiatives, especially of the problems faced in existing initiatives.

### 3.4.1 The technical problem domain

With a technology centred approach towards smart city the problems discussed in the literature surrounds the use and implementation of technology as well as the consequences of this use for individuals and society. The most frequent occurring problems concerns privacy, security and interoperability (Table 3).

From a technology perspective, smart city embeds ICT within city infrastructure. In many cases this includes diffusion of sensors and wireless sensor networks (WSN) in the city with the capability of real-time data gathering (Baccarne et al., 2014). Zanella et al. (2014) refer to this process as the deployment of urban internet of things. This fusion of ICT and IoT with urban systems requires a high degree of *interoperability*. Interoperability refers to the ability of different systems to interact and share information. As explained by Theodoridis et al. (2013):

“Cities consist of very complex systems of different types: civil engineering infrastructures, ICT infrastructures, societal networks, financial networks, etc. [...] The ability to automatically share data, interact and combine services whenever and wherever is required, will be an inherent feature of the smart cities.” (Theodoridis et al., 2013, p.1).

In a study, which set out to highlight problems in smart system integration Heo et al. (2014) discuss interoperability issues that have to be solved in order for the smart city to become a reality. They found that tight and effective integration among city systems is a key challenge. This relates to the issue of accounting for future integration of additional systems that has to fit into the overall system architecture (ibid). Furthermore, Zanella et al. (2014) argue that non-interoperability is a major challenge because cities have many legacy systems and heterogeneous technologies that needs to be welded together in order for the smart city to develop. It is evident that overcoming interoperability issues is crucial to the smart city development.

Smart city also brings about several apprehensions concerning security and privacy. Bianchini and Avila (2014) evokes an ethical dimension and discuss that information monitored by sensors can affect the rights of the inhabitants due to violations of the original purpose of the data collection. For example, aggregation of data could return unforeseen patterns that intrudes upon the individual integrity of citizens. This view is supported by Kitchin (2014a) who points to ensuing risks of panoptic surveillance and argues that there is an inherent tension between development of systems to improve city governance and the threatening of citizens right to privacy (Kitchin, 2014a).

Some authors highlight data security concerns related to IoT-based smart city solutions. Tuballa and Abundo (2016) draw attention to physical security, cyber security and vulnerabilities in smart grids. Additionally, Heo et al. (2014) accentuate the dangers of failures in system functionality that could cause severe security threats, affecting privacy. Others identify WSN security as a key issue for smart cities (Wu et al., 2016). In contrast to this pure technical security perspective, Baron (2012) argues that smart city is an integrated view of the city and its infrastructures. In this understanding social and governance issues become equal to technology and infrastructure which brings about issues such as:

“[...] readiness to share and use data in a privacy context; setting up standards concerning city and citizens data gathering and aggregation across huge number of microscale installations; offering data security in a large system composed of numerous sub-systems” (Baron, 2012, p.41).

In conjunction with Baron (2012), Boulos and Al-Shorbaji (2014) argue that smart cities need to figure out how to make sense, as well as how to make the best use of big data while preserving citizens' privacy and data security.

In view of all that has been mentioned so far, data security and privacy issues seems to be viewed as equally urgent issues in the smart city transformation together with problems of interoperability. Notably, the literature expresses many more, yet less recurrent challenges. Some authors report of problems of ensuring accessibility of data and services in the smart city (Balakrishna, 2012, Elmaghraby and Losavio, 2014, Piro et al., 2014) as well as issues related to collecting big data and finding value in the analytics (DeRen et al., 2015, Khan et al., 2014).

Other publications raised concerns in regards to measuring cost-benefits and the returns of smart city investments (Tuballa and Abundo, 2016, Vilajosana et al., 2013). Villanueva et al. (2013) accentuate challenges of implementation and deployment mechanisms while Bakıcı et al. (2013) and Bianchini and Avila (2014) discuss difficulties of providing necessary smart city.

Touching on other infrastructure related problems, Buck and While (2015) and Kitchin (2014b) both emphasize the risks of cities relying too much on technology and solution providers causing technological lock-in effects. Furthermore, Balakrishna (2012) points to the lack of full scale testbeds to learn from which is also made evident by Hernández-Muñoz et al. (2011) who conclude that most existing smart city initiatives do not allow for full scale experiment under realistic operational conditions due to the limited size of the testbeds.

### 3.4.2 The non-technical problem domain

*Collaboration* is the most frequent debated challenge. Collaboration concerns problem with internal silos between municipal departments, the lack of a structure to discuss relevant smart city projects with other departments as well as absence of an aligned vision for the city development (Van den Bergh and Viaene, 2015). Another problem is that many of the smart city initiatives are uncoordinated efforts performed independently by different city departments (ibid). Moreover, achieving local engagement and collaboration across departments as well as a clear definition of roles and responsibilities (Bakıcı et al., 2013) in conjunction with weak collaborative engagement with various stakeholders (Kitchin, 2014b) are also considered predominant problems. Similarly, Baccarne et al. (2014) emphasize that:

“[...] collaboration is central in smart cities, not all projects involve all the actors, policy, research, citizens and private partners, in the city. Especially the lack of involvement of private partners and possible business models forecloses the long-term sustainability and economic value creation of smart city projects.” (Baccarne et al., 2014, p.178).

In concert with previous authors, Paskaleva (2011) further underlines the importance of collaboration and claims that there is a need to reorganize collaboration in ways that are more effective and long-lasting, since collaboration between different stakeholders is a critical factor in smart city development.

Other frequent problems in the literature are related to *financial* aspects of smart city. Difficulties regarding financing of smart city initiatives (Breuer et al., 2014), limited funding available and disparate financing structures (Vilajosana et al., 2013) as well as the lack of clear business models (Zanella et al., 2014) and large up-front investment costs (Manville et al., 2014) are identified as issues that hamper the development of local collaboration and innovation platforms (Breuer et al., 2014). According to Carvalho (2014) limited public funding and private investments required for smart cities initiatives raises important questions and Manville et al. (2014) point to risks of turning fixed capital to local experimental infrastructure projects and the difficulties of monetize on smart city investments because the benefits of the “smart” capabilities takes long time to develop.

In conjunction to Manville et al., (2014), Ferrer et al. (2013) sum up the financial challenges of smart city by pointing to the high investment risks in innovations due to the large investment volumes required as well as the long time for investments to reach profitability or return of expected values. In summary, it is clear that the literature is consistently arguing that funding is of great importance for the smart city development.

In addition to *financial* challenges the literature also discusses issues related to *governance* and *politics*. Examples of problems from a governance perspective are: challenges of providing incentives and flexible regulatory frameworks (Carvalho, 2014) and problems of institutional resistance (Lee et al., 2011). The importance of policy-making that supports smart city

development is also evident. Lee et al. (2014) express the need for decision-makers to formulate the right governance structure that will support smart initiatives.

Looking at problems from a political point of view smart city initiatives struggle with on the one hand political hyper activism and too much technology driven enthusiasm and on the other hand with restraints of high investment risks which in turn makes smart city initiatives vulnerable to policy swings (Nam and Pardo, 2011b). Moreover, Vilajosana et al., (2013) accentuates that political uncertainties could hamper smart city development.

For instance, Buck and While (2015) argue that innovation is compromised even when technology has potential, due to the ‘messy’ reality of cities social and political contexts. Meijer and Bolívar (2015) stresses that it is important for city managers to understand that smart city technology by itself will not make the city smart. The new capabilities will emerge first with institutional change and a new socio-technical form of governance.

In contrast, Kitchin (2014b) evokes a critical stance and anticipates dangers of technocratic and corporate forms of governance which he fears could lead to municipal control creep and the hollowing out of state provided services that would exacerbate inequalities in the society. However, the majority of the *governance* and *political* problems raised by the literature stress the importance of policies that mitigate organizational silos and support smart city initiatives as well as the need for political support of smart city initiatives.

The literature also emphasize *contextual* problems which refer to problems of often localized and isolated character from existing smart city initiatives due to low integration of these projects (Mattoni et al., 2015). According to Hernández-Muñoz et al. (2011) exportation of best practices may not occur easily because of the influence of geographical variables and locally contextualized experience of existing smart city initiatives as identified by Manville et al. (2014). Manville et al. (2014) further debate that local communities are likely to resist learning from other cities due to the tendency of relying foremost on local embedded experience. This probably constitutes an obstacle to the continued development of smart city.

Similarly to governance and political problems, Kitchin (2014a) once again put forward a critical perspective when it comes to contextual problems. He opposes other authors by claiming that the use of canonical examples in conjunction with the absence of thorough empirical case studies of specific smart city initiatives, as well as comparative research that contrasts smart city developments in different locales, might impede the smart city development. All of the mentioned challenges suggests that city policymakers should recognize that each city must take its local rooted organizational culture into account and how this will affect the ability to roll out or solicit new smart city services (Lee et al., 2014).

In addition to the most frequent occurring problems in the literature a number of authors have considered problems such as interoperability of city services and problems of citizen engagement (Baron, 2012, Buck and While, 2015, Lee et al., 2011) and policies promoting stakeholder collaboration (Mattoni et al., 2015, Paskaleva, 2011, Vilajosana et al., 2013) as well as value proposition and potential of smart cities (Baccarne et al., 2014, Nam and Pardo, 2011b). This thesis will continue with an empirical approach and hope to contribute, although in limited scale, to the literature with new empirical informed experience of problems encountered in current European smart city initiatives.

Chapter 3.4 key takeaways:

- Problems are subdivided into non-technical problems and technical problems.
- Non-technical problems constitute collaboration, financial, governance, contextual and politics
- Technical problems constitute security, interoperability and privacy.

## 4 Empirical Findings

This chapter captures noteworthy similarities and divergences regarding how the interviewees; recognize smart city as a concept, discuss return on investment, and finally outline the predominant problems experienced from their smart city initiatives. Tables summarizing anticipated returns on investment and predominant problems can be found in Table 8 (ROI) and Table 9 (problems) respectively. Hereinafter follows Table 7 that displays a consolidation of the twelve interviews that were conducted to gather the empirical data.

**Table 7. Consolidation of Interviewees**

#	City	Name	Role
1	Aarhus	Line Gerstrand Knive	Business and city development at Aarhus mayor's department
2	Aarhus	Birgitte Kjærgaard	Project manager of Open Data Aarhus and participating in Smart Aarhus Secretariat
3	Bristol	Suzanna Wilson	City innovation manager
4	Dublin	Jamie Cudden	Coordinator in Dublin smart city
5	Dublin	Pauline Riordan	Manager in Dublinked Open Data Platform and innovation network
6	Eindhoven	Neeltje Sommers	Program manager of the Smart Society Eindhoven
7	Helsingborg	Magnus Ydmark	City planning manager of Helsingborg
8	Lund	Peter Kisch	Enterprise and innovation platform manager and part of digitalization and smart city within Lund
9	Malmö	Ulf Linderöth	Project manager of The Digital Malmö and employed on the department of communication and IT-governance
10	Rotterdam	Frank Vieveen	Program manager of the digital economies and urban development
11	Santander	Juan Ramón Santana	Senior researcher and member of the technical coordinator team from the University of Cantabria in SmartSantander
12	Skellefteå	Marie Larsson	Manager of quality and innovation running quality enhancements

### 4.1 Smart City Perspective

Interestingly, the interview data indicate that the interviewees present a uniform understanding of the components of a smart city which remarkably conformed to great extent with the smart city model previously presented in chapter 3.1, Figure 5. All the interviewees see smart city as a way to improve and connect their social and physical infrastructure. The technical infrastructure is perceived as a prerequisite to this process. Another important factor highlighted by all interviewees is the importance of collaboration by connecting the key stakeholders in the city; the municipal, industries, universities and the citizens. The empirical data

indicates that the difference between the cities in terms of their understanding of the smart city concept cannot be found in the overall conceptualization of smart city but rather in the practise of and implementation of smart city initiatives.

The most evident difference between the interviewees is how they look at the role of technology in the smart city. However, the empirical data indicates a slight difference in what extent the interviewees emphasise technology as a driver in the smart city. A dividing line can be drawn between the more technology inclined interviewees and those less technology inclined; *technology centred* versus *non-technology centred*.

Four out of twelve interviewees lean towards a technology-centric perspective. They tend to emphasise the role of technology as the main driver to become smart. Innovations is seen as driven by the use of data and wireless sensor systems as a way to create new services and expand the capabilities of the city.

Eight out of the twelve interviewees adhere to a non-technology centred perspective. They cater more towards relationship building and argue that becoming “smart” is not achieved through the use of technology but rather by development of new forms of collaboration between the stakeholders in the city. This symbiosis of collaboration in the city is seen as the main driver of innovation.

However, it must be mentioned that the interviewees’ occupational role, experience and the nature of the smart city initiative they are engaged in may affect how they reflect on the role of technology. Interviewees who come from the open data and IoT environment tend to advocate a more technology centred and data driven attitude while interviewees working with city innovation or similar organisational roles tend to take on a non-technology centred position. Furthermore, the interviewees’ smart city perspectives or conceptualizations arguably affect what kind of problems they have experienced or choose to highlight and put emphasis on.

Chapter 4.1 key takeaways:

- Municipalities lean towards a non-technology centred perspective, technology centred perspective or a mixture of the two as the main driver behind smart city.
- Interviewees occupational role as well as experience may affect what perspective they tend to which arguably could affect what problems they experience.
- The interviewees’ definition of smart city shows great similarities with the theoretical interpretation, illustrated in section 3.1, Figure 5.

## 4.2 Return on Investment

This section outlines similarities and differences between what cities want to achieve with smart city and secondly, how they measure their return on investment. From an overarching standpoint, it is obvious that most, if not all cities embark on the smart city concept to do more with less in order to maintain the original standard of living. In conjunction with literature, the majority of interviewed cities hoped to achieve economic, environmental or societal sustainability with some nuances, with is further illustrated in Table 8. These particular impacts will be further examined separately in this section. Notably, other impacts are abbreviated OTR in Table 8 and further discussed in section 4.2.4.

Notably, only one interviewee mentioned the growing urbanization as the primary reason for transforming towards smart city. When asked about the motives behind the smart city initiatives, some cities argued that municipalities cannot go on like business as usual because the changing demography; where people live longer and hence the portion of support from working citizen decreases, introduces greater challenges than ever before (Kjærgaard, Larsson, Knive and Ydmark). Notably, Kjærgaard, Larsson, Knive and Ydmark all represent Scandinavian cities which raise the question if perhaps this challenge particularly concerns Scandinavian cities?

Cities outside of Scandinavia hoped to achieve similar outcomes with a smart city transformation but with differentiating motives. The transformation for Dublin was triggered by IBM when IBM decided to move to Dublin with the intention of opening up one of their twelve global smart city research labs in 2010 (Riordan, Dublin). Riordan explains that Dublin saw this as an opportunity to leverage both financial and human resources because Ireland experienced capacity issues in the public sector. Similarly, Eindhoven stumbled upon smart city by chance through collaboration with Atos, Philips and a local technical university (Sommers, Eindhoven). The companies together with the university exposed opportunities for the municipality to act upon, with lighting in the streets to stabilize the flow and safety in the inner city.

In Santander, the Smart Santander project was triggered through a joined collaboration between the municipality and universities. Santander has a strong background in IoT and wireless technologies and the municipality together with universities were exploring new technologies to try something new. More specifically, Santana explains that the smart city initiative stems from a conference in Santander, encompassing people from the municipality and the university where the university provided convincing opportunities and ways of implementing it which the municipality agreed upon. It could be argued that the university was the predominant initiators rather than the municipality. Nonetheless, the underlying motive to support a smart city initiative did not encompass challenges with growing urbanization, nor demographic changes.

Bristol was the only interviewee that specifically saw smart city as a solution to tackle the growing urbanization. Wilson states that earth's population will grow to nine billion people in 2050 and most of them will live in cities. She expands upon this and accentuates that most of the climate change emissions stem from cities. Wilson argues that there is a need to considerably change how environmental resources are consumed towards a more sustainable setting (Wilson, Bristol).

Rotterdam diverges in comparison to previous cities by chasing a rather visionary goal. Vieveen explains that the city does have some dots in the horizon they intend to achieve but there is not an end goal. Smart city for Rotterdam is a long-term program or process.

“[...] we want to show in that world expo that we are really a front runner in the new ways cities are build or maintained tended to let’s say an example of a future or smarter city.” (Vieveen, Rotterdam).

Rotterdam attempts to realise this farsighted goal by connecting the outside world with the inner world of Rotterdam, creating a holistic approach that not only encompass the internal players in the city itself but also communities outside of city and country borders.

<b>Table 8. ROI - Consolidation of Empirical Data</b>					
#	Interviewees	Impacts			
		ECO	ENV	SOC	OTR
<b>1</b>	Aarhus (Knive)	x		x	x
<b>2</b>	Aarhus (Kjærgaard)		x	x	
<b>3</b>	Bristol (Wilson)	x	x		x
<b>4</b>	Dublin (Cudden)		x	x	x
<b>5</b>	Dublin (Pauline)			x	x
<b>6</b>	Eindhoven (Sommers)		x	x	x
<b>7</b>	Helsingborg (Ydmark)	x	x		x
<b>8</b>	Lund (Kisch)	x	x	x	x
<b>9</b>	Malmö (Linderoth)	x	x	x	x
<b>10</b>	Rotterdam (Vieveen)	x			x
<b>11</b>	Skellefteå (Larsson)	x		x	x
<b>12</b>	Santander (Santana )	x	x	x	
	<b>Sum weight:</b>	<b>8</b>	<b>8</b>	<b>9</b>	<b>10</b>

#### 4.2.1 Economic sustainability

Eight out of the twelve interviewees explicitly accentuate economic sustainability as one of the predominant reasons to invest in smart city. Interestingly, the majority does not intend to leverage smart city to generate greater revenue than before but rather to maintain the economic welfare they prepossessed as they plan for the future. Santana further exemplifies this:

“The thing is, the city is not thinking about making money out of this [...]. They are proving us services like, garbage collection service, they are not trying to make money from collecting garbage, but they are trying to improve this to avoid spending much more money in the future so this were for example, with the sensors, we give the data to the park garden management guys and they can use the data in order to know if they should garden or not, to save money and all of these things. But, they are not trying to make money off of it.” (Santana , Santander).

Linderoth from Malmö and Larsson from Skellefteå expand upon Santana’s statement and argue that cities must find different solutions in contrast to traditional ones to achieve the level of service provided today. They do not have sufficient resources or the financial support if the municipal continues like the present day. The word efficiency is frequently mentioned in

association with economic sustainability. In concert with previous interviewees, Kisch accentuates needs to be considerably more efficient as a city and how it operates in unity. Kisch pictures the city as one machine that could be streamlined to better appoint efforts.

Similarly, Line representing Aarhus, explains that the public income is going to decrease within the next years due to demographic changes and to coop with that, cities needs to operate more efficiently. She debates that a city is effective when it goes across sectors and silos, referring to internal silos within the municipal organization as well as external silos between public, private and university. From an economic lens, Aarhus would like to create and nurture growth for their companies.

Rotterdam and Dublin also concentrate their efforts to stimulate economic growth for their companies, although they apply a slightly more aggressive approach. Vieveen in Rotterdam draws attention to theories concerning a third industrial revolution that has been foreseen by Jeremy Rifkin and Vieveen argues that the world is in the middle of this industrial revolution. Rotterdam works proactively together with 23 cities, knowledge institutes, and large amounts of companies as well as start-ups to change the economic system. The foremost objective is to put Rotterdam on the map in order to attract the world expo and stimulate the new economical industrial area. This stimulate can be achieved by attracting citizens and businesses:

“We see that the economic part of a smart city is just as important, or why are you working on improving your city? Why do you want to make it smart? You do that because you want to attract people living there and attract the business doing there, and the people living there and also the people visiting the city. If you are an attractive city, then people want to stay there and live there and that is good for the economy and you need the economy to further invest in the city so it goes hand in hand.” (Vieveen, Rotterdam).

Riordan explains that Dublin explores solutions that are going to better help manage the city; she argues that it is ultimately all about services at the end of the day. Dublin strives towards better city management through engaging with smaller businesses and entrepreneurs in order to try and grow new enterprises around new solutions. Riordan debates that the size of Dublin is perfect to frame the system complexities of larger cities but still small enough to easily connect with the right people to develop ideas. Riordan sees this as a great opportunity for any solution, developed in Dublin, to be globally transferable or scalable.

Exactly what Dublin hopes to achieve with better city management and transferable solutions is not explicitly outlined, however, the charted opportunities was interpreted as a means to increase economic efficiency in the city and to spur economic growth in the industry through innovative solution, based off the interview.

In contrast to Rotterdam and Dublin, Eindhoven steers away from economic incentives and strictly peruses environmental and societal concerns. When Sommer is asked about what Eindhoven hopes to achieve with smart city; improving the quality of life through enhanced safety and mobility takes the centre stage in addition to environmental aspects such as energy consumption targets in 2040.

However, while Eindhoven does not explicitly target economic sustainability, it is oftentimes an accompanying factor in smart city initiatives according to Linderoth. Smart city or sustainability in cities intertwines incentives in all three domains, economic, environmental and societal. The collaboration between technology, people and the physical space can interact in order to create value and efficiency in the city while still reducing the environmental footprint

(Linderoth, Malmö). With that said, it could be debated that Eindhoven focuses on societal and environmental objectives and does not necessarily exclude economic sustainability but rather consider it as an added bonus.

#### 4.2.2 Environmental sustainability

Comparably to economic sustainability, eight out of the twelve interviewees explicitly identified environmental sustainability as one of the prime motives for smart city investments. Remarkably, environmental sustainability holds equal weighted in comparison to economic sustainability, although the motives and expressed considerations towards environment objectives were significantly less extensive than those concerning economic sustainability.

Bristol explores how technology and innovation can be used to meet the challenging targets with energy reduction and to be carbon neutral by 2050. Wilson explains that Bristol has participated in various programs since 2010 in an attempt to investigate how energy, transport and open data could help the city meet their green sustainability goals.

“[...] for example, on some of our energy projects, it has been about work with schools or tenants in social housing properties to support the reduction in energy demand to help reduce fuel bills [...]” (Wilson, Bristol).

Notably, the desired return on smart city investments rarely only encompass one domain, but several. In line with Linderoth’s statement about intertwined incentives, Bristol attempts to reduce energy consumption while simultaneously decreasing the fuel bills. Furthermore, Linderoth explains that Malmö has pressure to lower the environmental footprint in addition to becoming free from fossil fuel amongst other objectives. Malmö is exploring how digital solutions can help better utilize current premises rather than building new ones.

Linderoth further exemplifies; smart real estate allows monitoring real time data in automatic control engineering, district heating and energy consumption to better allocate resources. For instance, with the support of such system, Linderoth could demonstrate that the construction of a new school was not needed if existing premises were bundled up and utilized better.

In this scenario, Malmö did not have to spend money on construction and additional energy management to support that building while still satisfying the request as well as contributing to its own environmental goals. Similarly, Lund strives towards more overarching decision making regarding water purification and energy systems to make them more cost-efficient and smarter but also to reduce the strain on the environment.

Eindhoven also pursues environmental objectives with their smart city initiatives, although, not with the same emphasis as seen with Bristol and Malmö. Sommers explain that Eindhoven have several road-maps containing short-term as well as long-term energy target that encompass questions such as; what should we do right now to leverage modern technology and what is energy going to be like in 2030 or 2040? Sommer advocates the importance of making short-term decisions now that prepares them for the long-term as well.

Santander, Dublin, Rotterdam and Aarhus briefly mention environmental sustainability but do not go into greater detail about the environmental objectives or why it is important apart from making the city life more comfortable and inhabitable. The word improved quality of life or liveable city was apparent in these four interviews and could arguably be summarized with a citation of how Santander accounts for environmental sustainability:

“[...] for example reducing traffic congestion because it reduces the environmental problems in the city to make it a more habitable and liveable city. All these things that make the life of the citizens easier [...]” (Santana, Santander)

In contrast, Helsingborg positions environmental sustainability as their top priority. In similarity to the other interviewed cities, Helsingborg attempts to reduce the amounts of resources used in search of more cost-efficient solutions while reducing their environmental footprint. Additionally, Helsingborg participates in The Greater Copenhagen where climate adaptation is one of Helsingborg’s responsibilities.

The Greater Copenhagen is a political platform for promoting collaboration and economic growth across 79 municipalities throughout eastern Denmark and Skåne in southern Sweden (Greatercph.com, 2016). Ydmark explains that climate adaptation concern challenges with the rising sea level just outside of the city. Helsingborg lies low and is located along the seaside with connection to central urban areas but also several communities. The threat of rising sea levels primarily concerns the urban areas where Helsingborg already experience flooding when the winds are heavy.

This challenge ties into the city planning of Helsingborg; ensure that there are routes for the excessive water in order to adapt the terrain, street levels and slope levels in order to steer the water. Helsingborg recently got a digital model, delivered by Sweco that helps the city to monitor the water in order to take appropriate actions.

Helsingborg is also participating in a project called Urban Magma, which concerns the city’s technical maintenance system, such as; electricity, sewage system, heating, recycling and waste management. Through Urban Magma, Helsingborg is building a sewer system from the ground up in a new district close to the harbour.

“We are introducing a brand new sewer system in Helsingborg with three pipes rather than the standard one. We can now make the most of organic waste which will be sub-verted into gas and returned to the agriculture. One can also separate the [can’t hear] from the drain from the rest of the water so we do not have to waste drinkable water to flush the toilet. This is more efficient. [...] Because it is only the actual poop-water that needs to go through a thorough cleansing process that is very costly. Waste generated by households is managed in a different way which generates bio gas that generates revenue. This provides a resource to sell rather than a strain. Water from showers and sink that just need some cleansing are treated appropriately.” (Ydmark, Helsingborg).

Ydmark argues that environmental considerations are Helsingborg’s guiding start but it also involves economic sustainability. He explains that successful smart city projects try to find a solution that upholds a combination of the two.

“Preferably, meaningful motives need to be argued from both economic and environmental standpoints. In this instance with the three outgoing pipes, it reduces the load on the treatment plant which may extend the time before investing and constructing a new treatment plant, postponing that investment into the future.” (Ydmark, Helsingborg).

The majority of interviewees consider environmental sustainability as an important impact to steer towards when investing in smart city initiatives. Interestingly, environmental sustainability is rarely, if ever, the only end goal with smart city but environmental sustainability is predominantly bundled with economic incentives. Notably, Bristol and Helsingborg both considered environmental sustainability as the primary objective. However, cities lean towards cost

reducing incentives rather than environmental concerns when further articulating the beneficial impacts with smart city initiatives, such as; reduced fuel bills for Bristol and postponing costly investments for Helsingborg and Malmö.

#### 4.2.3 Social sustainability

Social sustainability holds a slightly larger weight than economic and environmental sustainability with a total of nine interviewees. There is a consensus amongst the nine interviewees; smart city can be leveraged to develop new societal solutions and services to better manage the city. These solutions predominantly stem from universities, industries and entrepreneurs and not the municipality itself. For example, Aarhus aims to make more and better services for citizens by sharing the data that was originally controlled by the municipal with external parties. Aarhus as well as Santander advocate comparable services that draws inspiration from a solution in San Francisco;

“It is like the app; fix my street [...] the citizens can take a picture with their smart phone of any disturbance in the city, so a sign that has been knocked over, or a hole in the street and send it to the city directly and get the status on when is it getting fixed. And for the city it is easier because we can do several maintenances in one drive and don't have to check it out ourselves. And then there is a private company that is making money, running this errand.” (Knive, Aarhus).

Aarhus discussed an additional example where the GPS data from busses was made available to the public which generated new services that exceeded transportation services previously provided. One application was financed through commercials, another one was entirely free and a third one cost a few dollars to access a more advanced application.

“The thing here is that, citizens get more to choose from, you can get the free app or you can get a nicer app while the transportation company makes money and the city does not spend any money on making this service. That is the basic goal.” (Knive, Aarhus).

Furthermore, Knive briefly touches upon opportunities with IoT regarding car parking in cities. Traffic congestions could be reduced with the support of sensors that help guide city drivers towards an available parking spot. Not only could it reduce traffic congestion and CO<sub>2</sub> emissions but the sensors could also be used to measure water, power and heat that could contribute to new city services while leveraging a more sustainable usage. Santander has already made progress on this very idea.

Santana in Santander explains that parking sensors are deployed beneath asphalt throughout Santander to monitor available parking spots in a particular street or parking lot. Moreover, Santander together with a German company developed sensors to measure noise levels in addition to recognizing sounds patterns, recognizing the sirens from ambulances for instance.

In Skellefteå, smart city is leveraged to deliver an increased value for citizens that they could appreciate. Similar to Aarhus, Skellefteå aims to instil a more intimate relationship with the citizens to provide services they want. Larsson debates that Skellefteå cannot continue like they have always done, this concerns both the public sector and the companies that are stationed in Skellefteå. She anticipates that new solutions will emerge from a co-creation with industries. By sharing data, external parties can propose smarter solutions than the municipality can and even the municipality's core business is sometimes better handled with solutions suggested from external sources.

Kisch, representing Lund, argues that cities are on the constant lookout for new services and new qualities for those that work and inhabit that city. Kisch explains that Lund can develop new solutions such as; digital health care and home care service in addition to new services that do not exist today with a more holistic perspective and more intimate relationship with industries as well as with the inhabitants of the city. However, that is merely a desirable future and not a full-fledged reality today.

Summer accentuate more concrete examples in Eindhoven on the contrary to Lund's strategic approach to social sustainability. Although, it is noteworthy that both cities explore how co-creation can fulfil their own agenda. Both economic and environmental sustainability take a backseat to social sustainability in Eindhoven's transformation towards smart city. Summer explains that Eindhoven attempts to improve the quality of life through enhanced safety and mobility as two examples. The smart city project was initiated as a response to stabilize the commotion in a particularly unsafe street in collaboration with Philips, Atos and technical universities. The street decibel is measured to determine the level of noise which then runs through an algorithm that determines if the street is getting unsafe. For instance, if a riot were to start, the police would receive an early warning and prevent the riot from escalating. Additionally, lighting is used to provide a warm atmosphere and evoke soothing feelings amongst the pedestrians.

#### 4.2.4 Other impacts

Few variances were revealed when examining the empirical data apart from the three most reoccurring impacts extracted from the literature. To spur innovation was the most desirable outcome of smart city project amongst these variances and it was specifically advocated in ten out of the twelve interviews. The two interviews that do not specifically use the word innovation are still emphasizing new collaborations in order to find new solutions and services for the city. Notably, innovation is fundamentally present throughout all interviews and hence a desirable return on smart city investments.

It could be argued that innovation is not the final objective by itself; however, the cities rely on innovation to achieve economic, environmental and social sustainability. For example, Bristol assembles innovation teams to stimulate new innovations to help meet their challenging environmental targets with carbon neutrality by 2050 and deficit energy reduction use as well.

On the contrary, Riordan explicitly state that Dublin's main objective with smart city is to spur innovation in the city. Dublin is coming out of an economic recession and it becomes quite clear to Riordan that Dublin has to capitalize on the smart ecosystem that they have and try to promote openness as a smart city to encourage both investments and grow their own solutions in addition to solutions that could be globally transferable. Dublin has launched a platform in order to provide a single point of information, a single contact point for those industries that are looking to engage in smart city projects. Riordan explains that they consider proposals through the website that pass their four criteria; innovation, sustainability, impact and feasibility.

“We want to stimulate innovation in Dublin and capitalize; I suppose on the ecosystem that we have here. We have a lot of global tech-companies with work-force and research clusters and so and open data community. That has always been our primary objective.”  
(Riordan, Dublin)

Cudden, in concert with Riordan, argues that even if smart city initiatives will see an increase in budget, it will generate greater pressure to deliver. He explains that, Dublin is not going to be managed like they would like to unless Dublin co-innovates together with industries, educational institutes and entrepreneurs. In similarity to Dublin, Rotterdam highly values innovation. As previously mentioned, Rotterdam participate in extensive projects with several industries, universities, start-up communities and the Cambridge innovation centre that landed last year in Rotterdam. Interestingly, even Rotterdam's definition of smart city places innovation in focus:

“Smart city there are many definitions but in Rotterdam we like to emphasize the innovation in and with the city. That is rather broad perspective but, we want to emphasize that smart means to practise the innovation in your city.” (Vieveen, Rotterdam).

Ydmark and Kjærgaard both accentuate the importance of emphasizing an entrepreneurial or innovation-oriented mentality; to try new things. Ydmark from Helsingborg, argues that Helsingborg is entering an innovation-oriented mind-set, where they trim the organization to promote innovation instead of adhering to old demands and limitations.

By the same token, Kjærgaard explains that Smart Aarhus acts as an umbrella over all concrete smart city projects in Aarhus. Smart Aarhus is a mind-set that frames new innovative ways of thinking throughout these projects in collaboration with businesses, private sectors, knowledge institutions, citizens and the public sector. An example of such project would be; Open Data Aarhus which is one of Aarhus corner stones.

Particularly open data are frequently reoccurring throughout the interviews when discussing innovation in smart city. All interviewees attempt to leverage open data to some extent in collaboration with internal and external parties to stimulate innovation, new services and solutions.

Chapter 4.2 key takeaways:

- Determining return on investment is important in all levels of collaboration in order to demonstrate value to attract investors, human resources and to align work force.
- Successful projects reap benefits in several domains, for example: economy and environmental sustainability.
- Innovation is leveraged to achieve economic, environmental and social sustainability.
- Municipalities looks to the open data concept as their predominant innovation-enabler.

### 4.3 Measuring Return on Investment

Measuring return on investment in smart city initiatives is a complex task because it involved numerous stakeholders in collaboration towards differentiating objectives in an emerging phenomenon. Cudden, representing Dublin, debates that the term return on investment is an important aspect to take into account in some types of projects.

“I mean given the examples of these workshops with our operations staff they also don't have the right data at the right time to make good decisions so then the question is asked back to them; ok how much are you willing to pay for access to that data? And they are all in silence, so everyone wants more but they don't know what the value of it is to

them so its catch 22. I think you have some worked out value or whatever but everyone wants better data but who's going to pay for it?" (Cudden, Dublin).

As outlined above, all cities have goals with their investment into smart city but the empirical data shows limitations in how progress towards these goals are measured. Aarhus, Dublin, Skellefteå and Bristol do not specifically measure their return on investment but rather observe if collaborations were increased with external parties and how many new services that spawned off a particular data set. Skellefteå measures number of companies that collaborate with the research institutions and number of companies that are supported in order to introduce new products to the market. Skellefteå does not have an overarching goal with their smart city projects. Every project has their own indication and one indication could be, for example; to carry out a certain amount of activities and processes together with firms.

In addition to measuring number of participating industries, Aarhus, Dublin and Bristol measures success in terms of the number of new services based on open data. The measurements frame the number of times a certain data set has been called and the number of services hatched off data made open by the municipality.

"Today we have been counting the number of solutions that have been developed, the number of applications on open data and I suppose our challenge going forward is to try to find suitable roots to market for the city or the citizens. And then to identify cost savings, but we have no metrics around cost savings. It is actually very difficult to determine enterprise creation metrics. We often do not know who are using our data because it is open data, so by its nature, it is quite difficult to quantify, who is taking advantage of the data we have published." (Riordan, Dublin).

Kjærgaard accentuate similar difficulties in their open data project in Aarhus. They also measure the number of times a data set was requested and number of services that was generated off the open data, but because the data is open, it is difficult to measure who is developing services and what solutions that hatched off of it. The data can be downloaded or called via an API and the service provider does not have to tell the municipality anything. Kjærgaard encourages service providers to register or to tell her what they use the data for to support more use-cases and to get more data, however, that could contradict the openness, she argues. She states that entrepreneurs and businesses are interested in the data but plenty of them are still in a phase where they do not know a lot about open data.

Rotterdam collaborates with the world counsellor city data and the smart city planner which contains one hundred indicators of how to measure smart city, maintained by the ISO organization. Vieveen refers to a recent investigation that concluded that all smart city initiatives measure their own indicators in their own way and that there is no standardization. Rotterdam hopes to develop new standards, a limited number of indicators which can be used to measure the city, rather than hundreds of outdated standards that do not apply anymore. These standards would help a city to market itself, learn from others and to compare against competition. Vieveen further explains this with an example:

"Let say that one city has a very low water usage per citizen and let's say you have the double as high water consumption, you can ask yourself; why is this, and then start a conversation with other cities on; what have you done to achieve this so that your citizen use not so much water. Because all water that you use needs to be cleaned and this is very expensive. That is what we think of about measuring the cities." (Vieveen, Rotterdam).

Eindhoven do not truly measure if their projects are successful or not but rather consider them as innovation incubations where they experiment with new things in order to improve quality of life. Sommer explains that return on investment is important to talk about with corporations in order to demonstrate quantifiable incentives and how it can scale up for them in this collaboration which is difficult because Eindhoven values social sustainability. Sommer advocates a scenario when both goals can be combined since societal success also brings financial success. That being said, Eindhoven does not measure today but are currently working on more quantifiable measurements. However, Sommer assumes that Eindhoven is in the midst of a conversion and that more quantifiable measurements will follow:

“Well I think we are at the start of a transition. You see right now that the people are connected to the initiatives are slowly growing, it’s like an oil spill, so more people are getting familiar with the initiatives and want to be connected to them and I think in the next several years we are going to see a lot more.” (Sommer, Eindhoven).

It is evident that measuring the return on investment is an important concern when discussing smart city investments, especially in partnership with the industry. However, few cities quantify measurements or outline cost-benefits analysis but rather observe how smart city can strengthen collaboration which arguably serves as a means to stimulate innovation.

Chapter 4.3 key takeaways:

- Smart city is considered as an innovation incubation with no standardized way of measuring return on investment or success.
- European cities monitor growth in collaborative partners and numbers of new services developed by co-creating partners. Baby steps towards quantifiable measurements.
- Several cities are working towards more quantifiable measurements.

## 4.4 Problems

Table 9 on the following page encapsulates the twelve interviews that were mapped into the theoretical framework to provide a lucid summarization. Hereinafter follows noteworthy comparisons and contrasts from each problem domain.

### 4.4.1 Collaboration

The interviews provide convincing evidence that collaboration in smart city development is a major challenge. All of the interviewees highlight some of the problems related to collaboration thus giving collaboration a firm stance in the empirical data. The main problems raised relates to weak internal collaboration, mentioned by eleven out of twelve interviewees, and external collaboration, mentioned by eight interviewees, as well as a lack of an aligned vision of smart city development that was mentioned by seven interviewees.

Weak internal collaboration is about challenges to overcome municipal organisational barriers and developing cross organisational collaborations. Knive, Cudden, Linderoth and Ydmark all highlight different aspects of this. Cudden in Dublin and Linderoth in Malmö accentuate the problem of fragmentation of systems within the municipality.

**Table 9. Consolidation of Empirical Data Part: 1**

<b>Non-technical problem domain</b>	<b>Interviewees</b>	<b>Weight</b>
<b>Collaboration</b>		<b>12 / 12</b>
- Weak collaborative engagement with external stakeholders	Kisch, Knive, Kjærgaard, Cudden, Ydmark, Wilson, Riordan, Santana	8
- Weak collaborative engagement with internal stakeholders	Kisch, Riordan, Skellefteå, Knive, Kjærgaard, Cudden, Linderoth, Ydmark, Vieveen, Santana, Wilson	11
- The lack of an aligned vision of the city development with external and internal stakeholders	Kisch, Skellefteå, Sommers, Knive, Linderoth, Ydmark, Vieveen	7
- Issues concerning institutional resistance	Kisch, Skellefteå, Linderoth, Vieveen	4
<b>Financial</b>		<b>10 / 12</b>
- Limited funds for smart city initiatives	Riordan, Sommers, Wilson, Santana	4
- Difficult to monetize on smart city investments	Riordan, Kjærgaard, Cudden, Ydmark	4
- Large up-front investment	Knive, Linderoth, Ydmark, Vieveen	4
- Long term delay before reaching maturity / profitability	Cudden	1
<b>Governance</b>		<b>4 / 12</b>
- Control creep, the hollowing out of state provided services, widening inequalities and dispossession of land and livelihoods	Kisch, Riordan, Skellefteå,	3
- Formulating the right governance structure given organizational barriers to supporting smart city initiatives	Kisch, Riordan, Santana	3
<b>Contextual</b>		<b>4 / 12</b>
- Influence of geographical variables, exportation of best practices may not occur easily	Skellefteå, Knive, Cudden	3
- Difficult to extend local imitations to multi-city projects due to the localized character of initiatives	Ydmark	1
- The use of canonical examples and one-size fits all narratives	-	-
<b>Political</b>		<b>5 / 12</b>
- Political uncertainties hampering public and private investments	Sommers, Knive, Vieveen, Cudden, Riordan	5
- Political hyper-activism	-	-

**Table 9. Consolidation of Empirical Data Part: 2**

Technical problem domain	Interviewees	Weight
<b>Security</b>		<b>4 / 12</b>
- Big Data in public clouds brings with it issues relating to security	Knive, Riordan	2
- Challenges of smart city infrastructure integration: Security concerns	Vieveen	1
- Outsourcing of power and control to private sector providers	Riordan, Skellefteå	2
<b>Interoperability</b>		<b>8 / 12</b>
- Issues of service interoperability	-	-
- Smart city infrastructure integration: system interoperability	Kjærgaard, Cudden, Vieveen, Santana, Kisch, Skellefteå, Linderoth, Knive	8
<b>Privacy</b>		<b>8 / 12</b>
- How to make sense and best use of such 'big data', while preserving citizens' privacy and data security	Wilson, Kjærgaard, Kisch, Ydmark, Knive	5
- Key issue relates to the privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens' routines and habits in case of malicious or unintentional data exposure Smart city technologies may encourage increased surveillance	Santana, Kisch, Riordan, Skellefteå	4

Linderoth explains that the system fragmentation can be traced back to the early beginning of the digitalisation of the municipality, a process that started long before the vision of going towards smart city, where every silo developed their own solutions and systems. Likewise, Cudden also identifies organisational silos as the reason behind the fragmentation of systems within the municipal. He advocates that the only way to account for increasing fragmentation is by collaborating within the city in the development and procurement of new systems and services.

According to Knive, Linderoth and Kisch organisational silos stem from the way cities are organised behind functions with different organisational responsibilities and own budgets. Knive highlight that silos become barriers to the smart city development since smart city and digital technologies by its nature have to cross organisational boundaries. She comments that:

“Yes, I mean it is still, smart city or digital technologies go across silos and within the city we are still divided in sections which are culture, technical department that is responsible for roads and the city, it's schools, it's elderly care, it's social and so on. They

have their own budget, so in terms of having to collaborate and invest together, it can be challenging because it's a new way of thinking that only permits slowly" (Knive, Aarhus)

However, it is not only a question of organisational barriers and budgets. For instance, Peter Kisch in Lund identify the diverging needs amongst the municipal departments as a challenge for establishing collaboration. This concern is also shared by Ydmark in Helsingborg and Vieveen in Rotterdam. Ydmark explains that from an organisational standpoint, if one part of the organisation sees great potential with a smart city initiative it is always a challenge and difficult to convince other parts of the organisation. Because other departments might not share the same incentive or do not see the direct benefit of it as they have other needs. Vieveen expand on this by explaining that it is also a question of responsibilities:

"[...] I got colleagues that are responsible for the street lighting, I got colleagues that are responsible for the sewer system or the parking lots and things like that and what you see is that these colleagues have only one responsibility [...] And everything that you want to combine [...] for instance [...] let's say connectivity to our street lightning or charging equipment for electronic vehicles, this complicates their tasks [...] If you complicate their tasks it is not always easy to convince colleagues to cooperate. And so that takes some kind of mind shift to people and this is one of the biggest challenges [...]" (Vieveen, Rotterdam)

Another significant challenge that is related to collaboration is the lack of an aligned vision of the city development. However, this problem ties up closely with both problems of weak internal collaboration as well as building external collaborations. The challenges of weak internal collaboration as described above is arguably related to lack of an aligned vision. For example, Kisch in Lund accentuates that the city need to come up with new cross-departmental cooperation's on digitalization. He mentions that different departments have different needs and the challenges lies in how to find those paths that crosses organisational boundaries and breaks with the old mentality of viewing IT as a questions only for the IT department. He comments:

"I think you have to turn it around and say that the digitization and smart city is in some way, it has to be like in the front seat, integrated with the organisation" (Kisch, Lund)

This view is also supported by Linderoth in Malmö who identifies a challenge to start working more cross-border. Linderoth mentions that in Malmö they have had workshops aiming to raise awareness and encourage collaboration across organizational boundaries, but he acknowledges that there is still a long road ahead.

Similarly, Knive recognize the need to connect all the parties in the city, both the municipality and businesses into one system. However, this is easier said than done and Sommers insights on the problem of contradicting visions between different stakeholders is arguably a factor hampering collaboration between stakeholders. For instance, she explains that the municipality might be driven by societal values like reducing poverty whilst external parties such as investors want to see a return on investment in terms of financial outcomes in the end.

The lack of an aligned vision is also dependent on problems with external collaborations. Ydmark in Helsingborg points to the potential problems that stem from cooperation with third parties such as real-estate owners. According to Ydmark, the city might have a vision of using smart ICT to transform real-estates in the city in order to reduce the overall energy consump-

tion in the city. In this case there might be problems because this includes collaborating with the real-estate owners that might not share the same vision. Ydmark explains:

”[...] actors that are indirectly affected such as real-estate owners that are required to change may prove problematic. They might need to invest in new technology or whatever it can be in their property. Then you need to convince them to go through this change.” (Ydmark, Helsingborg)

Similarly, Linderöth expresses concerns in relation to collaboration with external parties due to diverging visions. He states that in Malmö they have worked with big companies but this has not always been easy because the companies generally want to see that there are profits in the end. It stands clear that the municipals experience challenges in collaborating with the industry due to diverging visions of what to achieve in the end. A final comment by Ydmark in Helsingborg encapsulate the essence of this:

“To have smart systems, for example, we must collaborate with construction management in areas where we are developing. They must be convinced to do these three new pipes instead of the traditional drain or we shall now work with information boards, or whatever it may be. We as municipal can help guide and clearly set the boundaries, but ultimately they must accept it [...] The municipal power has diminished which accentuates the increased importance to get along. Municipal and external parties together must promote city districts” (Ydmark, Helsingborg)

Another problem of external collaborations is related to the lack of citizen engagement and how to make citizens aware of new solutions which is further highlighted by Santana in Santander: “If the people do not know about the new services, the service is useless”. The challenge of engaging with the public is also accentuated by Riordan in Dublin. She thinks it is important that the city tries to avoid talking about technology and data and instead and instead focus on the needs and problems and try to engage people around that.

Similarly, Wilson in Bristol highlight problems of working with community engagement. Her experience stems from the citizen sensing project in Bristol and she explains that it is a problem to find communities where people are active and have energy to participate. In contrast to Riordan she thinks it is important to actually put the technology in focus and engage with the citizens about the technology and what the sensors can do and what the data can be used for. However, the major concern by Wilson is that community engagement is a resource intensive and costly work which makes it major challenge for the municipal to achieve due to scarce resources.

The problems in the framework related to internal resistance to change was only mentioned briefly by four interviewees and it was only Skellefteå and Riordan from Dublin that explicitly raised it as a challenge. Skellefteå has experienced resistance in the organisation when they have drilled down in the projects to an operational level. They conclude that the resistance mainly springs from uncertainties among the employees about the effects by digitalization and what the new smart city vision will lead to in the end. In the case of Dublin, the reason behind resistance is the potential loss of control when municipal data is release into the open data as explained by Riordan:

“[...] there have been examples where we have released data and performance related data that has been for example visualized in ways that maybe don't tie in with our own KPI:s”. (Riordan, Dublin)

The feeble support for institutional resistance could be explained by the fact that it is closely related to weak internal collaborations. It can be argued that internal resistance is a factor negatively influencing internal collaboration in the municipal. However, this is only a speculation and not supported by the interview data.

#### 4.4.2 Financial

Financial challenges are prominent in the interview data and mentioned by ten out of twelve interviewees. All problems carry equal weight within the financial problem category, except of the problem of *Long term delay of profitability / Maturity*, which was only mentioned once.

Looking at the problem of limited funds i.e. difficulties getting funding for smart city initiatives, this concern was mentioned by four interviewees. Sommers from Eindhoven argues that a city with a larger budget can “effect more different projects and end them, than all those who have lesser budget “. She also believes that there is a need to find other stakeholders than the municipality that are willing to invest in the smart city projects. In her opinion it is necessary to combine different budgets in order to be able to do more and to increase the initiatives to a larger scale.

Similarly, Riordan in Dublin experiences a capacity issue that includes both financial and staff time. She explains that the reason behind this is the general capacity issue in the public sector in Ireland due to macroeconomic factors related to the financial crisis in 2008. In conjunction with both Riordan and Sommers, Wilson underscore that it’s difficult to get funding. However, she emphasises that this is especially the case in projects related to community engagement:

“[...] that allows you to have this trusted relationship with citizens where they are willing to try technology and let you put kit into their homes and get quite sensitive data from them which they otherwise would not be willing to share.” (Wilson, Bristol)

Viewing this problem from another perspective, Santana in Santander focuses on the whole smart city initiative lifecycle. He points to the fact that there is a need to have money to maintain the technology that has been deployed into the city, also after the initiative or project has ended.

The problem: *Difficulties to monetize on smart city investments* were evident in four cities. Riordan explained Dublin have looked to other cities that have done some initial testing around different kind of sensor based solutions in the parking area, and concluded that there are no viable cost-benefit so far in these kind of solutions. From an open data perspective, Kjaergaard assert that there is a general problem regarding investment since it is the municipal who bear the costs but others who reaps the benefits of it. In her opinion this makes it very hard to anticipate the returns or benefits of this kind of investments. Cudden also point out problems of how to demonstrate the effects of smart city initiatives. He states:

“I mean given the examples of these workshops with our operations staff they also don’t have the right data at the right time to make god decisions so then the question is asked back to them, ok how much are you willing to pay for access to that data? And they all are in silence, you know, so everyone wants more but they don’t know what the value of it is to them, so it’s a catch 22 [...] you know who is going to pay for it? That is a really good question.” (Cudden, Dublin)

The challenge of *large up-front investments* in smart city is also present in the interviews. Linderoth from Malmö explains that accounting methods used by the public sector is problematic when it comes to large investments in projects that will last several years. He explains that in Malmö the municipality uses annual budgets. This is a problem since smart city initiatives generally run over a few years' time and it is hard to prove an immediate effect. Therefore, it is hard to plan for smart city projects with a lifecycle longer than a year, at least if the effects of the projects are not realized during the same budget year and could be accounted for in the annual budget.

The importance of proving the effects of investments is accentuated by both Linderoth in Malmö and Ydmark in Helsingborg. Ydmark explains how the municipality reason regarding large infrastructure investments:

“Shall we spend 25 million to enhance this system in this manner or build a new system? We compare and contrast effects with alternative procedures. [...] It is important to find cost-efficient ways of achieving what we set out to do.” (Ydmark, Helsingborg)

It stands clear that large up-front investment concerning infrastructure comes with many uncertainties that push municipals into a more risk adverse position. For example, Ydmark highlight that the large investment cost is the reason why many smart city projects are tested thoroughly in test-beds and pilots to ensure that it is a cost efficient solution to archive what it is set out to do. This is also pointed out by Knive:

“Yes, there are, because the last couple of years, smart city initiatives has been primarily pilots because [...] some of them are controversial and have to be tested because IT infrastructure investments are really, really big. That is a challenge” (Knive, Aarhus)

To sum up, ten out of twelve interviewees accentuated challenges related to the financial problem category in the theoretical framework. Interestingly, looking at the particular problems in the framework, each of them is only mentioned by four out of twelve interviewees, except for the last one that is barely evident in the empirical data. Consequently, the empirics arguably demonstrate that financing a smart city initiative is difficult but for differentiating reasons.

#### 4.4.3 Governance

Governance problems were not particularly prominent in the interview data. Only four out of twelve interviewees touched upon problems relating to the governance problem category. Riordan in Dublin, Kisch in Lund and Skellefteå mentioned problems concerning municipal control creep while Santana in Santander touched upon problems of governance structure to support smart city development.

Riordan accentuates problems on the subject of open data. She mentions that open data might lead to misinterpretations that could be used against the municipal and cause harm. Kisch considers risks of future democratic problems in a smart city where new services are developed outside the boundaries and control of the municipal and the public sector. However, this is not an experienced problem but rather an elaboration on a future development. Similar to Kisch, Skellefteå also anticipates challenges about municipal control creep and hollowing out of state provided services. They discuss that if the municipality's core tasks are being outsourced to private contractors in the smart city development, it can have consequences, espe-

cially regarding integrity. Furthermore, they also see this as a potential political challenge because municipal core services are currently strongly anchored to the municipality.

Contrary to Kisch, Riordan and Skellefteå, Santana in Santander accentuates the importance of having the right governance structure to support smart city development. He has experience of challenges that stem from long municipal processing times regarding decisions of deployment of new technology and solutions in the city. This is a problem because technology changes very fast and when the decision is finally there the technology might no longer be useful or relevant.

#### 4.4.4 Contextual

Problems related to the problem category *contextual* in the theoretical framework were not particular evident in the empirical data. Only one third of the interviewees touched upon some of the problems related to contextualisation. While three of the interviewees talked about problems related to *Influence of geographical variables, exportation of best practises may not occur easily*, only one city identified problems related to *Difficult to extend local imitations to multi-city projects due to the localized character of initiatives*. Problems associated to *The use of canonical examples and one-sizes fits all narratives* was not evident at all in the interview data.

Problems related to *Influence of geographical variables, exportation of best practises may not occur easily*, were mentioned by both Skellefteå and Knive. They put focus on political and cultural differences that they anticipate might hamper sharing and copying of experiences and best practises between nations and cities in smart city projects. Skellefteå highlight challenges of localized factors related to governance such as what is the responsibility of the municipal? How much power and authority has the municipal and to what extent the municipality dictates the conditions in terms of the city concerning for instance administration of the schools or the public transfer system? Similarly, Knive identifies cultural differences between the Nordic countries and southern Europe that might affect sharing of best practises since the solutions will be developed according to local needs:

“If you go to southern Europe it is more different and they have different challenges. [...] Also we have very little hierarchy whereas in southern Europe it is more traditional, the way power is organized. Leaving a lot of initiatives to citizens is very natural to Scandinavians, whereas in southern Europe there is more control in some ways” (Knive, Aarhus, p.5).

Similarly, Cudden recognizes differences between cities although in more general terms. He argues that what fit in one city does not necessarily fit another city because every city is different and may have to follow different business models and rely on different solutions according to local needs.

In contrast to Skellefteå, Cudden and Knive, Ydmark put more focus on the localized character of initiatives and aspects that makes it *difficult to extend local imitations to multi-city projects*. When asked if Helsingborg draws knowledge or best practises from other cities and apply it in Helsingborg, he replied:

“Well, the challenge is, does it even work? Are there any legal, technical limitations because we have entirely different systems? Those are the primary considerations. Alt-

hough, the technical challenges are often solvable if the idea is good and the principle work.” (Ydmark, Helsingborg)

Interestingly the majority of the interviewees seem to contradict or refute the *contextual* problems in the problem framework. For instance, Wilson in Bristol explain that the Bristol sensing program was born out of studies of similar initiatives in cities like Barcelona and Amsterdam. She states that:

“So generally I think we are very keen on learning form others in the open data movement and cities like Amsterdam, New York, Rio are really leading the way. And very there have been some very good studies with thing they have done and how cities can learn from that which I think we need. And we are also looking at some of the sharing in the UK. There’s a network of smart cities in the UK, about 20 cities that meet two or three times a year to share what they are doing and try to understand from each other. So I think this is important.” (Wilson, Bristol)

Riordan from Dublin also explains that Dublin is participating in a smart city collaboration with around 20 other cities in the UK. According to Riordan Dublin look to London as an example of how to measure performance of their open data platform. Furthermore, she underlines the importance of learning from the experience from other cities of what has worked or not and this has played a positive role for the development of smart city in Dublin.

The same experience is shared by both Sommers in Eindhoven and Santana in Santander. Sommers report that they have several European collaborations in which they exchange knowledge and learn from other cities. Similarly, Santana from Santander mentions that the city, along with the University of Cantabria, is participating in several European Union funded projects, some of them working with interoperability and federation of existing testbeds and infrastructures from other cities, in an attempt to harmonize current initiatives throughout Europe (FIESTA – interoperability - <http://fiesta-iot.eu/> and FESTIVAL – federation - <http://www.festival-project.eu/>).

#### 4.4.5 Political

Politics is undoubtedly recognized as an important factor by the interviewees. However, what is interesting is that the interviewees in general do not experience any problems from a political point of view. On the contrary, most of them claim to have a good political support for their smart city initiatives. For example, in Bristol the mayor has actively supported and promoted the smart city program as well as helped build international networks and put Bristol on the international smart city map.

The same experience is also shared by Malmö. Ulf Linderöth pictures Malmö as a city with a political consensus in matters related to smart city and particularly emphasizes that a few of the municipal council members have strong commitment and interest in the smart city development which is contributing to the development. The importance of having political ambitions or a strategy for smart city is further underlined by Skellefteå:

“It is the politicians who make all the decisions, so in that sense they are an active stakeholder in the smart city. They do not manage the details but are in charge on a higher level; the policy and strategic level.” (Skellefteå)

The only city that seems to struggle with the local political support is Dublin. Jamie Cudden explains that Dublin have a challenging environment because of the lack of a directly elected mayor which negatively affects the political control of the city and indirect the smart city initiatives.

Even though most of the cities claims to have well developed political support there is an understanding of the liability that comes with changing political majorities and possible changes in support and budget for the smart city. This is highlighted by Sommers in Eindhoven and further accentuated by Vieveen in Rotterdam. Vieveen believes that the four-year political mandates in the city council can affect the ability to drive long-term projects because each new political majority often have their own programs. Since smart city is seen as a long-term commitment, communicating this to the politicians could be a challenge according to Vieveen.

In conclusion, the overall experience among the interviewees is that they have good political support. Only a few interviewees commented about challenges and problems related to the uncertainties that comes with politics and issues related to political hyper activism was not noticeable in the interview data. Political-hyper activism could be of importance to investigate further since it touches upon a more critical perspective. Since this thesis do not adopt a critical perspective on smart city it is considered to be out of scope thus left out for future research to commit to.

#### 4.4.6 Security

Problems related to security are not particularly prominent in the interview data. Only one third of the interviewees mentions security issues and most of them only briefly acknowledged that security is a difficult problem. This is best expressed by Knive from Aarhus and Vieveen from Rotterdam who both admit that security is as a big issue in the smart city as a concept. However, they do not recognize any problems in their own smart city initiatives regarding security.

The problems that are mentioned are related to big data as well as the risks of outsourcing power and control from the municipal to private parties. For instance, Riordan in Dublin explains that corrupted data could create bad intelligence that may trigger for instance the flooding alarm which risks causing unnecessary panic among citizens.

Furthermore, both Dublin and Skellefteå anticipate risks of losing control over privacy and integrity if services performed by the municipal is being outsourced to private entrepreneurs. Riordan explains that Dublin has already experienced problems of losing control when services are outsourced. She explains that in previous procurement of services the municipal paid to little attention to questions of data ownership. This has resulted in a situation where they do not have control over important data which has hampered innovation:

“I would say, when we have procured smart solutions over the previous years, data rights have not often featured in the public tender, so we have had the case in a number of different carriers where the third party has retained all data rights which made it difficult to actually encourage a continuous innovation in those areas, because I suppose the access to the resources has been locked in to the actual technology provider. [...] That is one challenge, something we really need to look at going forward. I know the same thing happened in the UK, when services were outsourced that everything was

outsourced, the whole management and the data and the service was outsourced so that there was very little transparency and very little opportunity for innovation in those areas.” (Riordan, Dublin)

The reason why security is not perceived as a big problem in the empirical data, despite having strong evidence in the literature, might be explained by Wilson in Bristol who thinks that attitudes towards data has changed considerably during the last years as shown by her comments below:

“I think attitudes towards data has changed considerably even over the last five years from what people think is acceptable to share and behaviours kind of change all the time so I think unless there is kind of major breaches of data people tend to be probably more relaxed than they should about it.” (Wilson, Bristol).

In conclusion, security is not experienced as a problem in the smart city initiatives because society has matured and are more aware about how to manage this issues. However, security is emphasised as being an important challenge.

#### 4.4.7 Interoperability

Eight out of twelve interviewees recognize interoperability as a problem although from different angles. Notably, issues relating to service interoperability was not evident in the interview data.

Looking at interoperability problems, Vieveen identifies the lack of a clear smart city architecture as the biggest challenge. A contributing reason stems from the lack of generic equipment. Vieveen takes intelligent street lighting as an example. He does not want to buy certain equipment with a fixed set of features because this limits the architecture in the smart city. He wants to be flexible and asks for equipment where he could add different kind sensors depending on the needs. Challenges concerning architecture in the smart city is also expressed by Kisch from Lund:

“[...] should you centralize or decentralize solutions? Should you think network solutions or mainframe? This applies not just to smart solutions but also the operative technology like how to tie together water treatment technology. Should you have a large water treatment plant or several small that are linked in a network with smart solutions that can work independently? The same applies to the energy system. Should we have a large power plant or should we have 70,000 solar cells on the roof that can work separately on a network? It's all about this, resilience and reliability for the city's survival.” (Kisch, Lund)

According to Skellefteå as well as Knive and Kjærgaard in Aarhus the main challenge about interoperability is connecting the cities many data systems, all with different standards, to the open data portal. The lack of data standards is a problem especially from a user and developer perspective. Because when the open data is provided in 30 different formats it is difficult for people and companies that are trying to develop new services to make use of the data. Knive commented that:

“We have around 2000 different data standards or data systems within the city, so of course we cannot extract all of them and put them onto the open data portal. Many of

them has to be worked on, converted and made into certain standard that go on to the portal” (Knive, Aarhus)

This problem is also mentioned by Skellefteå who states that:

”Systems to be included in our IT operations often does not follow standards, [...] and it costs money to integrate into operational use.” (Skellefteå)

Other problems about interoperability are related to cities’ legacy infrastructure and systems on top of each other as mentioned by Cudden in Dublin. He argues that many cities in Europe now have started replacing legacy infrastructure and this process has enhanced the problems of interoperability because integrating new systems from vendors in a changing legacy infrastructure is associated with many challenges.

Linderoth in Malmö highlight problems of proprietary vendor systems and accentuates the difficulties that both hardware and software vendors use different standards and work with proprietary systems. This hampers interoperability and flexibility for the municipal because it makes it difficult to connect technologies and solutions from different vendors.

Linderoth gives an example from the deployment of free Wi-Fi in the city. The municipal run into problems because the hot spot vendors followed diverse standards which made it impossible to connect different vendor products in a common network. For that reason, Linderoth anticipates many difficulties of developing an open data network in the city because of the widespread use of proprietary systems. He states that it is difficult to get data from closed systems used by different parties within the city, for instance property owners among others.

#### 4.4.8 Privacy

There is a general concern amongst the interviewees that smart city comes with challenges to integrity and privacy. Eight out of twelve cities accentuated privacy concerns as a major challenge concerning the development of more data driven city administration and opening up of public data for creation of new services.

Wilson in Bristol accentuates difficulties regarding how to account for the risks of citizens feeling spied upon or that “big brother is watching you” as Linderoth puts it. Wilson maintain the importance of inviting citizens in a dialogue around this subjects to inform what the sensors can do, what data is collected and how they can make use of it. This challenge is also supported by Kisch in Lund who mentions that the municipal is evaluating how and where data is generated and what they should do with it as well as who should have access to the data.

Wilson in Bristol, Linderoth in Malmö and Kjaergaard in Aarhus bring up worries of breaching privacy when managing open data. In Malmö, they have discussed how they can reach a security level that will make people feel safe when using the new services without the risk of being bombarded by various deals or advertisement. Similarly, Wilson report that in Bristol the municipal is very careful when handling public data to ensure that people cannot be identified and also that the municipal is not going to breach any data policy rules. However, despite the effort of securing data, there are still uncertainties as expressed by Kjærgaard:

“Privacy, it’s a tuff subject. It’s hard to secure that no privacy infused data is passed to the open data platform. In Denmark we don’t have a single recipe on how to be sure we don’t breach privacy.” (Kjærgaard, Aarhus)

Kisch in Lund stresses that there are huge challenges of moving towards a more data driven city administration and argues that integrity and confidentiality is always important in the public sector context especially in the health care sector. When more and more areas in the municipal become digitalized outdated laws and regulations creates uncertainties for the municipalities regarding their responsibilities to secure privacy.

This might affect what cities chose to do. For example, according to Santana , the city of Santander has decided to not gather any data that could be traced back to the individual due to the fear of breaching privacy regulations. One example of this is that Santander actually decided to not deploy a parking solution based on cameras in public spaces due to the privacy concerns of how the data from the cameras should be managed. This tendency of cities taking a more risk adverse stance as well as being more conservative in their decisions is also supported by Riordan in Dublin and Skellefteå:

“Privacy is a real issue for the municipal. The data mining and data analytic capabilities develop far ahead of the legislation that is lagging behind. Because of this Riordan explains that Dublin probably takes a bit conservative stance in sharing data, because privacy is a real worry.” (Riordan, Dublin)

Skellefteå continues:

”It is easy to get kind of controlled society; given that everything is recorded. Somewhere there's a limit to when you go too far. I would not call it resistance but I call it a challenge to be addressed in the flow of information, so to speak.” (Skellefteå)

To summarize, it seems that most cities acknowledge the challenge of adhering to privacy rules and regulations as well as the cumbersome work of managing the data before publication. However, it is generally not experienced as a direct problem in terms of cities not being able to make use of open data. For instance, both Ydmark in Helsingborg and Knive in Aarhus mentioned that open data comes with difficulties but also point to the fact that it is not a problem in their cities since they have good knowledge of the boundaries and the rules to abide by. Yet, the worries surrounding public data may push cities into a more conservative fold as expressed by Riordan in Dublin.

#### 4.4.9 Newfound problems

The theoretical framework encapsulated much of what the empirical data revealed to be problematic in smart city initiatives, however, the interviews exposed some additional challenges. An extract of the more predominant challenges that were not covered in the framework are represented in table 10 and can be examined in its entirety in the appendix 2, Table 11. Notably, all of these new challenges were previously identified when developing the theoretical framework but they did not occur frequently enough in comparison to those currently listed in the framework.

The lack of expertise, knowledge and technology awareness in the municipality was cited in six out of the twelve interviews which makes this the most recognized new challenge in smart city initiatives. The general consensus between the six interviewees is that it is difficult to

prepare and scope up new projects because the municipality does not always have the skills needed in-house when moving towards innovation. This challenge stems from the fact that municipalities tend to outsource technology in the public sector in the past few years, according to Riordan, representing Dublin. Sommer experienced similar challenges in Eindhoven:

**Table 10. Extract of: New Problems - Consolidation of Empirical Data**

New problem	Interviewees	Weight
- Lack of expertise, knowledge and technology awareness in the municipality	Sommers, Riordan, Kisch, Ydmark, Cudden, Kjærgaard	6
- You do not reap what you sow	Skellefteå, Wilson, Kjærgaard, Kisch, Knive, Ydmark	5
- Rapid developing technologies makes it difficult to plan ahead, technology ages fast	Skellefteå, Vieveen, Cudden, Knive, Wilson	5
- Lack of business model	Skellefteå, Kisch, Cudden, Kjærgaard, Wilson	5
- Outdated rules and regulations hamper smart city advancements	Sommers, Kisch, Vieveen, Knive, Kjærgaard	5
- Awareness, understand the need for change	Riordan, Cudden, Wilson, Kjærgaard	4

“Well I think the thing that's holds us back is transparency. We do not know which knowledge or which initiatives are available everywhere because there is so much, it's hard to find the things you need in your city”. (Sommer, Eindhoven).

The lack of awareness in Dublin and Eindhoven arguably ties into the challenge with quantifying and measuring return on investment. As previously mentioned, most cities are struggling to develop quantifiable measurements to demonstrate the value for co-creating partners. An increased awareness of available expertise, knowledge and technology in the municipality

could arguably serve as a stepping stone towards more tangible project scopes in addition to more tangible value creation for different stakeholders.

The difficulties in creating value for industrial partners leads the conversation to the second most predominant challenge amongst newfound challenges; lack of business model. The lack of economic business model or use-cases makes it challenging to justify financial investments. External parties and municipal decision makers would like to understand what their money is spent on and what can be expected in return which is rather difficult due to a high degree of vagueness. Kjærgaard draw from an example she experienced with her open data project in Aarhus:

“[...] if we use resources to put, for example from energy data from our platform to make them publicly available and it costs resources for us to make them ready for that. We don't know always if anything, if they are used, if anyone used them for anything.

That's often a challenge because we have a lot of other things to do in the municipality, we have to prioritize. If you do not know what you can benefit from making data available, you would maybe not prioritize it." (Kjærgaard, Aarhus).

Kjærgaard expands on this challenge and debates that the lack of business case and use-cases is further complicated by fact that not all investors directly benefit off the investment. Five out of the twelve interviewees acknowledge the third new challenge; you do not necessarily reap what you sow. This challenge is specifically evident in the interview with Wilson, representing Bristol:

"Because they need to be delivered at scale and across a number of silos and each individual silo does not necessarily see the value for it amongst themselves and doesn't know, you know, and couldn't make a case across the organisation from within their own silo." (Wilson, Bristol).

Wilson states that Bristol was fortunate to get external funding to further experiment with smart city projects. She argues that the external funding allowed her the necessary freedom to experiment without asking for considerable investments from stakeholders that do not directly benefit.

The fourth new challenge concerns rapidly developing technologies that makes it difficult to plan ahead because technology ages fast. Equivalent to the previous challenge, this challenge was expressed in five cities. Aarhus constituted one out of these cities and Knive further accentuates the challenge:

"Well, IT development is difficult because it goes so fast so the cities usual pace with making decision and getting the investment and so on, sometimes makes the solution that is bought, already outdated before it is implemented. We have been trying to do small pilots instead of huge investments. But, now we're getting to a point where, if you have basic digital infrastructure within the city you can build lots of smart city solutions on top of it." (Knive, Aarhus).

Additionally, Knive debates that future infrastructure should be able to connect new technologies with sensors and services the cities already have in place. Vieveen, representing Rotterdam, expands on Knive's statement and argues that there is no clear technology architecture for a smart city. Vieveen accentuates the need for general equipment that can incorporate numerous solutions simultaneously when coordinating future city planning.

"[...] what I'm looking for is that I need some generic equipment, something in the street, a pole in the street, where you could add different types of things, lighting is one, sensors are one, charging equipment is one, and then you start to think about the other way around. Ok I have lighting system, what can I add to it? So I want to have generic solution instead of a [can't hear] solution with an add on." (Vieveen, Rotterdam).

The misalignment in available technology and its coherent design decisions carried the same weight as the final new challenge: outdated rules and regulations hamper smart city advancements. The cities that expressed this challenge essentially argue that laws and regulations on national level were created in a pre-digital era which, impose restrictions that do not fit the reality cities operate in today. Similar issues are evident in Eindhoven, according to Sommer. Although, Sommer is expecting a societal shift:

“We are really speaking of a transition in the whole society and it has many different aspects and many different stakeholders. In order to get all of them to look at the same page, is a challenge. Because like law and legislation and things like that is all outdated so you have to find you own path for several things.” (Sommer, Eindhoven).

It could be argued that several of the new challenges are not new unique challenges but rather subdivided problems of the more overarching challenges with return on investment and the most predominant problems framed in the theoretical framework. Notably, the interviewees frequently describe similar challenges but rarely explicitly differentiate the challenges from one another which arguably indicate that most aspects are highly intertwined and dependent on each other. Municipalities face greater challenges than before in order to maintain their current service level and are forced out of their comfort zone towards an increased collaboration with internal as well as external stakeholders.

Chapter 4.4 key takeaways:

- Municipalities understand the need for change but do not know how and with what means.
- 11 out of 12 cities experience difficulties particularly with internal collaboration and hence the most predominant problem in this research.
- Internal organisational silos with differentiating agendas and budgets hamper collaboration with internal and external organisations.
- European cities have difficulties financing smart city but for different reasons.
- Internal systems are fragmented and difficult to integrate which, hinder data aggregation.
- Managing sensitive data on individual level is problematic.
- Security, Governance and Politics are crucial for project success but not perceived as problematic.
- Smart city initiatives are difficult to orchestrate due to no direct benefits and lack of supporting business model.
- Rapid developing technologies and outdated rules and regulations hamper smart city planning and investments.

## 4.5 Empirics summarization

Municipal decision makers tend to approach their respective smart city initiative with a non-technology centred perspective, technology centred perspective or a mixture of the two. The applied perspective may dictate how problems are approached a solutions developed. Most interviewees possessed a strategic organisational role and leaned towards a non-technical approach or a mixture of both. It could be argued that their occupational role as well as experience affected this outcome.

Furthermore, the interviewees definition of smart city concept shows great similarity with the theoretical interpretation, illustrated in section 3.1, Figure 5. Although, it is notable that few cities extend the smart city initiative outside city borders. Most projects are small in scale, experimental in its nature and not readily applicable in a larger context.

Determining return on investment is important in all levels of collaboration in order to demonstrate value to attract investors, human resources and to align work force. However,

municipalities merely measure how their collaborative networks grows in addition to numbers of new services that spawns off open data. Successful projects reap benefits in several domains, for example: economy and environmental sustainability. All cities attempt to spur innovation to achieve economic, environmental and social sustainability. Municipalities leverages the open data concept as their predominant innovation-enabler.

Municipalities understand the need for change but do not know how and with what means. Collaboration and financial were the two most predominant problem domains. 11 out of 12 cities experience difficulties particularly with internal collaboration and hence the most predominant problem in this research. Municipalities have difficulties financing smart city but for different reasons. Finally, and interestingly, the security and political problem domains are crucial for project success but not perceived as problematic.

## 5 Discussion

The theoretical framework represent a compilation of an extensive literature review in search of anticipated return on investment and predominant problems with smart city initiatives. Similarities and divergences between the theoretical and empirical findings requires further discussion in order to refine the theoretical framework but also to contemplate on why these research findings were generated. This chapter is divided into two parts; the first part discusses the findings regarding return on investment while the second part discusses how the theoretical framework of problems could be altered based on the research findings. The chapter concludes with a new iteration of the framework as a result from comparing the theoretical and empirical findings to frame the most predominant problems.

### 5.1 Return on Investment

No significant divergences between the theoretical and the empirical findings were evident. This theoretical review suggests that return on investment is important to discuss from the municipal's perspective in order for the municipality to uphold the prepossessed service level it currently enjoys. Chourabi et al. (2012) in conjunctions with Wilson from Bristol and Knive from Aarhus argue the importance of quantifying return on smart city investment to invest scarce resources wisely but also to demonstrate a value to stakeholders within the municipal organisation as well as external partners from the industry. Ferrer et al. (2013) in concert with Vieveen in Rotterdam debate the importance of demonstrating value in order to attract investors but also to attract skilful industries and citizens which are essential to manage future challenges with the growing urbanization.

However, the smart city concept is still emerging which invites new organisational as well as technical challenges to the municipality that convolutes the current discussion regarding return on investment which was further strengthened by the absence of academically published articles on the subject. The empirical findings show that these challenges force municipal decision makers to settle with vague overarching contributions to economic, environmental, social sustainability or a mixture of the three rather than evaluating quantifiable return on investment which convincingly confirms the theoretical results. The theoretical template in section 2.4 was developed before conducting the analysis and arguably influences the empirical findings. Perhaps the analysis would result in different findings through a grounded theory in contrast to approaching the analysis with a pre-determined framework and prejudiced mindset.

Furthermore, all cities attempted to leverage innovation through co-creation with external parties. Innovation was frequently mentioned in the empirical data as a desirable opportunity with smart city and it was interpreted as a means to progress towards economic, environmental and social sustainability rather than an end goal itself. Zygiaris (2013) in conjunction with Ericsson (2012) and Gartner (2015) argue that innovation in smart city is enabled through data that is gather and analyzed with the support of IoT. Santana in Santander specifically accentuate the importance of leveraging IoT to nurture new innovative solutions. Although, it

is evident that most, if not all municipal decision makers, have the ambition to share data internally as well as externally. Making data open and readily available that was previously contained within the municipality is now considered as the big enabler to spur innovation.

Notably, Dameri and Rosenthal-Sabroux (2014) debate that citizen involvement plays a critical role in both social and technical transformation and that citizens are simultaneously producers and consumers of the smart city concept and hence central to smart city development. This theoretical finding is not evident in the empirical data, apart from Aarhus and Bristol that proactively approach and involve citizens in the development. All other cities emphasize the importance of catering to the citizens, and literature as well as empirical data indicate that social sustainability is top priority with the smart city concept. However, the empirical findings show that few cities actually include citizens despite the importance expressed by Dameri and Rosenthal-Sabroux (2014).

On one hand, this result could indicate that citizens are not important in the advancements or smart city initiatives in pursuit of social sustainability. On the other hand, it could suggest that internal organisations within the municipality in addition to industries and universities help support the initiatives with much needed financial and human resources and hence have greater influence of project outcomes. In the case of the latter, new smart city solution and services may be rejected by the citizens because they do not serve the citizens' needs, resulting in a smart city investment without any return. Additionally, it may instil a digital divide amongst the inhabitants, as accentuated by Bowerman et al. (2000) and isolate parts of the city rather than increasing collaboration.

The results of the literature review suggest that municipal decision makers do not measure return on smart city investment which is further strengthened in the empirical findings. The empirical findings argue that measuring return on investment is important and cities are working towards quantifiable measurements. However, smart city is currently considered an innovation incubation with no standardized way of measuring returns or success. Seemingly all interviewed cities in this research have project specific measurements such as; reducing energy bills in a residential area, reducing CO<sub>2</sub> emissions with smarter ways of parking and navigating through the district in addition to increasing the safety in a particular street. However, no city managed to apply these solutions throughout an entire city, let alone between cities in collaboration.

## 5.2 Problems

This sections discuss how the theoretical framework compares to the empirical findings and the framework is then refined based the outcome. Each problem category will be studied individually.

### 5.2.1 Collaboration

Collaboration and co-creation is considered the fundament to leverage smart city as a concept throughout literature (Dameri and Rosenthal-Sabroux, 2014, Chourabi et al., 2012, Nam and Pardo, 2011a), however, it also appears to be the most significant problem according to the empirical findings. Weak collaboration with external stakeholders were identified in eight interviews and entire elven interviewees accentuated difficulties with weak collaborative en-

agement with internal stakeholders. These two challenges from the theoretical framework were confirmed in the empirical findings in a convincing fashion and therefore continuously belong to the problem framework.

The challenge with a lack of an aligned vision of the city development with external and internal stakeholders was expressed in seven interviews which represents a majority of the interviewed cities. It could be argued that a majority of the empirical data is enough to confirm the theory, however, this challenge will merge into the previously mentioned challenges of weak collaboration. It is argued that the weak internal and external collaboration is an effect, caused by the lack of an aligned vision of the city rather than a distinct problem.

A similar motive is argued in regards to the last collaborative challenge: issues concerning institutional resistance. Issues concerning internal resistance was evident in four cities and arguably a cause to the weak collaborative engagement with internal stakeholders, however, there are probably additional reasons since it merely occurred in four out of twelve interviews. It could be argued that the lack of aligned vision in conjunction with institutional resistance explain the difficulties municipalities experience when collaborating with internal stakeholders. Consequently, both the lack of an aligned vision and issues concerning institutional resistance are removed from the problem framework and henceforth considered as convincing root causes to weak collaboration.

Collaboration
- Weak collaborative engagement with external stakeholders
- Weak collaborative engagement with internal stakeholders
- <del>The lack of an aligned vision of the city development with external and internal stakeholders</del>
- <del>Issues concerning institutional resistance</del>

### 5.2.2 Financial

In contrast to other problem domain such as; collaboration, the financial problem domain does not have one particular problem that is recognized in a majority of the interviewed cities. Interestingly, ten out of twelve interviewees experienced one or two of the financial problems that have been extracted from the literature review, however, no particular problem holds a greater weight than four. The results suggest that almost all municipal decision makers experience difficulties financing smart city initiatives but for different reasons. Moreover, no regional specific considerations could be derived when further examining the geographical distribution amongst the cities. For instance, limited funds for smart city initiatives was evident in Dublin, Eindhoven, Bristol and Santander. Difficulties to monetize on smart city investments was accentuated in Dublin, Aarhus and Helsingborg. Lastly, Aarhus, Malmö, Helsingborg and Rotterdam confirmed the problem with large up-front investment.

The empirical findings support three out of four problems from the theoretical framework to some extent but not in the same convincing fashion as seen with weak collaboration amongst internal stakeholder. It is argued that most, if not all, perceive the financial domain problematic but for different reasons and all three problems therefore continuously belong to the problem framework. The fourth problem, which was extract from a research conducted by the European Commission (Ferrer et al., 2013), debated that financing smart cities are problematic due to the long term delay before reaching maturity or profitability. This problem was expressed in merely two interviews and therefore not considered a predominant problem and hence removed from the problem framework.

Furthermore, it is argued that the two newfound problems; *you do not reap what you sow* and *lack of business model*, earn a place in the financial problem domain. Empirics shows that municipal decision makers need the financial support from internal organisations as well as external industries, however, that support is impeded by a lack of business models and the fact that all parties may not see the direct benefit on their investment. It could be debated that these two problems further contribute to the weak collaboration with internal and external stakeholders as identified in section 5.2.1, however, they will belong to the financial problem domain based on mentioned motives.

Financial
- Limited funds for smart city initiatives
- Difficult to monetize on smart city investments
- Large up-front investments
- <del>Long term delay before reaching maturity/</del> profitability
- You do not reap what you sow
- Lack of business model

### 5.2.3 Governance

The literature suggests that governance has an obvious position in the problem framework. It is mentioned by eight unique authors which counts as a medium to high weight in comparison to other problem domains. On the contrary, the empirics suggest otherwise and the majority of interviewees do not recognize any governance issues going towards a smart city. In the empirical findings, governance was amongst the weaker problem domains, only mentioned in four unique interviews. That only accounts for one third of the total of 12 interviews which is not a convincing result.

Kitchin (2014b) anticipates dangers of development of technocratic and corporate forms of governance which he fears could lead to municipal control creep and the hollowing out of state provided services which in turn could exacerbate inequalities in the society. These concerns were evident in Lund as well as Skellefteå. Although, Kisch in Lund and Skellefteå only elaborate on future anticipated challenges rather than express real-life experiences which fur-

ther weakens the empirical result. It is only Riordan from Dublin and Santana from Santander who actually has experience of real challenges relating to governance. Evidently, Control creep, the hollowing out of state provided services, widening inequalities and dispossession of land and livelihoods will be remove from the framework.

Lee et al. (2014) argue the need for decision-makers to formulate the right governance structure that will support smart initiatives. This problem is only mentioned by Santana in Santander. However, looking at the emerging new problems, five interviewees mentioned problems with outdated rules and regulations that hampers smart city development. Laws and regulations could arguably fit into what Lee et al (2014) defines as governance structure. With that addition of the newfound problem: *outdated rules and regulations hamper smart city advancements*, governance as a problem category shows strong evidence in both the literature review and the empirical findings and hence still earns a place in the framework.

Governance
<ul style="list-style-type: none"> <li>- <del>Control creep and the hollowing out of state provided services, widening inequalities and dispossession of land and livelihoods</del></li> <li>- Formulating the right governance structure given organisational barriers to support smart city development</li> <li>- Outdated rules and regulations hamper smart city advancements</li> </ul>

#### 5.2.4 Contextual

Mattoni et al. (2015) and Manville et al. (2014) accentuate the difficulties with imitating smart city projects from other cities because new smart city solutions are exceedingly localized and of isolated character. Exportation or adaptation of best practises and experience sharing may not occur easily due to geographical variables and the high level of locally contextualization (Hernández-Muñoz et al., 2011). A sum of four cities anticipated difficulties in contextual problem domain but did not draw examples from their own experience.

Interestingly, all cities participate in communities, programs or other networks where knowledge, experience and practises are shared. Learning from others' success and failures were crucial for municipal decision makers in determining feasibility and anticipated return on investment. Additionally, the empirics show that learning from other city projects speeds up the advancement of smart city initiatives and avoids doing the same mistake someone else already have done.

The theoretical findings in concert with the empirical findings arguably indicates that contextualization is a critical success factor in smart city initiatives, however, it was not perceived problematic throughout the empirical data and hence removed from the framework.

### Contextual

- ~~Influence of geographical variables, exportation of best practises may not occur easily~~
- ~~Difficult to extent local imitations to multicity projects due to the localized character of initiatives~~
- ~~The use of canonical examples and one size fits all narrative~~

### 5.2.5 Political

Challenges framed in the political problem domain were amongst the weaker domains throughout the theoretical review and that is further strengthened in the empirical findings. The political problem domain contains two problems, first one states that political uncertainties will hamper public and private investments and the second problem concern political hyper-activism. Similar to contextualization as recently discussed, politics was not expressed as problematic but rather as an important enabled in driving smart city initiatives. For instance, Wilson argues that Bristol can circumvent numerous financial and collaborative challenges with the support from politics which have allowed Bristol a greater freedom in exploring and innovating.

Rotterdam, Aarhus and Eindhoven accentuate problems with drawn out procurement processes and outdated laws that hamper smart city progression which arguably is not a result of political uncertainties. However, Dublin is truly the only city that has first-hand experience with political uncertainties with the absence of a directly elected mayor. This results in scattered smart initiatives without a united stance. Problems concerning political hyper-activism were not evident in any smart city initiative.

The empirical and theoretical findings indicate that politics play an imperative role in supporting smart city initiatives and arguably a suitable critical success factor but not a predominant problem. The entire political problem domain is henceforth removed from the framework based on the weak contribution from literature and lack of recognition in the empirical findings.

### Political

- ~~Political uncertainties hampering public and private investments~~
- ~~Political hyper-activism~~

### 5.2.6 Security

Security in association with technology has arguably been a hot topic throughout industry as well as academia for several years now. Problems with security in smart city were well represented by numerous authors throughout the literature review between the years of 2012 to early 2016 and hence convincingly earned a place in this problem framework. Interestingly, the same level of concern was not evident in the empirical findings. Merely four cities expressed security as problematic. When further contemplating on the reasons behind the divergence between theoretical and empirical findings, this thesis in conjunction with Wilson from Bristol argue that the attitudes towards data has changed considerably in recent years and modern people are aware and hence more conscious of what information to share and not to share. The results arguably indicate that security is still as important as before but less of a problem and more of a success factor. The entire security problem domain is therefore removed from the framework.

Security
<ul style="list-style-type: none"><li>- <del>Big Data in public clouds brings with it issues relating to security</del></li><li>- <del>Challenges of smart city infrastructure integration: Security concerns</del></li><li>- <del>Outsourcing of power and control to private sector providers</del></li></ul>

### 5.2.7 Interoperability

The literature review and ultimately the problem framework framed two problems with technical interoperability; issues of service interoperability and difficulties with system integration in city infrastructure. Notably, no interviewee experienced issues with service interoperability. This thesis argues that interoperability between services has not yet become a problem for mid-sized European cities because smart city initiatives are considered innovation incubations and most projects are experimental and therefore only implemented in a small scale. This issue would arguably become a more considerable problem when more services are integrated within the city and convincingly even more so between cities in collaboration. Although, in the current time of writing this paper, mid-sized European cities do not consider issues of service interoperability a predominant problem and hence removed from the framework.

In contrast to service interoperability, difficulties with smart city infrastructure integration were expressed in eight cities. The empirical data show that municipalities maintain hundreds and sometimes thousands of different information systems, some of which are doing tasks that is already done by existing systems. The jungle of information systems hamper and sometimes prohibit proper data aggregations which is cumbersome because municipal decision makers have the ambition to collect and analyse data from IoT and open data, according to the

empirical findings. Perhaps this problem would be even more evident in the empirical findings if the interviewees had a more technical responsibility. Problems with smart city infrastructure integration showed a strong representation in both theory and empirics and therefore continuously belong to the problem framework.

Furthermore, it is argued that the newfound problem; *rapid developing technologies makes it difficult to plan ahead, technology ages fast*, earns a place in the interoperability problem domain. This particular challenge was expressed as a significant problem in five cities which represents a minority and therefore should not be included in this framework since it would constitute a predominant problem in comparison to other problems. However, this problem was not included in the framework prior to interviewing and still managed to emerge in five interviews independently. This thesis in concert with the English motto; ask a silly question and you will get a silly answer, debate that this problem would carry a larger weight throughout the empirical findings if it was encompassed in the framework before gathering empirical data.

Interoperability
- <del>Issues of service interoperability</del>
- Smart city infrastructure integration: system interoperability
- Rapid developing technologies makes it difficult to plan ahead, technology ages fast

### 5.2.8 Privacy

The literature review in concert with the empirical findings provide firm support of privacy being a concerns among cities moving towards smart city. Eight authors in the literature review mentions privacy issues and equally many of the interviewees accentuates privacy concerns as well. Challenges framed in the privacy problem domain were divided into two sub categories but the empirics suggest that the two sub categories are intertwined and should stand as one sub category in the problem framework. Henceforth the first problem in the privacy problem domain will be kept because it best encapsulates what is expressed in the literature as well as in the empirics. Moreover, it supports the challenge of making use of data while preserving privacy which is the real kernel of the problem.

The problems posed by the interviewees essentially surrounds challenges of moving towards a more data driven city administration. There are concerns of violating citizen privacy or breaching privacy regulations when managing open data and making use of real-time data analysis. For instance, both Wilson in Bristol and Kjaergaard in Aarhus express worries of breaching privacy when managing their open data platforms.

Overall, the privacy problems perceived by the cities fits well with the challenges raised in the literature. For example, Bianchini and Avila (2014) highlight that information monitored by

sensors risk intruding upon the individual integrity of citizens due to the emergence of unanticipated patterns of data aggregation. Similarly, Kitchin (2014a) point to risks of increased surveillance and explains that the development of systems to improve city governance could lead to breaches of citizens right to privacy. The same concerns are supported by several interviewees. Wilson in Bristol highlight difficulties regarding how to account for the risks of citizens feeling spied upon. Linderoth in Malmö talks about risks of citizens felling that “Big brother is watching you”.

Conclusively, the strong empirical grounding in conjunction with the firm literature stance, makes the privacy problem domain an obvious candidate to the final problem framework.

#### Privacy

- How to make sense of and best use of such ‘big data’, while preserving citizens’ privacy and data security
- ~~Key issues related to privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens’ routines and habits in case of malicious or unintentional data exposure. Smart city technologies may encourage increased surveillance~~

#### 5.2.9 New problem

The lack of expertise, knowledge and technology awareness in the municipality emerged in six out of twelve interviews without a predetermined mind-set or targeted interview questions. This problem was not captured in the theoretical framework but still occurred in half of the cities. No sensible motive is further argued when contemplating on the problem’s absence in literature in contrast to the empirical findings.

The lack of expertise, knowledge and technology awareness in the municipality arguably ties into the collaboration, privacy, interoperability and financial problem category all at once. This problem convolutes technical possibilities, business models as well as potential collaborative paths. This newfound problem will therefore create a new problem domain, although, it has influence on several other problem domains.

#### Awareness

- Lack of expertise, knowledge and technology awareness

5.2.10 Iteration of the Problem Framework

The new iteration of the problem framework is the result of a theoretical review that encompass 61 articles in addition to empirics of 44 interviews, accounting for the 32 interviews conducted in the pre-study that led up to the analysis of 12 more in-depth interviews in this thesis. The refined and new iteration of the problem framework structures the most predominant problems for municipality decision makers in mid-sized European cities with convincing support from both literature and empirical data.

<b>Table 13. New Iteration of the Problem Framework</b>	
<b>Non-technical problem domain</b>	<b>Technical problem domain</b>
<p>Collaboration</p> <ul style="list-style-type: none"> <li>- Weak collaborative engagement with external stakeholders</li> <li>- Weak collaborative engagement with internal stakeholders</li> </ul> <p>Financial</p> <ul style="list-style-type: none"> <li>- Limited funds for smart city initiatives</li> <li>- Difficult to monetize on smart city investments</li> <li>- Large up-front investment</li> <li>- You do not reap what you sow</li> <li>- Lack of business model</li> </ul> <p>Governance</p> <ul style="list-style-type: none"> <li>- Formulating the right governance structure given organizational barriers to supporting smart city initiatives</li> <li>- Outdate rules and regulations hamper smart city advancements</li> </ul>	<p>Interoperability</p> <ul style="list-style-type: none"> <li>- Smart city infrastructure integration: system interoperability</li> <li>- Rapid developing technologies makes it difficult to plan ahead, technology ages fast</li> </ul> <p>Privacy</p> <ul style="list-style-type: none"> <li>- How to make sense and best use of such 'big data', while preserving citizens' privacy and data security</li> </ul>
<p>Awareness</p> <ul style="list-style-type: none"> <li>- Lack of expertise, knowledge and technology awareness</li> </ul>	

## 6 Conclusion

The ambition of this study was to advance the discussion on return on investment and in addition to exposing the most predominant problems with smart city initiatives in mid-sized European cities. Hereinafter follows two concluding discussions that summarize the research findings with the ambition of answering each research question respectively.

- What return on investment do municipal decision makers hope to achieve with smart city?

This study in conjunction with literature has identified three predominant domains in which municipal decision makers hope to achieve return on their smart city investment; economic, environmental and societal sustainability. From an overarching standpoint, it is obvious that most, if not all cities engage in smart city as a strategy to leverage the innovation potential embedded in concept in order to achieve higher productivity as a way to maintain the original standard of living.

Interestingly, municipal decision makers argue the importance of determining return on investment in order to demonstrate value to collaborating partners in order to attract investors, human resources and to align work force. However, no city actually measures ROI apart from a few cities that observe if new solutions hatched of their open data and if new actors joined their particular smart city network. Smart city is an emerging concept and commonly considered as an innovation incubation which, may explain the absence of quantifiable measurements.

Return on investment from an economical perspective is leveraged through reduced costs and increased value delivery through the municipal services, as accentuated by Zygiaris (2013). Cities hope to stimulate economic growth for their local companies through engagement with smaller businesses and entrepreneurs. Additionally, economic incentives are predominantly bundled with environmental sustainability in order to attract industries, skilful citizens and to co-create new enterprises around new solutions.

Moreover, cities embark upon the smart city concept as a way to further the development of new societal solutions and services to better manage the city. The research findings indicate that cities strive for a more intimate relationship between citizens, industries and governmental institutions. Municipal decision makers have an ambition to develop new services in order to achieve a more social sustainable city that strengthens the relationship with stakeholders and commitment to the city as accentuated by Walravens (2015).

- What are the most predominant challenges in a smart city from the municipal decision maker's perspective?

This research has shown that the most predominant problems in smart city initiatives stem from six problem categories; collaboration, financial, governance, privacy, interoperability and awareness with a total of thirteen particular problems.

Collaboration was the most predominant problem and was evident in all interviews. Particularly evident was the difficulties with internal collaboration which was cited in 11 out of 12 cities. Collaborations problems was tightly followed by the financial problem domain that appeared in ten out of twelve interviews. The empirical data provided the final framework with a new financial problem: *you do not reap what you sow*. This elucidates the problem that it is not the one who makes an investment that will reap the benefit of it.

While the literature suggested that governance had an obvious position in the problem framework, the empirical findings recognized it as amongst the weaker problem domains, only mentioned in four unique interviews. However, a new problem emerged from the empirics that strengthened the position of the governance problem category. Five interviewees mentioned problems with outdated rules and regulations that hampers smart city development. With the addition of this newfound problem, the governance problem category was adopted into the final problem framework thus established as one of the five main problem cities experience going towards smart city.

The empirical findings in concert with the literature has identified privacy as a predominant challenge. Challenges framed in the privacy problem domain surround issues of managing sensitive data on individual level when moving towards a more data driven city administration.

Interoperability problems concern difficulties of achieving a smart city infrastructure integration which was particularly evident in both theory and empirics. Furthermore, yet another newfound problem emerged in the empirical findings; *rapid developing technologies makes it difficult to plan ahead, technology ages fast*, which earned a place in the interoperability problem category in the refined problem framework.

Finally, the new problem category: *Awareness* was added to the new iteration of the problem framework, which, include the problem: *the lack of expertise, knowledge and technology awareness*. This problem convolutes technical possibilities, business models as well as potential collaborative paths and hence spans across all technical as well as non-technical problems.

To close up on the conclusion of problems, one of the more surprising as well as noteworthy findings that emerged from the study of problems was the empirical refutation of the security, contextual and politics problem categories despite its significance in the literature. All three problem categories were accentuated as important success factors among the interviewees which arguably underscore the importance of these factors in smart city initiatives but these problem categories were not perceived problematic and hence not suitable in the problem framework.

Overall, this study has raised important questions about the nature of return on investments and problems in smart city initiatives. The results indicate that there may be a tight correlation between the problems experienced in the development of smart city initiatives and the expected return on investments. The problems captured in the framework arguably explain why

many smart city initiatives are still running in isolation and why municipal decision makers advocate quantifiable measurements to determine return on investment but still do not measure it. Notably, these are the authors' speculations and should be treated as such.

The key strengths of this study is the insights it provides for practitioners of what to expect from smart city investments in conjunction with a comprehensive framework of the most predominant problems with smart city initiatives. The knowledge contribution that this provides practitioners arguably helps steer away from uncertainties by addressing what problems to address in order to achieve expected return on investments. It is the authors' hope that this thesis will support practitioners and scholars in the ongoing advancement of the smart city initiatives in Europe.

In essence, there is no smart city without collaboration. To become smart, it is necessary that cities collaborate with internal organizations and external partners. Conclusively, a city must chose be smart or to be alone.

### 6.1.1 Limitations

The scope of this research was limited in terms of number of participants included in the research population because the study employed qualitative data gathering using interviews. Though, the study was conducted in several settings, ten different cities across Europe, which arguably makes the results generalizable outside the specific cities. Since most cities included in the study were located in northern and western Europe, this arguably indicates that the result can be applied to northern and western Europe cities. In the case of applicability to southern and eastern Europe as well as outside of Europe, there are no guarantee that the result will stand its ground since no experience of cities from these contexts were included in the study apart from Santander in Spain.

There is also a need to reflect upon the size of the cities. Since the study only included mid-sized cities there are no empirical evidence that the problem framework or the expected return on investments will apply to smaller cities under 100 000 inhabitants as well as to metropolitan areas. However, the literature that was used to develop the problem framework does not confer to the delimitations in this study which arguably imply that the problem framework is valid in a broader context as well.

It must also be discussed that the ambitious scope of this thesis accounts for both problems and return on investment which has arguably limited the ability to drill down deeply in all the problems and aspects on return on investment. More in-depth interviews concentrated to fewer problems or only on certain aspects of return in investments may provide answers not stumbled upon by this study. However, the broad scope uncovered plenty of interesting findings, many of which not fit for this thesis but for other researchers to pursuit.

### 6.1.2 Recommendations for further research

This thesis identifies four major areas as further research opportunities:

- The smart city definition or conceptualization guiding the cities could arguably affect what problems experienced and what kind of return on investments anticipated as mentioned already in chapter 4.1. This is also related to the association between experienced problems and expected return on investment as mentioned in the beginning of this chapter. This thesis identifies a future research opportunity about the role of smart city definition in the experience of problems and a further investigation of correlation between problems and return on investments.
- The surprising result that security is not seen as a problem is also worth taking a closer look at. Since IT security is commonly recognized as a challenge in any ICT context it is peculiar that security is not perceived problematic in smart city initiatives. There is arguably a need to further drill down on challenges concerning IT security in the smart city context.
- Similarly, to security, politics is also disregarded as a problem in this study. Since politics generally is seen as an important institutional factor, it is suggested that future research, maybe even outside the ICT field, take on the challenge to further drill down on the role of politics in the smart city development.
- Finally, there is a need to test the findings in this study in a broader quantitative study that has the ability to include a wider target sample of hundreds of cities across the whole of Europe. A survey questionnaire based on the result if this research would contribute to the knowledge of problems and expected return on investments in smart cities in Europe and further strengthen or disprove the findings in this study.

## Appendix 1: Exhibits

	A	B	C	D	E
1	Allmänna frågor	Subfrågor	Stavanger / Jarl @ Lyse	Dublin / Rob Kitchin	Mannheim
2	What is your role in the city?		Jarl jobbar för bolaget Lyse Han jobbar där uteslutande med kunder inom väg- och	Rob is a researcher at the university. He is researching what the city is doing and has	He is the marketing manager
3	What is smart city for you?		Jarl anser att det blir en smart city-lösning först när flera system kommunicerar för att skapa ett större	He defines smart city as when trying to use ICT to help the management and governance of the city. They	A city where you can network and with the city
4		What is important for the city to focus on while	Det största problemet kan vara att städerna (iallafall i Norge) vill bli "Smarta städer" men ingen vet vad dom vill göra eller hur dom vill bli det.	to make sure that the solutions match the agenda of the city rather than whoever is selling the technology. It should be the city that sets	inhabitant should be able to make the city attractive
5		What advantages do you think smart city can	Man har ett huvudfokus på att smart city-lösningar skall göra livet enklare för invånarna i staden. Detta genom exempelvis tidigare förslag	N/A	
6		What is needed to realize said advantages?	Äter igen så är problemet att städerna inte har definierat sina behov längre än "vi vill bli en smart stad". Det krävs att städerna sätter sig och först	N/A	

Exhibit 1: Snapshot covering questions worth investigating based on answer volume and frequency.

$f_x$	A	B	C
1	Problems	Author	Year
2	Big data problems SC: No value proposition, problems collecting, analyzing and store data	(Khan, Z., Kiani, S.L. and Soomro, K., 2014) - A framework for cloud-based context-aware information services for citizens in smart cities	2014
3	Security issues of WSN	(Wu, J., Ota, K., Dong, M. and Li, C) - A Hierarchical Security Framework for Defending Against Sophisticated Attacks on Wireless Sensor Networks in Smart Cities	2016
4	Low integration of SC projects, projects are not modular, flexible and scalable, difficult to evaluate the advantages of SC projects	(Mattoni, B., Gugliemetti, F. and Bisegna, F) - A multilevel method to assess and design the renovation and integration of Smart Cities	2014
5	Missing tools to create an urban development policy that is able to coordinate both public and private initiatives		
6	Barriers of developing Smart grid: security, data protection and privacy issues related to WSN, cost and benefits, physical security and cyber threats, no full scale testbed example to learn from, no consumer engagement, compatibility and interoperability issues,	Tuballa, M.L. and Abundo, M.L. - A review of the development of SmartGrid technologies	2016
7	SC literature lacks analysis of the management of Smart City initiatives and faced problems	Bakıcı, T., Almirall, E. and Wareham, J - A Smart City Initiative: the Case of Barcelona	2013
8	Local engagement and collaboration across departments		
9	Creating a cross-departmental cooperation and clear definition of		

Exhibit 2: Snapshot covering problems divided into technical (blue) and non-technical (green) problem domains

**Technical problems** ☆

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	A	B	C	D	E	F	G
1	<b>Problem summarization</b>	<b>Auth</b>	<b>Domain</b>				
2	The kernel of security concerns is the information handled by the system: The availability of the information for its use and services	Elmaghraby and Losavio, 2014	Accesability				
3	access and availability to data and services within the Smart city is still one of the primary challenges	Balakrishna, 2012	Accesability				
4	Availability issue: users need to fetch contents in a fast, reliable, and effective way	Piro et al., 2014	Accesability				
5	Mobility issue: it is necessary to guarantee the seamless support of mobile users which should not experience any service interruption when moving across different access networks;	Piro et al., 2014	Accesability				
6	reinforced marginalisation of excluded citizens	Buck and While, 2015	Citizen exclusion				
7	Smart grid: compatability issues	Tuballa and Abundo, 2016	Compatability				
8	Smart grid: no consumer engagement	Tuballa and Abundo, 2016	Consumer engagement				
9	Big data: Problems collecting data	Khan et al., 2014	Data processing				
10	Big data: Problems analyzing data	Khan et al., 2014	Data processing				
11	Big data: Problems store data	Khan et al., 2014	Data processing				
12	Challenges of big data in smart cities: Low degrees of automation in quick queries and the						

Exhibit 3: Snapshot of all of technical problems identified in literature

**Non-technical problems** ☆

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	A	B	C	D
1	<b>Problem summarization</b>	<b>Weight</b>	<b>Authors</b>	<b>Domain</b>
2	Low integration of SC projects, scalability of projects, hard to evaluate advantages		Mattoni et al., 2015	Integration, scalability, evaluation
3	Missing tools to create an urban development policy that is able to coordinate both public and private initiatives		Mattoni et al., 2015	Policy,
4	SC literature lacks analysis of the management of Smart City initiatives and faced problems		Bakıcı et al., 2013	Research
5	Local engagement and collaboration across departments		Bakıcı et al., 2013	Integration
6	Creating a cross-departmental cooperation and clear definition of roles and responsibilities		Bakıcı et al., 2013	Integration, roles&responsibility
7	Providing effective governance actions in the case of budget restrictions		Bakıcı et al., 2013	Governmental action
8	creation of triple helix, networks, clusters and collaborations		Bakıcı et al., 2013	Integration
9	Pure Bottom Up or Top Down implementation approach not working		Breuer et al., 20	Implementation Strategy
10	Local innovation platform has problems in building collaboration due to these factors: organisational, financial, diverging visions, Valorisation, Scalability		Breuer et al., 20	Financial, integration, scalability
11	Need for policy changes, limited capital availability, and piecemeal funding structures are preventing investment in smart cities		Vilajosana et al.,	Policy, Financial, Limited Funds
12	Political uncertainties hampering public and private investments		Vilajosana et al.,	Politics
	inconsistency in international, national, and regional rules and			

Exhibit 4: Snapshot of all Non-technical problems identified in literature

1	Occasions: 9	Definition: SC technologies poses privacy issues of information (	
2	<b>Problem</b>	<b>Author</b>	<b>Domain</b>
3	Challenges od SC infrastructure integration: privacy concerns	(Heo et al., 2014)	Privacy
4	smart city technologies may encourage increased surveillance	(Buck and While, 2015)	Privacy
5	The kernel of security concerns is the information handled by the system: The "privacy" and confidentiality of the information	(Elmaghraby and Losavio, 2014)	Privacy
6	Privacy and Trust/ Anonymity	(Theodoridis et al.,2013)	Privacy
7	Big Data in public clouds brings with it issues relating to privacy	(Balakrishna, 2012)	Privacy
8	Issues of panoptic surveillance	(Kitchin, 2014 & 2014b)	Privacy
9	Smart Cities will generate commercially valuable data on the patterns of behaviour of individuals and will have to establish informed consent of the individuals in striking the balance between the value we enjoy and the privacy we lose when organisations learn so much about us from those footprints in Cyberspace	(Boulos and Al-Shorbaji, 2014)	Privacy
10	key issue relates to the privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens' routines and habits in case of malicious or unintentional data exposure	(Bianchini and Avila, 2014)	Privacy
11	Smart grid: privacy issues related to WSN	(Tuballa and Abundo, 2016)	Privacy
12	citizen's "right to privacy" are entangled with the challenge of cyber security	(Elmaghraby and Losavio, 2014)	Privacy == Security
13	issues related to their acceptance by the population such as data privacy, information security, availability, interoperability, and the		Privacy+Security+Interoperability+Scalability

Exhibit 5: Snapshot of how the technical problem: Privacy, was aggregated

1	Collaboration occurrences: 11 authors	Definition: Internal silos between municipal departmnets, internal and external conflicting goals, divergi	
2	<b>Problem</b>	<b>Author</b>	<b>Domain</b>
3	Local engagement and collaboration across departments	Bakici et al., 2013	Integration
4	Creating a cross-departmental cooperation and clear definition of roles and responsibilities	Bakici et al., 2013	Integration, roles&responsibility Policy
5	creation of triple helix, networks, clusters and collaborations	Bakici et al., 2013	Integration
6	Local innovation platform has problems in building collaboration due to these factors: organisational, financial, diverging visions, Valorisation, Scalability	Breuer et al., 2014	Financial, integration, scalability
7	lack of involvement of private partners and possible business models forecloses the long-term sustainability and economic value creation of smart city projects	Baccame et al., 2014	Integration
8	Problem of many stakeholders in decision-making of SC initiatives	Zanella et al., 2014	Decision Making, Integration
9	setting up standards concerning city and citizen's data gathering and aggregation across huge number of microscale installations	Baron., 2012	Integration, Policy
10	the lack of a structure to discuss relevant smart city projects with other departments	Van den Bergh and Viaene.,	Organizational
11	many of the smart city initiatives are uncoordinated efforts performed independently by the departments	Van den Bergh and Viaene.,	Integration
12	the lack of a structure to discuss relevant smart city projects with other departments	Van den Bergh and Viaene.,	Integration

Exhibit 6: Snapshot of how the non-technical problem: Collaboration, was aggregated

## Appendix 2: Tables

<b>Table 1. Top 10 Information Systems Theories 2014 Part: 1</b>			
<b>#</b>	<b>Theory</b>	<b>Applicable degree</b>	<b>Motive</b>
1	Institutional theory	Limited	Institutional theory attends to the deeper and more resilient aspects of social structure. This theory is debatably applicable to some degree since internal as well as external stakeholders ultimately determine if the new changes are used or not. However, this theory will be excluded in this particular thesis because it centres on institutional emergence, conformity, conflict, change, isomorphism which does not encompass a technical perspective. Nor does it frame any variables similar to return on investments or otherwise and hence surrounding a too narrow scope.
2	Social network theory	Irrelevant	Social network theory views social relationships in terms of nodes and ties. This theory focus on nodes and links in order to leverage node size, density as well as link strength. This theory is determined to have a low applicable degree in this thesis because it does not encompass social, cultural or organizational aspects that help build a smart city. To some extent, it could be debated that increased numbers of nodes could further leverage smart city collaboration and enable synergies as seen within the mobile ecosystem (Constantinou and Vakulenko, 2014) ,however, that association is determined farfetched and hence not applicable in this research.
3	Contingency theory	Partly	The claims optimal organization / leadership style is contingent upon various internal and external constraints. The theory considers efficiency and organizational performance and evaluating its influence on strategy, technology, task, organizational size, structure, and culture. The theory does not stray too far off this particular thesis, however, it addresses these variables from an individual and firm perspective which lack educational institutions and governmental institutions. Furthermore, the framework results in organizational performance in terms of financial achievement and volume which is merely one of several potential outcomes with smart city.
4	Organizational culture theory	Limited	Different concepts of culture, stemming from two distinct disciplines (anthropology and sociology) study organizational culture type, organization culture strength, and culture congruence in order to achieve performance, organizational effectiveness, employee commitment, employee satisfaction. The focus on culture, organization and individual level is undoubtedly relevant in fusing industries, government, citizens and universities together however, this theory will be excluded its emphasis on organizations and the deep-seated philosophical approach that reflect upon values and beliefs within the organization.
5	Transaction cost economics	Irrelevant	Transaction cost economics focus on economics and related disciplines, a transaction cost is a cost incurred in making an economic exchange. The level of applicability is determined low because this theory originates within micro-economics and encompasses a firm perspective which does not take technology, governmental institution or social factors into account and hence discarded.

**Table 1. Top 10 Information Systems Theories 2014 Part: 2**

#	Theory	Applicable degree	Motive
6	DeLone and McLean IS success model	Limited	This theory provides a general and comprehensive definition of IS success that covers different perspectives of evaluating information systems. DeLone and McLean IS success model concerns the technology perspective of information system, such as; system quality, information quality, service quality, but does not encompass for the managerial standpoint and will therefore be discarded. This model could arguably be used in part with other organizational models to create a uniform model suitable for this thesis.
7	Technology acceptance model	Limited	TAM is an adaptation of the Theory of Reasoned Action (TRA) to the field of IS. TAM measures technological system usage through perceived usefulness and perceived ease of use which is arguably applicable to some degree. This model takes an individual standpoint and hence leave all organizational complexities smart city encounters, such as internal and extern collaboration. Therefore, the technology acceptance model perceives low applicability.
8	Socio-technical theory	Partly	Socio-technical theory centres on a fit between the technical sub-system and the social subsystem which together made up an organization to make predictions of the impact of technology on business efficiency and productivity. The level of analysis hones in on the Organization, its employees and its environment which arguably address a multitude of challenges that are evident in smart city initiatives. However, this model steers away from exploring problems and derisive impacts with smart city that has not been sufficiently exposed which may limit the exposure of new findings. Furthermore, the municipal standpoint debatably values different aspects than organizations which complicates the applicability of this theory
9	Garbage can theory	Limited	The Garbage Can theory, or model, attempts to explain some organizational decision-making anomalies-in particular, decision making by "organized anarchies" where preferences are not clear, technology is not clear, or participation is fluid. Seeing as literature considers smart city to be fragmented and fussy, this theory could provide a guiding light when technology and organizational preferences are unclear. Although, similarly to preceding theories, this theory centres on a firm's perspective and hence suffers from the same limitations which results in limited applicability.
10	Diffusion of innovations theory	Limited	DOI theory sees innovations as being communicated through certain channels over time and within a particular social system. This theory measures compatibility of technology, complexity of technology and relative advantage in order to evaluate implementation success or technology adoption. DOI frames a group, firm, industry and societal perspective which is arguably one of the most fitting IS theories in regards to this thesis. However, the lack of organizational consideration in addition to the highly defined model which does not allow for further exploration of the emerging concept makes this theory applicable to a limited degree.

<b>Table 11. New Problems - Consolidation of Empirical Data</b>		
<b>New problem</b>	<b>Interviewees</b>	<b>Weight</b>
- Lack of expertise, knowledge and technology awareness in the municipality	Sommers, Riordan, Kisch, Ydmark, Cudden, Kjærgaard	6
- You do not reap what you sow	Skellefteå, Wilson, Kjærgaard, Kisch, Knive, Ydmark	5
- Rapid developing technologies makes it difficult to plan ahead, technology ages fast	Skellefteå, Vieveen, Cudden, Knive, Wilson	5
- Lack of business model	Skellefteå, Kisch, Cudden, Kjærgaard, Wilson	5
- Outdate rules and regulations hamper smart city advancements	Sommers, Kisch, Vieveen, Knive, Kjærgaard	5
- Awareness, understand the need for change	Riordan, Cudden, Wilson, Kjærgaard	4
- Risky with technology lock-in with vendors that offers closed systems	Kisch, Cudden, Vieveen	3
- Procurement process is slow and limiting	Linderoth, Vieveen, Cudden	3
- Difficult to scale up from pilot project and test-phases	Sommers, Cudden, Wilson	2
- Tech-companies do not understand how cities work and their needs	Cudden, Vieveen	2
- Ego and opportunity to be first mover encourages competition rather than collaboration	Sommers	1
- Smart city affects the entire city, not just the municipality	Sommers	1
- Can't relying on business as usual	Skellefteå	1
- smart city hype exaggerates potential	Riordan	1
- Lack of killer use-case	Kjærgaard	1

## Appendix 3: Interview Guide

<b>Table 12. Interview Guide Overarching Questions</b>	
<b>Motives</b>	<b>Generated Interview Questions</b>
<p>Smart City</p> <ul style="list-style-type: none"> <li>- Identify standpoint, techno-centric or non-techno-centric in addition to grasp their understanding of SC</li> <li>- Identify key stakeholders involved in smart city The lack of an aligned vision of the city development</li> </ul> <p>Return on Investment</p> <ul style="list-style-type: none"> <li>- Explore how they treat return on investment in smart city</li> <li>- Identify domain: eco, economic, social or other</li> <li>- Explore how the anticipated impact is measured</li> </ul> <p>Problems</p> <ul style="list-style-type: none"> <li>- Identify experienced and anticipated problems with smart city</li> </ul>	<ul style="list-style-type: none"> <li>- What is smart city to you?</li> <li>- Who are the key stakeholders in smart city?</li> </ul> <ul style="list-style-type: none"> <li>- What do you hope to achieve with smart city? – Why is that important?</li> <li>- What triggered the smart city initiative?</li> <li>- To what extent did the smart city initiative achieve the objectives?</li> <li>- How do you measure smart city performance?</li> </ul> <ul style="list-style-type: none"> <li>- What challenges or problems have you experienced with smart city?</li> <li>- What problems have you encountered with your smart city initiative?</li> <li>- What challenges do you anticipate in future smart city initiatives?</li> </ul>

<b>Table 12. Interview Guide Non-Technical Domain</b>	
<b>Non-technical problem domain</b>	<b>Generated Interview Questions</b>
<p><b>Collaboration</b></p> <ul style="list-style-type: none"> <li>- Weak collaborative engagement with internal stakeholders</li> <li>- Weak collaborative engagement with external stakeholders</li> <li>- The lack of an aligned vision of the city development</li> <li>- Issues concerning institutional resistance</li> </ul> <p><b>Financial</b></p> <ul style="list-style-type: none"> <li>- Limited funds for smart city initiatives</li> <li>- Difficult to monetize on smart city investments</li> <li>- Large up-front investment</li> <li>- Long term delay before reaching maturity / profitability</li> </ul> <p><b>Governance</b></p> <ul style="list-style-type: none"> <li>- Control creep, the hollowing out of state provided services, widening inequalities and dispossession of land and livelihoods</li> <li>- Formulating the right governance structure given organizational barriers to supporting smart city initiatives</li> </ul> <p><b>Contextual</b></p> <ul style="list-style-type: none"> <li>- Influence of geographical variables, exportation of best practices may not occur easily</li> <li>- Difficult to extend local imitations to multi-city projects due to the localized character of initiatives</li> <li>- The use of canonical examples and one-size fits all narratives</li> </ul> <p><b>Political</b></p> <ul style="list-style-type: none"> <li>- Political uncertainties hampering public and private investments</li> <li>- Political hyper-activism</li> </ul>	<ul style="list-style-type: none"> <li>- Have you experienced any difficulties in collaborating with internal and external stakeholders? If yes, what would that be?</li> <li>- What is your vision of smart city and what stakeholders does it concern?</li> </ul> <ul style="list-style-type: none"> <li>- How do you measure anticipated investments in smart city?</li> <li>- What you experienced any financial challenges with investing in smart city initiatives? And if Yes – What would that be?</li> </ul> <ul style="list-style-type: none"> <li>- What difficulties have you experienced from a governmental perspective?</li> <li>- Who provides and owns control over city services in your smart city?</li> <li>- Are there any barriers for organizations to support the smart city?</li> </ul> <ul style="list-style-type: none"> <li>- Do you imitate other smart city initiatives within and outside city borders?</li> <li>- How has that worked out for you?</li> </ul> <ul style="list-style-type: none"> <li>- How is politics influencing smart city investments?</li> </ul>

**Table 12. Interview Guide Technical Domain**

Technical problem domain	Generated Interview Questions
<p>Security</p> <ul style="list-style-type: none"> <li>- Big Data in public clouds brings with it issues relating to security</li> <li>- Challenges of smart city infrastructure integration: Security concerns</li> <li>- Outsourcing of power and control to private sector providers</li> </ul> <p>Interoperability</p> <ul style="list-style-type: none"> <li>- Issues of service interoperability</li> <li>- Smart city infrastructure integration: system interoperability</li> </ul> <p>Privacy</p> <ul style="list-style-type: none"> <li>- How to make sense and best use of such 'big data', while preserving citizens' privacy and data security</li> <li>- Key issue relates to the privacy of the information monitored by sensors, and to the implications that the violation of this principle can have on citizens' routines and habits in case of malicious or unintentional data exposure Smart city technologies may encourage increased surveillance</li> </ul>	<ul style="list-style-type: none"> <li>- What experienced problems stem from technology in smart city initiatives?</li> <li>- How do you monitor citizens?</li> <li>- How do you manage privacy?</li> </ul> <ul style="list-style-type: none"> <li>- How is the power and control over services distributed amongst the stakeholders?</li> <li>- Have you experienced any difficulties with that?</li> <li>- Any technology generating security problems?</li> </ul> <ul style="list-style-type: none"> <li>- How are the services received by the stakeholders? (Understood, appreciated)</li> <li>- How did you perceive the system interoperability? (Integration, compatible)</li> </ul>



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