Master's Degree Thesis

Smart Cities: Strategic Sustainable Development for an Urban World

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Abstract: Global urbanisation trends and pressing issues around sustainability pose great challenges for cities. The smart city concept has been developed as a strategy for working with cities as they become systematically more complex through interconnected frameworks, and increasingly rely on the use of Information and Communication Technology to meet the needs of their citizens. This thesis explores the concept of smart cities as a potential urban construct that can address the social and ecological sustainability challenges which society faces. Smart cities are defined as cities where *investments in human and social capital, and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*. Through structured interviews with smart city practitioners and sustainability experts, the strengths and limitations of the smart city concept are identified and organised through the Framework for Strategic Sustainable Development (FSSD). Then, a Strategic Sustainable Development (SSD) approach is applied as a method to maximise the benefits of the concept, and to mitigate any identified limitations. This thesis recommends a planning guide, informed by an SSD approach, to help smart cities move strategically towards their smart city vision and also move society towards sustainability.

Keywords: Smart City, Sustainability, Strategic Sustainable Development, Citizen Participation, ICT, Strategic Planning Process

Statement of Contribution

This thesis has been achieved through a collaborative method from the three members of the group who came together through the shared desire to study cities in a sustainability context. All members made a significant and equal contribution enabling the finalisation of this project. By bringing our personalities, motivations and previous experiences together, we all contributed in our own unique manner and complemented one another.

Her verbal and written communication skills allowed Caroline to contribute to the content of meetings, advisory correspondence and the detailed editing of the thesis through diligence and attention to detail. Due to his strong organisational skills, critical thinking and experience in leadership, Joseph structured and organised our work processes, established a continuous work discipline and ensured the production of our deliverables. With strong analytical skills, reliability and her ability to multitask, Sonya contributed to the significance of our report with devotion and enthusiasm, and maintained the link between our thesis team and our advisors.

We all co-created the design of the three phases of our research and throughout the whole process all decisions were consensus-based and tasks were divided equally amongst us. We worked very closely together and made sure to continuously support and guide each other, and keep a wonderful and loving atmosphere within the group.

Sonya Frey Joseph E. Kelemen Caroline Colldahl

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Executive Summary

Introduction

Human development since the Industrial Revolution has had serious impacts on the environment, and the growth and destructive actions of human society have resulted in negative impacts on the Earth's sub-systems (Steffen et al. 2011). We are therefore facing a systematic sustainability challenge (Ny et al. 2006), wherein human behaviour cannot continue on the same course without having significant negative impacts on future generations' ability to meet their needs (O'Brien 1999). Reaching sustainability will require significant and widespread changes in human behaviour.

The global urbanisation trend is creating an urgency to find smarter ways to manage the accompanying challenges (Nam and Pardo 2011). Sustainable cities have become a highly desired goal for future urban development. For the scope of this thesis, we focus on the concept of smart cities, defined as cities where "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu, Del Bo and Nijkamp 2011, 6). Smart cities highlight important aspects of sustainability, such as the need for responsible resource management, energy efficiency, and citizen engagement. However, the smart city concept can only help a city to reach sustainability if it allows it to function within the natural boundaries of the Earth. Given the present day understanding of the smart city concept, it is unclear whether it holds the necessary characteristics to ensure that sustainable development can occur. Smart cities are highly complex and interdependent, since they are built from large, interconnected systems. Studying them would therefore require an approach that works well in complexity. By studying the smart city concept through a Strategic Sustainable Development (SSD) approach, one is able to examine it from a systems perspective, and evaluate whether sustainability can be reached in a strategic manner.

Applying sustainable development in a strategic manner is achieved through a systems-thinking approach, an understanding of sustainability through a definition that is based on scientifically-reviewed principles, and a backcasting-from-principles strategy. The SSD approach can be applied through a framework, referred to as the Framework for Strategic Sustainable Development (FSSD). This allows for various stakeholders working within a concept to develop a shared mental model, which aids in the understanding and planning for complex problems.

The purpose of our research will be to explore the concept of smart cities through a lens of sustainability, informed by an SSD approach. The inherent systems thinking mindset within the SSD approach allows us to effectively examine and address problems that are complex and require innovative solutions. We seek to investigate whether the increasingly popular concept of smart cities can truly be applied as an approach for making cities sustainable. Any identified opportunities for enhancements of the concept will be addressed with recommendations based on an FSSD perspective.

Our thesis intends to answer the following overarching question, hereafter referred to as the main research question: *What recommendations can be made to help smart cities move more effectively and efficiently towards sustainability?*

In order to address the main research question, our thesis intends to answer the following three secondary research questions:

Research Question 1: What does the FSSD reveal about the smart city concept in moving a city towards sustainability?

Research Question 2: What are the experiences of practitioners currently applying the smart city concept?

Research Question 3: What insights can practitioners with FSSD experience offer in addressing the challenges identified by the smart city practitioners?

Methods

Joseph Maxwell's (2005) interactive model for research design was used to structure our research around five key components: goals, conceptual framework, research questions, methods, and validity. Through the grounded theory approach, we examined our results in a way that allowed for theories to emerge from the collected data. Further, the Smart City Model and the FSSD provided conceptual frameworks which informed our data collection and analysis process.

Our research was divided into three phases:

Phase 1 consisted of a literature review, exploratory interviews, and the development of the research design. During this phase, we gathered information about the smart city concept through an extensive review of the existing literature. We also conducted exploratory interviews with researchers and practitioners in the area of smart cities in order to gain an understanding of the concept. Through this process, we identified aspects of the smart city concept that may conflict with sustainable development, and these findings in turn informed our research questions.

During **Phase 2**, we conducted an FSSD analysis of the smart city concept that enabled us to understand any benefits and limitations of the concept in terms of socio-ecological sustainability. These results were coded along the generic five-level framework for planning, and compared to the levels of the FSSD. Informed by the differences identified in the FSSD analysis, we conducted interviews with smart city practitioners in order to gain an understanding of the real world application of the concept. These responses were analysed and coded along the five levels of the FSSD. Based on the responses we received from the smart city practitioners, we identified common challenges with the application of the concept with regards to sustainability. These challenges were then used as a basis to inform our interviews which were conducted with FSSD practitioners. These practitioners offered us recommendations on how to address these challenges in order to aid the development of a smart city to occur in a sustainable manner.

During **Phase 3**, the results of the interviews and the FSSD gap analysis were discussed to better understand the potential smart cities have in reaching sustainability. Given the limitations that were identified through this thesis, we developed a strategic planning process that contained recommendations on how smart city practitioners can apply the smart city concept in a more strategic way to help cities more efficiently and effectively move towards sustainability.

Results

To answer our first research question, we conducted an FSSD analysis to identify any commonalities and differences between the smart city concept and the FSSD. We identified that the smart city concept focuses on examining the city and its sub-systems within it, which differs from an SSD perspective, which emphasises the importance of understanding the role of a system in terms of the greater socio-ecological system. Success for the smart city concept is defined as being "well-performing in six characteristics [of the Smart City Model]" (Giffinger et al. 2007, 11). Although this definition of success already places emphasis on sustainability, gaps emerge when viewing them through the lens of the FSSD. Without a strategic framework that applies a principled definition of success, actions that are implemented carry a risk of being inefficient, ineffective, or contradictory to the overall sustainability goals of a city. From a strategic perspective, the smart city concept applies aspects of backcasting-from-scenarios from its existing definitions of success. Contrasted to the prioritisation recommendations from the FSSD, the prioritisation process for smart city initiatives can be considered incomplete if it only recognises return on investment. Although the actions recommended by the smart city concept attempt to incorporate sustainability, the absence of a principled definition of success along with strategic guidelines creates a risk that actions and initiatives taken may result in unsustainable outcomes. The existing tools that aid smart cities in reaching success are developed individually, based on the cities interpretation of the smart city concept, and the needs they have identified within their context. Further, communication platforms exist that allow for smart cities to collaborate and cooperate on various smart initiatives.

To answer our second research question, we conducted semi-structured interviews with smart city practitioners to gain insight on their experience of using the concept in real-world contexts. Results from our interviews found that practitioners in general held positive attitudes about the smart city concept. Interview results also highlighted challenges that occur at the various levels of the FSSD. We found that the smart city concept is difficult to define, and issues can arise without a shared understanding. Smart city practitioners also noted that there is no central definition of success within the characteristics of the Smart City Model, and that an understanding of sustainability is often not shared between the different stakeholder groups. Various strategic planning process models were expressed, and backcasting was frequently applied to reach the goals outlined by the cities' steering documents and climate plans. Consistently, smart city practitioners expressed the importance of involving citizens and stakeholders in the planning and decision-making groups, but they also expressed difficulties in holding effective engagement processes. Further, prioritisation processes were often determined by political ambitions and available budgets.

Through speaking to smart city practitioners and completing an FSSD gap analysis, we identified various challenges that could be overcome through the application of an SSD approach. Eight FSSD practitioners were interviewed about their methods in applying the SSD approach, and they offered recommendations and suggestions on how to overcome limitations in terms of sustainability within the smart city concept. Recommendations were made with respects to sustainable urban development, effective planning, measuring success, engaging stakeholders, and developing actions plans through prioritisation processes.

Discussion

The discussion explores how the concept of smart cities can help urban environments develop in a more sustainable manner. Identified limitations bring forth a need for a strategic planning process to be implemented. By combining our results from the three research questions with an existing SSD planning tool, we were able to develop a planning and decision-making process that offers guidance to smart city practitioners on how to move their communities strategically towards sustainability.

The process consists of six phases:

Phase 1: Get ready
Phase 2: Create a Smart City Vision
Phase 3: Baseline Assessment
Phase 4: Brainstorm Compelling Smart City Actions
Phase 5: Prioritisation Process and Strategic Action Plan
Phase 6: Assessment Stage

Phase 1 involves preparing for the planning process through the assembly of the core team, task organisation, and providing education of the SSD approach. Phase 2 focuses on developing a smart city vision through a participatory process that involves a wide variety of stakeholders. In this phase, success is defined within each of the smart city characteristics and framed within the conditions necessary for sustainability. During phase 3, practitioners assess the current realities of a smart city, and through this, strategically important areas for sustainable development are identified. During Phase 4, actions are brainstormed through a backcasting strategy, with the input of various stakeholder groups. This list of actions is then developed into a strategic action plan during Phase 5 through a prioritisation process. Phase 6 is the assessment stage where the progress of various initiatives is evaluated and communicated to the public. This phase also provides smart city practitioners with the ability to reassess the planning process, and to make necessary modifications to their strategic action plan.

Conclusion

The smart city concept is a powerful approach for moving cities towards sustainability in an increasingly urbanised world. Through the application of an SSD approach, current sustainability limitations of the smart city concept can be mitigated, leading cities to develop towards sustainability in a more efficient and effective manner.

Glossary

ABCD Planning Process (ABCD): A four-step strategic planning process designed to implement a Strategic Sustainable Development approach (Ny et al. 2006).

Action: "Any project or activity of human origin" (Canadian Environmental Assessment Agency 2013).

Backcasting: A strategic planning method, in which a desired successful future is envisioned first, and steps are defined to attain those conditions based on the current reality (Ny et al. 2006).

Backcasting from Sustainability Principles: A strategic planning method utilising a shared vision of success framed within the four Sustainability Principles (SPs), in order to plan towards the envisioned future in a strategic step-by-step manner (Holmberg and Robèrt 2000).

Baseline Information: "A description of existing environmental, social and economic conditions at and surrounding an action" (Canadian Environmental Assessment Agency 2013).

Benchmarking: The use of structured comparisons to help define and implement best practices (NHS 2009).

Biosphere: The portion of the Earth that "encompasses all biological activity, which is of vital importance to the functioning of natural and human engineered ecosystems, and by extension the services nature provides free of charge to human society" (Chiaviello and Amar 2011, 39).

Complex system: A system that consists of a relatively large number of parts that interact in complex ways and produce a behaviour that can occasionally be counterintuitive and unpredictable (Robèrt et al. 2010).

Community: The people of a district or country considered collectively, especially in the context of social values and responsibilities (Oxford Dictionaries 2013).

Community Engagement: The involvement of the community in the creation and implementation of major decisions (TNS Canada 2013a).

Creative tension: The gap between the current reality and the envisioned future (Senge et al. 1994).

Data: "Information output by a sensing device or organ that includes both useful and irrelevant or redundant information and must be processed to be meaningful" (Merriam-Webster 2013).

Evaluation: "The determination of the significance of effects. Evaluation involves making judgements as to the value of what is being affected and the risk that the effect will occur and be unacceptable" (Canadian Environmental Assessment Agency 2013).

Five-Level Framework for Planning in Complex Systems (5LF): A generic framework for planning, analysing and decision-making in complex systems utilising five distinct, non-overlapping levels: Systems, Success, Strategic, Actions, and Tools (Robèrt et al. 2002).

Framework for Strategic Sustainable Development (FSSD): "A generic five level framework used to understand and plan progress towards a sustainable society using backcasting from Sustainability Principles to prioritise strategic actions" (TNS Canada 2013a).

Grounded theory: A constant comparative method, which is a frequently applied and valid research strategy within qualitative research (Glaser and Strauss 1967, Kolb 2012).

Governance: "The action or manner of governing a state or organisation" (Oxford Dictionaries 2013).

Holistic: An approach that is "relating to or concerned with wholes or with complete systems rather than with the analysis of, treatment of, or dissection into parts" (Merriam-Webster 2013)

Information and Communication Technology (ICT): Technologies that provide access to information through telecommunications. ICT is similar to Information Technology (IT), but with a primary focus on communication technologies, such as the Internet, cell phones, wireless networks and other communication mediums (Tech Terms 2010).

Indicator: "Anything used to measure the condition of something of interest. Indicators are often used as variables in the modelling of changes in complex environmental systems" (Canadian Environmental Assessment 2013).

Key Performance Indicator (KPI): "Represent a set of measures focusing on those aspects of organisational performance that are the most critical for the current and future success of the organisation" (Parmenter 2010, 4).

Lithosphere: "The outer solid part of the Earth including the crust and uppermost mantle" (US Geological Survey 2012).

Measures: "The dimensions, capacity, or amount of something ascertained by measuring" (Merriam-Webster 2013).

Monitoring: "A continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted" (Canadian Environmental Assessment Agency 2013).

Participation: The notion of taking part, sharing and acting together (Tilbury and Wortman 2004, 50).

PESTLE analysis: An analysis that can be used to define external trends within the political, economic, social, technological, legal and environmental areas, which have an effect on the external environment of an organisation (Cambridge Business English Dictionary 2013)

Platform: "A hardware and/or software architecture that serves as a foundation or base" (PC Magazine 2013).

Region: "Any area in which it is suspected or known that effects due to the action under review may interact with effects from other actions. This area typically extends beyond the local study area; however, how far it extends will vary greatly depending on the nature of the cause-effect relationships involved" (Canadian Environmental Assessment Agency 2013).

Six characteristics: Refers to the six characteristics of the Smart City Model. Each characteristic comes with a set of factors that evaluate success under each characteristic. The characteristics are: Smart People, Smart Environment, Smart Living, Smart Mobility, Smart Economy and Smart Governance. (Giffinger et al. 2007)

Smart City: A city where "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu, Del Bo and Nijkamp 2011, 6).

Smart City Model: A classification system under which smart cities can be developed and assessed through six distinct characteristics (Giffinger et al. 2007).

Smart grid: "A class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation" (US Department of Energy 2013).

Society: "A human community, usually with a relatively fixed territorial location, sharing a common culture and common activities" (ICAAP 2013).

Socio-ecological system: The system made up of human society within the biosphere (Boyden 1994).

Stakeholder: Any individual, entity or group who has a direct or indirect interest in an organisation because they can affect the organisation or be affected by the organisation's actions, objectives, and policies (TNS 2013a).

Strategic Sustainable Development (SSD): A development and planning approach based on first-order principles for sustainability. Encompasses systems thinking, the funnel metaphor, the four Sustainability Principles (SPs), backcasting, and the FSSD (TNS Canada 2013a).

Sustainability Challenge: The continuing decline in capacity and resources that support human society, under which a continuous decline creates conditions that no longer enable human society to sustain itself (Robèrt 2000).

Sustainability Principles (SP): "First-order principles for sustainability that are designed for backcasting from sustainability" and are based on scientific laws and knowledge (TNS Canada 2013b, Ny et al. 2006).

Systems thinking: "An approach to problem solving that assumes the individual problem is part of a much larger system. This approach is particularly important in complex systems where the interconnection between parts is not always clearly understood" (TNS Canada 2013a).

Transparency: A "lack of hidden agenda and conditions, accompanied by the availability of full information required for collaboration, cooperation, and collective decision-making" (Business Dictionary 2013).

Table of Contents

List of Figures

1 Introduction

1.1 The Sustainability Challenge

When examining Earth from a 'systems thinking' perspective, it is evident that society today is behaving in ways that are both socially and ecologically unsustainable. Our development since the Industrial Revolution has had significant impacts on the environment, and we are now well within an era where the changes on Earth can be largely attributed to destructive, widespread human behaviours (Steffen et al. 2011). Earth itself is a closed system to matter, but is open to energy, primarily in the form of solar energy (Victor 1991). Within our planet, sub-systems such as the Biosphere and Lithosphere[1] exist, between which matter and energy naturally flow and are exchanged. Life on earth inhabits the Biosphere, wherein living organisms exchange matter and energy with their ecosystems through natural cycles. Without the interference of human activity, these cycles oscillate through natural rhythms. However, today the growth and destructive actions of human society have resulted in negative impacts on these sub-systems, and we are therefore facing a systematic sustainability challenge (Ny et al. 2006). Examples of such can be seen through systematic increases of pollutants and man-made chemicals in the natural world (Law and Stohl 2007; Nriago 1990), increasing levels of atmospheric carbon due to the burning of fossil fuels (Canadell et al. 2007) and the vast destruction of natural habitats (Kennish 2002; Vitousek et al. 1997). Further, the structure of society functions within a system that no longer allows all individuals to meet their basic human needs. This can be observed through social problems such as inequality and an erosion of trust within our social fabric (Gustavsson and Jordahl 2008). If such behavioural patterns continue, the Earth will lose its ability to provide us with the necessary resources and conditions to meet our human needs.

It is evident that this behavioural trajectory cannot continue without having significant negative impacts on future generations' ability to meeting their needs (O'Brien 1999). The sustainability challenge can be described through the use of a funnel metaphor (Figure 1.1). This metaphor depicts civilization entering a funnel where the narrowing walls represent the continuously degrading socio-ecological system, through resource depletion, destruction of ecosystems, and social conflicts, which are brought on by society's unsustainable activities. By disregarding the funnel walls, we fail to recognise the continuing decline in capacity and resources to support human society, and create conditions that no longer can sustain human activity (Robèrt 2000). The question mark in the image represents the unforeseeable future if humankind's behavioural patterns continue. In order to reach social and ecological sustainability, society must adapt to functioning in a manner that does not disrupt the natural balances within the systems on Earth.

[1] The biosphere "encompasses all biological activity on Earth, which is of vital importance to the functioning of natural and human-engineered ecosystems, and by extension, the services that nature provides free of charge to human society" (Chiaviello and Amar 2011, 39). The lithosphere "is the outer solid part of the earth, including the crust and uppermost mantle" (US Geological Survey 2012).

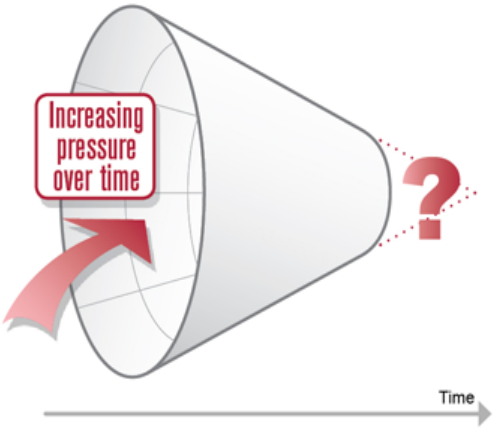

Figure 1.1 The Funnel Metaphor (TNS Canada 2013c)

1.2 Cities and the Sustainability Challenge

Half of the world's population is currently residing in cities, and it is expected that this number will rise to 70% by 2050 (UN World Urbanization Prospects 2011). In Europe alone, 80% of citizens live and work in cities (Correia and Wunstel 2011). Cities are developing into epicentres of economic growth, and it is projected that by 2025, 600 of the world's largest cities will produce 60% of the global GDP (McKinsey Global Institute 2011). With 80% of global greenhouse gas emissions originating from them (Lazaoiu and Roscia 2012), cities deliver a significant contribution to climate change. This unparalleled rate of urban growth is creating an urgency to find smarter ways to manage the accompanying challenges (Nam and Pardo 2011). However, most cities do not have strategies in place that are sufficiently progressive to adapt to the inevitable population increases occurring across the globe. As cities continue to grow, many will be stretched beyond the capacities of their infrastructure, and will suffer adverse consequences (Antrop 2004).

Cities inherently face vast challenges, which can only be resolved through a systematic approach. Simply the gathering of such a large amount of people tends to lead to disorder (Johnson 2008). Murray, Minevich, and Abdoullaev (2011) point to current waves of social unrest experienced throughout the world as a clear indication that our old institutions are inconsistent with a complex and fast changing world. Borja (2007) identifies costly consequences, such as difficulties in waste and resource management, increased air pollution and other concerns such as traffic congestion, and that resource systems have been developed in isolation of each other (Sustainable Cities International 2010). Washburn (2010) also identifies other technical and physical problems such as deteriorating and outdated infrastructures within cities. Further, these problems are aggravated by the high levels of diverse stakeholders, social and political complexity and mutuality (Chourabi 2012), constantly changing political leadership, and financial resources which have not been kept level with cities' needs (Sustainable Cities International 2010).

However, the characteristics of cities also make them an excellent platform to experiment and prototype future sustainability initiatives. Cities hold the potential to be sustainable because they are self-organising learning systems, which allow communities to learn and work with each other (Innes and Boore 2000). Factors such as high living density and a dependence on shared resources place cities in the position as being platforms for sustainable development, since they possess characteristics under which sustainability can be modelled (UN

Worldbank 2012). Murray, Minevich, and Abdoullaev (2011) point out that as cities grow, they can develop in ways that meet the economic, environmental, social and cultural needs of their citizens.

1.2.1 Moving Cities towards Sustainability

Sustainable cities have become a highly desired goal for future urban development. However, there are several differentiating descriptions of what exactly a sustainable city should look like. According to the think-tank Sustainable Cities International (2010), a city should adopt city-specific sustainable development strategies in order to foster innovation and advancements within infrastructure and technology, whilst also increasing efficiency gains. Bulkeley and Betsill (2005) address how strongly cities and local governments actually can influence the challenges of sustainability. Several obstacles are faced when creating a sustainable city, and the interpretation and implementation of sustainability are shaped by the various forms of governance, which challenges the traditional distinctions between local, national and global politics. Bulkeley and Betsill (2005) further argue for long-term approaches that centre on sustainability, to ensure that cities can better anticipate and cope with rapidly changing conditions.

Cities can be seen as motors used to move towards sustainable development, and the management of these complex systems requires innovative and sophisticated planning tools and concepts (Rotmans, Asselt, and Vellinga 2000). Rather than being independent from one another, Nam and Pardo (2012) state that the existing planning tools and concepts are mutually connected and overlap with each other. This can result in vast confusion in terms of definitions, which in turn complicates the application and usage of such tools and concepts. Jabareen (2006) identifies four types of sustainable urban forms, and describes how their design concepts contribute towards sustainability: neo-traditional development, the urban containment, the compact city, and the eco-city. Schatz (2007) identifies the three types of developments within our increasingly urbanised habitats as being the digital city, the intelligent city, and the smart city. Murray, Minevich, and Abdoullaev (2011) identify three solutions for cities moving towards sustainability: knowledge cities, which focus heavily on education, lifelong learning and personal growth; digital cities or cyber-cities, driven primarily by investments from large information and communications technology vendors aiming to enable vast interconnectedness; and eco-cities, which focus on environmental sustainability through the widespread adoption of renewable resources. Murray, Minevich, and Abdoullaev further state that a holistic and systemic integration of these three city types results in a new urban planning approach, namely, the smart city. Batagan (2011) states that this systemic approach can address the sustainability challenges in the urban context.

1.3 Smart Cities

The concept of smart cities is difficult to define. While the description of a smart city is often context dependent, it is commonly understood that a city is not smart when: 1) There is too much of everything in it; exemplified by an excess of vehicles, food, water, and energy consumption; 2) the various networks within a city are unable to communicate and function as a whole-system; 3) the networks within a city are static and inflexible; and 4) the stakeholders within a city are not involved at all levels of decision-making and planning processes that develop and evolve a city towards its vision (Copenhagen Cleantech Cluster 2012). However, identifying an operational definition for the scope of this thesis requires a closer examination of context-specific definitions.

1.3.1 Smart City Definitions

The conceptual components of a smart city can be divided into three categories: technology, people and institution. A city can therefore be considered as smart when investments in these specific areas of development lead to sustainable growth and enhanced quality of life (Dawes and Pardo 2002). According to Toppeta (2010), a smart city strives to combine Information and Communication Technologies (ICT) and Web 2.0 technology with other urban planning methods in order to find innovative, intelligent and efficient solutions, contributing to increased sustainability and liveability for its citizens. However, it is important to recognise that the concept of smart cities is not just limited to technological advancements, but rather aims to promote socioeconomic development (Nam and Pardo 2011). Social inclusion is a key characteristic of smart cities (Allwinke and Cruickshank 2011), and any opportunities for economic development need to be coupled with investments in social capital (Scott 2010). Smart cities can be summarised as being places that are forward thinking in the areas of people, living, economy, governance, environment, and mobility (Giffinger et al. 2007). For the purpose of this thesis, we have therefore selected the definition put forth by Caragliu, Del Bo, and Nijkamp (2011, 6) which states that a city is smart "when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance".

1.3.2 Characteristics of Smart Cities

The definition of smart cities by Caragliu, Del Bo, and Nijkamp (2011) is based on the Smart City Model, developed by Giffinger et al. (2007). This model is a classification system under which smart cities can be assessed and developed through six distinct characteristics (see Figure 1.2). The Smart City Model was developed as a ranking tool for evaluating mid-sized European smart cities in the areas of economy, people, governance, mobility, environment and living. Through this model, a city can examine its current state, and in turn identify the areas that require further development in order to meet the necessary conditions of a smart city (Giffinger et al. 2007). Cities can use this model to individually create goals based on their unique circumstances by following the vision outlined by the six characteristics (Giffinger et al. 2007; Steinert et al. 2011).

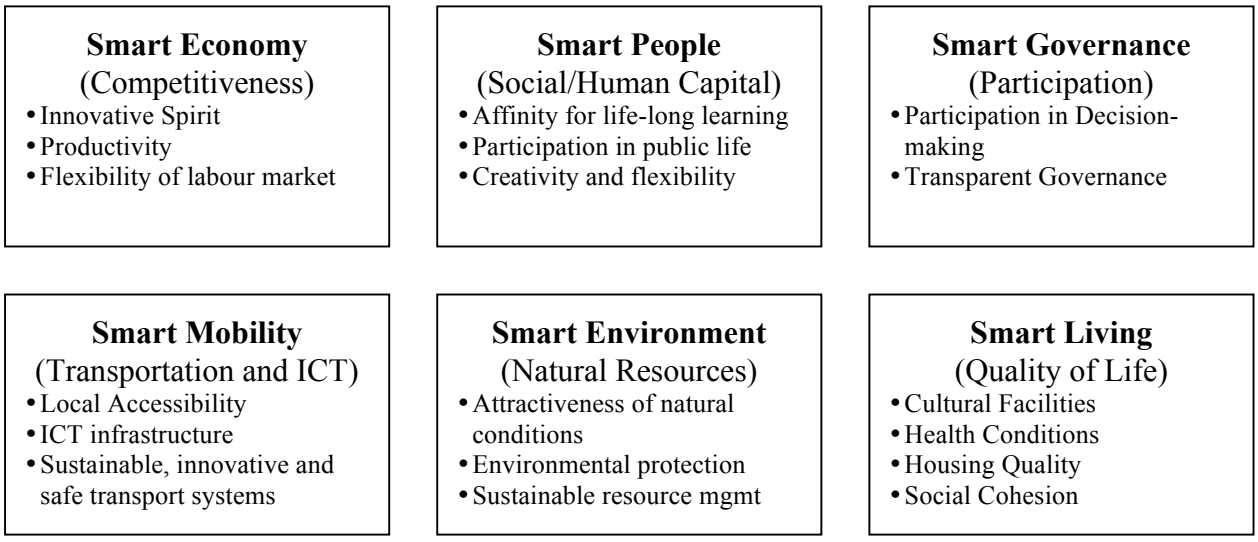

Figure 1.2 Six Characteristics of the Smart City Model (Giffinger et al. 2007)

Smart Economy refers to a city's overall competitiveness, based on its innovative approach to business, research and development (R&D) expenditures, entrepreneurship opportunities, productivity and flexibility of the labour markets, and the economical role of the city in the national and international market.

Smart People means delivering a high and consistent level of education to the citizens, and also describes the quality of social interactions, cultural awareness, open-mindedness and the level of participation that citizens hold in their interactions with the public life.

Smart Governance more specifically addresses participation at a municipal level. The governance system is transparent and allows for citizens to partake in decision-making. ICT infrastructure makes it easy for citizens to access information and data concerning the management of their city. By creating a more efficient and interconnected governance system, barriers related to communication and collaboration can be eliminated.

Smart Mobility advocates more efficient transportation systems (e.g. non-motorised options) and promotes new social attitudes towards vehicle usage, ensuring that citizens have access to local and public transportation, and that ICT again is integrated to increase efficiency. Smart cities seek to increase how efficiently people, goods, and vehicles are transported in an urban environment.

Smart Environment emphasises the need for responsible resource management and sustainable urban planning. Through pollution and emission reductions, and efforts towards environmental protection, the natural beauty of the city can be enhanced. Smart cities promote the reduction of energy consumption, and the integration of new technological innovations that result in efficiency gains.

Smart Living seeks to enhance the quality of life of citizens, and does so by providing healthy and safe living conditions. Citizens in smart cities have easy access to health care services, electronic health management, and to diverse social services.

1.3.3 Pathways of Influence for Smart Cities

In order for a city to develop within the six characteristics of the Smart City Model, Nam and Pardo (2012) suggest that strategic plans need to be implemented through three pathways. These can be categorised as *technological*, *human*, and *institutional* pathways. Prioritising actions at this stage is heavily reliant on financial availability, so smart city researchers often recommend that actions should "go lean" in terms of financial investment (Cohen 2012).

The technological pathways are also referred to as the instrumental-economic perspective (Huber and Mayer 2012), and outline the necessity for well-functioning and connected infrastructures to exist within a city. ICT networks allow cities to collect, process, and analyse data, with the goal being to gain predictive insight that will allow officials to make strategic decisions and actions (Arup 2010). Further, virtual and ubiquitous technology becomes important in a smart city where inhabitants live increasingly mobile lives (O'Grady and O'Hare 2012). To develop the technological aspects of a smart city, innovative technologies need to be incorporated into the city. This strategy "integrates technologies, systems, infrastructures, services, and capabilities into an organic network that is sufficiently complex for unexpected emergent properties to develop" (Nam and Pardo 2012, 288). However, technology alone will not automatically lead a city to becoming smart (Hollands 2008); strategies within human and institutional pathways are also required.

The human pathways refer to the role of human infrastructure, social capital, and education within cities (Nam and Pardo 2012). Citizens within smart cities are encouraged to be creative, well educated, and open to communicate and learn from each other. This can be achieved by breaking down knowledge silos, and instead allowing information to flow freely between people through a transparent and inclusive system (Copenhagen Cleantech Cluster 2012). Within human pathways, the success of a city is dependent on its citizens and their interaction with one another (Nam and Pardo 2012). Citizens are seen as the "creative change agents that jointly shape urban transformation" (Huber and Mayer 2012). It is therefore necessary to adopt a strategic approach that offers increasingly accessible services to all citizens, whilst removing barriers related to language, culture, education, skills development, and disabilities (Coe Paquet and Roy 2001).

Institutional pathways refer to the role of government, and the relationships between government departments and non-governmental organisations. A central purpose of government within a smart city lies in creating an integrated and transparent governance system, engaging in strategic and promotional activities, and reaching out to create partnerships with various stakeholders in a city (Nam and Pardo 2012). From this perspective, smart cities need an inclusive, multi-stakeholder approach to decision-making and planning processes. Strategies within this domain emphasise collaboration and cooperation between governments, stakeholders, and citizens (Nam and Pardo 2012). Further, it is essential for government systems to share their smart city vision (Cohen 2012), goals (Dirks, Gurdiev and Keeling 2010), priorities, and strategic plans (Eger 2009) with the public and appropriate stakeholders.

1.3.4 Actions and Tools for Smart Cities

Cities striving to be smart must take concrete actions that follow their specific strategic plans to reach their determined success (Nam and Pardo 2012). These actions can be organised around the six characteristics of the Smart City Model, and are usually in direct response to the strategic plans along the three pathways of influence mentioned in the previous section. It is important to note that most of the actions within smart cities are executed through the extensive use of ICT.

Smart Economy: The common goal of actions under this characteristic are to enhance the economic strength and competitiveness of the smart city in national and global marketplaces. By initiating actions that create and maintain social network groups for entrepreneurs and collaborating with various stakeholders (e.g. universities, businesses, NGOs) in order to boost innovation through the creation of think tanks (Toppeta 2010), a smart city can improve its economic position. Further, increased access to broadband Internet allows citizens and businesses to use electronic methods in business processes (e.g. e-shopping, e-banking) (Steinert et al. 2011).

Smart People: Within this domain, smart cities strive to become cities with well-educated, socially inclusive and culturally aware citizens. To reach this result, cities can implement actions such as computer-assisted education and life-long learning programs, tailored services focusing on education, workshops and programs about good practices (e.g. sustainability, cultural-awareness) (Toppeta 2010), and initiatives supporting distance education and online courses (Steinert et al. 2011).

Smart Governance: The wide variety of actions connected to this characteristic enable a smart city to develop its governance method to be transparent and inclusive. These actions

are usually based on e-services (e.g. e-government), which connect and enhance collaboration between the governing body of the city and the inhabitants, businesses and institutions (Steinert et al. 2011). Frequently, initiated actions connected to Smart Governance are discussion groups for citizen involvement, platforms for information sharing, dematerialisation of bureaucratic processes, social-media networking, and crowd sourcing to involve stakeholders in decision making (Toppeta 2010).

Smart Mobility: The aims of actions connected to Smart Mobility are to enable a smart city to provide efficient transportation with low environmental impacts. The most common actions implemented by cities and municipalities under this characteristic are better meeting the mobility needs of the citizens with the wise use of urban planning, leading to a shift from individual to collective transportation methods, encouraging the use of non-motorised transportation (e.g. bicycles) and the integration of electric vehicles (Meeus, Delarue and Glachant 2011).

Smart Environment: As this characteristic puts an emphasis on sustainable urban planning and responsible natural resource management, opportunities could be explored in the areas of building stock and city energy management. Under building stocks management, frequent actions involve retrofitting existing buildings with innovative energy technologies (e.g. net-zero concept, solar derived technologies) in order to reduce energy use and CO_2 emissions. Concerning city energy management, opportunities exist that can improve energy infrastructure management (e.g. development of smart grids, shift in energy carriers, electricity production from renewable sources) and also more efficient water and waste management (Meeus, Delarue and Glachant 2011).

Smart Living: With the main focus on enhancing citizens' quality of life, smart cities have the opportunity to introduce actions such as projects in home automation (e.g. smart home, smart building services), develop services which enable citizens to have improved access to healthcare services (e.g. e-health, records management) and ensure the inhabitants are connected to social services through the use of innovative technologies (Van Landegem 2012). Also, ICT-based opportunities exist to enhance public safety, such as surveillance systems or inter-emergency service networks, which can reduce emergency response time (Toppeta 2010).

The European Union and various private-sector businesses, such as Siemens, IBM, and Cisco, are connected to the smart city concept and offer projects that fund action plans, which can aid in the development of smart city initiatives (European Commission 2012). Further, opportunities for inter-city collaboration are encouraged through online platforms, such as the EU Smart Cities and Communities platform, wherein cities can share experiences, practices and submit information for benchmarking in order to help other cities become smarter (Smart Cities and Communities 2012). The EU Smart Cities and Communities platform also offers tools for all phases of a smart city development process (Toppetta 2010). These include tools to understand the concept itself, tools for infrastructure- and network-development, and tools for monitoring and measuring progress. Examples of such tools are presented below.

Tools and models that help planners understand the concept are:

- Citizen Insight (inhabitant preferences/likely demand for public services)
- Standards lists (to understand local government operations across EU) (EDS Toolkit 2011)
- Web-pages and conferences on the topic of smart city

Some of the infrastructure and network development tools and programs are:

- Smart Cites IBM (IBM 2013)
- Smarter Neighborhoods, Smart Buildings SIEMENS (Siemens 2013)
- Box Projects ALCATEL (Alcatel-Lucent 2012)

Evaluation and benchmarking tools include:

- Digital City Self Assessment Tool (analysis tool with an automated reporting component) (Smart Cities 2012)
- Smart Cities Wheel (analysis and evaluation tool based on the six characteristics of the smart cities) (Cohen 2012)

Other tools often associated with the smart city concept:

- E-governance
- Smart Buildings
- Smart Sensors
- Wireless platforms

1.3.5 Smart Cities in the European Union

There are a number of projects in the European Union which fund smart city initiatives. The two major projects, by size, budget, number of members and geographical focus area, are the *Smart Cities and Communities European Innovation Partnership* and the *Smart Cities Project* (European Union n.d., European Commission 2012). The European Commission, one of the main institutions of the European Union responsible for managing and allocating funding, supports and finances these projects (European Union n.d.). The *Smart Cities and Communities European Innovation Partnership* was launched in July 2012, and has allocated €365 million for smart city projects in 2013. This partnership between members from municipalities and energy, transportation, and information technology industries aims to introduce integrated, innovative and efficient technologies for cities. This project seeks to improve municipal services, while decreasing pollution, reducing greenhouse gas emissions, increasing energy efficiency, and improving natural resource management (European Commission 2012). The *Smart Cities Project* is an innovative cooperative project between thirteen partners from six European Union countries from the Northern Sea region, and is funded partially by the *North Sea Region Program 2007-2013* of the European Union, and further by the municipal and academic members themselves. The goal of the project is to create an innovation network between members, in order to develop and provide improved e-services for urban citizens and businesses in the North Sea region, with a focus on sustainability (Smarter Cities 2013).

1.3.6 General Criticisms of Smart Cities

Murray, Minevich, and Abdoullaev (2011) state that in order to achieve the full potential of the smart city, a deep-rooted culture of innovation, learning, and partnership within and between the components of a city is required. A widely diverse population is needed to fuel collaboration and increase knowledge sharing between citizens. Difficulties when aiming to attract and retain this type of population are often faced due to outdated governmental policies and organisational structures in need of reform. Clancy (2013) notes that many smart city pilot programs have overlooked the need for citizen engagement and the public's role in the design process, which could have several negative consequences if the programs were to be implemented on a larger scale. Murray, Minevich, and Abdoullaev (2011) also identify

that the lack of financing is a major obstacle facing smart cities, even though there is research suggesting that the investment in the development of human capital contributes to economic growth.

Hollands (2008) criticises the actual term *smart city*, and refers to it as an urban labelling phenomenon. He claims that the definition is imprecise, self-congratulatory, leads to self-designation, and holds unspoken assumptions. Murray, Minevich, and Abdoullaev (2011) argue that due to the necessary increases in automation and interconnectedness, a smart city becomes vulnerable to large-scale failures as one single error can ripple through and break down the entire system. Future cyber-attacks are deemed as a major threat to smart cities, due to the challenges associated with providing security to a large magnitude of electronic devices and systems. Further, the authors identify socio-political risks associated with smart cities. The increased artificial constructs within a city can have dehumanising effects on its inhabitants, and the high level of monitored control can lead to the breakdown of social order. Further, the business-led approach to smart city development can marginalise people if they are unable to compete (Hollands 2008). This issue is also touched upon by Roumet (2010) who states that, since ICT is so closely related to smart cities, more attention needs to be devoted to issues such as mistrust in ICT, and how the private lives of inhabitants' will be protected.

Smart cities are further criticised based on the premises that the benefits of this urban digital revolution will not be able to reach everyone within the city. Instead of decreasing inequality between citizens, this digital divide may actually deepen social and cultural divisions by increasing the gap between skilled workers attracted to move to the city, and the IT illiterate, poorer, and less educated inhabitants (Peck, 2005; Graham, 2002). Additionally, it has been noted that certain smart city initiatives can have a negative effect on the environment, such as the fossil fuels and chemicals needed for development within transportation and ICT, and the amount of waste created due to the need for continuous technological upgrades (Newman and Kenworthy 1999; Sample 2004). The literature also raises the question of whether economic growth and environmental sustainability in terms of smart cities are compatible, and to what extent they may conflict with each other (Gleeson and Low 2000; Hollands 2008).

Given the current understanding of the global sustainability challenge, the emergence of smart cities can be viewed as a step in the direction of sustainability. Smart cities highlight important aspects of sustainability, such as the need for responsible resource management, energy efficiency, and citizen engagement. Referring back to the funnel metaphor, smart cities hold the potential to manoeuvre within a system that is faced with ever-decreasing resources and increasing demands. However, in order to reach socio-ecological sustainability, wherein a city functions within the natural boundaries of Earth and supports the requirements for a sustained social system, the smart city concept must address its challenges and opportunities in a strategic manner. Given the current understanding of the smart city concept, it is not evident whether it holds the necessary characteristics to ensure that sustainable development occurs. Without strategic guidance, achieving the successes of the six Smart City Model characteristics does not necessarily ensure that sustainability is reached. For example, developments within smart living may well result in resource depletion if materials are not sourced in a responsible manner. Further, increased dependency on technology may marginalise portions of the population who are unable to adapt, which would impede their abilities to meet their needs within a city. Smart cities are also developing into increasingly complex systems since they are built from large, interconnected structures. Studying this would therefore require an approach that allows analysis to occur within

complex systems. A possible approach for developing and planning when aiming to become a smart city is the Strategic Sustainable Development (SSD) approach, which allows a concept to be studied from a systems perspective to ensure that sustainability can be reached.

1.4 Strategic Sustainable Development

As illustrated previously, the funnel metaphor presents a reality wherein human behaviour on Earth is becoming increasingly unsustainable. Realising the vision of a smart city requires a comprehensive understanding of the city's complexities and interconnections between the social components and services and the physical environment (Nam and Pardo 2011). The path towards becoming a sustainable city requires strategic actions and tools, which address the complexities of a system in a holistic manner (Robèrt 2000). Through a Strategic Sustainable Development (SDD) approach, actors within a system can work together to actively transition from the current, unsustainable state of society, to a socially and ecologically sustainable society (Robèrt et al. 2002). Applying sustainable development in a strategic manner is achieved through a systems-thinking approach, an understanding of sustainability through a definition that is based on scientifically agreed-upon principles, and a backcasting from principles strategy. The SSD approach can be applied through a framework, which is referred to as the Framework for Strategic Sustainable Development (FSSD). This framework allows the various stakeholders to share a mental model, which aids in the understanding of the complex problems identified within the smart city concept.

1.4.1 Systems Thinking Approach

Understanding the conditions and factors that influence sustainability, specifically in urban settings, requires a systems-thinking perspective (Davidson and Venning 2011). This perspective calls for an awareness of the systems and sub-systems of any subject, along with the feedbacks and behaviours exhibited through the interactions of the system (Robèrt et al. 2002). In order to examine cities through a lens of sustainability, one must understand the systems under which the city functions. The Copenhagen Cleantech Cluster (2012, 6) states that "the basic premise for the development of smart cities is understanding the city as 'a system of systems': data, energy supply, waste management, infrastructure, transport, etc. The individual systems can be more or less smart or intelligent – and more or less intelligently integrated." Thus, studying a smart city from a systems thinking perspective allows for a better understanding of the interconnections and relationships, and creates the conditions necessary to develop inclusive and effective sustainability initiatives. Further, a systems thinking approach allows for a smart city to be examined within the context of the systems surrounding it, namely the greater social and ecological systems that function beyond the boundaries of the city.

1.4.2 The Sustainability Principles

A principled definition of sustainability presents the minimum necessary conditions under which society needs to operate to function in a sustainable manner (Holmberg and Robèrt 2000; Ny et al. 2006). In order to define sustainability, a rigorous scientific peer-reviewed process was conducted, which resulted in the creation of four principles of sustainability. These are referred to as the four Sustainability Principles, and state that:

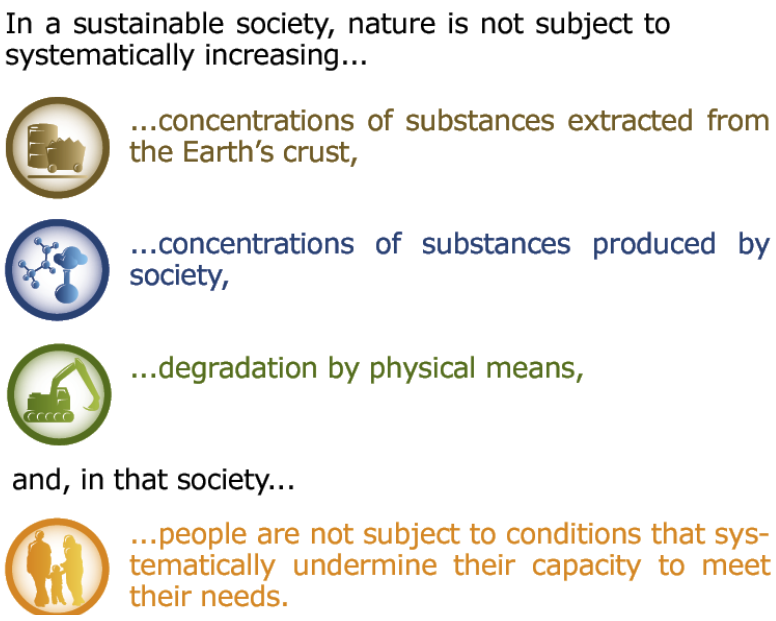

Figure 1.3. The Four Sustainability Principles (Image: TNS Canada 2013b; see Robèrt et al. 2002).

1.4.3 Backcasting from Principles

Creating strategies and executing actions that take both short-term and long-term perspectives into account can be done through a backcasting from principles approach that works towards a vision of success set in the future (Holmberg and Robèrt 2000). Unlike forecasting, which uses current trends and paradigms to inform future outcomes, backcasting applies a perspective that highlights the overall goal to work towards. This approach is particularly well suited for complex problems such as sustainability, since significant changes are required and current approaches are unable to fully address such issues (Dreborg 1996).

Backcasting starts with a vision that outlines what an ideal future would look like. To ensure that the vision remains sustainable, an SSD approach dictates that it be framed within the boundaries of the four Sustainability Principles. As long as the vision remains in line with these four principles, actions can be taken that will progressively move towards sustainability.

1.4.4 The Framework for Strategic Sustainable Development

Addressing the sustainability challenge without undermining the complexity of the problem requires a framework that allows practitioners to communicate through a shared mental model. Solving intricate problems can be done through a Five Level Framework for Planning in Complex Systems (5LF), which allows for problem analysis and decision making strategies to be developed through five categorical levels (see Figure 1.4) (Waldron et al. 2008). When applied to sustainability, this framework provides practitioners with the necessary model to understand the sustainability issues in a given setting. This is referred to as the Framework for Strategic Sustainable Development (FSSD), which describes five categorical levels through a sustainability lens (Robèrt et al. 2002).

On the Systems level, the various antecedent conditions and outcomes of systems and sub-systems are illustrated. The sustainability challenge is described at this stage, along with the interconnections between the various systems, and the role a given system has within the greater biosphere. This level also requires a closer examination of the scientific laws that govern the natural world; specifically the Laws of Thermodynamics (TNS 2013b). At the Success level, the overarching goal of being sustainable is described through the four Sustainability Principles, and applied to the given system. Planning can be done through these principles, since they are based on a scientific-agreed upon view of the world, and necessary, sufficient, general and concrete enough to achieve sustainability. Also, these Sustainability Principles are mutually exclusive to increase clarity (Holmberg and Robèrt 2000). The Strategic level applies backcasting from principles as a strategic guideline, and proposes prioritisation questions that help practitioners determine which actions should be implemented. The FSSD advises for an upstream thinking approach, which means addressing a problem at its root cause, rather than merely finding solutions for any resulting consequences or symptoms. Developed actions can then be prioritised through a minimum of three strategic prioritisation questions, which ask: i) Does this action proceed in the right direction, with respect to the Sustainability Principles? ii) Does this action provide a flexible platform to link future investments in the same direction?, and iii) Is this action likely to produce a good return on investment (not limited to financial returns)? (Robèrt 2000). Initiatives and actions that align with the prioritisation guidelines created in the Strategic level are then developed and implemented under the Actions level. The Tools level describes instruments that support and measure actions, thus aiding in the implementation of the overall plans and its objectives (Robèrt et al. 2002).

Figure 1.4 Framework for Strategic Sustainable Development (Image: TNS Canada 2013)

1.5 Research Purpose

Current urbanisation trends predict that most of the world's population in the future will reside in cities (UN World Urbanization Prospects 2009). Understanding the features that facilitate cities being sustainable is key in creating a future where humankind can flourish and live in balance with the natural world. The rise of smart cities is a promising trend, since some emphasis on sustainability is already included in the concept. However, facing the complexity of the sustainability challenge can be aided through a strategic understanding of what is required to reach sustainability in an urban context. Therefore, the purpose of our research will be to explore the concept of smart cities through a sustainability lens to identify any areas that can be improved through an SSD approach. Through a systems-thinking approach that is based on a principled understanding of sustainability, the SSD approach is particularly effective in addressing problems that are complex and require innovative solutions. By examining the smart city concept through the FSSD, we seek to investigate whether this increasingly popular concept can truly be an approach for making cities sustainable. Any identified opportunities for enhancements of the concept will then be addressed with recommendations based on an SSD perspective.

1.5.1 Research Questions

Our thesis intends to answer the following overarching question, hereafter referred to as the main research question: *What recommendations can be made to help smart cities move more effectively and efficiently towards sustainability?*

In order to address the main research question, our thesis intends to answer the following three secondary research questions:

Research Question 1: What does the FSSD reveal about the smart city concept in moving city towards sustainability?

Research Question 2: What are the experiences of practitioners currently applying the smart city concept?

Research Question 3: What insights can practitioners with FSSD experience offer in addressing the challenges identified by the smart city practitioners?

1.5.2 Scope and Audience

Our scope is set within smart cities in the European Union. Our focus will centre on mid-sized and large European cities, defined as having more than 50 000 people, and at least one university. Further, each city should already be receiving EU funding for smart city initiatives. Our aim is to develop recommendations for smart city practitioners to improve the sustainability potential of their smart city approach, by outlining a strategic planning process to allow smart city practitioners to implement an SSD approach in the city context. Our audience will therefore be smart city practitioners who are already working with the concept, but are seeking to improve their strategic planning processes when making their city both smart and sustainable.

2 Methods

In this section, we describe the research design of our study and the general methods used to collect and analyse our data.

2.1 Research Design: Maxwell's Interactive Design

For our research design, we chose to adopt an interactive model which had no order, nor directionality and would help us to not only gain an understanding of the actual structure of our study, but also to plan our study and carry it out (Maxwell 2005). As qualitative research requires a less restrictive concept of design than other traditional linear approaches, this model allowed us to ensure that each phase could merge together as a functioning whole. Our research was designed around the five components as shown in Figure 2.1.

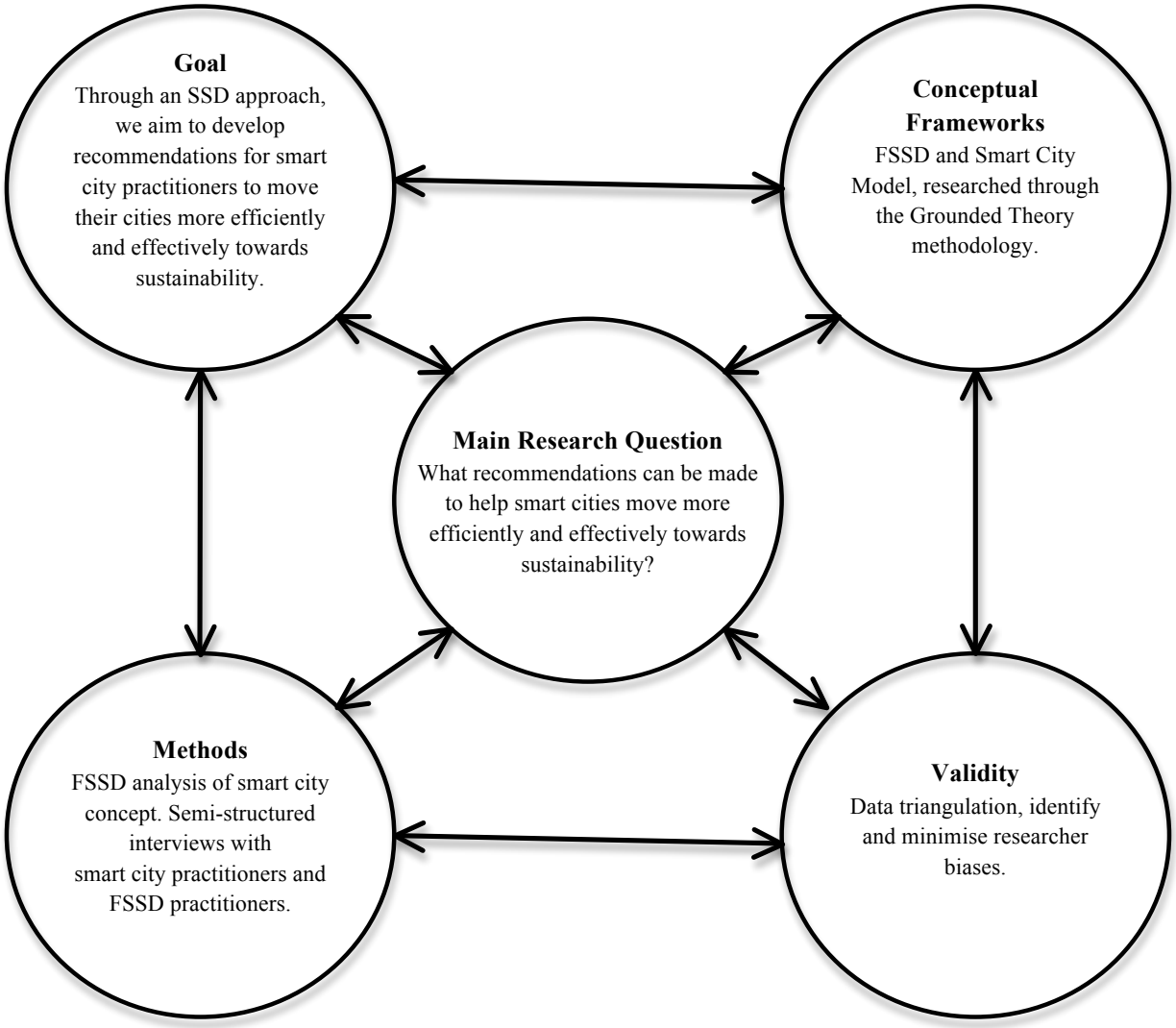

Figure 2.1 Research Design (adapted from Maxwell 2005)

Goals: We wished to develop a strategic planning process for smart cities through an SSD approach, increasing the effectiveness of this concept when applied by smart city practitioners for cities working towards sustainability.

Conceptual framework: The group shared the established paradigm of grounded theory as a methodology for qualitative research. The two theoretical models of the FSSD and the Smart City Model were applied.

Research questions: The research questions were formulated after the goals and conceptual framework of design were determined to help us clarify what we specifically wanted to understand through conducting this study. The primary research question is "*What recommendations can be made to help smart cities move more efficiently and effectively towards sustainability?"* This overarching question is answered through the three secondary research questions, presented in section 1.5.1.

Methods: Data was gathered by first completing a literature review and exploratory interviews, which allowed us to develop our research questions. From a theoretical understanding of smart cities, an FSSD gap analysis was completed to identify any differences between the concept and the recommendations of the framework. To establish whether these identified differences were occurring in practice, we interviewed smart city practitioners about their experiences in working with smart cities. These findings identified specific areas of challenge, which then informed our interviews with FSSD practitioners. The data was transcribed and coded following each data collection wave in order to identify patterns, and the data was cross-referenced in order to assess the smart city concept, and develop our recommendations.

Validity: In order to identify and address validity threats we integrated data from a variety of sources (triangulation), and continuously identified and attempted to minimise biases.

2.2 Conceptual Frameworks: Grounded Theory, FSSD, and the Smart City Model

Grounded theory is applied throughout this study as a qualitative research methodology. We also relied on two conceptual frameworks to guide and inform our research: the Framework for Strategic Sustainable Development (Robèrt et al. 2002), and the Smart City Model (Giffinger et al. 2007).

Grounded theory (GT) method, also referred to as constant comparative method, is a research strategy within qualitative research (Glaser and Strauss 1967; Kolb 2012). Contrary to a hypothetico-deductive approach, which begins with a hypothesis that is validated through careful experimentation (Haig 1995), GT does not allow for a pre-formed hypotheses and theorsy to shape a process of research (Glass and Strauss 1967). Theories are developed through an inductive process that systematically examines and reflects on the data that is collected, and in turn allows for the study of the phenomena they represent (Corbin and Strauss 2008). Further theories are then developed from these conceptual ideas, which are generated through coding and rigorous analysis (Glaser and Strauss 1967). Simply put, "grounded theory is discovery of theory from data" (Glaser and Strauss 1967, 1).

The *Framework for Strategic Sustainable Development* (FSSD) (Robèrt et al. 2002) is a strategic tool that allows users to develop a structured overview of complex problems using systems thinking. The five-levels of the FSSD (Systems, Success, Strategic, Actions, and Tools) provide a structure under which information and assumptions can be organised. Usage of the FSSD as a conceptual model ensures that the big picture of global socio-ecology sustainability is kept in mind when considering how to best utilise other existing tools and

concepts. The FSSD helps frame other tools and concepts by asking how these can assist with the movement of society towards sustainability.

The *Smart City Model* (Giffinger et al. 2007) presents six distinct characteristics depicting under which a smart city should aim to develop. Each characteristic comes with a set of factors that evaluate success. This model provides a lens through which one can evaluate the relative strengths and weaknesses of smart cities. The model was made primarily for mid-sized cities, but has been applied in different contexts.

2.3 Phases of Research

We divided our research into three separate phases (see Figure 2.2).

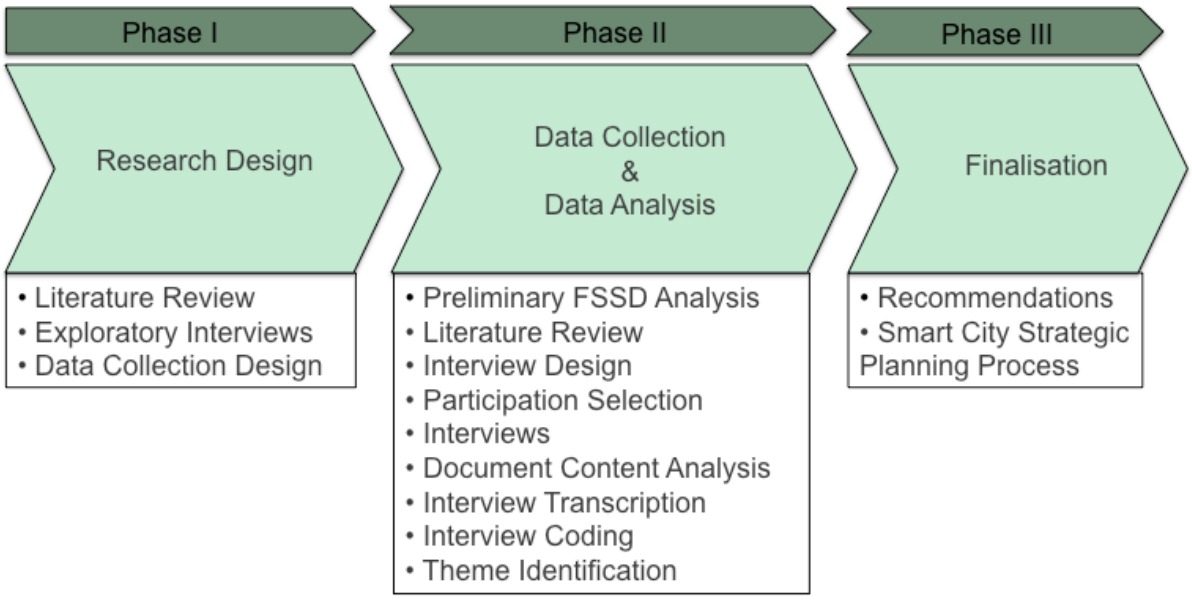

Figure 2.2 Phases of Research

2.3.1 Phase I: Research Design

We began our research by collecting information around the subject of smart cities through examining peer-reviewed articles, working papers, professional articles, websites, books, and informative documentaries. To ensure a common understanding of the literature, we presented papers within the group and held discussions on the findings. The literature review was one way for us to identify our research questions. However, we refined our questions through conducting exploratory interviews with researchers and practitioners in the domain of smart cities. This was done to comprehend the concept in greater depth, and to understand whether there were any challenges within the field. We had the opportunity to speak with two prominent experts from the academic field of smart cities and urban development, and two practitioners working with smart cities (see Appendix A for Exploratory Interview Information).

Based on the literature review and the conclusions drawn from the exploratory interviews, we developed our main research question that centred on creating recommendations for the smart

city concept from an SSD approach. Three secondary questions address what an FSSD analysis reveals about the smart city concept, what the experiences in applying this concept are for smart city practitioners, and what insights FSSD practitioners can provide in addressing any reported challenges. Through a grounded theory approach, the identification of a problem and the development of our research questions enabled us to create a data collection process that provided us with the necessary data to answer our research questions.

2.3.2 Phase II: Data Collection and Data Analysis

In understanding the sustainability aspects of smart cities, our research first viewed the concept through the lens of the FSSD. An FSSD gap analysis was conducted in order to determine what this framework would reveal about the smart city concept in moving cities towards sustainability. This was done through mapping the essential elements of the smart city concept along the levels of the generic five-level framework (Waldron et al. 2008), and contrasted to an idealised FSSD informed smart city, out of which differences were identified. The areas identified as holding differences between the current smart city concept and the FSSD provided us with guidance on how to design our interview questions for the smart city practitioners.

We began the interview portion of this phase by conducting a short document content analysis to understand what components need to be included in an interview to obtain clear and valid results. We then identified and contacted smart city practitioners in the EU region, based on EU-funded projects for the development of smart cities. We developed an interview guide (see Appendix C) that each interviewer followed. Interview questions were informed by the 5-levels of the FSSD analysis and the Smart City Model. For example, the FSSD recommends that at the Strategic Level, a minimum of three prioritisation questions should be applied to select appropriate actions. The FSSD gap analysis revealed that the smart city concept does not provide concrete guidelines for action prioritisation, so our interviews with smart city practitioners included questions such as question 10 "How do you prioritise smart city actions?" (see Appendix C for further questions). Through the application of purposeful sampling, recommended by Maxwell (2005), we contacted 27 smart city practitioners within EU cities. Of the smart city practitioners contacted, seven practitioners responded and offered to participate in our research (see Appendix D for Smart City Practitioner Information). Of those, four interviews were conducted through video-conferencing, one over the phone, and two practitioners were interviewed in-person.

The responses obtained from the smart city practitioners were first coded along the levels of the FSSD, through which subsequent themes related to experienced challenges were identified. These challenges provided structure for the interview questions for the FSSD practitioners (see Appendix E for FSSD Interview Guide). We set out to contact FSSD practitioners who have experience in urban contexts. Through semi-structured interview questions, practitioners were asked about their experiences in city planning. Further, we inquired on how they would address the challenges of the smart city concept previously identified by the smart city practitioners. In total, 14 FSSD practitioners were contacted, and eight practitioners offered to participate (see Appendix F for FSSD Practitioner Information). All FSSD practitioners were interviewed through video-conferencing. The data collected from the FSSD practitioner interviews was coded along the common challenge themes identified by the smart city practitioner interviews.

Interviews were conducted with at least two thesis members present, and lasted for an average of 58 minutes for smart city practitioners, and an average of 49 minutes for FSSD

practitioners. All interviews were recorded digitally, and transcribed by the interviewers. They were then shared amongst the group to ensure consistency and to protect information from being disregarded. The interview transcripts were coded individually by each member of the thesis team, followed by a team examination and discussion to identify overall findings, and to ensure consensus amongst the coding schema. The data from the interviews was coded along the themes defined by the five levels of the FSSD, which had originally informed the questions created for the interview. A second coding was then conducted, aimed at identifying themes, patterns, commonalities, and discrepancies amongst the responses. The coded themes were tallied to give us an indication of how frequently common responses were made. Further, responses that were particularly insightful or unique were highlighted.

Throughout this phase, we also continuously conducted a document content analysis based on any reports or documents shared by both smart city and FSSD practitioners.

2.3.3 Phase III: Finalisation

The general themes that emerged from our two interview processes (smart city practitioners and FSSD practitioners) were synthesised into a document, highlighting the key findings. The interview answers provided by the smart city practitioners gave insights on what the relative strengths and limitations of the smart city concept were. The interview results from the FSSD practitioners provided information on how the smart city concept can be further developed, and how it can contribute to sustainable city development, strengthened through an SSD approach. In concluding our research, we set out to mobilise our knowledge and findings by creating a planning process that can directly help smart city practitioners to optimise the sustainability potential of the smart city concept. Through the application of an SSD approach, we offer a planning process that recommends how practitioners can apply the smart city concept in a more strategic manner.

2.4 Expected Results

In answering our question of what recommendations can be made to help smart cites move more effectively and efficiently towards sustainability, we expect that an SSD approach can offer significant contributions to the strategic planning process of smart cities. By examining the theoretical structure of the smart city concept through an FSSD lens, we expect that some components will be in alignment with the framework, but that differences will also emerge, particularly within the systems, success, and strategic levels. We expect that our interviews with smart city practitioners will yield results that show a variety of strengths and limitations of the smart city concept in practice. Speaking to those limitations, FSSD practitioners will provide advice and recommendations on how to maximise the potential of the smart city concept, so that it can be applied in a manner that directly addresses the global sustainability challenge.

2.5 Validity

Validity within qualitative studies refers to the degree of knowledge about a research topic, and how it corresponds to the actual reality of a subject (Cho and Trent 2006). Within qualitative research, certain threats with regards to validity exist, such as researcher bias and situational reactivity (Maxwell 2008). Researcher bias refers to “bias introduced by an experimenter whose expectations about the outcome of the experiment can be subtly communicated to the participants in the experiment” (Merriam-Webster 2013). Situational

reactivity refers to the conditions under which data is collected that can potentially influence the quality of results (Maxwell 2008). Throughout our thesis, we minimised these risks by implementing strategies to *identify* specific threats to the validity. One primary strategy implemented was triangulation, which refers to "collecting information from a diverse range of individuals and settings" (Maxwell 2008, 245). Since triangulation "gives a more detailed and balanced picture of the situation" (Altrichter et al. 2008, 147), we relied on cross-examining the results obtained from the literature review, the FSSD gap analysis, and from our interviews to search for patterns within the research data. Further, in transcribing the data and sharing it amongst group members, we ensured that all the data contained 'rich' information and was viewed as a whole picture, thus increasing the reliability of our concluding results. Throughout the interview process, we continuously requested clarification from interviewees to ensure that the data we were collecting was not being misinterpreted or clouded by the interviewers' biases (Maxwell 2008).

While it is difficult to control for the situational reactivity brought on by the presence of a researcher (Maxwell 2008), we attempted to minimise that threat by asking non-leading, neutral questions, while maintaining a light, conversational tone. Further, we started each interview by fully explaining the purpose of the research, and giving all respondents the option of remaining anonymous. Additionally, all the interviewees were given the choice to not answer certain questions, or withdraw their participation at any point in time without providing a reason for doing so.

3 Results

This section presents the results that aim to answer the three research questions presented in this study. Results include the findings of the FSSD gap analysis of the smart city concept, interview responses from smart city practitioners, and interview responses from FSSD sustainability experts.

3.1 FSSD Gap Analysis

By applying the FSSD as a structural analysis tool, the smart city concept is examined through the five levels to identify the purpose, strengths, weaknesses, challenges, and gaps of this concept in terms of sustainability. This portion of the results section (also displayed in Appendix B) aims to provide information that can answer the first Research Question: *What does the FSSD reveal about the smart city concept in moving a city towards sustainability?*

3.1.1 Systems Level

At the systems level, we seek to understand the relevant structure under which a concept functions, and the assumptions that are held within that system. The smart city concept primarily examines the city itself as a system, which holds a multitude of sub-systems (Chourabi et al. 2012). These sub-systems function as an "organic whole", which allows them to behave in a coordinated and intelligent manner (Mitchell 2006). The scope of the smart city concept lies within self-defined urban boundaries, and focuses on examining the "complex multi-dimensional network of a system of systems" (Toppeta 2010). From an FSSD perspective, a concept requires an awareness and understanding of the socio-ecological system under which it operates.

With regards to sustainability, the smart city concept recognises the importance of both social and ecological sustainability (Hollands 2008, Toppeta 2010); however, the concept makes no mention of its role in greater ecological and social systems, and does not elaborate on its effect on those systems. The smart city concept itself does not dictate any scientific understanding or assumptions about its interactions with the Earth's systems (such as an understanding of system dynamics, thresholds, the laws of thermodynamics, bio-geochemical cycles, and the fundamental human needs) that would help practitioners working within smart cities to understand the risks of an unsustainable 'business as usual' approach. Instead, the concept assumes that 'smart' and 'sustainable' are mutually inclusive, and that "the smart city approach is a way of developing a sustainable city" (quote by Søren Smidt-Jensen, Copenhagen Cleantech Cluster 2012).

3.1.2 Success Level

Success is defined as "the overall goal that needs to be achieved in order for a planning process to be successful" (Robèrt et al. 2010, 27). The concept describes a city as smart when "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu, Del Bo and Nijkamp 2011, 6). The success of a smart city is described as being "well-performing in six characteristics [of the Smart City Model]", (Giffinger et al. 2007, 11),

which address some aspects of sustainability, but does not explicitly describe what success in terms of sustainability within the six characteristics would look like.

Contrasting the six characteristics of the Smart City Model to the success criteria of the FSSD highlights some differences. Overall, the smart city concept seeks to expand ICT frameworks to better meet the needs of citizens (Topetta 2010). However, without an understanding of material life-cycles, material toxicity, and the energy efficiency and management of such systems, actions and initiatives can, in the long-run, undermine the ability of a city to function in a sustainable manner. Smart economy highlights the need for national competitiveness through innovative businesses and flexible and well-educated labour markets. However, sustainable development in this domain can only occur if the economy is based on industries and businesses that strive to be competitive through sustainable practices. From a smart city perspective, success within the domain of smart people can be achieved by providing high levels of education, creating a system where citizens are culturally aware and open-minded. Informed by the FSSD, meeting these criteria of success would improve citizen's quality of life, creating a stronger community within the city. The definition of smart governance is strongly aligned with the success criteria of the FSSD, since it is based on a democratic process that encourages citizen participation, and also provides a transparent government system, and allows for information to be easily accessed by citizens. In terms of smart mobility, smart cities advocate for transportation systems that are efficient, with an emphasis on non-motorised and fossil-fuel free options. This domain is highly in line with FSSD-thinking, since smart mobility requires transportation systems that have low environmental impacts. Smart mobility further addresses the needs of citizen's to have access to local and safe transportation, which meets the citizens' needs. Smart environment is well aligned with success within the FSSD because it places high importance on responsible resource management, reduction of pollution and greenhouse gas emissions, and increased ecosystem protection. Smart living seeks to enhance the quality of life of citizens through the creation of safe and healthy living conditions. Ecological sustainability can also be achieved through retrofitting existing buildings to improve efficiencies and creating strict sustainability standards for new buildings. In terms of social sustainability, citizens in smart cities are provided adequate access to heath care, thus improving their quality of life.

The smart city concept does not offer an exhaustive definition of success in terms of sustainability, nor does it offer practitioners principles that are general, concrete, non-overlapping, sufficient, necessary, and science-based. Such principles would aid a city to plan towards success by providing practitioners with guidance on deciding what aspects are necessary for reaching sustainability (Holberg and Robèrt 2000). When strategically planning towards sustainability, an FSSD approach suggests that there is value found in first understanding a scientifically-based principled definition of success, from which one can backcast from. Therefore, sustainability should be understood through the four Sustainability Principles to "define what society must stop doing in order to preserve the socio-ecological system" (Robèrt et al. 2010, 39) and that the city's vision of success and goals should function within the constraints of these principles. Without a strategic framework that applies a principled definition of success, actions that are implemented run a risk of being inefficient, ineffective, or contradictory to the sustainability goals of a city. Overall, the smart city concept lacks a general and agreed-upon definition of *how* sustainability is defined (Cohen 2013).

3.1.3 Strategic Level

At the strategic level, strategic guidelines should be applied to select actions that move cities towards success (Robèrt 2000; Robèrt et al. 2002). The smart city concept deems ICT as a key strategic driver in moving cities forward towards being smart and sustainable (Arup 2010). Smart city planning strategies attempt to work within the complexity of cities by developing not only technological aspects, but also human and institutional aspects (Nam and Pardo 2012). By having the six characteristics of a smart city defined, practitioners are able to apply backcasting to reach those desired states. The needs of the city's citizens are always considered for the development of smart initiatives (Huber and Mayer 2011). Values such as institutional transparency, inclusion, and participation are adopted throughout all levels of a city (Coe, Paquet and Roy 2001; Nam and Pardo 2012). In determining which actions to prioritise, Boyd Cohen (2012) advises that initial actions need to "go lean", meaning that they should be financially viable and hold a high return on investments early on. The smart city concept therefore contains some components that already fall in line with strategic planning from an FSSD perspective.

In terms of strategy, a limitation of the smart city concept is that it does not possess a framework or guidelines that can strategically aid cities in becoming smart and sustainable. This deficit can be connected to the challenges concerning the lack of a concrete definition of success, mentioned above in the Success level analysis. Although the literature connected to the six characteristics of the Smart City Model offer some guidance over actions which can fulfil each domain, the findings at the Success level show that the concept itself does not offer any basic principles which a vision can be framed within and backcasted from.

However, differences also exist between the two concepts that can create conditions under which actions are not applied in a strategic manner. Without clear strategic guidelines, cities cannot plan for sustainability from a systems perspective. Further, according to the FSSD, the prioritisation process in smart cities is incomplete if it only considers the financial return on investment of certain initiatives. The FSSD suggests a minimum of three prioritisation questions, outlined in section 1.4.4, which additionally consider whether an action is moving in the right direction, and whether an action provides a flexible platform which can be further developed from (Holmberg and Robèrt 2000).

3.1.4 Actions Level

At this level, strategic guidelines should result in concrete actions being selected, which move a city towards success. Within the Smart City Model, the six characteristics are connected to possible actions, which can move development forward in the areas highlighted by the characteristics. The FSSD suggests that actions should seek to move society in the direction of global socio-ecological sustainability. Both the FSSD and the smart city perspectives realise that no two cities are the same, and it is therefore impossible to create a prescriptive action plan that meets the needs of all cities (Robèrt 2013). The challenges of a smart city are complex and unique, and therefore require actions that are tailored to the specific needs of a city (Cohen 2012).

The smart city concept does not guarantee that actions and initiatives taken will result in the systematic reduction of violations of the Sustainability Principles. For example, increasing a city's ICT infrastructure is frequently recommended in the literature as an action to take for cities to become smarter in the six characteristics (Graham and Marvin 2001). Various social and ecological issues can arise in cities that heavily rely on ICT, such as alienating parts of

the population due to a digital divide (Partridge 2004), and creating a grid that requires large amounts of material upgrades and energy expenditure to function (Hollands 2008).

3.1.5 Tools Level

This level seeks to identify the tools that support the planning process within a system. Both the Smart City Model (Giffinger et al. 2007) and the Smart City Wheel (Cohen 2012) can be used as tools to help municipal stakeholders (e.g. citizens, city departments, the private sector) communicate using a common language, and to assess and develop cities within the six characteristics (Cohen 2012). Further, online platforms such as the EU Smart Cities and Communities Platform allow smart city practitioners from different cities to share their experiences and find avenues for collaboration and co-creation (Smart Cities and Communities 2012). The FSSD suggests that at this level, tools should be identified that support a city's efforts to reach global sustainability, once the actions are selected using the strategic guidelines.

Since the smart city concept is not trademarked or owned by a specific organisation or network, the development of strategic tools for helping to implement and measure strategic actions is done by individual municipal departments and tailored to their specific needs, based on their interpretations of the concept. While the existing tools aid smart city practitioners to communicate with each other, there is a lack of tools available for cities to create strategic development plans, and build appropriate engagement processes.

3.2 Smart City Practitioner Interview Results

To gain a more thorough and real-world understanding of the application of the smart city concept, we interviewed five practitioners who work with the concept in a city context. The practitioners were all working with aspects of the concept, and were situated in cities in Denmark, Germany, Portugal and Sweden (see Appendix D). Further, we also conducted interviews with two smart city regional experts: Mirko Presser from the Smart City Lab at the Alexandra Institute, and Peter Larsen at the Oresund Smart City Hub. These practitioners provided us with a more objective and technical perspective of the smart city concept. This portion of our report presents our results that aim to answer the second research question: *What are the experiences of practitioners currently applying the smart city concept?*

3.2.1 Smart Cities in Context

In response to question 2 *"When did [city name] start working towards becoming a smart city?"* four out of five smart city practitioners responded that they started working specifically with the smart city concept from 2008 onwards. Stefan Svensson (2013), Stockholm IT department manager, answered that his city began to consider questions around being 'smart' 10 years ago. With regards to question 3 *"What was the reasoning and motivation for [city name] to start working towards becoming a smart city?"* interviewees noted that smart initiatives were being implemented even before they were being labelled as such. Francisco Gonçalves (2013), Lisbon Environmental Project Coordinator, stated that "the motivation behind becoming a smart city was that the projects that are the basis for the smart city concept were already under development at that time, and that we could use the smart city concept as an umbrella term for these initiatives", and Emilie Hvidtfeldt (2013), Copenhagen Project Manager, stated that "smart initiatives were already in the process of being applied before [2008], but they were just not being referred to as such." Gonçalves

(2013) further described that adopting the smart city concept puts Lisbon on "its path towards being a true open ecosystem, where ICT systems have the potential to be adopted at most different levels of usage and engage all stakeholders on the city's route of being a smart and sustainable city".

Political ambitions and budgetary considerations were also reported to influence the decision of adopting the smart city concept. Hvidtfeldt (2013) stated that the term smart city was written into their budget in 2012 as a result of their politicians being inspired by other cities' progress through their use of the smart city concept. Svensson (2013) stated that politicians became motivated to showcase Stockholm as a world-class city, and raise its international importance. Ulrich Dilger (2013), Stuttgart Project Manager, responded that the motivation for Stuttgart to become a smart city stemmed from a response to the politicians' desire to keep up with this new emerging trend. With regards to funding possibilities, Henrik Johansson (2013), Växjö Environmental Coordinator, stated that Växjö began referring to their initiatives as "smart city projects" in 2008, in order to be eligible for municipal development funding from the European Union, through the Smart Cities and Communities Initiative (SCCI).

Mirko Presser (2013), one of the interviewed smart city regional experts, stated that the motivation for cities to become smart lies in the desire to gain economic importance and growth. He further explained that, due to the current economic crisis and the resulting need for budget cuts, European cities see the smart city concept as an opportunity to increase efficiency, and therefore save money within their city's systems. Further, he claimed that cities can be categorised through a three tier approach when adopting the smart city concept. 'Tier one' contains cities that are willing to take a risk to try out something completely new. 'Tier two' consists of cities that adopt different existing technologies and create a business model that fits the needs of the city. These cities tend to have a strong economy, an existing high-tech industry, and highly motivated and involved citizens. The majority of cities adopting a smart city approach fall under 'Tier three', wherein they wait until there is a proven and tested smart solution for which the costs have been reduced due to widespread market demands.

3.2.2 Systems Level

In response to the question 4 *"How do you define a smart city?"* all interviewees mentioned the use of data or ICT as part of their smart city definition. City-specific interviewees also mentioned sustainability (4/5), and included citizen engagement as part of their definition (3/5). Examples of smart city definitions included:

> A city that combines citizen participation and ICT. It is a combination of making use of ICT tools to foster participation, entrepreneurship, and sustainability (Gonçalves 2013),
>
> The smart city is about making a city that is for the citizens, by using data and technology and new smart stakeholder integration partnerships to develop a city that has more life quality and that is easier to live in and that functions better… smart is also sustainable." (Hvidtfeldt 2013), and
>
> A smart city is a city that combines modern Information and Communication Technologies, good access to knowledge and quality of knowledge through

universities and high schools, well developed social and environmental capital, and good transportation possibilities (Svensson 2013).

Dilger (2013) answered that the common definition describes a city that pushes forward towards sustainability using ICT. Some confusion regarding the concept was also expressed, in that Johansson (2013) questioned whether "a smart city is a city that is devoted to sustainable development, or is it a city that is devoted to sustainable development through IT?"

In response to question 5 *"Have you experienced any challenges in understanding the concept of smart cities?"* interviewees answered that the available definitions are either incredibly broad or very long or too specific (1/5), that a lack of a shared understanding and definition of the concept makes it hard to work towards a shared goal (2/5), no challenges are experienced since they have a clear idea of what a smart city is (1/5), and the unique nature of cities present additional challenges in understanding the concept (2/5). As Gonçalves (2013) described, "the smart city concept differs between all the smart cities because they have different strategies because they have different problems."

In response to question 12 "*What are the benefits of implementing the smart city concept, and its initiatives?"* interviewees acknowledged the positive effects of a more informed public, improved perception of a city, and increased attention to urban sustainability. Gonçalves (2013) stated that by having more information available to the public, the number of voters engaging in collective measures like participatory budgeting has increased, and the entrepreneurial sector is also growing. Hvidtfeldt (2013) responded that they had experienced huge benefits from being deemed as a climate friendly and smart capital through increases in tourism. Further, she stated that delegations from other city councils were visiting their city to learn about their smart city solutions. Svensson (2013) said that through the smart city concept, the city could now provide better services for the citizens and could keep the citizens more informed about how to access those services. Johansson (2013) believed that the benefits of the smart city concept come from the fact that the indicators and factors connected to the Smart City Model help address all the aspects of sustainability. Speaking specifically to ecological impacts, Dilger (2013) stated that "the benefits [of being a smart city] will be seen as higher efficiency and lower costs of public spending, reduction of negative effects connected to different fields such as traffic jams being reduced in transportation additional to reduced environmental impacts."

From the perspective of the regional smart city experts regarding the definition used for smart cities and the challenges connected to the application of the concept, Presser (2013) stated that a smart city is a city that continuously assesses its current context and proactively adapts and innovates to meet the ever-changing future conditions. In his opinion, the smart city concept is sometimes used simply as a brand or label. He further illustrated this through an example, in that "if you create efficient public transportation in a city, that does not mean that you are smart, but if you reinvestigate your organisation and try new partnerships and co-invest in an infrastructure that is interconnected, then you become smart". In terms of the smart city concept being sustainable, Peter Larsen (2013) also mentioned, "if you only focus on the environmental and technological aspects of smart cities, then no, it can't be a sustainable concept. But if you also consider people and solutions for people, then it can."

3.2.3 Success Level

In response to question 14 "*How does [city name] define sustainability?"* two out of the five smart city interviewees referred specifically to the Brundtland report's[2] definition of sustainability, which states that "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Report of the Brundtland Commission 1987, 15). Two further interviewees mentioned the notion of future generations as part of their definition of sustainability. Johansson (2013) stated that sustainability is "sustainable energy and sustainable use of land and water, and of course efficient waste management". Challenges in developing a definition were further reported by Johansson (2013), who stated that "we are actually having quite big discussions about how to define things such as sustainability. It is very complicated since the different departments all have different ideas about what sustainability is."

In response to question 15 and 16 *"Is this definition shared between members of your department"* and *"Is this definition shared between your department and the various stakeholders you work with?"* all city-specific smart city practitioners answered that a basic definition is shared within their own department, and stated that this definition is not formally shared with other departments or with their various stakeholders.

In response to question 7 "*How do you measure success in the various smart city initiatives you are implementing?*" all interviewees answered that no central smart city department exists in their city, and that every department has department-specific indicators and methods to measure success. Interviewees also stated that key performance indicators (KPIs) were currently being developed, or that strategic documents with targets and indicators to measure their annual sustainability performance were being used (3/5), that success is measured through energy efficiency pilot projects where stakeholders can give direct feedback, and smart meters can report real time data (1/5), that success is measured mainly in terms of their climate goals (2/5), and that success is measured through political elections (1/5). As Gonçalves (2013) explained, "indicators are the municipal elections, naturally every 4 years. If you're doing well, you get voted for again." Two interviewees highlighted the difficulties when measuring and evaluating their progress within the social development of their cities. As Hvidtfeldt (2013) described it, "some things are much more difficult than others to measure, such as how happy people are. But we try to quantitatively measure how the citizens feel about their environment, how they feel in the city, are they satisfied they are with the way things are done and look and feel and if they have enough green areas."

Speaking directly to the Smart City Model, Presser (2013) stated that the six characteristics should be looked at as being interconnected and not independent components, and that a city can only develop by connecting these areas to each other. Larsen (2013) emphasised that the needs of each city need to first be understood, and then applied to the Smart City Model.

Further, Presser (2013) stated that measuring success can be done through taking either a micro or macro perspective. At the micro level for example, changes in traffic congestion can be measured through simple real-time data. On a macro level, success is measured through

[2] The Report of the Brundtland Commission, 1987. *Our Common Future*, Oxford University Press.

more holistic indicators like economic growth. He further mentioned that benchmarking is important, but advised that cities should focus on using existing benchmarking measures, as opposed to developing new ones.

3.2.4 Strategic Level

With regards to question 8 *"What is the planning process behind making your city smart? What are the challenges in that process?"* all practitioners stated that they conduct planning in accordance with the existing city strategic plans and other steering documents. These city strategies were defined as Environmental and Energy strategy (2/5), and Sustainable planning strategy (2/5). Interviewees described their planning processes as participatory processes that involve the relevant stakeholders depending on the project (4/5). Interviewees also mentioned the important role of their city's political agenda in guiding the planning and decision-making process (2/5). Hvidtfeldt (2013) stated that Copenhagen uses a sustainability-planning tool, which allows them to evaluate each project in terms of economical, environmental and social sustainability during the planning process. Dilger (2013) pointed out that their city does not have a planning process that is applied in a uniform manner; rather, each department has its own unique planning process.

In response to question 9 *"What is your stakeholder-engagement process like? What stakeholders do you involve in the smart city planning process and what are the challenges in that domain?"* all practitioners described the process as a series of municipal meetings and workshops. Gonçalves (2013) stated that they organise meetings and workshops through the use of social media in the different neighbourhoods and districts to encourage public participation. Hvidtfeldt (2013) answered that their engagement process differs along the stages of the planning process, and that different stakeholders are involved at each level. With regards to public involvement, Hvidtfeldt (2013) further stated that "on a strategic level and on a political level, we always think about the citizen's involvement, but maybe when you go down to the technicians' level you probably would think of them less." As a further challenge, she stated that it is difficult to convince stakeholders to participate unless they see a promising business case connected to their involvement. Svensson (2013) stated that stakeholders are free to participate in meetings, and described the engagement process as advertisement campaigns aimed towards citizens. Johansson (2013) and Dilger (2013) both answered that citizens have the opportunity to express their opinion and give suggestions about development projects through city-organised workshops and meetings. Dilger (2013) also added that the law dictates that citizens must be involved through all phases of a planning process. Johansson (2013) expressed that it is oftentimes a challenge to keep people informed about their opportunity to be involved in discussions, and Dilger (2013) noted that it is difficult to keep the stakeholders involved in the process after initial meetings. When asked about which stakeholders are involved in the planning process of smart city initiatives, interviewees included the following: citizens (5/5), universities (2/5), NGOs (3/5), businesses (4/5), politicians (2/5), and others, depending on the nature of the project (2/5).

In response to question 10 *"How do you prioritise smart city actions?"* interviewees stated that they prioritise smart city initiatives and projects through: the city's government political agenda (or "what the politicians want" (Gonçalves 2013)) (2/5), available budget (2/5), and expert opinion (1/5). Johansson (2013) described their prioritisation process as a process that starts at the municipal council level, where yearly budgets are allocated to each department. The budget for each department is distributed depending on what yearly goals and projects have been set forth. After the budgets are allocated, each department has the opportunity to prioritise between the actions put forth by their department. Further, two interviewees stated

that their city practices a participatory budgeting approach, where citizens can democratically decide on how to allocate portions of the municipal budget.

In response to question 11 *"How do you inform citizens about your various smart city initiatives?"* interviewees indicated that they inform their citizens through several mediums, such as local newspapers (4/5), web pages (5/5), local television (3/5), public events (3/5) e-services (1/5), and e-governance platforms (1/5). Regional city expert, Larsen (2013), described the planning process for developing smart city initiatives as first identifying and developing partnerships with relevant stakeholders, setting up a vision with corresponding goals, and encouraging citizen involvement and participation. This participatory process enables specific challenges of a city to be identified and solved. Larsen (2013) further noted that the initiatives taken need to create solutions that are actually relevant to the city, because they will only move forward if there is an existing demand for the implementations.

When asked about which stakeholders should be involved in a smart city planning process, Presser (2013) and Larsen (2013) stated that stakeholders from the private, public, and research sector should be able to participate. When asked about the engagement process, both regional experts also stated that cross-departmental collaboration is important to come up with innovative and smart solutions. Additionally, Larsen (2013) noted that a common challenge is that "stakeholders do not talk to or understand each other, because they do not speak the same language". In connection with the prioritisation process, Larsen (2013) suggested that smart city initiatives could be prioritised through looking at the competencies within the region, analysing the commercial potential of and financial investment connected to an initiative, and choosing an action that serves a common interest of the majority of the stakeholders.

3.2.5 Actions and Tools Level

In response to question 6 *"Within the six characteristics of the Smart City Model, what are some initiatives you are currently working on/ implementing in your city?"* a wide range of initiatives were reported. Under the characteristic of 'smart mobility', interviewees mentioned projects such as expanding metro lines, investing in bio-fuel buses, and implementing electric bike programs. Under 'smart governance', e-governance platforms, open-data platforms, and participatory budgeting projects were stated. Within 'smart environment', interviewees mentioned initiatives that seek to expand renewable energy capabilities in their city, improving water quality in lakes, and implementing projects to reduce CO_2 emissions. Under 'smart economy', projects involved investments in government-business partnerships and funding for start-ups and creative industries. Interviewees described projects under 'smart people' as being cultural vibrancy and social integration programs. Within 'smart living', projects around improving energy-efficiency in existing building stocks and sustainable urban development projects were mentioned.

Common themes amongst reported challenges emerged from the smart city practitioner interviews, grouped into four distinct challenge areas. Difficulties were reported in the areas of effective planning, measuring success, engaging stakeholders, and prioritising actions. These identified challenge areas informed the interview questions for the FSSD practitioners, and aimed to provide us with information and insights on how those challenges can be addressed from an SSD perspective.

3.3 FSSD and Sustainability Expert Interview Results

Through both the FSSD gap analysis, and the smart city practitioner interviews, specific challenges were identified which relate to the global sustainability challenge (see Appendix G for summary). FSSD sustainability practitioners were interviewed with questions geared at providing solutions for these identified challenges. This portion of our report aims to provide our results to answer the third research question: *What insights can practitioners with FSSD experience offer in addressing the challenges identified by the smart city practitioners?*

3.3.1 The Smart City Concept in Context

Through the FSSD gap analysis, differences were identified, creating uncertainties as to whether the smart city concept can adequately address the sustainability challenge. Pong Leung (2013), TNS Canada Senior Associate, stated that there are many opportunities that ICT can provide in the areas of measurements, communication and monitoring, but in terms of sustainability, ICT is value neutral, since it can be both beneficial or damaging for a city's development. Further, he added that "[digitalisation] is happening…it's not something that we can say stop to...the main thing is how we steer it to a direction so that is helping cities become sustainable" (Leung 2013).

Regina Hauser (2013), Board Member of TNS International, answered that, in her opinion, 'smart city' and 'sustainable city' are great labels, since they inspire people to move towards sustainability. Concerning ICT, she added that technology is a great tool, but society tends to over-rely on it. In her opinion, in order to meet the challenges concerning sustainability, people should live compassionately towards each other and nature. John Purkis (2013), TNS Canada Senior Associate, stated that ICT is critical to help cities manage information and make smarter decisions. Further, he stated that it does not matter how much potential ICT holds, since the transition towards a sustainable future will not occur unless smart city practitioners view things from a systems perspective, and are able to articulate what success is within sustainability. Sarah James (2013), co-director of the Institute for Eco-Municipality Education and Assistance, stated that an SSD approach with a participatory planning process would be more effective in helping cities to reach sustainability than the smart city concept, since it provides a systematic approach and a shared understanding of a principled definition of sustainability. Lisa MacKinnon (2013), Sustainability Coordinator on the Dane County Board of Supervisors, answered that, in her opinion, the most significant benefit of the smart city concept is its potential to improve democracy, but only if it is applied in a transparent, engaging, meaningful and citizen-centric manner. Monica Pohlmann (2013), Sustainability Strategist and Facilitator at Monica K. Pohlmann and Associates, stated the smart city concept can incorporate smart and practical strategies for saving money, reducing impact, and making cities more accessible for everyone. Later, she added that even with its potential to make cities sustainable, the smart city concept is still not widely understood and applied.

Dave Waldron (2013), founder of Synapse Strategies, questioned, "is the smart city concept helping, or it is funnelling resources away from the poor for a love of technology?" Further he stated that ICT should serve cities in the areas of improving quality of life and restoration of natural systems. He also stressed the notion that ICT can easily be turned into a negative tool in the wrong hands, such as a tool for an oppressive government. To counter this threat, he recommended an open data platform provided by ICT through which people can collaborate and share their inventions.

3.3.2 Considerations for Sustainable Urban Development

With regards to the challenges identified from both the FSSD analysis and smart city practitioner interviews around the notion that urban development in smart cities may not occur in a sustainable manner, the FSSD practitioners noted various considerations. Leung (2013) stated that sustainable development in each characteristic of the Smart City Model should always be examined through a lens of the Sustainability Principles. Hauser (2013) answered, that a general definition of sustainability should be applied through the six characteristics in order to avoid confusion amongst planners and to provide opportunity for the city to develop in a sustainable manner. Purkis (2013) answered that smart city practitioners using the smart city concept have to come up with a clear description of success in terms of sustainability in each of the areas highlighted by the six characteristics. He also stated that by having defined success, cities can then develop and apply appropriate metrics to track and measure their performance. James (2013) stated that an SSD approach paired up with sufficient participatory planning and institutionalisation can ensure that development in the areas defined by the six characteristics remains sustainable.

MacKinnon (2013) stated that in order to ensure sustainable development, it is important to establish a system that allows a city to analyse initiatives and pass decisions through a filter, characterised as the four Sustainability Principles. Duke Castle (2013), Principal of the Castle Group, pointed out that to achieve sustainable development, sustainability and climate change have to be made relevant for people. Further, he added that in order to make sustainability relevant again there is a need for an emotional shift to occur in society. Waldron (2013) stated that he disagrees with the way the six characteristics of the Smart City Model are structured, because it suggests a hierarchical order between the characteristics and also divides up a whole system into silos. The practitioner suggested combining all characteristics and recognising them as one living system that is supported by technological (non-living) systems. Further, he suggested that by following this mental model, an overarching strategy should be created with a goal of restoring the living systems.

All eight practitioners stated that there is a need for a shared understanding of sustainability, and that it should be defined by the four Principles of Sustainability. Further, Purkis (2013), James (2013), and Pohlmann (2013) responded that having a shared and principled definition of sustainability allows for the communication of complex issues, and enables transformational change. As described by James (2013), “having shared principles where all departments and agencies in a city are using the same principles to guide sustainability in their own issue areas will more likely bring about a systems approach where the results of all those actions complement each other and work towards the same goal rather than conflict with each other."

3.3.3 Effective Planning and Vision Creation

The interviews conducted with smart city practitioners identified challenges centred on the development of effective planning processes and the creation of a compelling vision. Four FSSD practitioners referred directly to the need for a systems approach, and three practitioners referenced the specific application of the FSSD. As stated by James (2013), “using the FSSD in a planning process will automatically bring about a systems approach to developing [sustainability] initiatives” and Castle (2013) stated that “without an FSSD approach, [municipalities] won’t really understand what sustainability is”. James (2013) elaborated that an effective planning process, where a shared vision is framed within the four Sustainability Principles, creates a network of actions that can then be developed in ways that

are strategic. She further stated that the adoption of the four Sustainability Principles and boundary conditions reduces the appearance of conflicting goals and actions between city departments, since they all follow a shared overall goal. The majority of practitioners mentioned the need for a co-created vision, framed within the four Sustainability Principles. Further, two practitioners mentioned that the vision-creation component is also the most difficult part of the planning process. With regards to the leadership style necessary for effective vision creation, Waldron (2013) recommended a transitional leadership approach, which should highlight and address the envisioned future of a city.

An effective planning process that maintains a systems approach is the 'ABCD' process, mentioned by three FSSD practitioners. As stated by Leung (2013), this process involves educating and engaging people, creating a vision, assessing current realities, determining focus areas, and deciding and evaluating possible actions. With respects to a city planning approach, James (2013) noted that "if you have a planning process, defining a shared vision, and developing an action plan with the four Sustainability Principles at each stage…you will automatically come up with a systems approach". Specifically to the smart city planning process, Leung (2013) recommended that smart city practitioners should determine success in each of the six smart city domains, and then create a vision for each area which is framed by the four Sustainability Principles.

3.3.4 Measuring Success

Both the FSSD analysis and smart city practitioner interview results indicated that difficulties exist within the creation and implementation of metrics that measure progress towards success. All FSSD practitioners, apart from one, noted the importance of keeping a continuous measuring process of the actions leading to success, as defined by the developed vision. For example, Purkis (2013) stated that it is "very important to continuously measure progress and to be open, honest, and transparent". MacKinnon (2013) noted that it can be incredibly demoralising when people have committed to an action and realise that no one is tracking its progress. Hauser (2013) stated that progress measures need to easily be communicated to a wider audience, and provided reported CO_2 levels as an effective example. Some practitioners stated that competitive benchmarking may add value at the bureaucratic level, but did not recommend this as a measuring strategy as this may not be meaningful for the citizens and may not lead the city strategically towards its vision of success.

Leung (2013) stated that appropriate metrics need to articulate progress towards determined strategic goals aligned with the Sustainability Principles, which can then lead cities to develop indicators to measure success against the goals in each smart city characteristic. Purkis (2013) emphasised that is it vital that metrics measuring success are connected to the vision and goals. Further Pohlmann (2013) stated that such progress measures should target the various systems within a city. Leung (2013) and Purkis (2013) mentioned that progress metrics should only be developed after an action plan is in place, which would ensure that the sustainability indicators really measure the progress of each of those proposed actions.

3.3.5 Stakeholder Engagement

The engagement of a city's stakeholders through a transparent and inclusive system is a central component of the smart city concept. Various engagement processes are already in place, but existing challenges in this domain were raised by smart city practitioners. When discussing the planning process for urban sustainability with FSSD practitioners, three

practitioners emphasised the importance of involving stakeholders from all levels of a community. All practitioners mentioned citizens as a key stakeholder group, and Castle (2013) emphasised that "the most effective change comes from citizen groups who are engaged". MacKinnon (2013) and Castle (2013) stated that citizens need to therefore be engaged at all phases of a planning process. Within the citizen stakeholder group, Castle (2013) emphasised the need to understand the generational differences, as younger citizens feel passionately about the future, but are oftentimes under-represented, while older citizens are more vocal on local issues, but also focus more on short-term matters. Purkis (2013) stated that it is important not to overlook the business-sector as an important stakeholder group, since "the impact and their ability to help achieve the city's goal is critical...if the businesses can't see their role in [the process], a city cannot move forward". Two practitioners recommended stakeholder mapping as a method to identifying the appropriate stakeholder groups as these groups will change depending on the nature of a project. With regards to the smart city concept, Leung (2013) added that an analysis within the six characteristics could be done to determine the appropriate stakeholders. Hauser (2013) stressed that overall, the stakeholders involved in a planning process should be people who are "committed and passionate, and who are willing to take responsibility for the community".

As stated by Pohlmann (2013), an engagement process is a two-way relationship. Waldron (2013) said that an effective facilitator within this process needs to be able to "let go of control", and allow for peer-to-peer learning to occur through mediums such as open meetings, as opposed to open houses, so that genuine dialogue can take place. Overall, practitioners noted that engagement processes should 1) be open for people to participate, while also ensuring that stakeholders choosing not to participate are informed of the decisions made; 2) not involve too many people, since this can dilute the process; 3) only rely on social media mainly as a tool to collect a broad range of information, which one can then explore further through other mediums; and 4) develop a clear understanding of what group(s) are responsible for making various decisions. Further, Leung (2013) and Waldron (2013) stated that the engagement process should be fun, and should encourage participation through integration. Practitioners expressed the need for meeting stakeholders where they are at, which on an emotional level was described as engaging with them through a shared language, and on a physical level was described by Leung (2013) as literally meeting people at public events, as opposed to expecting them to attend scheduled municipal meetings. Purkis (2013) stated that engagement can take place in different ways, but needs to engage people within a spectrum ranging from merely informing stakeholders, to actually empowering stakeholders. Purkis (2013) further explained that an effective engagement process can create trust, wherein stakeholders feel that they are part of the process and the solution, which in turn creates a sense of a common direction.

3.3.6 Prioritisation Process

The FSSD gap analysis highlighted the absence of a specific prioritisation process aimed at sustainability, offered by the smart city concept. Smart city practitioners reported that they apply city-specific prioritisation processes; however, did not specifically address how their prioritisation process would ensure that actions are implemented lead to sustainability. As a method for prioritising actions, half of the FSSD practitioners recommended that the three prioritisation questions proposed by the FSSD (related to return on investment, flexible platform, and right direction) should be used as the basis for prioritisation. An additional prioritisation question was mentioned by Purkis (2013), as being "Is this action going to help

us address our biggest sustainability challenges, which have been identified during the baseline assessment?" Purkis (2013) added that cities will have a set of strategic priorities that are specifically important to them, which have to be addressed through asking additional questions during the prioritisation process. In cases where cities choose to not use the three prioritisation question of the FSSD, Hauser (2013) stressed the need to still create questions that relate back to sustainability. Leung (2013) highlighted that the key aspect of a good prioritisation process is that the decision-making framework is shared not only by decision-makers, but also with additional stakeholders.

James (2013) mentioned that the three prioritisation questions can be used to arrange actions along a timeline. Specifically, she suggested that cities should "develop a 1-5-10 year timeline of when actions can and should be implemented... the actions chosen for the first year are always the ones that do not need a lot of resources, money, or special regulations to be passed. So, one should develop a timeline with the action plan, and involve department staff, and citizens in that process." James (2013) further stated that the challenge with implementing long-term actions is that, even though government officials understand the importance of thinking 20-25 years ahead, they usually are only able to commit to plans on a 5-year basis. MacKinnon (2013) also brought up this challenge by stating that government decision-makers are always thinking one budget ahead, and therefore tend to disfavour initiatives that require long-term financial commitments.

Three practitioners discouraged the practice of citizen-informed prioritisation, such as participatory budgeting. Pohlmann (2013) argued that citizens tend to favour actions that function in their self-interest, over actions that address the common good. Further, she stated that having citizens vote on action-prioritisation without prior knowledge and understanding simply results in people stating a self-serving opinion. Castle (2013) added that allowing citizens to vote broadly on every issue does not result in an effective method for prioritisation.

4 Discussion and Recommendations

This section discusses the findings under each research question, and provides recommendations for how smart cities can more effectively and strategically move towards sustainability.

4.1 The Smart City Concept through the FSSD

The smart city approach has emerged from a demand to create more efficient, sustainable, and liveable models for cities (Toppeta 2010). We examined the smart city concept through the five levels of the FSSD. This analytical tool enabled us to identify any benefits and challenges of the concept with regards to sustainability.

Although the smart city concept addresses the need for sustainability to be incorporated into city planning, the concept only considers the city itself, and the systems that exist within it. Through the Smart City Model, the need for improved social and ecological sustainability is addressed through the characteristics of economy, people, governance, mobility, environment, and living, but the approach falls short when communicating the subtle relationships between those characteristics, and the greater natural systems beyond the boundaries of a city. Without an understanding of the natural laws that govern Earth's cycles, cities that apply a smart city approach run the risk of implementing initiatives and solutions that can in the long run lead them away from sustainability. In taking a systems approach, cities are better equipped to understand their role, influences and impacts within the greater socio-ecological system. This knowledge results in an improved understanding of the interconnections between the systems, and how antecedent conditions influence and determine outcomes. The underlying assumption that 'smart' is 'sustainable', and that development within the six characteristics inherently leads to sustainability, is also problematic since it does not provide cities with an understanding of what is required for the socio-ecological systems of the Earth to remain intact. This perception of sustainability can be attributed to the fact that the smart city concept is still relatively new, and a limited amount of theoretical research exists. It can therefore be argued that the current understanding of sustainability, coupled with the siloed understanding of city systems, may not provide a systems perspective that will allow cities to adequately address the sustainability challenge.

The analysis of the smart city concept through the FSSD revealed that the concept is being applied as an approach to lead cities towards sustainability. Success is defined as performing well within the six characteristics of the Smart City Model (Giffinger et al. 2007). An implicit definition of success within each of the six characteristics offers city planners an understanding of what success would look like under each domain. However, this does not guarantee that reaching success within these domains will result in sustainable outcomes. For a city to strategically work towards sustainability, the FSSD first recommends that it adopt a definition of success in terms of sustainability that is informed by the inherent social and ecological systems of the Earth. Through a scientific understanding of the human-created mechanisms that destroy these systems, the four Sustainability Principles define sustainability in a manner that allows for cities to strategically move towards sustainability by functioning within the boundaries of these principles. Therefore, being 'smart' within the boundaries of the Sustainability Principles, will result in cities being sustainable. A possible

solution, informed by the SSD approach, would be to frame the success definition of each of the smart city characteristics within the four Sustainability Principles. To illustrate this, we can imagine the Smart City Model at a point where it fully complies to the definition of success in accordance with the SSD approach. At this point, the city relies on renewable and clean energy sources that do not depend on fossil fuels, and that do not emit pollutants that gradually accumulate in nature. Urban development is conducted in a manner that preserves the ecosystems within and around the city, and still allows the city to grow in a manner that meets the needs of citizens while minimally affecting these natural systems. All citizens will be able to access the necessary resources and services that meet their basic human needs, which would create a social system that fosters trust, equality, and inclusion. The criticism of smart cities is frequently rooted in the approach being applied simply because it is trendy and popular. As stated by Haydee Shoembar (van Beurden 2011, 52), "the greatest pitfall is wanting to be a Smarter City is because it is sexy". However, even if the motivation for becoming a smart city is rooted in a desire to create an improved image, we believe that if the development works towards being in line with the conditions presented by the four Sustainability principles, the end outcome is still positive and should be recognised.

A key strategic driver for smart city development lies in the implementation of Information and Communication Technology (Arop 2010). In a city's pursuit to become sustainable, technology which increases efficiency and interconnectedness is often deemed as a perfect solution. However, not understanding the effects of this technology from a holistic perspective, which considers the overall effects at all levels of a system, can result in initiatives that undermine social and ecological sustainability. The smart city concept highly emphasises a citizen-centric approach, which aims to always consider the needs of all citizens in order to maintain and provide a high quality of life. As cities develop increasingly sophisticated methods through which citizens can stay connected and informed, they do however also run the risk of creating a digital divide that alienates portions of the population (Peck 2005; Graham 2002). In order to develop actions and initiatives that meet the needs of citizens while also reducing their negative contribution to the principles of sustainability, smart cities should develop strategic guidelines through a systems perspective which ensures that development occurs in an ecologically and socially sustainable manner.

The FSSD offers strategic guidelines that can help smart cities create an effective planning process. By backcasting from a principled definition of success, outlined by the Sustainability Principles, cities can develop actions and initiatives that continuously lead them towards their goal of being both smart and sustainable. If city practitioners define success through the characteristics of the Smart City Model, they already employ a degree of backcasting, since they are planning backwards from a desired state. This process can yield solutions that address upstream problems, rather than the consequences or symptoms of such problems. Since smart city practitioners already apply backcasting as a strategy, sustainable development can be ensured if their definition of success is framed within the four Sustainable Principles, thus allowing them to address the fundamental causes of sustainability violations. The FSSD also provides strategic guidance on how to prioritise actions and initiatives. With respects to prioritisation, the literature on smart cities advises urban planners to select actions that have high returns on investment, so that a developmental momentum can be maintained (Cohen 2012). The FSSD also highlights the need to consider the return on investment of a given action, but adds that the return on investment does not necessarily need to be limited to financial benefits, and can also include human or social capital returns. Actions should also be prioritised based on their ability of being a flexible platform, and how strongly they move cities in the direction of sustainability. From an SSD perspective, cities

are encouraged to apply these three criteria as basis for the prioritisation process, as well as further questions that address the unique needs, goals, and characteristics of their city.

Smart cities emerged in the past decade as a strategy to mitigate the problems of a rapidly urbanising world (Chourabi et al. 2012). The smart city concept provides direction within six areas of development needed to occur for cities to be able to continue thriving, and suggests strategies around the integration of ICT and citizen-centric initiatives that address social and ecological sustainability. However, the FSSD analysis identified some differences, particularly around the Systems, Success and Strategic levels, which point to a risk that the concept will not necessarily lead cities to reach sustainability. However, if the smart city concept is combined with aspects of the SSD approach, these gaps can be appropriately addressed, and the smart city approach can then become an effective concept in guiding cities towards becoming sustainable and thriving places.

4.2 Smart City Practitioners Interview Discussion

Smart city practitioners were interviewed about their experiences in working with the smart city concept, and provided insights on how smart cities are developed.

Smart city practitioners reported that their motivation for becoming a smart city stemmed from factors such as political ambition, economic and budgetary constraints, and as an opportunity to label existing ongoing initiatives. Frequently, cities were already developing in ‘smart’ manners, and were therefore applying the label ‘smart city’ retroactively. Regional smart city experts expressed that the trend of becoming a smart city was fuelled by cities’ desire to gain economic growth and importance. These findings go against the notion that a significant obstacle for smart cities lies in the lack of funding for smart initiatives (Murray, Minevich and Abdoullaev 2011). It seems that cities are in fact implementing the smart city concept to run more efficiently and save money, and also to become eligible for funding for smart city initiatives, particularly from the EU. However, these results may not hold true in contexts where the funding systems differ. If cities lack the economic motivation provided by the EU funding structure, they may be more hesitant and less ambitious in how and when they implement smart city initiatives. Smart city practitioners also expressed that the smart city concept results in positive outcomes such as a more informed public, improved perception of their city, and increased attention to urban sustainability.

In defining what a smart city is, practitioners reported challenges in this area because no widely applied definition exists. Two practitioners noted that the lack of a shared definition within the smart city concept made it difficult for cities to work together. Common themes within the definition mention the application of ICT and extensive citizen engagement. With regards to ICT, all practitioners held a positive opinion on implementing such technologies to further city development. However, no mention was made of the negative social and environmental effects of such widespread technological implementations, such as the systematic increases of electronic waste which can result in toxins accumulating in nature. Further, almost all practitioners mentioned sustainability as part of their smart city definition, which is noteworthy since no practitioner mentioned sustainability as their motivation for becoming a smart city. These findings may be due to the fact that the majority of practitioners hold the assumption that smart is equal to sustainable, and that any development in becoming smart automatically leads towards sustainability. One interviewee pointed out that it is difficult to develop an agreed-upon definition of sustainability within a city government, since different departments all hold different understandings. This lack of a

shared definition between city departments and between cities creates conditions that make it challenging to work together towards a shared vision of a smart city. Speaking to sustainability, if the various city departments apply a value-based understanding of sustainability, it becomes challenging to create a common sustainability definition across departments that still speaks to the specific goals of each department. Implementing a definition of sustainability that is principle-based, and is developed through scientifically agreed upon conditions, allows for departments to still meet the necessary conditions of sustainability, but make them applicable them to their unique goals and actions. Further, this principle-based definition allows for more accurate metrics to be created that can directly measure the progress of actions towards a goal. This problem could be solved if the smart city concept would provide a uniform definition of what a smart city is, and how sustainability is defined within it.

In discussing performance measures of smart cities, all practitioners mentioned that no central smart city department exists to continuously measure the progress of initiatives. While the various departments of a city keep track of progress of actions that are relevant to their initiatives, the results are not shared in an open manner that would allow a smart city to be continuously evaluated on its path towards sustainability. Instead, the measures remain fragmented, and do not allow for strategic decisions to be informed. Three practitioners mentioned that they are in the process of developing smart city KPIs that would allow them to measure the progress of their city, while others mentioned that steering documents, such as the city's climate goals, exist as their method for measuring success. However, if these metrics are not developed from a systematic understanding of sustainability, they may prove to be ineffective because they only measure certain aspects of sustainability, and may instead focus on characteristics that do not indicate actual progress. So, while there is an ostensible desire for cities to continuously measure their progress, the smart city concept does not provide guidance on when, how, and with whom to develop indicators.

Smart city practitioners stated that they have existing strategic plans and steering documents which provide guidance on how to reach goals within areas such as Environment, Energy, and Sustainability. Cities apply backcasting from those strategic goals, but for sustainability to be reached in a complex system, backcasting should occur from a smart city vision that is bound within the Sustainability Principles. Practitioners further stated that the planning processes applied in reaching the strategic goals differ from department to department. The fact that the planning process is not applied in a uniform manner can result in decreased interdepartmental cooperation and effectiveness. Interestingly, the planning process described by regional smart city experts was closely aligned with the planning process recommended by an SSD approach. The regional experts proposed a planning process for developing smart city initiatives as first forming strong stakeholder relationships, then setting up a vision with corresponding goals, and continuously encouraging citizen involvement and participation in order to identify specific challenges of a city to be addressed and solved. Such a process has the benefit of allowing urban development plans to be built in a strategic manner since they continuously work towards a co-created vision of success rooted in sustainability. Cross-departmental collaboration was stressed as being important to developing innovative and smart solutions, which we believe to be a vital component for creating and implementing initiatives that address the goals of many departments. Additionally, the regional experts emphasised a need for a shared language to be developed so that stakeholders can communicate effectively with each other. These findings suggest that an SSD approach would work well within this context, but our findings from the city-specific smart city practitioner interviews show that such a process has not yet been actively applied in practice.

In terms of stakeholder engagement, smart city practitioners stressed that citizens represent the most important stakeholder group. These findings are in concordance with the theoretical understanding that smart cities develop through a citizen-centric approach (Allwinke and Cruickshank 2011; Nam and Pardo 2011). The engagement process in smart cities was most commonly described through various meetings and workshops, as well as keeping citizens informed through mediums such as email, media outlets, and e-platforms. In applying a citizen-centric approach, it may be important to engage with citizens through a dialogue-based communication style, as opposed to simply informing them. By engaging citizen groups and other key stakeholders in two-way communication approaches, smart cities are better able to understand the needs of such groups. From the smart city practitioners' side, there is evidence that they are eager to engage stakeholders in the planning processes. However, practitioners voiced that stakeholders often do not get involved unless there is a compelling business case for them, or that they become disinterested after initial meetings. Further, practitioners mentioned that it is challenging to keep stakeholders, particularly citizens, informed about planning meetings and workshops. These findings imply that smart cities have a need for a planning process that speaks directly to stakeholders, and that inspires them to participate.

Smart city practitioners stated that proposed actions tend to be prioritised through a city government's political agenda, through available funding in the budgets, or through recommendations made by experts. By relying on ever-changing political agendas as a mode of prioritising tasks, or by only considering actions that are 'lean' enough to fit in a current budget, smart cities risk only putting forth short- to medium-term initiatives. Two smart city practitioners mentioned that they engage citizens in prioritisation processes by offering participatory budgeting, which allow citizens to vote for initiatives that they would like to see implemented in their communities. However, practitioners did not state that they applied any form of formalised prioritisation process, that would move a city most quickly towards its smart city vision, that would be flexible in terms of continued improvement, and that would provide a sufficient return on investment in order to allow for further development. Without a formalised prioritisation process, action plans can lack the strategic components that would allow them to quickly and efficiently lead cities towards sustainability. However, the identified absence of a prioritisation process voiced by the smart city practitioners could be due to the fact that a prioritisation process is often applied in an intuitive manner, whereas the SSD approach recommends formalised prioritisation progress guidelines.

The various initiatives described by the smart city practitioners all fit under the developmental characteristics of the Smart City Model. In the interviewed cities, most initiatives tended to fall under the categories of smart environment, smart governance, and smart mobility, which raises the question as to whether these three areas are of strategic importance for the cities. Development in these areas are oftentimes directly felt by citizens, since they yield improvement in how citizens move around in cities, as well as the natural attractiveness of the city. Further, municipal governments are more likely to maintain their political position if they engage with citizens in a transparent and open manner. While practitioners did not state that the Smart City Model was used specifically to guide the development of initiatives in their city, it does imply that the model can act as a categorisation scheme under which initiatives can be organised. Although many of the reported smart initiatives were addressing issues of sustainability, this does not guarantee that developed actions will strategically lead cities towards sustainability.

The results from the smart city practitioner interviews point to smart cities being a prevalent trend of cities that aim to respond to the pressures of urbanisation, and move cities towards sustainability. However, the practitioners did identify various challenges associated with the concept, particularly focused on the areas of effective planning, measuring success, stakeholder engagement, and action prioritisation. We suggest that an SSD approach, tailored to the smart city concept, would aid in bridging those gaps.

4.3 Addressing Smart City Challenges from an SSD Perspective

Through the interviews with smart city practitioners, various challenges of the smart city concept were identified. We theorised that these challenges can effectively be overcome through an SSD approach. To gain a deeper understanding of how this approach can address the challenges of the smart city concept, interviews with FSSD practitioners were conducted. The challenges were presented, and the FSSD practitioners described potential solutions from their experience in working with cities to reach sustainability through an SSD approach.

We presented the FSSD practitioners with an overview of the smart city concept. The FSSD practitioners generally held positive opinions about the concept, due to its citizen-centric approach, its ability to inspire people to move towards sustainability, its potential to improve democracy, its capacity to reduce environmental impact and save cities money, and its capability to make cities more accessible for everyone. Differencing opinions were raised about the widespread application of ICT in smart cities. Some practitioners noted that ICT holds the opportunity to facilitate measuring, communication, and monitoring systems within a city, which would help cities manage data and make smarter and more informed decisions. Other practitioners were more cautious with regards to the application of ICT in cities, in that society tends to over-rely on it, and that it can be a dangerous tool in the wrong hands, which can be damaging for a city's development. No matter how much potential ICT holds, FSSD practitioners believe that alone, ICT is not enough to facilitate the process towards becoming a sustainable city, which is in concordance with the theoretical findings from the literature review.

Smart city practitioners hold the assumption that being 'smart' is equal to being 'sustainable'. However, the manner in which they define these concepts differs from city to city. FSSD practitioners recommend that to overcome the challenges that result in having an unclear definition, and to ensure that development within the smart city concept remains sustainable, the characteristics of the Smart City Model should be framed within the boundaries of the Sustainability Principles, that would then serve as a definition of success. By holding a shared and principled definition of sustainability, smart cities will be better able to communicate complex issues. This would help cities hold a share a definition of sustainability, but would not resolve the need for a common definition of a smart city. It was interesting to note that a practitioner disagreed with the structure of the six characteristics of the Smart City Model, since in his opinion, it suggests a reductionist and siloed approach that inherently counteracts a systems perspective. However, we believe that this model offers a framework that provides clarity and understanding of the complex systems within a city.

Interviews with smart city practitioners revealed that a lack of a systems approach creates difficulties in developing initiatives that satisfy the needs of many different city departments. FSSD practitioners recommended that a planning process is needed that allows for practitioners and stakeholders to co-create a vision for a city from a shared understanding of

sustainability. Specifically, FSSD practitioners mentioned the 'ABCD' process, an SSD-based planning approach, which involves educating and engaging people, creating a shared vision, assessing current realities, determining focus areas and developing corresponding metrics, and evaluating possible actions. The 'ABCD' process was created as a strategic planning process to implement an SSD approach in a real-world context (Ny et al. 2007), and was suggested as it can effectively be applied in city and municipal planning contexts since it guides planners to take a systems approach. When applied in a smart city context, a planning process based on the 'ABCD' process, can help cities plan strategically, and also address some of the challenges voiced by smart city practitioners in this domain.

With an ABCD process, practitioners are provided with guidance on how to create an effective vision for a city. FSSD practitioners stressed that the vision creation process can be the most difficult part of the planning process. An effective, co-created vision stands as the foundation of a successful planning process. Smart city practitioners were advised to create a vision that is well-suited for the unique characteristics and needs of their city, and that the process should involve the opinions and insights of a wide range of stakeholders. Getting key stakeholders in a city to come together is most likely a lengthy, difficult, and costly process, which will present challenges to a smart city practitioner. However, it is a foundational element of an effective planning process, and needs to be in place before subsequent steps can be taken. Further, FSSD practitioners recommended that, as a part of the vision creation process, success should be defined within each characteristic of the Smart City Model, and be framed by the four Sustainability Principles. This would allow for development within each of the six characteristics to progress in a sustainable manner, and to ensure that each characteristic is understood through the same lens of sustainability, and weighted and considered equally.

Within smart cities, success is measured through various indicators, developed through the numerous departments of a city's government. Systems already exist within smart cities that allow them to continuously track the progress towards their goals. FSSD practitioners recommended that success within the different areas of the Smart City Model should be tracked through continuous measures that are developed in line with the four Sustainability Principles. This would ensure that progress towards each goal also implies progress towards sustainability. Further, the strategic goals within a city's vision need to be measurable through developed indicators that clearly reveal when a goal has been reached. Specifically within an action plan, each selected action needs a corresponding sustainability progress measure to avoid measuring factors that are redundant or that do not actually align with the strategic direction of the action plan. Therefore, it is fundamental to develop metrics for strategic goals developed within the vision in order to assess a smart city's progress towards sustainability. However, practitioners who want to apply an SSD approach will need to develop appropriate metrics that measure progress through compliance with the four Sustainability Principles. The Smart City Model already offers some guiding metrics that indicate progress within each of the six smart city characteristics, and this assessment guide can offer practitioners a good starting point for developing city-specific metric. It was also recommended that cities keep stakeholders continuously informed about the progress of initiatives through a system that is open, honest, and transparent. This should be done to keep stakeholders engaged and involved, and to keep city officials accountable for the initiatives they implement. Because of the inherent emphasis on sharing information in smart cities through online mediums, progress towards a city's goal could effectively be shared through online platforms.

The engagement process recommended by the FSSD practitioners involves a wide range of stakeholders from all levels of the community. Throughout the stages of a planning process, stakeholder groups need to be involved to varying degrees. Smart city practitioners need to carefully assess which stakeholders to involve and when, particularly because of the multitude of stakeholders within a city. This is important because, as one FSSD practitioner highlighted, involving too many stakeholders can run the risk of diluting an engagement process. Both the FSSD practitioners and the smart city practitioners identified citizens as a central stakeholder group. FSSD practitioners identified businesses as also being a critical stakeholder group for moving cities forward. This is noteworthy, since our literature review findings critique the smart city concept for being too business-focused. These findings highlight the need for a strategic stakeholder selection process, which identifies who to involve, and when. Research by Alimli, Imran, Ireg and Nichols (2008) advises for stakeholders to be involved at five different levels, based on the number of participants involved, and the levels of engagement required. Many individuals can be involved in settings that simply aim to inform, while far fewer individuals can be included in engagement processes that seek to empower. There is a need to identify the relevant stakeholders within each of the six Smart City Model characteristics, based on how each group can influence the success within a characteristic.

The smart city concept does not propose a specific prioritisation process, and smart city practitioners reported that their main considerations primarily address the political agenda of a city's government, and the available budgets. A more strategic process can provide guidance that would ensure that actions effectively and efficiently move cities towards sustainability. FSSD practitioners recommend that, at a minimum, the three prioritisation questions proposed by the FSSD need to be applied to determine which actions should be implemented in a city. Further prioritisation questions can be created, which align specifically to the strategic goals of a smart city. It is difficult to remove city politics from action prioritisation, but since the success of a city is a shared goal regardless of political affiliations, it is vital for planners to inform action selection beyond the preferences of political leaders. FSSD practitioners advised that actions can then be arranged along a timeline in a way that compels cities to think along both short-, medium and long-term time-frames. This addresses the challenge of city officials favouring short-term returns, and creates a momentum for reaching the strategic goals outlined by the vision. It is important for practitioners to continuously reinforce the need for long-term sustainability planning, since sustainable development is an ongoing evolution. Participatory budgeting is used as a tool for initiative prioritisation in several smart cities. Some FSSD practitioners mentioned that participatory budgeting could in theory be regarded positively since it can increase democracy by directly involving citizens, but also that this approach should be applied cautiously as it can result in citizens simply voting based on self-interest, which runs the risk of decreasing the efficiency in which a city can reach sustainability. This difference in opinions indicates that participatory budgeting remains a controversial issue that requires further research before concluding recommendations can be made on this matter.

FSSD practitioners overall expressed positive opinions about the smart city concept. Informed by the suggestions made by FSSD practitioners, we propose a planning process that builds on the benefits of the smart city concept to help smart city practitioners strategically move their city towards sustainability.

4.4 Strategic Planning Process for Sustainable Smart Cities

Smart cities are being developed to address the sustainability challenge. However, as our research has shown, the approaches applied in these cities do not provide smart city practitioners with a planning process which would allow smart cities to develop strategically towards sustainability. In order to aid smart city practitioners in planning towards sustainability, we propose the use of a strategic decision making process that is based on a Strategic Sustainable Development approach, and incorporates key aspects of the smart city concept. Through the development of a six-phase process that is based on the 'ABCD' planning process, we aim to helps cities incorporate a sustainability perspective into their strategic smart city goals. We recognise that planning in a smart city is incredibly complex, and involves countless departments and stakeholder groups. Our proposed process offers a general overview for planning that is aimed at providing information about the SSD concepts, and guidance on how to apply them in a smart city context. The concepts presented in this section should be applied and tailored to the unique characteristics and needs of a city.

We developed this process by incorporating our findings from both the theoretical analysis of the smart city concept, and the interview results from smart city practitioners and FSSD practitioners, into an 'ABCD' planning process tailored to the needs of smart city practitioners. We suggest the application of the process at different levels and phases. The process should be executed at three levels, first on a city level involving all departments and necessary stakeholders, then at a departmental level, and then back to the city level. The initial level of this process would involve creating a strategic developmental action plan for sustainability in the smart city. Using the experiences gained from the city level planning process, departments would conduct the same process on their level in order to develop and align their departmental goals in accordance with the higher-level smart city strategic goals. Then, we recommend an assessment step on the city level, so that the results and lessons learned at the departmental stage can be incorporated into the city level strategic action plan.

The framework of the ABCD process, as well as concepts within it, is based on various sources, including Chapter 9 from the *Strategic Leadership towards Sustainability* textbook (Robèrt et al. 2012), *Planning for Sustainability – A Starter Guide* (TNS Canada 2012), and the *Integrated Community Sustainability Planning Guide* (ICSP 2009).

The process consists of the following phases:

Phase 1: Get ready
Phase 2: Create a Smart City Vision
Phase 3: Baseline Assessment
Phase 4: Brainstorm Compelling Smart City Actions
Phase 5: Prioritisation Process and Strategic Action Plan
Phase 6: Assessment Stage

We suggest that smart city practitioners should use the process continuously, since development and implementation of the strategic plan is an iterative process and by using the data and information gathered through the progress measures, assessments can be made to move the city towards sustainability.

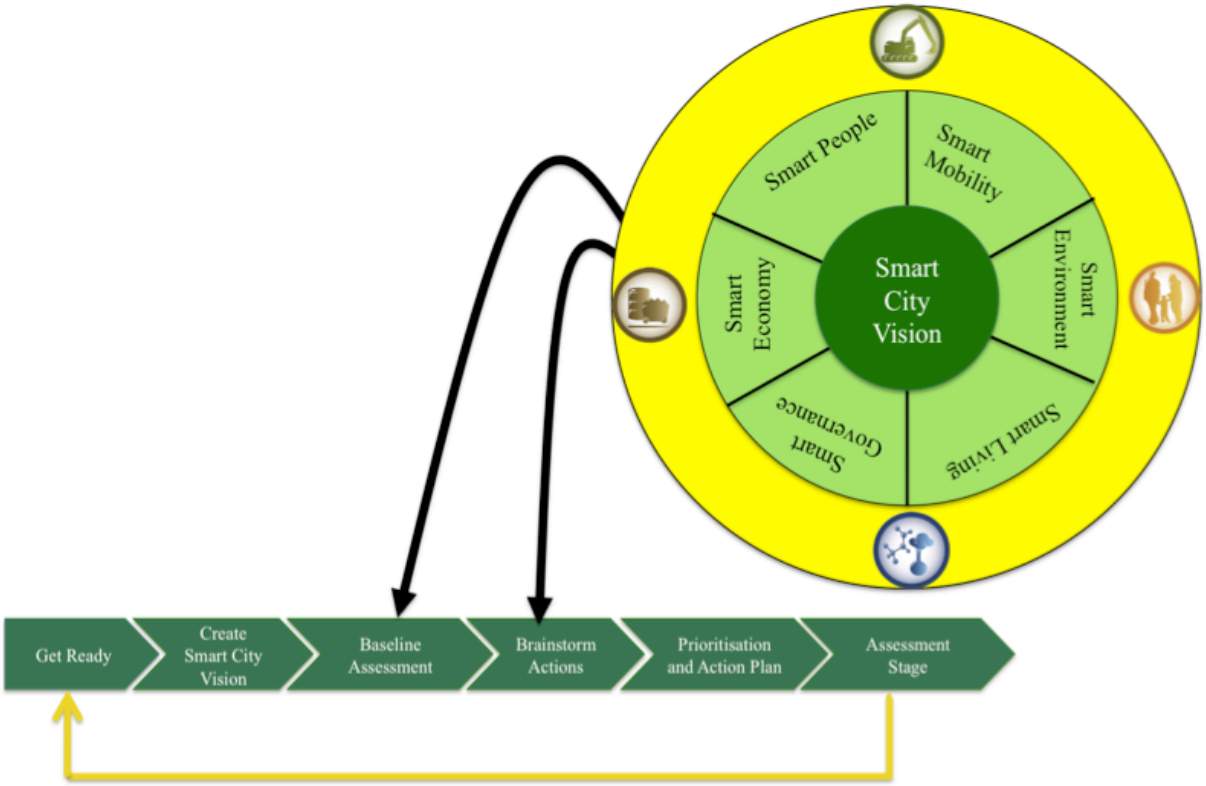

Figure 4.1 Strategic Planning Process for Sustainable Smart Cities

At Phase 1, participants prepare for the planning process. This includes the assembly of the core team, task organisation, education in an SSD approach and the smart city concept, and stakeholder selection for the planning process. Phase 2 involves the creation of a smart city vision, which is shared amongst all. The vision is created by incorporating the city's core ideology, the envisioned future, and the defined success in each of the smart city characteristics, framed by the four Sustainability Principles. As described in the introduction of our thesis, the four Sustainability Principles present the minimum conditions which society needs to meet to operate in a sustainable manner (Holmberg and Robèrt 2000; Ny et al. 2006).

The Sustainability Principles (Holmberg and Robèrt 2000; Ny et al. 2006) state that in a sustainable society, nature is not subject to systematically increasing

> … concentrations of substances extracted from the Earth's crust [SP1];
> … concentrations of substances produced by society [SP2];
> … degradation by physical means [SP3];

and, that in society...

> … people are not subject to conditions that systematically undermine their capacity to meet their needs [SP4]

Phase 3 involves assessing the city's current reality, by examining its activities through the lens of the Sustainability Principles and analysing its impact on the socio-ecological system. Phase 4 entails brainstorming of possible actions to move the city towards sustainability, whilst keeping the previously created smart city vision in mind. In Phase 5, practitioners

create a smart city strategic action plan through prioritising and weighting the actions brainstormed in the previous phase, to ensure that the city develops strategically towards sustainability. In Phase 6, practitioners assess the overall progress of the various initiatives, and continuously communicate with stakeholders. Based on our results, a smart city review team needs to be established to communicate progress measurement results to the stakeholders, and develop and implement specific smart city tools. Further, this phase serves as an opportunity to loop back to the previous phases of the process to assess and enhance the strategic action plan by the use of the lessons learned from the process and the data gathered through measuring the success of the initiatives in the action plan. Each of these phases are discussed in more detail below.

4.4.1 Phase 1: Get Ready

This phase is the first step of the planning process, which aims to build a shared understanding and language with regards to sustainability and the SSD approach to ensure consensus, and to co-create guidelines that can then be applied throughout the planning process. Smart city practitioners should first gain an understanding of the SSD approach. Then, this knowledge, as well as an understanding of the smart city concept, should be shared amongst the stakeholders.

Our results indicated that there is a need for dialogue around a shared understanding of sustainability and the smart city concept in order to allow effective communication to take place between the stakeholders. Conversations need to address why sustainability is a desirable end state, and how the smart city concept can aid in reaching that goal. By frequently and consistently engaging in sustainability conversations with the various groups, smart city practitioners are able to raise awareness and explore the level of interest within the different stakeholder groups with regards to the issues at hand. This is done in order to ensure that a need for a sustainability planning process is understood, and that stakeholders are able to understand how the smart city concept can aid in reaching the goal of sustainability.

Through the assembly of the initial planning team, ideally containing members coming from each department of the city and from each stakeholder group, various process leaders can be identified who can facilitate the planning process. At a minimum, representatives from the public, business, educational, and political sectors need to be involved. It is vital that each participant in the planning process holds an understanding of sustainability, and that the smart city concept that is shared with all members. This can be achieved through educating participants on the SSD approach, and the manner in which it can be applied in urban contexts. In order to implement this planning process, it is necessary to have the process itself reviewed and assessed in terms of the needs of stakeholders. From there, the facilitators should create agreed-upon guidelines for the planning process, and the participants should task organise and decide which individuals or teams are responsible for tasks such as communication and logistical support.

4.4.2 Phase 2: Create a Smart City Vision

This phase involves the development of a shared smart city vision that is framed within the four Sustainability Principles to ensure that any actions developed further on remain within the boundaries outlined by a scientifically-based definition of sustainability.

Through having a shared understanding of the relevant concepts, stakeholders can now move on to develop a compelling vision of a smart city, defined by a shared purpose, common

values, and strategic goals. First, participants should define the core ideology of their city, based on what services the city wants to provide to society, and what values the city wants to hold. By narrating an envisioned future, all participants can vividly imagine what their city would look like in a sustainable future. Further, this creates the conditions necessary to brainstorm bold and daring goals that empower and motivate stakeholders. Since these ambitious goals can be highly motivational, they create a creative tension that pulls participants forward to work towards a vision they are deeply passionate about. FSSD practitioners highlighted that this portion of the strategic planning process is challenging, and will oftentimes require several months to complete so that the input of a wide range of stakeholders can be gathered.

From this compelling vision, participants can now begin to define what success looks like within each of the six smart city characteristics, based on the Smart City Model and the specific needs of the stakeholders. It is recommended that the whole vision of the smart city be framed within the four Sustainability Principles to ensure that the city can function and develop in a sustainable manner. Further, each of the six smart city characteristics should have a corresponding vision of success that is also held within those same sustainability constraints. In order to facilitate the visioning process of a future smart and sustainable city, a brief outline of what future success within the six characteristics can look like is found in table 4.2 below. This process will then enable participants to develop smart city strategic goals that can fall under the various characteristics. It is vital that these strategic goals are framed in a manner that makes them measurable, clear, and attainable. The outcome of this phase results in a formalised definition of success within each of the smart city characteristics, and a shared intention among the participants to work towards that vision.

Table 4.2 Vision of Success within Future Smart Cities

Smart City Characteristics	Vision of Success
Smart Economy	Success in Smart Economy can be described as sustainable economical development in compliance with the four Sustainability Principles. Through investing in innovative sustainable solutions and supporting research and development the city increases its economical role in the national and international market.
Smart People	Success in Smart People can be explained as having educated and skilled citizens that are culturally, socially and environmentally aware and willing to represent their opinion and will by participating in decision making processes about the city's development. These citizens also behave in accordance with the Golden Rule, meaning they treat others the way they want to be treated and interact with other humans in a manner which does not undermine their ability to meet their human needs
Smart Governance	Success in Smart Government can be characterised as a transparent, citizen centric-government, which functions in line with the concepts of strategic sustainable development, and develops the smart city through practices such as participatory governance and creating interconnected and efficient governance

	systems.
Smart Mobility	Mobility in a smart city involves energy and time efficient transportation systems developed through innovative and sustainable processes. Transportation systems do not rely on fossil fuels and instead are fuelled by renewable energy sources or involve non-motorised options. Further, the systems used are produced through sustainable industrial processes and work at minimising their environmental impact. The planners develop the city's mobility system in compliance with the four Sustainability Principles, while maintaining a citizen-centric planning approach.
Smart Environment	Success in the characteristic of Smart Environment is reached when the city's urban development plans and resource management policies are in full compliance with the four Sustainability Principles. This is achieved through initiatives that reduce pollution and greenhouse gas emissions, reduce energy consumption, increase energy efficiency of existing systems, implement strategic and sustainable urban planning processes, and preserve and protect natural areas.
Smart Living	Success in Smart Living can be characterised as safe and healthy living conditions that can be accessed by all citizens. The public services provided by the city are of high quality and equally accessible by all citizens, and function in compliance with the four Sustainability Principles.

4.4.3 Phase 3: Baseline Assessment

After the development of a shared smart city vision of success, and a clear understanding of how success is defined under each characteristic, participants can now move on to assess the current reality of their city. Existing measuring systems or indicators can be applied at this point for a more comprehensive understanding of the current state.

Participants start by conducting an internal analysis of the city's performance along the six smart city characteristics. This assessment identifies any areas and initiatives that are already in line with the city's vision, while also recognising any violations that are occurring with respect to the Sustainability Principles. Participants should weigh their current negative sustainability impacts to determine what areas are of strategic importance in moving towards sustainability. Additionally, the participants have the opportunity to conduct an operational analysis that would identify the products and services supplied to the systems of the city, the value chains the various departments rely on, and the waste and by-products that are in turn created. Further, it is important to evaluate the overall planning and governance structures that the city relies on as its decision-making framework.

This is followed by an external analysis that identifies the exterior factors that have an impact on the city's ability to reach its vision. Through this, the city can assess both the external factors and trends affecting the city, and the stakeholder relationships that have an impact on

the city's operations. A PESTLE analysis can be used to define external trends within the political, economic, social, technological, legal and environmental areas which have an effect on the organisation (Cambridge Business English Dictionary 2013). Further, the participants can identify their relationships with external stakeholders and the impacts these relationships have on the city through creating a stakeholder map. Our results suggest that stakeholder mapping is an effective strategy for identifying relevant actors within the city, and can be completed within each of the six smart city characteristics. This would distinguish which relationships are strong or weak, and whether any key stakeholder relationships have been overlooked. Additionally, we recommend practitioners to scope their analysis beyond the boundaries of their city, and also consider their impacts in surrounding areas such as neighbouring municipalities and rural areas.

This phase provides insights on what areas the city is doing well in with regards to sustainability, and where actions can be implemented to strategically move the city towards its goals. Further, a shared understanding of the gaps between the current reality of the city and the successful sustainable future is established with respect to the six characteristics of the Smart City Model.

4.4.4 Phase 4: Brainstorm Compelling Smart City Actions

The process of developing a description of success (Phase 2) and of analysing the current reality (Phase 3) for each smart city characteristic may have already inspired stakeholders to generate suggestions for initiatives and investments. Phase 4 builds upon this, and provides the opportunity for stakeholders to brainstorm possible actions and initiatives together.

During this phase, participants start brainstorming actions through a strategy of backcasting from the defined smart city vision. The brainstorming is conducted as a workshop that encourages creativity, innovativeness, and participation. This workshop should aim to involve additional stakeholders that have been identified as being relevant during the stakeholder mapping process. Brainstorming actions should occur for each of the six characteristics of the Smart City Model, placing particular emphasis on the strategic focus areas and the strategic goals. Participants are encouraged to 'think outside the box' to come up with actions that can lead to success in more than one development area of the Smart City Model.

4.4.5 Phase 5: Prioritisation Process and Creation of the Strategic Action Plan

In this phase, a smart city strategic action plan is created through the prioritisation of the actions brainstormed in the previous phase.

After a compelling list of actions has been created, practitioners develop prioritisation criteria with the input of participants that determine which actions are going to be implemented. When prioritising, the SSD approach suggests a minimum of three prioritisation questions. These questions provide strategic guidance to help practitioners determine which actions will most effectively and efficiently lead a city towards sustainability (Holmberg and Robèrt 2000). The SSD prioritisation questions are (adapted from Castle 2013 and ICSP 2009):

Right Direction: Does the initiative move us in the right direction?

Does it move us towards our vision or description of success within a specific smart city characteristic?

Does it move towards eliminating a violation of the Sustainability Principles?

Flexible Platform: Does the initiative serve as a flexible platform (i.e. a stepping stone) towards future moves?

Are future sustainability options still available or is this a dead end?
Is the sunk cost of this action or initiative a barrier to switching later?

Return on Investment: Does the initiative provide a sufficient return on investment?

What are the direct costs of this action?
What direct savings or increased revenues might accrue?
What risks are there of not taking this action?
What intangible benefits or other forms of 'capital' will this action provide? (e.g. social or political returns)

Our findings from the smart city practitioner interviews revealed that actions that meet the objectives of several smart city characteristics are deemed as being 'smarter' and therefore more favourable. Special consideration should thus be given to actions that are synergistic satisfiers, which fulfil the success criteria of more than one smart city characteristic. It is recommended that actions selected need to yield positive responses from all three prioritisation questions, or they need to at least justify why a prioritisation criteria is not met.

After the list of prioritised actions has been finalised, the practitioners need to determine which of those actions will be implemented in the short-, medium-, or long-term. Short-term actions can be deemed as "low hanging fruit" which can be implemented immediately and up to 12 months and can have a significant impact in a very short amount of time and can yield sufficient capital that can be re-invested into long-term actions. Medium-term actions require more capital and implementation time, and are therefore put in place between one- to two-year periods. Long-term actions are implemented beyond the two-year mark and require a significant investment that may need to be acquired through previous actions' return on investment.

An action implementation table can be created as an initial framework for a strategic action plan document. Actions are described and categorised under the six characteristics. Further, the table allows practitioners to report who is responsible, how much the initiative will cost, what measures are associated with the actions, what the implementation schedule is, and the action's current status. This provides practitioners with an overview of the strategic actions being implemented in the smart city. Further, this document allows for informed decisions to be made beyond the strategic planning process of a smart city, and can complement city decisions involving budgets and development plans. For this document to remain relevant and useful, it needs to be updated and reviewed frequently, and publicly shared.

4.4.6 Phase 6: Assessment Stage

After the completion of the strategic action plan, it now becomes important to continuously review and track the progress of the various actions. Practitioners need to assign a review board that is responsible for monitoring and evaluating the ongoing work within the city. Without this process, there is a risk that the entire strategic planning document quickly becomes outdated and obsolete. This review phase establishes whether the city is effectively meeting its goals, and taking the necessary steps towards reaching its developed vision. Through this process, a city can effectively compare and track its progress over time, and develop a holistic view of its achievements. The review board needs to frequently

communicate with the relevant stakeholders to share the progress status. This keeps stakeholders involved, and creates a chain of responsibility which maintains the momentum of the action plan. This review phase, if done in a transparent manner, will communicate to stakeholders that they can influence change in their city, which will motivate them to continue participating. The results from this review process provide a basis for future strategic decisions to be taken, thus ensuring continuous improvements of the city's strategic action plan.

Following the six phases of this strategic planning process in an iterative manner, smart city practitioners can maximise the potential of being socially and ecologically sustainable within the smart city concept. By applying the SSD approach, we hope that smart city practitioners can more effectively plan towards sustainability within the areas of smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

4.5 Limitations of Research

The concept of smart cities is fairly new, and a limited amount of research is therefore available. While this gave us opportunities to explore many different aspects of the smart city concept, the lack of peer-reviewed research may possibly have compromised the validity of the assumptions under which we functioned. Additionally, our results showed that cities held different understandings of what the smart city concept is. Since our literature findings showed that the smart city concept is actively being applied in the EU, we limited our scope to only include European smart cities. Therefore, some findings we present, particularly related to funding structures, may not apply to other regions. Further, a cultural and governance aspect that is unique to European cities will generate results that are not necessarily generalisable to other cities.

One potential limitation of our results stems from the data collection methodology we applied, which involved holding semi-structured interviews with smart city and FSSD practitioners. A limitation of having a semi-structured interview was that the interviewees often answered in ways that gave us rich and diverse information, but did not always respond in ways that fully addressed our question. In order to keep the interview process pleasant and professional, we had to balance our level of directness without exerting too much control. In speaking to the smart city practitioners, all were familiar with the concept and were actively applying it in their city. However, the professional backgrounds and positions they held were quite varied, and we therefore tended to get information skewed to their expertise. By speaking to one practitioner per city, we may have collected results that only reflected the opinions of one individual, and that can therefore risk misrepresenting the city as a whole. Further, out of the 27 cities we contacted, only seven practitioners were willing to participate, potentially limiting the generalisability of our results. All smart city practitioners were based in Europe, while all FSSD practitioners were active in North America, which creates a level of disconnect between the recommendations and the real-world applicability of the recommendations. In speaking to FSSD practitioners, varying levels of knowledge and experience of the smart city concept existed, which affected how detailed and specific their responses were.

Approaching this research from an SSD perspective may have resulted in elements of subjectivity, since we hold a direct knowledge of the SSD concepts, but only hold an indirect knowledge of the design of smart cities and the smart city concept. Such assumptions may have shaped our research in ways that skewed the objective reality of smart cities. Due to

time constraints, we did not request feedback from smart city and FSSD practitioners on the applicability and effectiveness of our proposed strategic planning process, and therefore did not integrate any further recommendations into our finalised process. However, it is our intention to continue communicating with smart city practitioners in order to refine the planning process so that it can effectively be applied in a real-world context.

4.6 Future Research Possibilities

The concept of smart cities contains many research areas that can be further examined from an environmental and social sustainability perspective.

While this thesis focuses on a theoretical discourse of the smart city concept, Paul Bevan, Secretary General of EUROCITIES, suggested that it would be interesting and valuable to perform case studies of specific smart cities in order to examine the extent under which progress in each of the six smart city characteristics individually and collectively can contribute to sustainability. Since smart cities have a strong dependence on ICT hardware, the accumulation of e-waste and the need for high amounts of energy to support these networks poses a direct threat to sustainability efforts. Further research can examine the realities of this, and what strategies should be put in place to best mitigate this issue. Further, since our scope only focused on European smart cities, it would be interesting to examine and contrast how other smart cities on a global level approach the concept of smart cities.

Since smart cities place high importance on citizen engagement and often attempt to do so through online mediums, future research could examine what methods work best to include and motivate citizen participation in decision-making processes through indirect communication platforms, such as social media. This area of research could also examine to what extent citizen input is necessary and beneficial in decision making processes, in approaches such as participatory budgeting. Interview results also showed that the concept of participatory budgeting holds a level of controversy; therefore future research can examine in what contexts this can best be applied to ensure that citizens are adequately able to influence governmental directions. Finally, future research can examine how the smart city concept can contribute to transparency, trust, and increased quality of life within the socio-ecological system.

5 Conclusion

Global urbanisation and the sustainability challenge are putting increasing pressure on urban systems. A new way of thinking, with an emphasis on taking a systems perspective, will be required to address these challenges. The concept of smart cities already holds the potential to address aspects of the sustainability challenge by promoting citizen participation, developing innovative and smart solutions for sustainability, increasing efficiency in city systems, and adopting a transparent and inclusive governance system. Our research sought to make recommendations which could help smart cities move faster and more efficiently towards sustainability.

Through our research, we first conducted an analysis of the smart city concept through the lens of the Framework for Strategic Sustainable Development in order to reveal the benefits and limitations of the concept with regards to sustainability. This analysis explored the smart city concept through examining the six characteristics of the Smart City Model, and how sustainability is reached within each domain. The results showed that the smart city concept is already in line with many aspects of the SSD approach, and is particularly effective in developing solutions that are citizen-centric. However, a incomplete understanding of the socio-ecological system that a smart city functions within, coupled with an unclear definition of success in terms of sustainability was highlighted in our analysis of the smart city concept, as well as unclear strategic guidelines for reaching success. These findings lead us to take our research further by conducting interviews with smart city practitioners.

Interviews with smart city practitioners sought to understand the experiences of such practitioners currently applying the smart city concept. Overall, practitioners voiced positive opinions of the effectiveness of the smart city concept, but also highlighted challenges in the domains of planning, measuring success, engaging stakeholders, and creating and implementing an action prioritisation process. We surmised that many of these expressed challenges could be effectively overcome through an SSD approach, so we conducted interviews with FSSD practitioners to gain insight on how to best address these challenges. FSSD practitioners provided us with guidance on how to conduct effective planning in city contexts, create attainable goals with corresponding measurements, increase and maintain stakeholder group engagement, and how to best prioritise actions when leading cities towards sustainability.

Even though the smart city concept has an innovative and forward-thinking method in its approach to city planning, the concept does not necessarily allow for cities to develop in a sustainable manner. Therefore, a six-phase planning process was designed specifically for smart cites to implement a Strategic Sustainable Development approach while creating opportunities for city departments to collaborate, stakeholders to be fully engaged in the planning process, and citizens to be informed. The proposed ‘Strategic Planning Process for Sustainable Smart Cities’ aims to help smart city practitioners plan in ways that will efficiently and effectively move their city in the right direction towards sustainability.

We hope that this thesis contributes to the exciting research within smart cities, and aids in maximising the potential for the smart city concept to stand as a solution for sustainability in our increasingly urbanised world.

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Appendix A: Exploratory Interview Demographic Information

Name	Expertise	Date Of Interview
Boyd Cohen	Professor at the University of Buenos Aires; Smart city expert	Feb. 14, 2013
Rudolf Giffinger	Professor at Vienna University of Technology, Dept. of Spatial Development, Infrastructure, and Environmental Planning, author of "Smart cities: ranking of European medium-size cities")	Feb. 13, 2013
Henrik Johansson	Environmental coordinator, Strategic environment department, Växjö, Sweden	Feb. 19, 2013
Annette Holm	IT Director at the City Planning Office, Stockholm, Sweden	Feb. 20, 2013

Appendix B: Smart City Practitioner Interview Guide

	Smart City 5 LF	FSSD	Gaps
Systems Level	• Cities consist of sub-systems	•Awareness of the social and environmental systems •Scientific understanding of natural laws	• No mention of city's relationship with socio-ecological systems • No scientific basis
Success Level	• Success = development in 6 characteristics of the smart city concept • Smart = Sustainable • No clear smart city definition	• Principled-definition of sustainability	• No principled understanding of sustainability (4SPs) • Lack of shared conceptual understanding • No uniform definition of success
Systems Level	• Strategies along 3 pathways • Prioritisation based on cost-effectiveness	• Backcasting from SPs • Prioritisation Questions	• Some backcasting • Unclear strategic guidelines and planning framework •Incomplete prioritisation questions
Actions Level	• Actions along the 6 characteristics • Reliance on ICT	• Actions which do not violate the four SPs, and help cities move strategically towards sustainability	•Actions do not guarantee that SP violations are reduced/avoided (lack of framework)
Tools Level	• Smart City model / Smart City Wheel / ICT tools (e.g. smart grid)	• Tools that support efforts towards sustainability	• Various tools exist, but may not result in strategic development

Appendix C: Smart City Practitioner Interview Guide

#	Interview Questions for Smart City Practitioners
1	What is your role within the organization?
2	When did [city name] start working towards becoming a smart city?
3	What was the reasoning and motivation for [city name] to start working towards becoming a smart city?
4	How do you define a smart city?
5	Have you experienced any challenges in understanding the concept of smart cities?
6	In the following areas, what are some initiatives you are currently working on/implementing in [your city]? What have been the biggest challenges in those following areas? • Governance (maintaining a transparent and participatory government system) • Living (creating a healthy, safe, and culturally vibrant city) • Mobility (having highly accessible and sustainable transport systems) • People (fostering human and social capital growth) • Economy (high levels of innovation and entrepreneurship, international connectedness) • Environment (environmental protection and sustainable resource management)
7	How do you measure success in the various smart city initiatives you are implementing?
8	What is the planning process behind making your city smart? What are the challenges in that process?
9	What stakeholders do you involve in the smart city planning process? What is your engagement process like? What are the challenges in that domain?
10	How do you prioritise smart city actions?
11	How do you inform citizens about your various smart city initiatives?

12	What are the benefits of implementing the smart city concept, and its initiatives?
13	What challenges exist for the smart city concept? How do you feel these challenges could best be overcome?
14	How does [city name] define sustainability? (Follow up: What would success look like? How do you know when you have succeeded – in what ways do you measure success?)
15	Is this definition shared between members of your department?
16	Is this definition shared between your department and the various stakeholders you work with?

Appendix D: Smart City Practitioner Demographic Information

#	Interviewee	City	Country	Position	Date of the Interview	Length of the Interview
1	**Francisco Gonçalves**	Lisbon	Portugal	Environmental Engineer (Project Coordinator)	2013.03.22	48 min
2	**Emilie Sofie Hvidtfeldt**	Copenhagen	Denmark	Project Manager at City of Copenhagen	2013.03.25	1 hour 4min
3	**Stefan Svensson**	Stockholm	Sweden	Manager, IT Department, City Planning Office	2013.04.03	37 min
4	**Henrik Johansson**	Växjö	Sweden	Environmental coordinator, Strategic environment department	2013.03.21	1 hour 20 min
5	**Ulrich Dilger**	Stuttgart	Germany	Project Manager, Department of Urban planning and urban renewal	2013.03.21	41 min
6	**Mirko Presser**	Aarhus	Denmark	Lab- Head of research and Innovation, Alexandra Institute-Smart City	2013.04.12	1 hour 3min
7	**Peter Bjorn Larsen**	Oresund	Denmark/ Sweden	Smart City HUB Project Coordinator	2013.03.21	1hour 20min

Appendix E: FSSD Practitioner Interview Questions

#	Interview Questions for FSSD Practitioners
1	The smart city concept holds certain assumptions at the systems level. It assumes that Information and Communication Technology (ICT) is the future for sustainable cities, and that development must occur within six domains: people, governance, mobility, economy, environment and living. **In your opinion, what considerations need to be taken to ensure that development in those areas remains sustainable?**
2	Smart city practitioners express that being smart also means being sustainable. However, our interviews show that each practitioner defines the terms "smart" and "sustainable" differently. **In your experience, why is it important to have principled definitions of such concepts when working towards sustainability? What benefits does a shared understanding offer the process of helping municipalities or cities become sustainable?**
3	In speaking to smart city practitioners about their planning process, various challenges were identified. Practitioners mentioned that there is a lack of systems approach when it comes to developing initiatives. Further they mentioned that it is difficult to collaborate without a shared vision, and different departments often have different goals and budgets. **In your experience, what is an effective planning process that could be used to overcome these challenges? How can you create a vision that meets the needs of the various departments, whilst still meeting the necessary conditions needed for sustainability?**
4	Measuring progress towards success is an important component in reaching any goal. Through our research with smart city practitioners, we identified that many cities measure success through their climate goals. Various benchmarking tools are in the process of being developed, but are not yet applied. Further, the political goals strongly determine what cities define as success. **In your experience, what strategies work best for developing progress measures of success?**
5	In an urban planning process, smart city practitioners mentioned various challenges associated with stakeholder engagement. Examples include overcoming stakeholder apathy, and that solution become increasingly difficult to reach as more stakeholders are included in a process. **What are the essential elements of an effective engagement process? During a planning process for urban or municipal sustainability, what vital stakeholders need to be involved?**
6	When determining which initiatives to implement, the prioritisation process of smart city actions is largely determined by politics, and the amount of funding available. Interview results however also found that some cities use participatory budgeting approaches to involve citizens in prioritising which actions to take. **In your experience, what is the most effective method for prioritisation to ensure that actions remain sustainable?**
7	**Through this very introductory discussion about smart cities, do you see any obvious additional benefits or challenges to the approach in helping a city reach sustainability?**

Appendix F: FSSD Practitioner Demographic Information

#	Respondent Name	Area of Expertise	Date of the Interview	Length of the Interview
1	**Pong Leung**	Senior Associate, The Natural Step Canada	2013.04.15	41 min
2	**Regina Hauser**	Board Member, Board of Directors and Governance Board at The Natural Step International	2013.04.11	35 min
3	**John Purkis**	Senior Associate, The Natural Step Canada	2013.04.10	1 hour17 min
4	**Sarah James**	Co-Director, Institute For Eco-Municipality Education & Assistance, USA	2013.04.15.	47 min
5	**Lisa MacKinnon**	Sustainability Coordinator and Audit Analyst at Office of the Dane County Board of Supervisor, USA	2013.04.13	1hour 5min
6	**Monica Pohlmann**	Sustainability Strategist and Facilitator, Monica K Pohlmann & Associates, Canada	2013.04.12	44 min
7	**Duke Castle**	Principal, The Castle Group, USA	2013.04.12	31 min
8	**Dave Waldron**	Founder, Synapse Strategies, Canada	2013.04.12	1hour 5min

Appendix G: Identified Sustainability Challenges of Smart City Practitioners

Level of the 5 LF	Challenges Described by Smart City Practitioners
Systems	• smart city definitions too broad, too long definitions exist • every city will have different definitions of a smart city • concept based too much on energy and technology • the definition is not shared even at the departmental level, and there is a lack of shared understanding
Success	• smart cities focus too much on ICT, ICT alone cannot be the solution for sustainability • definition of sustainability is not shared within stakeholders • if smart is sustainable, but sustainable is not defined, then what is smart? • departments are working with different definitions of sustainability, through different tools
Strategic	• lack of systems approach towards SC initiatives → solutions need to involve many players to be holistic and we need to know what kinds of technologies are out there • lack of citizen-centric approach, development approach based on need (inclusive) • social sustainability goals are not favored because they are difficult to measure , cities emphasize mobility, governance, and environment • the more stakeholders you involve, the more complicated it becomes to reaching a solution • the actual effects (in form of sustainability) are not examined in the initiatives • people lose interest, the concepts need to be implemented in a way to maintain interest; citizens are only interested when they are affected negatively by initiatives (NIMBY) • lack of political support is a challenge, while it is what dictates funding • different departments have different goals, it is difficult to find ways to collaborate without a explicit shared goal and stakeholder involvement • no designated department responsible for smart city operations and development • SC solutions are largely dependent on budget • difficult to enforce rules that are not mandated by law • many city offices and people are involved, • existence of departmental silos • you need to provide a business case for companies • departmental budgets are different, therefore working together is hard • lack of success measure methodology • lack of targets and indicators (internal) • short term political cycles results in short-term goals • different departments have different success indicators • challenge in the reactive nature of strategy, the process should be proactive • challenge in communicating the benefits of the initiatives • planning process vary from department to department
Action and	• economic crisis, citizen distrust, growing social need, aging population, transportation and sustainability

Tools	• test and demonstration of SC solutions needs to be done before an action can be implemented large-scale • with ICT, there are challenges with regards to system compatibility • no specific smart city tools to assess progress

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