

**A framework for effective design thinking based
smart cities projects in Qatar**

**A Thesis Submitted for the Degree of Doctor of
Philosophy**

By

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Abstract

As cities continue to grow and digital technologies reshape urban life, the concept of smart cities (S-Cits) has gained global momentum. In Qatar, this transformation brings unique challenges—especially around citizen engagement, data privacy, and governance. The aim of this thesis was to develop a design thinking-based framework tailored to the Qatari context, to support the effective design and implementation of smart city initiatives that are inclusive, secure, and sustainable.

The thesis adopted a mixed-method approach, triangulating data from quantitative analysis of two surveys exploring S-Cit elements, with t-test and correlation analysis of data privacy and security issues, and in-depth qualitative analysis of interviews with expert stakeholders on various S-Cit factors. Statistical analysis was conducted using SPSS (v. 30). The first survey involved 40 Qatari citizens and focused on the readiness to engage with smart city concepts across six domains: economy, governance, people, mobility, environment, and living. The second survey involved 120 citizens and 35 experts and focused on their perceptions of data privacy, cybersecurity, and their impact on adoption. The quantitative research is supported by 12 semi-structured interviews with senior managers and stakeholders in Qatar's smart city initiatives. Case studies of Lusail Smart City and Msheireb added further contextual depth.

The findings show that while most citizens see clear benefits to smart technologies, the majority expressed concern about data misuse and transparency. A significant correlation was found between trust in data governance and willingness to adopt smart services. The interviews highlighted key obstacles, including fragmented policy, limited public engagement, and weak cybersecurity frameworks. Based on these insights, a design thinking framework was developed based on the theme of empathy, collaboration, iterative design, and long-term sustainability. The framework offers practical guidance for governments, urban planners, and developers to build smart cities that truly meet the needs of their communities—both in Qatar and in similar global contexts. This thesis contributes to the growing body of knowledge on S-Cits by offering both a theoretical and practical model for context-sensitive smart city development.

Keywords: smart cities; design thinking; citizen readiness; data privacy; cybersecurity; smart city adoption

Declaration

I declare that the research in this thesis is the author's work and submitted for the first time to the Post Graduate Research Office at Brunel University London. The study was originated, composed and reviewed by the mentioned author in the Department of Electronic and Computer Engineering, College of Engineering, Design and Physical Sciences, Brunel University London, UK. All information derived from other works has been referenced and acknowledged.

Dana AlAli.

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London, UK

Dedication

I dedicate this thesis to all the people who supported me during this journey, a three- years- experience full of challenges, growth, and achievements.

to all the people who believed in me long before I believed in myself,

to everyone who listened when I needed to talk, stayed when I needed a space, and encouraged me when I needed hope, this journey was never mine alone,

Thank you, from the bottom of my heart.

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List of Abbreviations

AI	Artificial intelligence
API	Application programming interface
CPE	Capability–Performance–Experience
GCC	Gulf Cooperation Council
GDP	Gross domestic product
IoT	Internet of things
KPI	Key performance indicator
PPP	Public-private partnership
QoL	Quality of life
R&D	Research and development
S-Cit-Adn	S-Cit adoption
S-Cit	Smart city
S-Cit-Eco	S-Cit ecosystem
S-Cit-Imp	S-Cit implementation
S-Cit-P	S-Cit project
SDG	Sustainable Development Goal
TAM	Technology acceptance model

Glossary of Key Terms

Term	Definition
Citizen Readiness	The willingness and preparedness of citizens to adopt and engage with smart city initiatives.
Correlation Analysis	A statistical method used to evaluate the strength and direction of the relationship between two variables.
Cronbach's Alpha	A statistical measure used to assess the internal consistency or reliability of a survey or test.
Cyber Security	Measures to protect smart city infrastructure and data from cyber threats.
Data Privacy	Protection of personal data from unauthorised access and misuse in smart city systems.
Design Thinking	A problem-solving approach focused on understanding user needs, challenging assumptions, and creating innovative solutions through iterative processes.
Design Thinking Framework	A structured approach for innovative solutions in smart city development, involving empathy, ideation, prototyping, and testing.
Industry 5.0	The next industrial phase focusing on human-machine collaboration for personalised and sustainable production.
IoT (Internet of Things)	A network of interconnected devices that collect and exchange data to improve services and infrastructure.
Purposive Sampling	A non-probability sampling method selecting participants based on specific characteristics relevant to the research.
Smart City	An urban area that uses advanced technologies like IoT, AI, and big data to enhance the quality of life, sustainability, and citizen engagement.
Smart Economy	Economic activities in smart cities driven by innovation, technology, and sustainable resource management.
Smart Environment	The use of technology and data-driven solutions to improve environmental sustainability.
Smart Governance	The use of technology to improve decision-making, transparency, and citizen participation in government processes.
Smart Living	Integration of technology in daily life to enhance comfort, convenience, safety, and sustainability.
Smart Mobility	Sustainable and efficient transportation systems enhanced by innovative technologies.
Smart People	Citizens in smart cities characterised by high education levels, creativity, adaptability, and civic engagement.
Society 5.0	A people-centric society integrating cyberspace and physical space to balance economic advancement with social problem-solving.
T-test	A statistical test used to compare the means of two groups to determine if they are significantly different from each other.

1.

Introduction

This introductory chapter introduces the area of research and presents the background against which this study is undertaken. This includes a brief introduction to the concept and development of smart cities (S-Cits), the need for their development, their various integral elements, and challenges associated with S-Cit implementation (S-Cit-Imp), covering the main area of focus of this research. This chapter also presents the research problem addressed by this research, followed by identification of its aim and objectives. Finally, the chapter highlights the significance of the research and its contribution to academic literature and practical implications.

1.1. Background On Smart Cities (S-Cits)

1.1.1. Fundamental Socio-Demographic Factors

The number and proportion of people living in cities has increased exponentially worldwide over the last two centuries. According to Moreno-Monroy *et al.* (2021), more than half of the global population lives in cities, necessitating extensive government intervention to ensure that the basic framework of governance is provided for, ensuring inclusiveness and collaborative approaches in urban ecosystems. Moreover, Lagakos *et al.* (2023) highlighted that there has been rapidly increased rural-urban migration in developing countries over recent decades, as people seek improved employment and lifestyle opportunities in towns and cities. The UN (2015) estimates that approximately 70% of all humans will be living in cities in the coming years, placing an overwhelming burden on existing cities, especially where little or no fundamental development has taken place to support the increasing population (e.g., improved and expanded housing, transport, sewage, healthcare, and education infrastructure). Cities face increasing strain on their ageing infrastructure, presenting strong challenges for sustainability in urban environments. Furthermore, urbanisation intrinsically leads to environmental degradation, due to urban sprawl and the exploitation of resources with little or no focus on sustainability. Furthermore, Wei and Ewing (2018) also pointed out that poor urban planning has also contributed to social inequalities wherein many communities face the challenge of access to basic services of education, healthcare, transportation, and livelihood opportunities.

1.1.2. “Smart City” Operational Definition and Conceptualisation

Arief *et al.* (2020) defined an S-Cit as an urban area that uses advanced technologies like internet of things (IoT), artificial intelligence (AI), big data, and communication networks to collect, analyse, and act on real-time data to enhance the quality of life (QoL), sustainability, and citizen engagement and economic productivity in urban areas. While the concept and

associated factors are discussed at length through this thesis, a brief illustration of typical features is shown in Figure 1.1.



Figure 1.1: IBM's typical features of a "smart city"

Source: Wu (2025)

Andrade *et al.* (2020) added that an S-Cit is designed to enhance the well-being of its inhabitants by prioritising inclusivity, sustainability, and citizen engagement. S-Cits have become an existential phenomenon, with many countries either having adopted the concept or in active stages of S-Cit adoption (S-Cit-Adn) (Habib *et al.*, 2020). Several academic definitions of S-Cits have been proposed by researchers, reflecting the increased interest of researchers in this evolving field.

Anthopoulos (2015) defined S-Cit as an integrated platform of technological ecosystem which facilitates interaction of multiple stakeholders such as citizens, government, companies and is capable of maintaining the different aspects of city management such as social, economic and environment, among others. In another definition, Silva *et al.* (2018)

proposed the concept of S-Cit as an ecosystem which is primarily driven by advancements in technology and focus on governance with the overall objective of providing a sustainable living for the citizens. A more simplistic definition was provided by LazaroIU and Roscia (2012), who stated that an S-Cit essentially comprises an urban ecosystem which pursues economic development, while also implementing sustainability measures such as reduction in greenhouse gases and pollution. Overall, the concept of S-Cit has been studied in various aspects, with most predominant ones focusing on the technological aspects of the S-Cit ecosystem (S-Cit-Eco).

The concept of S-Cits originated in the mid-1990s, but it gained significant traction from the 2000s onwards, primarily driven by the advancements in technology, enhanced computing power, and network connectivity which were used to provide solutions to the urbanisation problems and enhancing the QoL of the citizens (Deakin, 2013; Picon, 2015). The last decade has seen a significant increase in research related to S-Cits. However, much of the interest in S-Cits increased with data management, primarily driven by data analytics (Allam and Dhunny, 2019; Ismagilova *et al.*, 2019). This is primarily due to the reason that various embedded devices as well as software applications generate a vast amount of data which needs to be handled efficiently. In this regard, Gaur *et al.* (2015) pointed out that S-Cit architecture should account for management of voluminous data for its entire lifecycle for ensuring that the issues related to compliance, compatibility, ethics and reusability of data is adequately addressed.

Later research has also focused on the role of big data and data analytics as a key component to S-Cit architecture, and has also acknowledged that research in this area is still evolving as more and more countries implement S-Cits for addressing the core problems of urbanisation (Hashem *et al.*, 2016; Kirimtati *et al.*, 2020; Komninos *et al.*, 2019). Many researchers have attributed the focus on developing “smart” cities to the user side, noting the widespread adoption of smartphones and availability of ubiquitous Internet connectivity (Walravens, 2015). Other researchers have pointed out that the evolution of S-Cits has been shaped by the need to address the challenges of urbanisation and provide a sustainable ecosystem to the citizens from a more strategic perspective, whereby governance is characterised by transparency, accountability, and efficient delivery of services (Angelidou *et al.*, 2018; Haarstad, 2017; Yadav *et al.*, 2019). A significant contribution to academic literature related to S-Cits was made by Nam and Pardo (2011), who presented an S-Cit model which comprised three dimensions – technology, people and institutions.

This conceptualisation paved the way for research related to an integrated ecosystem of S-Cits which can help in solving urbanisation problems. In essence, researchers have argued that S-Cits provide a promising approach towards addressing the complexities of urbanisation, and working towards sustainable living and urban development (Bhattacharya *et al.*, 2020; D'Auria *et al.*, 2018; Wu *et al.*, 2022). This is primarily attributed to the argument

that technology can be significantly useful for increasing efficiency and QoL for citizens, while providing citizen-centric services with ease. Hence, it is also imperative to study S-Cit-Adn with respect to different aspects of urban living such as administration, public safety, governance, utilities, and citizen centric services, among others.

In this regard, Lombardi *et al.* (2012) pointed out that S-Cit-Imp should be derived from realistic representation of the urban environment and supported by effective policy making. This argument is based on the premise that while technology is the enabler, the S-Cit should be based on policies which promote effective governance. A similar argument was proposed by Zubizarreta *et al.* (2016), who proposed that S-Cits should be viewed as a holistic and integrated ecosystem which addresses the key aspects of urban planning and implements sustainability measures. As such, there is considerable interdisciplinary research related to S-Cits which is the attention of academia, business, practitioners, and policy makers combined (Axelsson and Granath, 2018; Sepasgozar *et al.*, 2019; Yeh, 2017).

1.1.3.S-Cit Adoption Factors

There have been several factors which have contributed to the increased S-Cit-Adn, which can be grouped under the “technological”, “governance”, and “citizen engagement” dimensions.

1.1.3.1. Technological

The most notable driver comprises the collection of advancements in various technologies and the convergence of key technological trends, which have made it feasible to conceptualise complex and integrated architecture of S-Cits. In this regard, Qian *et al.* (2019) highlighted the role of IoT, big data analytics, sensors, and network connectivity (such as 5G connectivity and wireless networks) as the key catalysts which have facilitated global S-Cit-Adn dissemination. Furthermore, the requirement of interconnectivity and compatibility between different systems have allowed data exchange among different applications and removed the need for legacy and silo systems (Ahad *et al.*, 2020). For instance, citizens in S-Cits can avail services through a single portal by filling in the necessary inputs (Piro *et al.*, 2014).

This is also facilitated by the reduction in costs of storage (particularly data storage), computing, and networks through the use of cloud-based platforms, which have formed the backbone of S-Cit-Imp (Mohanty *et al.*, 2016). In addition, Gharaibeh *et al.* (2017) also pointed out that significant enhancements in the processing speed have facilitated processing of data from different sources. Hence, the enabling technologies have proved to be the backbone of the S-Cits and have made it easier to implement the technological architecture in the S-Cit-Eco.

1.1.3.2. Governance and Policy Framework

The second driving factor for S-Cits has been the need to provide a robust governance and policy framework for the cities under different administrations. In this regard, Meijer and Bolívar (2016) pointed out that smart governance has been the key characteristic of S-Cits as it leverages information and communication technologies to improve decision-making while also ensuring a better collaboration with the different stakeholders. This view is also supported by Pereira *et al.* (2018) who pointed out that increased government interaction with the citizens and other stakeholders in S-Cits increase citizen engagement and lead to trust in the overall S-Cit-Eco. Furthermore, De Guimarães *et al.* (2020) asserted that the final goal in an S-Cit environment is to improve the QoL of citizens which requires to work on a long-term strategy for sustainable delivery of services such as healthcare, education, transportation, housing, waste management, and environment prevention, among others.

1.1.3.3. Citizen/ User Engagement

The third factor which has been identified as a significant contributor to S-Cit-Imp is the citizen engagement which leads to S-Cit-Adn. There has been significant interest with respect to the importance of citizen engagement in S-Cits in various countries such as Indonesia, Italy, India, and China, among others (Blasi *et al.*, 2022; Gil *et al.*, 2019; Kummitha and Crutzen, 2019; Yeh, 2017). Researchers have reported that factors such as perceived benefits, trust in the government, and social norms have been key influencers towards a positive citizen engagement (Cortés-Cediel *et al.*, 2021; Kumar *et al.*, 2020; Yadav *et al.*, 2019).

1.1.3.4. Sustainability and Environmental Issues

Finally, the quest for sustainability has been a main reason for conceptualising and implementing S-Cits, including socio-economic development and minimising the adverse environmental and ecological impacts associated with urbanisation, and city life and economic activities in general. Researchers have argued that sustainability can be achieved by a confluence of various factors such as use of robust technological architecture, policies, robust governance, and citizen engagement, among others, with potentially reduced greenhouse gas emissions due to technological efficiencies and renewable energy sources (Bibri, 2019; Silva *et al.*, 2018; Trindade *et al.*, 2017).

1.1.4.Challenges

Despite the manifold potential benefits of S-Cits, there are widespread concerns with respect to potential challenges and drawbacks, including issues of socio-economic equality concerning the “digital divide” and digital literacy:

1.1.4.1. Socio-Economic Inequality and Access

Due to prerequisite investment costs and latent infrastructural requirements, the advantages of S-Cit-Ecos might be limited to privileged people (in terms of their general socio-economic status or geographical location), thereby excluding others and increasing social inequalities (Kolotouchkina *et al.*, 2022). Researchers have highlighted the lack of access to digital technologies to certain socio-economic groups can have significant implications for service delivery in the areas of healthcare, education, housing, and economic opportunities (Shin *et al.*, 2021; Van Deursen and Mossberger, 2018).

1.1.4.2. Data Management

Another major issue with respect to the S-Cit-Adn is with respect to the management of vast amounts of data which is collected by the autonomous systems. Elmaghraby and Losavio (2014) pointed out that this often leads to the concerns regarding individual privacy and data protection, along with the capability of the government and administrators to safeguard the data while also ensuring ethical practices when using the data. Moreover, the use of the different systems within the S-Cit-Eco often poses challenges of interoperability and use of proprietary systems which can often increase the cost of implementation and maintenance of S-Cit systems (Ahlgren *et al.*, 2016; Chaturvedi and Kolbe, 2019).

1.1.5. Methodological Considerations and Research Gaps

Despite the challenges alluded to above, the conceptualisation and implementation of S-Cits has received considerable interest among academic as well as practitioner communities. As discussed above, academic literature on S-Cits have focussed on specific factors such as technological elements, governance, sustainability issues, citizen participation, and data privacy and security issues. It is recognised that a theoretical framework that universally clarifies the constituents of S-Cits remains absent. The limited perspective offered by literature, therefore, has left a gap for theoretical discussions of S-Cit models and projects in light of the various environment, resource-management, life quality, and sustainability issues.

In addition to that, the existing models of S-Cits lack empirical justification in the real-world context. Moreover, the discussion of design thinking in its relevance to contemporary S-Cit projects (S-Cit-Ps) is limited which has led to the research gap which provides a holistic approach to dealing with the intractable problems faced in the urban infrastructure and citizen centric services.

Furthermore, there is a research gap concerning reviewing different elements of S-Cits in the context of the S-Cit-Eco in Qatar, given the rapidly developing and novel nature of real-world applications and use cases. Considering the above, this study aims to address the research gap by applying a design thinking framework to develop a common user-centred

understanding of the challenges and potential scenarios for conceptualising and implementing S-Cits.

1.2. Problem Statement

There is growing interest in the effective and efficient management of cities, primarily due to the increasing urban population and the potential solutions offered by the latest technologies. Socio-demographic fundamentals due to urbanisation have resulted in increased pressure on policymakers in urban and national economic planning to provide basic services, as well as to increase social, economic, and environmental sustainability. In the past two decades, much of the problem of urbanisation has been addressed by this research is focused on formulating a holistic perspective of S-Cit conceptualisation and implementation using design thinking framework. Currently there is a paucity of literature which provides a holistic and comprehensive perspective of the different elements of S-Cits and how they can be used for the benefit of different stakeholders such as citizens, policy makers, government, and implementation agencies, among others. Prior research has focussed on the areas related to:

- The role of technology in building S-Cits (Ahad *et al.*, 2020; Ahlgren *et al.*, 2016; Gaur *et al.*, 2015; Krimtat *et al.*, 2020).
- The need to build S-Cits for solving urban city problems (Meijer and Bolívar, 2016; Sepasgozar *et al.*, 2019; Wu *et al.*, 2022).
- Citizen participation in S-Cits (Cortés-Cediel *et al.*, 2021; Gil *et al.*, 2019; Yadav *et al.*, 2019).
- Policy and governance framework in S-Cits (De Guimarães *et al.*, 2020; Pereira *et al.*, 2018; Ruhlandt, 2018).
- Sustainability aspects in S-Cits (Angelidou *et al.*, 2018; Bhattacharya *et al.*, 2020; D'Auria *et al.*, 2018).
- Data security and privacy issues related to S-Cits (Braun *et al.*, 2018; Cui *et al.*, 2018; Sookhak *et al.*, 2018).
- In recent years, there has also been more emphasis on the architecture of S-Cits, seeking to incorporate compatible technologies, and ensure that the voluminous data generated from the different systems is managed effectively (Gharaibeh *et al.*, 2017; Bibri, 2019).

While the above-mentioned areas in the domain of S-Cit-Ps represent multifaceted research areas, there is a lack of clear understanding in academic literature with respect to the strategic planning of S-Cit-Ps and adoption of a framework to include various components of S-Cits. Yigitcanlar (2015) also highlighted that there is a clear literature gap with respect to the theoretical framework which provides a comprehensive and holistic understanding of design, conceptualisation, implementation and maintenance of S-Cit-Ps. Moreover, policy makers and regulators may not possess adequate technical knowledge to interpret the understanding of the architecture of S-Cits, which may inhibit informed decision-making. Hence, it becomes imperative to present a framework which can provide a common understanding to the different stakeholders with respect to the different elements for designing an S-Cit-Eco. This is the main research problem which will be covered in this thesis. The study is also situated in relation to the extant literature concerning different elements of S-Cits, and seeks to present an overarching framework for interpretation of different stakeholders for informed decision-making.

1.3. Research Question, Aims and Objectives

Given the above problem statement, and the gaps in existing research (explained in detail in section 2.14), this study seeks to answer the following question:

- ❖ What are the key factors for the design, conceptualisation, implementation, and maintenance of S-Cit-Eco in Qatar?

The aim of this thesis is:

- ❖ To explore the key elements of an S-Cit-Eco and assess their influence on the acceptance of S-Cits among citizens in Qatar, with a specific focus on privacy and data security concerns, using a design thinking framework.

In pursuit of this aim, the thesis identified the following objectives:

1. To assess the readiness of Qatari citizens to adopt various aspects of S-Cits.
2. To investigate privacy and data security concerns regarding S-Cits among both citizens and experts.
3. To analyse the impact of privacy and data security concerns on citizens' readiness to adopt S-Cits.
4. To develop a roadmap for the implementation of S-Cits from the perspective of policymakers, considering privacy and data security as key factors.

Achieving the aim and objectives will be reflected in developing and presenting a framework for S-Cit-Imp, via a structured approach comprising a literature review, research methodology, data collection, data analysis, presentation of findings, and conceptual framework for S-Cit-Imp.

1.4. Significance of the Research

The field of S-Cits is evolving very fast, with many countries having undertaken significant investments to upgrade the standards of their cities and convert them into S-Cits. Hence, research in this field has attracted significant attention for a multitude of reasons, such as working towards the sustainability of existing cities, reduced degradation of the environment, supporting public transportation, and improving the QoL of citizens (Habib *et al.*, 2020; Kumar *et al.*, 2020; Meijer and Bolívar, 2016). This research aims to investigate the different elements of an S-Cit-Eco from a holistic perspective by using design thinking framework for conceptualisation and implementation of S-Cits. The findings of this research will be significant from both theoretical as well as practical perspectives.

From the theoretical point of view, the findings of the study have the potential to contribute to the existing literature by providing a framework which can help the stakeholders to understand the interaction of the different elements of an S-Cit-Eco as well as the various factors which influence the S-Cit-Adn. Secondly, this study is significant as it will address the research gap with respect to the strategic planning of S-Cit-Ps and adoption of a framework to include various components of S-Cits. The thesis will also compare the empirical findings with extant literature, to determine the extent to which they are consistent with prior research or present new insights in the chosen research area. This will help in understanding the key aspects of S-Cits, especially with respect to critical success factors for S-Cit-Imp, cyber security aspects in S-Cits and the data privacy and security aspects. Moreover, the findings of the study will be useful for different stakeholders such as policymakers, regulators, implementation agencies, citizens, and other stakeholders for interpreting the different aspects of S-Cits. It will not only help in understanding the challenges of setting up S-Cits in Qatar, but also elsewhere.

From a practical perspective, the findings of the study will be useful for stakeholders such as policymakers to understand the different elements of S-Cits as well as incorporate the framework which will be proposed in this research. This research will also highlight the beneficiaries of the study, and the benefits of its insights for society, through policy recommendations. The study will also reach out to various institutions such as educational institutions, and local government authorities for presenting the findings and incorporating in their knowledge repository. The ways in which the findings were validated are described in section 3.10.

Hence, this study will present a significant contribution and will be useful for academicians, industry professionals as well as policymakers. The framework will be useful for companies implementing S-Cit systems so that they can use the framework for identifying stakeholders and the interaction with the S-Cit-Eco. The benefits to the citizens are to be in the form of improved and robust architecture of S-Cit, as well as enhanced privacy and security measures. This will be included in the design framework that will be prepared as part of the dissertation report. Other beneficiaries include policy makers, architects, and service providers in the S-Cit-Eco. In the dissertation report, a detailed evaluation of the benefits to the different stakeholders will be presented.

1.5. Organisation of Thesis

Chapter 1 introduces the area of research germane to this thesis and presents a background of the study. This includes a brief introduction to S-Cits, the need for their development, their various constituent, challenges associated with S-Cit-Imp, and the focus area of the research. This chapter also presents the research problem which will serve as the guiding point for conducting the research. This is followed by identification of the aim and objectives of the research. Finally, the chapter highlighted the significance of the research and its contribution to academic literature and practical implications.

Chapter 2 presents an extensive and critical review of extant literature regarding various aspects of S-Cits. It begins with an introduction of S-Cits and follows up with the evolution of S-Cits over the past two decades. This is followed by reviewing the models of S-Cits which have received considerable attention in academic literature. The thesis has then reviewed the latest trends in S-Cits and compared it with the concept of Industry 5.0. This is then followed with the review of decision thinking framework for S-Cits and the critical success factors for S-Cit-Imp. The thesis has also extensively evaluated cyber security aspects in S-Cits and the data privacy and security aspects while also investigating their role towards S-Cit-Adn. Finally, the chapter reviews specific contexts of S-Cits (such as Lusail and Msheireb), and compares S-Cit-Ps in Qatar and UAE. Based on the reviewed literature, a theoretical framework is presented, and the specific research gap addressed by this research is identified.

Chapter 3 summarises the research methodology. The study used the “research onion framework” proposed by Saunders, Lewis and Thornhill (2016) to carry out a comprehensive review of the different aspects of methodology, data collection and data analysis. An evaluation of all the layers of research onion is presented, and the most appropriate choice is provided, with appropriate justification. The chapter further outlines the sampling strategy, sample size for the study and data analysis techniques for the study. Finally, the ethical issues related to the research are discussed.

Chapter 4 presents the results of a survey conducted among participants with S-Cit experience in Qatar. It explores six key parameters of S-Cits: Economy, People, Governance, Mobility, Environment, and Living. The chapter examines citizens' attitudes towards various aspects of S-Cits, and their willingness to accept S-Cit concepts. It concludes by proposing a conceptual framework for understanding Qatari citizens' readiness to embrace S-Cit initiatives, based on the primary research performed.

Chapter 5 summarises the investigation of data privacy, security concerns, and readiness to accept S-Cits in Qatar undertaken in this research. It outlines the methodology used, including a survey of both Qatar citizens and experts with experience in S-Cit-Ps. The chapter covers various aspects of S-Cit-Imp, including cyber security adoption, privacy concerns, and overall readiness to accept S-Cit technologies. It presents statistical analyses, including demographic characteristics, independent sample t-tests, and correlation analyses, to provide insights into the perceptions and attitudes of both citizens and experts.

Chapter 6 details the qualitative research conducted through semi-structured interviews with managers involved in S-Cit initiatives in Qatar. It explores key themes emerging from these interviews, including citizen readiness and acceptance, privacy and data security concerns, implementation strategies and challenges, and the role of design thinking in S-Cit development. The chapter also covers discussions on creating roadmaps for S-Cit-Imp and considerations of sustainability and cultural preservation in the context of S-Cit development in Qatar. It provides in-depth insights into the practical challenges and strategies employed by those actively involved in S-Cit-Ps.

Chapter 7 discusses the emergent findings in the context of the defined research aim and objectives. Based on the findings of the study, the key concepts related to the study area are discussed. The chapter also compares the findings of the study with extant literature, to assess the extent to which they are consistent with existing literature or present contrasting or new findings. This chapter also presents the design thinking framework of S-Cit-Eco based on the findings of the primary data collection from the participants.

Chapter 8 evaluates the proposed framework (developed based on the empirical findings), by considering the three elements of the design thinking framework and its application to the S-Cit context. The researcher also presents the expert evaluation of the proposed framework for S-Cit-Eco.

Chapter 9 summarises the entire research, and presents the recommendations based on the findings of the study. The chapter discusses the extent to which the research objectives have been met and offers strategic recommendations for key stakeholders based on the S-Cit framework proposed in the study. In addition, risk analysis with respect to the design and conceptualisation of S-Cits is presented. Finally, the thesis concludes in this chapter by

highlighting the contribution of the study, research, limitations of the research, and potential areas for future research.

1.6. Chapter Summary

This chapter has introduced the selected research area, highlighting the problem statement and listing the aim and core objectives of this research. It has also explained the significance of the research for the academic community, industry practitioners, and policy makers. In essence, this chapter sets the tone for introducing the research topic and setting the direction of the research. In the following chapter, the thesis carries out a critical review of academic literature in the areas which are relevant to the chosen research topic.

2.

Literature Review

2.1. Introduction

This chapter carries out an extensive and critical review of extant literature regarding various aspects of S-Cits. The chapter begins with an introduction of S-Cits, and follows up with the evolution of S-Cits over the past two decades. This is followed by reviewing the models of S-Cits which have received considerable attention in academic literature. The chapter then reviews the latest trends in S-Cits and compared it with the concept of Industry 5.0, followed by reviewing literature on the decision thinking framework for S-Cits and the critical success factors for S-Cit-Imp. The chapter also extensively evaluates cyber security aspects in S-Cits and the data privacy and security aspects while also investigating their role towards S-Cit-Adn. Finally, the chapter reviews specific contexts of S-Cits, such as Lusail and Msheireb, and compares major S-Cit-Ps in Qatar and UAE. Based on the reviewed literature, the theoretical framework is presented, and the research gap addressed by this study is identified.

2.2. Smart Cities

To comprehensively establish the nature of the selected research problem, and the gaps existing therein, this paper presents a discussion based on an extensive literature review. The literature review features the exploration of academic research based on the several components of the research area to only establish context for the discussion, and highlights the direction of this research. The discussion covers S-Cits, followed by the evolution of S-Cits. In addition to that, models of S-Cits, design thinking frameworks for S-Cits, Qatar's context of S-Cits, benefits and challenges to S-Cit-Ps, two specific S-Cit-Ps in the country – Lusail Smart City and Msheireb Downtown Doha, as well as a comparison of S-Cit-Ps in Qatar and the UAE, in order to outline the research gaps identified in the existent academic knowledge.

While literature identifies that the provision of services in the last century has significantly transformed the ways in which cities operate, the increase in industrial activities and populations has strained urban resources all across the world (Baltac, 2019). This transformation has presented a significant challenge to administrators and urban planners, and in light of modern digital technologies popularised since the 1990s, the concept and term of “smart cities” arose. Such urban configurations may also be referred to as “digital”, “electronic”, and “information” cities (Moura and Silva, 2019), but all of these understandings converge in the conceptualisation of S-Cits relevant to various political, industrial, and scientific entities.

Factors such as the overwhelming influx of population from rural to urban areas are also identified in the discussion justifying the imminent need for S-Cits (Höjer and Wangel, 2015). Literature draws relevance of the modern concept of S-Cits to stem from the early works of pioneering urban planners such as Howard (1898), who proposed the transformation of slums into neighbourhoods that were equipped with facilities for comfort and convenience, dubbed “garden cities of tomorrow”. The author’s emphasis on the use of modern technology for this purpose provides a solid basis for the theoretical approach toward S-Cits. However, this theoretical premise was not sufficient to attend to the rising complexities regarding overpopulation, energy consumption, resource management, and environmental protection (Jarrah, 2019). Although “cities of the future” have been continually planned over the last century, the recent decades have led to more precise theoretical frameworks being developed for the concept as a result of the stagnant rise in technological adoption across the world (Hajduk, 2016).

Various definitions of the S-Cit concept are available in the present academic literature. According to Chourabi *et al.* (2012), a city “connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure” is regarded as an S-Cit. This connection between the various entities is primarily grounded on the purpose for improvement of the QoL and efficiency of urban operations and services (Barth *et al.*, 2017). At the same time, definitions of S-Cits address the needs of present and future generations in terms of economic, social, and environmental aspects (Nam and Pardo, 2011). While such definitions lay the premise of the S-Cits concept, other definitions precisely refer to the use of IoT sensors, cloud computing, big data, AI, mobile devices, and applications to enable S-Cits (Mora *et al.*, 2020).

The contemporary model of S-Cits also relies on the discussion of the “digital divide” and considers aspects of accessibility, equality, and transparency in governance from a social point of view, and identifies four characteristics that are essential in an S-Cit model: “appropriate IT infrastructure, accessible and affordable internet access, generalised ability to use IT, and availability of useful content” (Harrison and Donnelly, 2011). The use of such technologies has been referred to in case studies undertaken during the planning of models for projects related to smart energy, smart transportation, smart building, smart healthcare, sustainable resource management, and environmental protection (Dameri, 2013).

Essentially, S-Cits remain a holistic concept that broadly comprises various characteristics of concepts such as eco-cities and digital cities (Biloria, 2019). Using Howard’s (1898) model, the term “future cities” is commonly regarded as a more populist alternative to S-Cits, although the latter remains predominant in academic analyses in numerous fields. Concerning specific S-Cit indicators, Lombardi (2012) identified indicators including public expenditure on R&D and education, as well as economic indicators like GDP and employment rate as integral in defining the context of S-Cits (Orbok, 2016). Moreover, sector

strength, international transactions, and foreign investment can qualitatively determine the potential of an S-Cit (Arkaraprasertkul and Rabitaille, 2022). Other researchers have also identified models of S-Cits through their socio-economic contexts and innovation (Neirotti *et al.*, 2014).

The reviewed literature reveals that there is limited research regarding the theoretical aspects of the S-Cit concept with most research undertaken from a policy perspective. The next section of the present literature review uncovers popular models of S-Cits.

2.2.1. The Evolution of S-Cits

The concept of S-Cits has undergone a series of changes and has evolved over the past two decades. The initial concept of S-Cits relied on the spread of urbanisation, facilitated by the adoption of information and communication technologies (Batty *et al.*, 2012). This was primarily during the period between 2000 and 2005 where S-Cits were termed as “ubiquitous cities” and focused on solving urban problems (Galloway, 2003). The basic idea was to leverage the potential of IT to create an ecosystem that was sustainable to support urbanisation. However, the later period, especially 2006-2010 saw the transformation of “ubiquitous city” into the fully-fledged S-Cit, where IT was used to solve citizens’ problems (Kim, 2010). In the subsequent five years (2011-2015), S-Cit services were available on trial basis which were citizen centric services (Leem *et al.*, 2019). However, there were still challenges with respect to sustainability and profitability of S-Cits. This was addressed during the subsequent years (from 2016 to the present), as sustainability has become an increasingly major issue for S-Cit development.

Furthermore, the concept of S-Cits evolved to an extent where an interdisciplinary approach is required under the complex phenomenon of S-Cits. This involved the study related to human and social capital, environmental aspects, and community psychology to ensure that sustainable S-Cits could be created (Andrisano *et al.*, 2018; Dameri, 2017). This view is also supported by Ahad *et al.* (2020) who identified that convergence of various factors such as infrastructure, economy, society, community, environment, and governance act as pillars of S-Cits apart from the basic requirement of information and communication technologies. Park, Del Pobil and Kwon (2018) also pointed out that the advancements in technology have also contributed to the evolution of S-Cits and that technologies such as the IoT, drones, machine learning, and AI, among others have become an indispensable part of the ecosystem within the S-Cits.

The academic research has also evolved as the focus of S-Cit concepts shifted from pure technological nature to socio-economic and sustainability aspects. Initial studies focused on architecture, components, technological infrastructure combined with urban infrastructure, and issues related to data security and privacy of the inhabitants (Al-Hader and Rodzi, 2009; Harrison *et al.*, 2010; Paskaleva, 2009). However, there has been an increased inclination

towards understanding S-Cits in the context of improving QoL for the citizens (Wang and Zhou, 2022). This implies that IT and infrastructure are necessary but insufficient criteria for cities to be categorised as “S-Cits” (i.e., additional criteria are required). Furthermore, the S-Cit services are expected to solve the citizens’ problems, while also ensuring citizen participation towards increasing acceptance of S-Cits as well as governance in such an ecosystem (Granier and Kudo, 2016). Having reviewed the evolution of the concept of S-Cits, the next section presents diverse models employed by academics to represent the concept from different perspectives.

2.2.2.Models of S-Cits

Different models of S-Cits have been developed in academic literature cutting across various interconnected fields, of which the most foundational are discussed in this section. More recent studies tend to be reiterations of these pioneering works, reflecting the homogenous and generic nature of enabling technologies and associated infrastructure. As noted by a recent analysis, the conceptualisation of an S-Cit model has long since been agreed upon, and analyses now focus on case studies (Wu, 2025). Nevertheless, it is useful from the outset to have a preliminary understanding of the contours of this field. Table 2.1 presents a synthesis of the strengths and benefits of various common S-Cit models covered in the present section.

Table 2.1: Synthesis of S-Cit models

Study	Type	Model	Focus	Strengths	Weaknesses
Dirk and Keeling (2009) Kanter and Litow (2009)	Overview Model	Systematic Integration	City operation, user and infrastructure systems	Addresses that multiple systems are comprised in an S-Cit	Limited applicability and no discussion of data
Harrison et al. (2010)	Overview Model	Multi-step data processing perspective of S-Cit	Instrumentation, interconnection, intelligence	Addresses systems and data effectively	Real life application remains missing
Liu and Peng (2014)	Definitional Model	Domains of S-Cits	Life enrichment, public administration, resource management	Provides understanding of the domains of S-Cits	Too simplistic, no technical understanding Developed based on the example of China, without generalisation
Giffinger and Gudrun (2010)	Definitional Model	Characteristics of S-Cits	Smart: economy, people, governance,	Provides a clear logical categorisation of the S-Cit	Does not provide a clear view of the components of the S-Cit
Liu and Peng (2014)	Smart City Architecture Model	Layers of S-Cit architecture	Sensing, transmitting, processing, and application	Present the building blocks of S-Cit architecture Comprehensive	The model is valid for the specific context of China Confined to data
Al-Hader et al. (2009)	Smart City Architecture Model	Data-Processing	Infrastructure, data storage, smart building management systems, interface	Addresses the integral need of data	Too restrictive to building architectures Does not address service-based infrastructure
Cimmino et al. (2014)	Smart City Architecture Model	S-Cit services cloud	Cloud services, telecommunication, core network, data	Telecommunication perspective of the S-Cit	Applicability to real-case context is not justified
Zygiaris (2013)	Smart City Architecture Model	S-Cit reference model	City, green city, interconnection, instrumentation, open integration, information	Presents the S-Cit as a multi-component innovation	Theoretical model with unclear practical application
Wenge et al. (2014)	Smart City Architecture Model	S-Cit architecture model	Data acquisition, data transmission, data visualisation, support service, domain service, and smart	Presents the building components of the S-Cit architecture Recommendation	The model presents a theoretical framework and recommendations but has not been empirically tested Too descriptive

Source: Author

Dirks and Keeling (2009) proposed that “system integration” is the defining characteristic of an S-Cit. Their model suggests that S-Cits organically integrate multiple systems, and the inter-relationship between these systems is such that a smart and efficient city is planned. The model is illustrated in Figure 2.1.

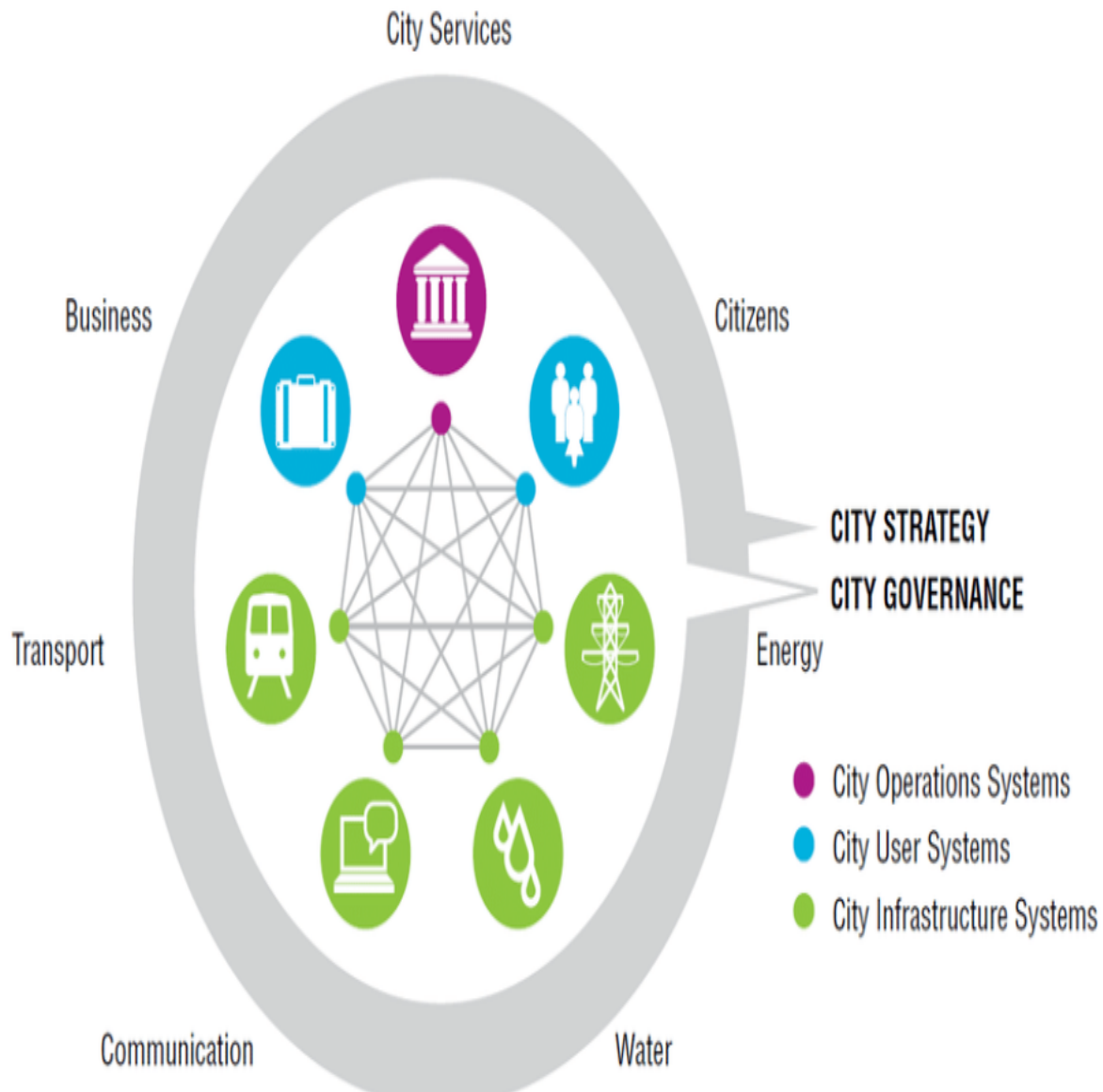


Figure 2.1: Cities as a system of systems

Source: Dirks and Keeling (2009)

Kanter and Litow (2009) developed this model to further state that S-Cits are a systematic integration between a network and the system of an entire system. A similar model was reiterated in later research by Javidroozi and Amini (2014), who argued that the real-time availability of services and the exchange of information involved to enable this can only be ensured if the systems involved therein are effectively integrated. Harrison *et al.* (2010) stated that real-world data capturing (or “instrumentation”) is the first step in a multi-step data processing perspective that drives S-Cits. The next component (“interconnection”) is

essentially the integration of this collected data with several processes that the S-Cit's infrastructure comprises, such as systems, organisations, industries, and value chains. The final component of this data-processing enabled model is intelligence, which refers to the creation of insights to deliver services of the S-Cit.

Liu and Peng (2014) have developed a model based on their research in China which has identified three essential domains of S-Cits: (1) “life enrichment”, such as the provision of homes, a nurturing community, and access to quality healthcare and education; (2) “public administrative and services”, such as the maintenance of law and order as well as provision of food, transport, tourism, and environmental protection; and (3) “resource management”, in terms of water, electricity, and waste. A broader and more widely accepted and iterated model of S-Cits is the Giffinger and Gudrun's (2010) six-domain model, as presented in Figure 2.2. and described below:

- Smart economy – an economy driven by innovation, technological expertise, and sustainable management of natural resources.
- Smart people – the increased competencies present in an S-Cit due to the complex nature of technologies and the demand for skilled personnel for the administration and operations of the city (De Santis et. al., 2014).
- Smart governance – efficient services provided to people through a coherent integration of technology, as well as the transparency and participation of diverse stakeholders in the decision-making in the governance of S-Cits.
- Smart mobility – represented by smart transport and ICT is another cornerstone of the S-Cit concept which ensures the flawless transfer of information and people, as well as their connectivity and safety. Smart mobility refers to the use of energy-efficient, environmentally sustainable transport and ICT systems which are integrated and well-optimised (Giffinger and Gudrun, 2010).
- Smart environment – refers to the effective management of natural resources in the city, and the conservation of natural resources.
- Smart living – the services such as health, housing, and education which are high-quality and characterised with innovation and harmony.

The balance between these domains ensures that the S-Cit provides benefits for both the people and the environment while contributing positive effects for the country in economic and social aspects (De Santis et. al., 2014).

Smart Economy (Competitiveness)	Smart People (Social and Human Capital)
Innovative spirit Entrepreneurship Economic image & trademarks Productivity Flexibility of labour market International embeddedness Ability to transform	Level of qualification Affinity for lifelong learning Social and ethnic plurality Flexibility Creativity Cosmopolitanism/ open-mindedness Participation in public life
Smart Governance (Participation)	Smart Mobility (Transport and ICT)
Participation in decision-making Public and social services Transparent governance Political strategies and perspectives	Local accessibility (Inter-)national accessibility Availability of ICT-infrastructure Sustainable, innovative, and safe transport systems
Smart Environment (Natural Resources)	Smart Living (Quality of Life)
Attractivity of natural conditions Pollution Environmental protection Sustainable resource management	Cultural facilities Health conditions Individual safety Housing quality Education facilities Attracting tourists Social cohesion

Figure 2.2: Six domains and characteristics of S-Cits

Source: Giffinger and Gudrun (2010, p. 15)

Models representing the architecture of S-Cits have also been presented in literature in the works of authors like Liu and Peng (2014), Cimmino *et al.* (2014), and Zygiaris (2013). The model by Liu and Peng (2014) suggests four layers: sensing, transmitting, processing, and application. The framework suggests that the components of the S-Cit architecture are interconnected which ensures the functioning of the S-Cit in every aspect. These building blocks and their components are presented in Figure 2.3.

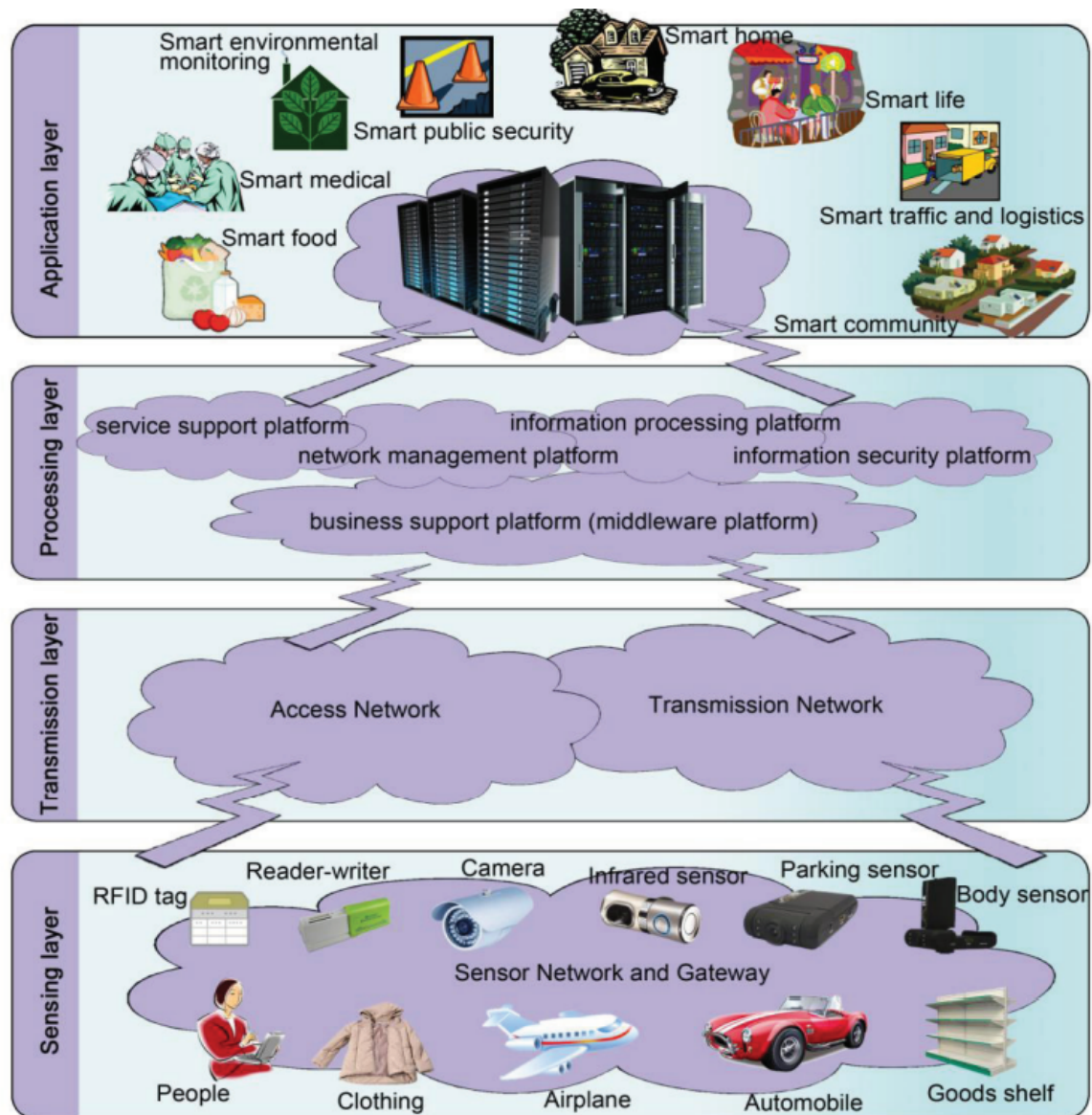


Figure 2.3: S-Cit architecture layers

Source: Liu and Peng (2014, p. 5)

Al-Hader *et al.* (2009) present another model for S-Cits derived from the perspective of S-Cit architecture and values data processing at the core of enabling S-Cits. Al-Hader *et al.* (2009) stated in their research that sending the processing of data serves as the basis for monitoring and controlling the management of network assets (Figure 2.2). This management is complex due to its operational framework, and therefore, the seamless provision and processing of data are integral for these assets to contribute to the services provided in an S-Cit. Al-Hader *et al.*'s (2009) S-Cit infrastructure relies on five layers, namely infrastructure, data storage, smart building management systems, interface, and integration. This is a pyramid infrastructure in which a vision for S-Cits is enabled (Figure 2.4).

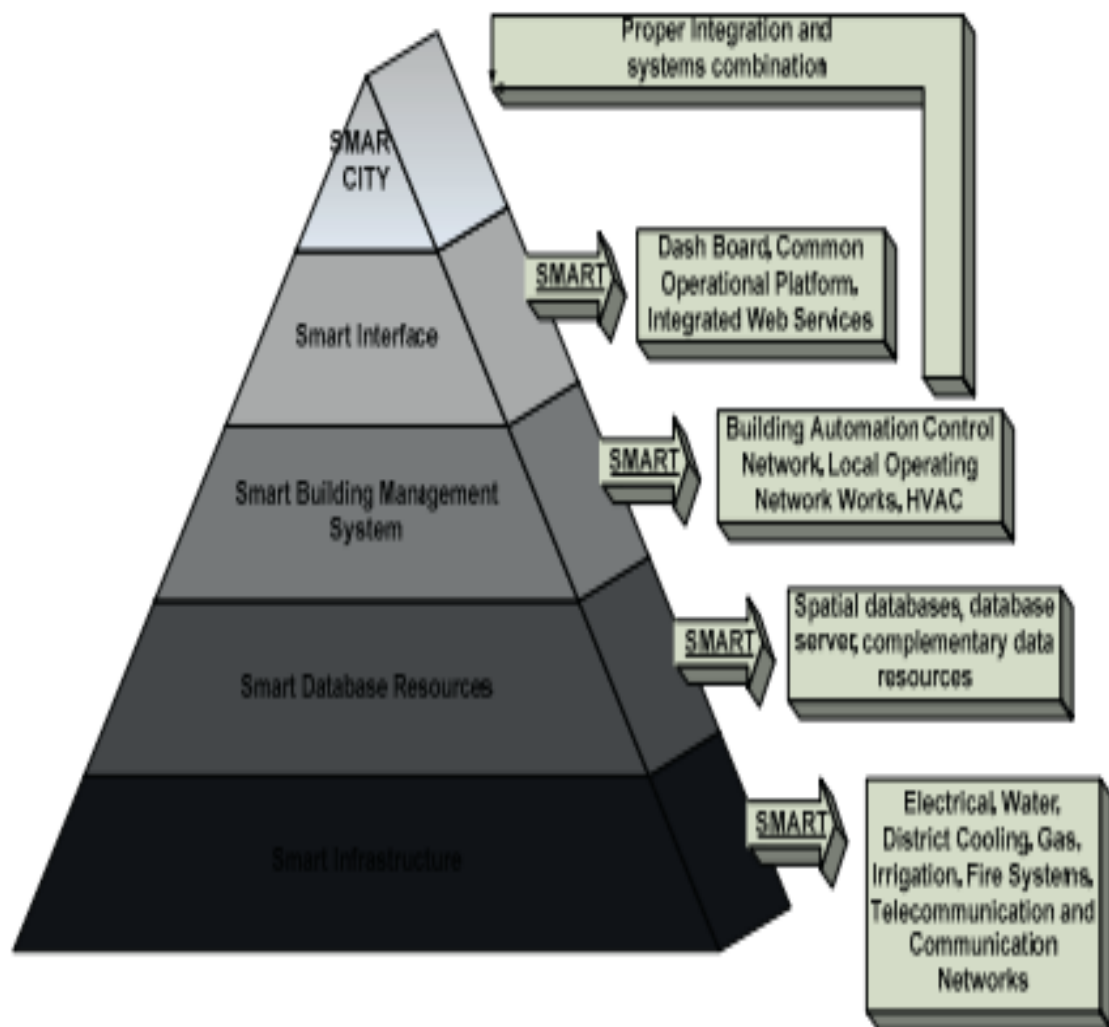


Figure 2.4: S-Cit development pyramid

Source: Al-Hader *et al.* (2009, p. 94)

Three domains of S-Cit architecture are provided from a telecommunications viewpoint by Cimmino *et al.* (2014) in their S-Cit architecture. The essence of the architecture is to enable the provision of S-Cit applications and services. This is done by integrating cloud technologies and virtual machines, as depicted in Figure 2.5.

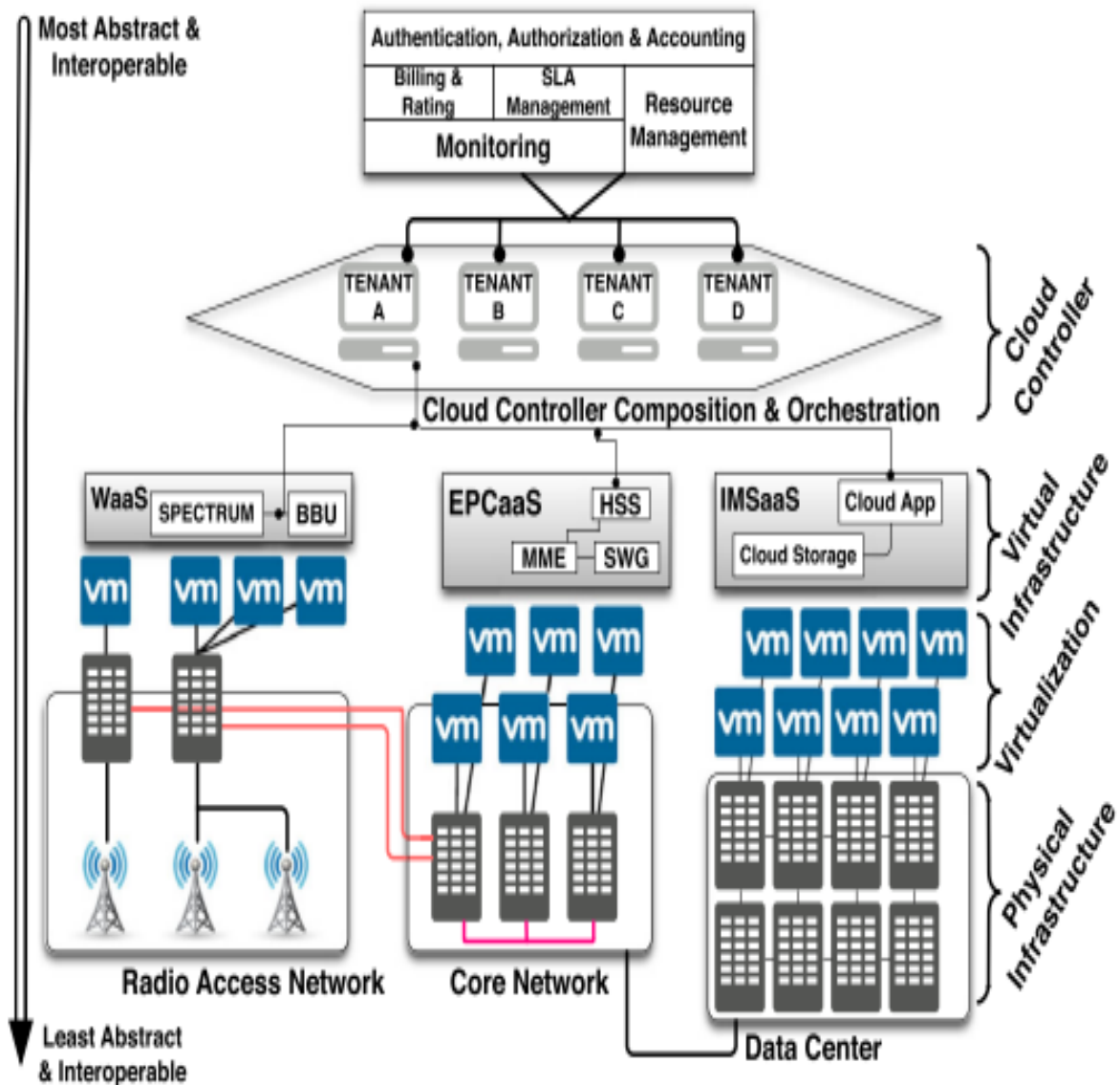


Figure 2.5: S-Cit services cloud infrastructure

Source: Cimmino et al. (2014, p. 17)

In addition to the above, Zygiaris (2013) presents a model of S-Cits with reference to the smart innovation ecosystem. There are seven layers of their model, which determine how smart the city is – city, green city, interconnection, instrumentation, open integration, application, and innovation, as illustrated in Figure 2.6. According to the model, sustainability assessment, evaluation and feedback are key factors contributing to sustainability of the S-Cit.

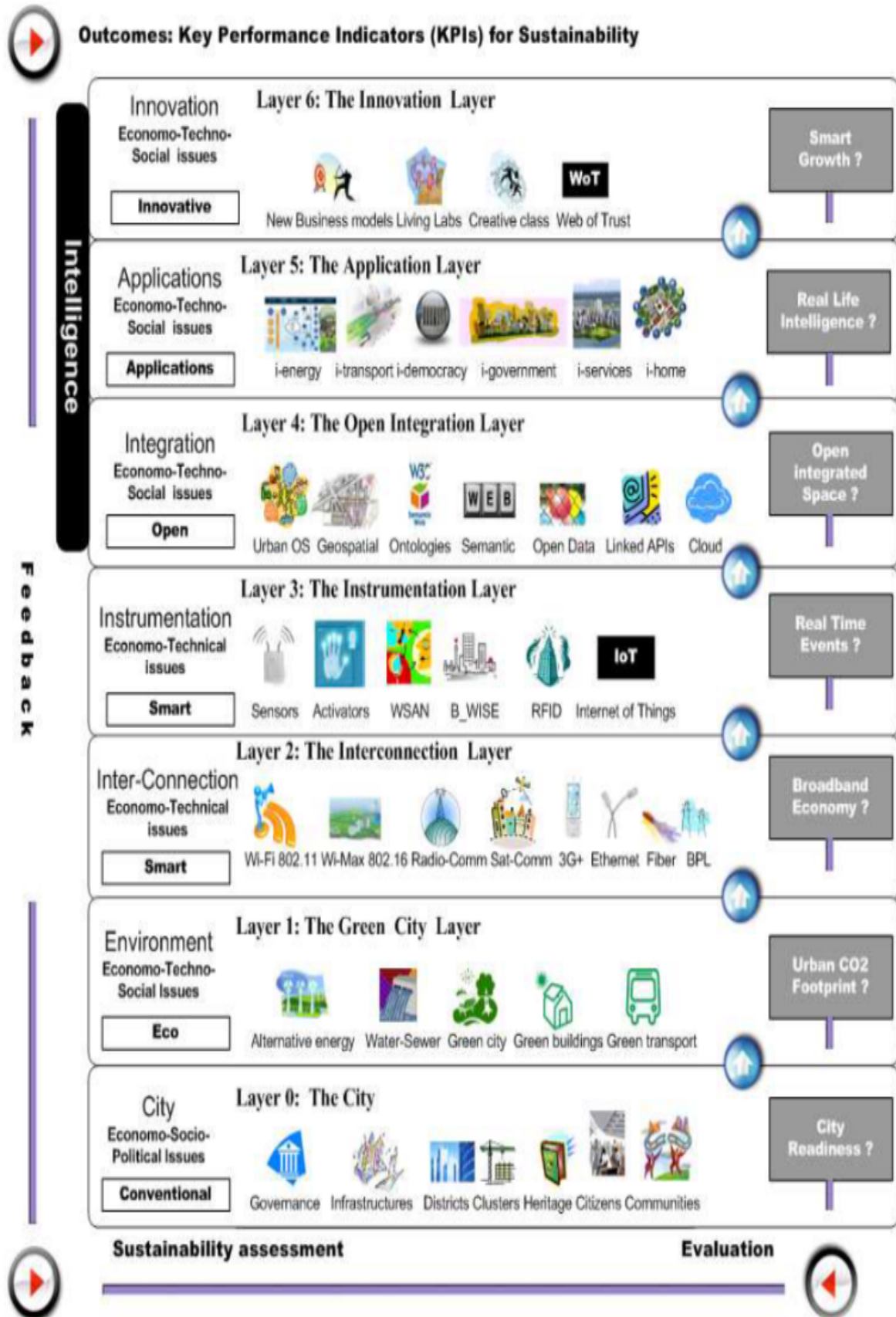


Figure 2.6: S-Cit reference model

Source: Zygiaris (2013, p. 219)

Moreover, Wenge et al. (2014) regarded S-Cits as a data-oriented problem in their model. A logical architecture is presented in their model with six layers – data acquisition, data transmission, data vitalisation, support service, domain service, and smart application (Wenge *et al.*, 2014). The flawless work of these components is supported by standard and evaluation on the one hand, and security and maintenance, on the other hand, as presented in Figure 2.7.

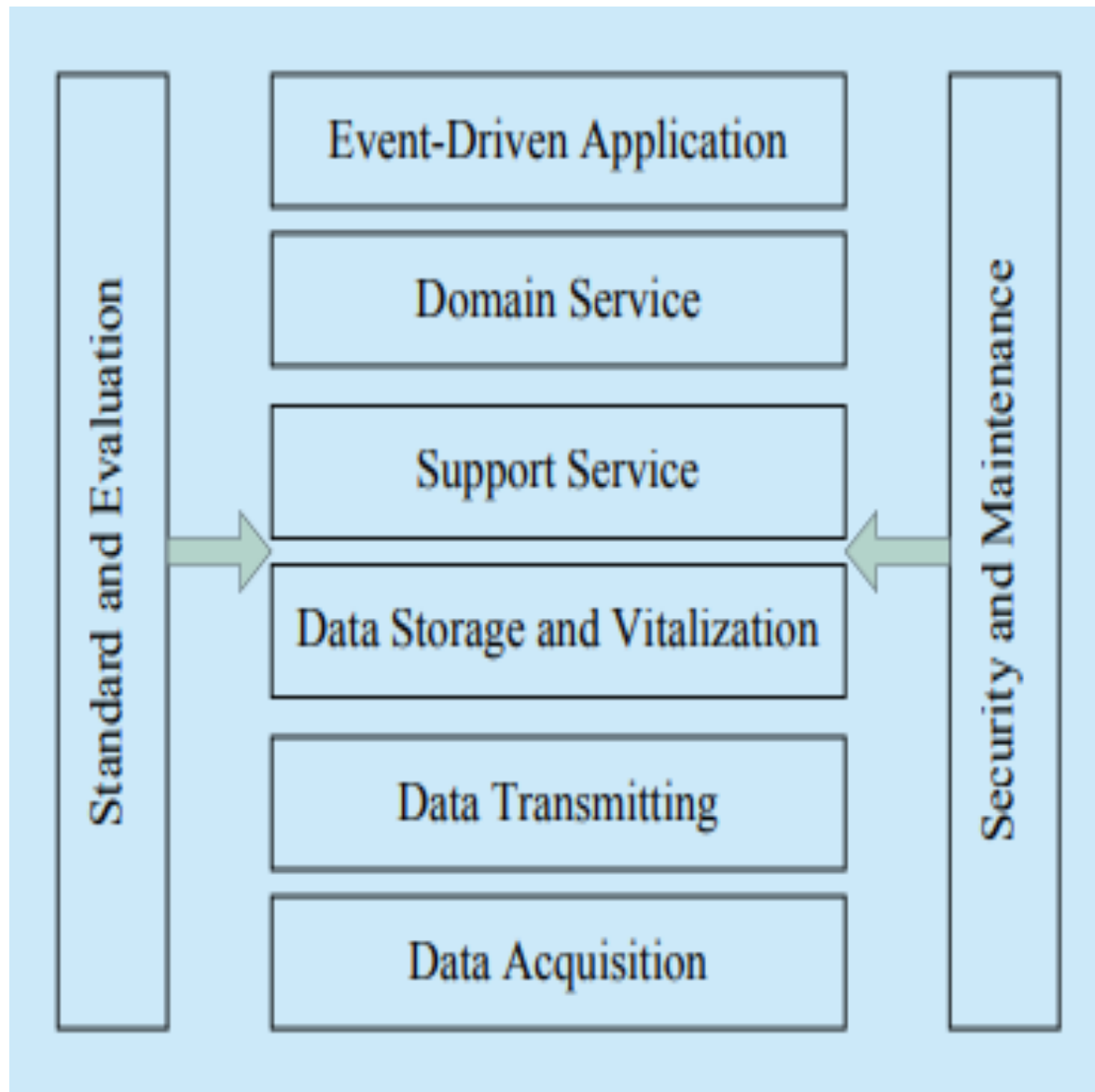


Figure 2.7: S-Cit architecture model

Source: Wenge et al. (2014, p. 60)

The review of S-Cit models presents different perspectives from which the models are presented. Even though the different models have diverse strengths, the prevailing gap identified is related to the lack of empirical justification of their applicability to the real-world case of S-Cits. The analysis shows that a multitude of models is derived from the viewpoint of S-Cit architecture. In order to provide a more detailed understanding of the logic behind

the creation of S-Cits, the following section is aimed at presenting a design thinking framework for S-Cits.

Reviewed literature reveals various parallel and overlapping conceptualisations of S-Cit-Eco, all of which concur on the core instrumental technological and human-centric elements, as summarised in Figure 2.8.

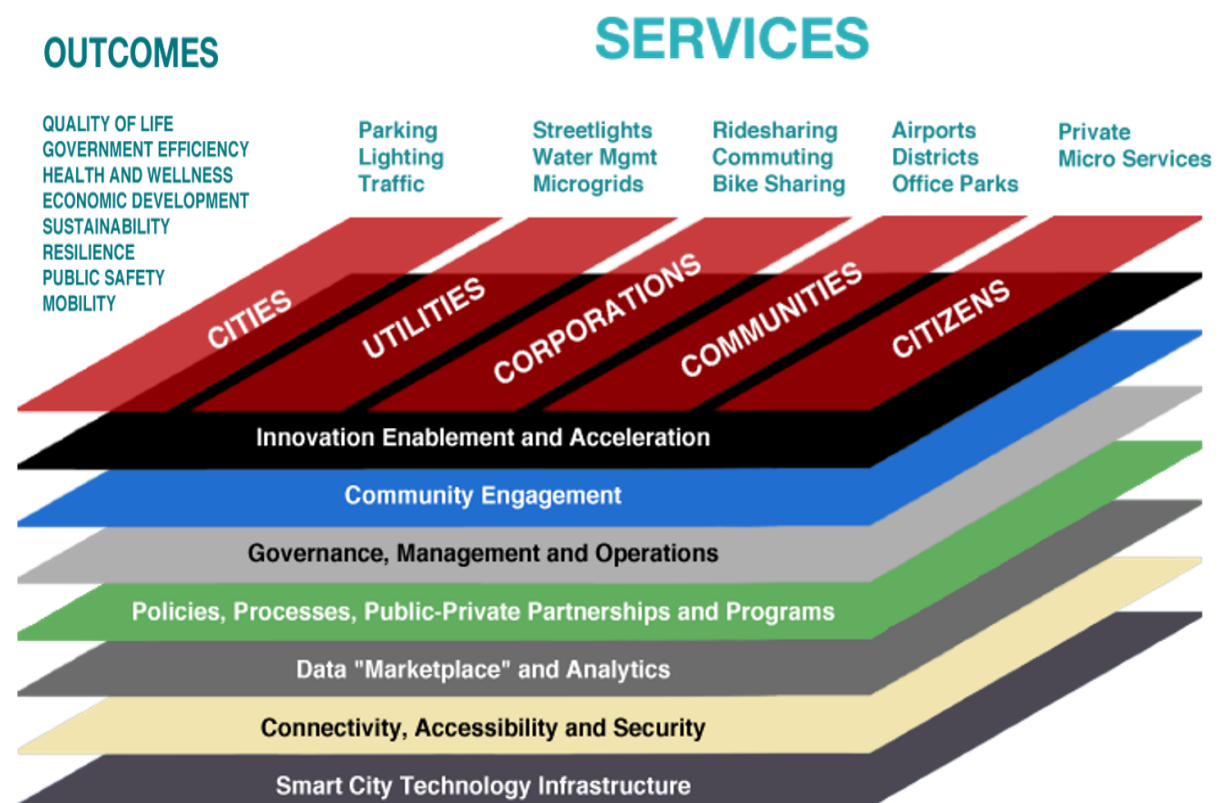


Figure 2.8: S-Cit-Eco conceptualisation

Source: Chan (2018)

2.3. S-Cits and Industry

The present section reviews existing knowledge related to S-Cits in the context of the Industry 5.0 concept. The section is divided into a conceptual evaluation of Industry 5.0, Society 5.0, as well as an analysis of the role of Industry 5.0 in S-Cits and lessons learnt from Japanese S-Cit-Ps.

2.3.1. Industry 5.0 Conceptual Evaluation

Industry 5.0 is a transition from the earlier conceptual version of Industry 4.0, which referred to the industrial revolution triggered by the advancements in technology and including key elements such as automation, data analytics, smart systems, machine learning, and AI, among others (Ghobakhloo, 2020). The first industrial revolution (1.0) was driven by human and physical labour in industries during the 18th and 19th century. This phase later evolved

to incorporate electrical and mechanical developments in manufacturing, while information and data became more important from the 1980s onwards. The latter stages of the industrial revolution were characterised by a shift to digital technologies with focus on process efficiency in Industry 3.0, and use of IoT, data analytics, and big data in Industry 4.0 to the integration of human mind and technology in Industry 5.0.

This study adopts the vision of Industry 5.0 as originally proclaimed by the European Commission (2020) in “Industry 5.0 – Towards a Sustainable, Human-Centric and Resilient European Industry”. This offers a more “human-centric” and sustainability-oriented paradigm than Industry 4.0, with emphasis on machine-human integration, labour rights, and environmental stewardship. Albeit though Industry 5.0 is in a nascent phase, the concept has attracted the attention of researchers to a great extent. Xu *et al.* (2021) defined the concept of Industry 5.0 which involves intertwining of human brain and working collaboratively with robots and smart machines.

The focus of Industry 5.0 is to increase productivity and enhance its contribution to society as defined by the European Union (European Commission, 2020). Furthermore, Nahavandi (2019) also highlighted that Industry 5.0 was visualised to promote the wellbeing of the workers involved in the production process and improve overall societal impact. These definitions point out the complementing role of Industry 4.0 with the focus on sustainable human centric development. One of the key aspects of Industry 5.0 is the skill of the labour force to manage digital technologies in various aspects of processes in an organisation. This is also in line with the need to increase competitiveness in terms of production efficiency and cost efficiency (Huang *et al.*, 2022). Section 2.12 notes the challenge of needing to develop knowledge workers for contemporary labour needs and digital economy development, as well as associated labour rights issues (e.g., one participant alluded to “empathising” with sanitation workers as well as citizens to develop “solutions that not only improved efficiency but also enhanced the working conditions for our staff”, as reported in section 6.4).

Support for this argument was also provided by Aslam *et al.* (2020) who argued that digital skilling of the workforce is necessary to work towards innovation which provides the basis for competitive advantage and growth of organisations. However, this presents a narrow view of Industry 5.0 wherein the main focus should be inclusive and collaborative growth of the workforce as well as society, which is aided by advancements in technology. Furthermore, industry and societal development should be viewed from the perspective of brain-machine interface and interaction.

In this regard, Sindhwani *et al.* (2022) developed a multi-criteria framework to analyse enablers of adoption of Industry 5.0 for achieving sustainability for integration of human values with technology and reported that “personal customisation criteria” were the highest weighted, followed by “human-machine collaboration”. These findings indicate that products

and services which can lead to an increase in QoL were either not considered or did not mature enough to reach the mass market. Hence, this also presents useful insights for different elements of human values and society for inclusion in Industry 5.0.

While there are considerable efforts from organisations, industries, and governments across the world for ensuring sustainability of social values along with adoption of latest technologies, there is also increased scepticism on the penetration of these technologies in human lives. In this regard, Sharma *et al.* (2022) pointed out that linking virtual reality with reality is the most critical deterrent which arises from issues such as privacy and security. At the organisational level, the challenges envisaged include investment in technologies and persistence during adoption of such technologies to generate meaningful results (Leng *et al.*, 2022). Furthermore, the upskilling of workers (especially concerning the use of prerequisite technologies) has also been acknowledged as one of the key challenges towards adoption of Industry 5.0.

2.3.2.Society 5.0 Conceptual Evaluation

Society 5.0 is a concept which aims for a prosperous human-centred society based on the integration of technology and human values. A more elaborate definition of Society 5.0 was provided by Deguchi *et al.* (2020), who stated that Society 5.0 should be manifest:

“Through the high degree of merging between cyberspace and physical space, will be able to balance economic advancement with the resolution of social problems by providing goods and services that granularly address manifold latent needs regardless of locale, age, sex, or language”.

This definition clearly elaborates the vision of Society 5.0 and argues for a “people-centric society”, where citizens can enjoy improved QoL. The concept of Society 5.0 emerged in Japan in a strategic national policy initiative with the objective of enhancing Japan’s competitiveness in a “smart society” (Fukuyama, 2018). The evolution of Society 5.0 has evolved on similar lines to the industrial revolution across different phases and can be represented in Figure 2.9 (Fukuyama, 2018).

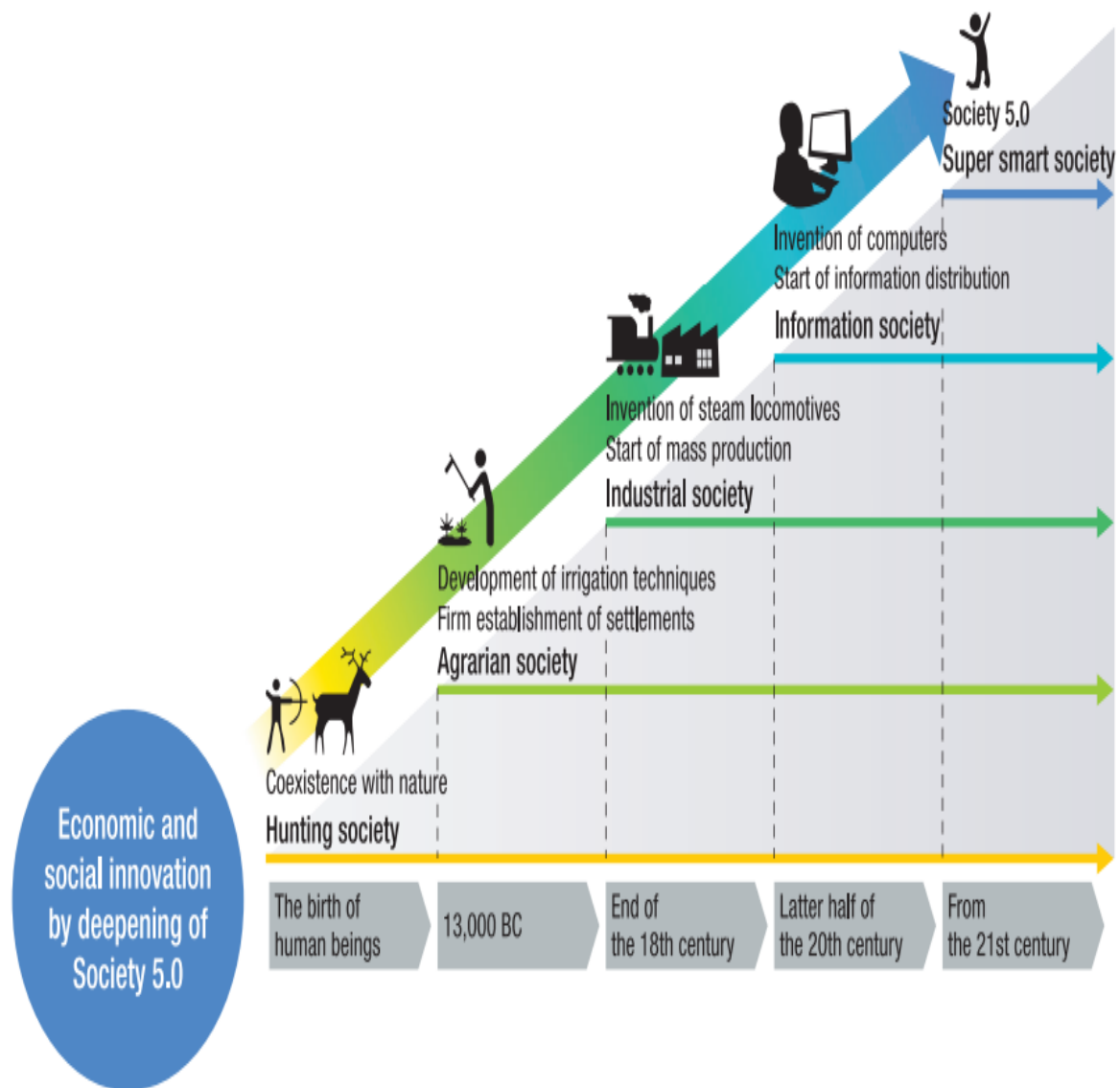


Figure 2.9: Evolution of Society 5.0

Source: Fukuyama (2018)

Looking back into the evolution of society, Society 1.0 primarily focused on harmonious co-existence of humans with nature. The second phase was concentrated upon agricultural cultivation and increasing organisational skills of the society. The third phase of society focused on integration with the industrial revolution and making mass production possible. Finally, Society 4.0 focused on transitioning to information society by leveraging the advancements of technology. It is observed that this concept is built on the platform of Industry 4.0 which integrates the advancements in technology to increase efficiency of business operations. To put into holistic perspective, Society 5.0 aims towards improving the QoL of people by leveraging smart technologies.

The inherent use of digital technologies as a fundamental component towards Society 5.0 has opened up debate for the necessary skill development. In this regard, Sa and Serpa

(2022) highlighted the importance of soft skills, alongside professional and technical skills. The authors argued that such amalgamation of skills should be a part of curriculum of higher education institutions so that the workforce can smoothly transition towards a “work life” where elements of digital proficiency, sustainability and technology-human interface are paramount for success. Similar findings were reported in the context of Indonesia where the authors reported that the educational system should prepare the students with inclusive education learning designs which are relevant to Society 5.0 (Mansur *et al.*, 2023).

The second issue which has been debated in the context of Society 5.0 is the role of knowledge leaders to facilitate effective implementation of Society 5.0. In this regard, Barker (2022) pointed out that the role of knowledge leaders is crucial towards creating a culture which can adopt Society 5.0 and work towards enhanced organisational performance, and the society as a whole. However, since this finding is based on secondary research and theoretical framework, further evidence is required to evaluate the pivotal role of knowledge leaders in shaping a society that is based on the principles of Society 5.0.

Furthermore, it is also imperative to understand the challenges and issues that are to be addressed in adopting Society 5.0 as a whole. In this regard, Kanbara (2022) highlighted that real life problems such as natural disasters to depletion of natural resources need to be tackled for a harmonious existence of people in Society 5.0. Again, since this being a nascent area of research, further research is needed to understand the challenges that can be faced in adopting Society 5.0.

2.3.3.The Role of Industry 5.0 in S-Cits

The concept of Industry 5.0 is being widely discussed as a futuristic model for managing organisations. The principles of Industry 5.0 have also been extended to the conceptualisation of S-Cits due to the underlying fundamentals of the technology enabled ecosystem. Sharma, Garg and Kiran (2020) carried out a preliminary study to understand the conceptualisation of S-Cits using Industry 5.0 and reported that a realistic view of technology is integrated with the societal context and values in order to create a sustainable society with economic, social, cultural, and environmental benefits. A similar (but more focused) study was presented by Kasinathan *et al.* (2022), who proposed an integrated framework of Industry 5.0 and Society 5.0 with S-Cits along with its influence on Sustainable Development Goals (SDGs).

The framework presents interesting insights on solving challenges in healthcare, infrastructure, supply chain, natural resources, and other issues associated with sustainable development. Interestingly, the studies on S-Cits also overlap with the ideas on solving these challenges, thereby presenting a natural alignment of principles of Industry 5.0 with the S-Cit-Eco. For instance, S-Cits conceptualise the use of technologies for enhancing agricultural produce by including AI, ML and IoT, a concept which also forms the basis of

principles of Industry 5.0 (Herath and Mittal, 2022; Maye, 2019). Similarly, Sharma and Arya (2022) proposed an environmental monitoring system using a UAV network based on IoT for capturing the exact cause of pollutants in the S-Cit-Eco based on Industry 5.0 perspectives. In another example, Usharani *et al.* (2022) suggested techniques of smart energy management in S-Cits using the principles of Industry 5.0. These are a few examples which can be leveraged for S-Cits to make the lives of citizens better.

As described previously, the concept of S-Cits has been around for some time, and has also seen implementation in practice. It broadly provides a framework of leveraging information and communication technologies to promote sustainable development practices to address the challenges of modern-day urbanisation. According to Lai, Lai and Lai (2021), S-Cits are based on the six pillars of “smart governance, smart economy, smart power, smart communication, smart transportation, and smart life”. However, more exhaustive planning is required to include more elements to incorporate Industry 5.0 and Society 5.0 in S-Cits. Some of the examples of S-Cits include Amsterdam, Antwerp, Singapore, London, and Copenhagen, which have incorporated these components, but which require continuous monitoring and improvement to align with the idea of Industry 5.0, which is still in its nascent stages. The majority of literature concerning such developments has been focused on technological interventions needed for the conceptualisation and implementation of S-Cits (De *et al.*, 2022; Fraga-Lamas *et al.*, 2021; Mukherjee, Raj and Aggarwal, 2023), and further research is required to evaluate the technological, human and governance aspects of Industry 5.0 and its application in S-Cits.

2.3.4. Lessons Learnt from Japanese Smart City Projects (S-Cit-Ps)

Japanese S-Cit-Ps, such as at Tokyo, Yokohama, Osaka, and Kyoto, have often been acclaimed as exemplary case studies of modern metropolitan cities based on complex traditional cities, accentuated by the high use of technologies to increase citizens' QoL (Khatoun and Zeadally, 2016; Lai *et al.*, 2020). The success of such cities is also attributed to a number of factors which have made these implementations possible. One of the interesting observations was highlighted by Granier and Kudo (2016) who pointed out that there is very little input expected from citizens in the S-Cit environment. Instead, the use of information technologies is expected to change the behaviour of the residents of S-Cits, thereby focusing on participation and compliance rather than involvement. This finding presents a contrary view to the earlier research which has argued for involvement of citizens for an effective governance through participation (Cardullo and Kitchin, 2019a; Schuurman *et al.*, 2012; Simonofski *et al.*, 2019).

There are various lessons to be learnt from the S-Cit-Ps in Japan. In one of the studies conducted by Trencher and Karvonen (2019), the researchers focused on smart health in the S-Cit of Kashiwanoha in Japan. The findings revealed that smart health strategies

facilitated through the S-Cit-Adn, coupled with monitoring and education have the potential for behavioural change and work towards tackling social problems. The findings of this study present useful learning which can facilitate S-Cit-Adn. In another study of S-Cits in the case of Yokohama, smart power transmissions provided smart energy management (Kono, Suwa and Ahmed, 2012).

It is also pertinent to note that such technologies were implemented in Japan long before S-Cits were envisioned in other parts of the world. Another key aspect of e-Governance was investigated in the context of S-Cits in Japan, and it has been reported that even though the citizen centric services are at maturity levels, there is still potential for improvement, especially services which are transactional in nature (Fietkiewicz *et al.*, 2017). The learnings from S-Cits are useful considering the continuous changes in technology and application of new elements derived from Industry 5.0.

2.3.5.Lessons Learned from South Korean S-Cit

The S-Cit in Seoul is seen as an example of a technology driven urban S-Cit environment which was developed with institutional support. The project was conceptualised by the Ubiquitous City Construction Act with the objective of resolving the environmental, health, transport and infrastructure related issues (Yoo, 2021). This Act focused on developing ICT-based infrastructure, which was applied to strengthen the competitiveness and livelihood in the city. This concept helped in strengthening the delivery of citizen centric services and led to improvement in the physical and digital infrastructure. However, due to the excessive focus on information and communication technologies, the S-Cit failed to deliver a meaningful increase in QoL of the citizens residing in the S-Cit (Kim *et al.*, 2021; Yang *et al.*, 2020).

To overcome this limitation, the initiative of Smart Seoul 2015 was launched with a focus on human-centric experience in the S-Cits and was facilitated by the reform of the Ubiquitous City Construction Act with the Smart City Act in 2017 (Yoo, 2021). The Smart Seoul 2015 project involved a more inclusive approach by strengthening governance, administration, economy, and overall QoL for the citizens. The main aspect of Smart Seoul 2015 was to promote sustainable living through the use of digital technologies and promoting economic growth. These principles were aligned with the S-Cit-Ps across the world, such as San Francisco, Amsterdam, Dubai and others (Capra, 2016; Lee *et al.*, 2014; Singh, 2015).

However, one of the main limitations of the embedded principles is that the conceptualisation focuses mostly on implementation and governance. This can be interpreted from the definition of S-Cit Act which defines S-Cit as:

“a sustainable city where various city services are provided based on city infrastructure constructed by converging and integrating construction

technologies, and ICTs to enhance its competitiveness and livability”. (Yoo, 2021)

However, this definition does not emphasise the cyber security aspects of S-Cit-Imp, which requires collaboration from different stakeholders as well as a thorough implementation strategy to meet the challenges related to cyber security concerns in an S-Cit environment.

Prior research has well acknowledged the strategy and implementation of the ‘Smart Seoul’ and its contribution to the improvement in the lives of the citizens through different features. Lee *et al.* (2014) highlighted the importance of coordination between public and private actors on an open innovation platform to encourage participation in an S-Cit-Eco. The authors highlighted the integration of cultural, social, and digital aspects to enhance living standards in S-Cits. Gretzel *et al.* (2018) argued for the case of smart tourism development in the “Smart Seoul” S-Cit. Moreover, Joo (2023) also explored the role of the policy of “Smart Seoul” in local and global agendas for development. These studies clearly highlighted the role of S-Cits in today’s urban planning and argue the need to delve into the S-Cit conceptualisation and implementation to gain a deeper insight on the topic.

2.4. Design Thinking Frameworks for S-Cits

Plattner *et al.* (2010) defined design thinking as the process of devising courses of action aimed at changing existing situations into preferred ones. Lom and Pribyl (2021) described design as the conscious and intuitive effort to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype. These two perspectives can be combined to define design as both a structured and creative activity, which aims to solve problems and create value in a thoughtful and intentional way. Design thinking has become a critical component of discourse and planning regarding S-Cits, with leaps and bound in the theoretical development of the design thinking concept occurring parallel to the development of the S-Cits concept in recent years. As explained below, there is no universal “design thinking framework”; rather, this study is guided by the fundamental design thinking considerations of “empathising, defining, ideating, prototyping and testing”. The actual conceptual framework development and evaluation undertaken in this study are presented in Chapters 7 and 8, but this is beyond the scope of this preliminary review of literature pertaining to the concept.

By its intrinsic characteristics, design thinking is a framework used for problem-solving. The design thinking framework involves an iterative and non-linear process to create prototypes and models focused on innovative solutions (Plattner *et al.*, 2010). Although there is a lack of consensus with respect to the definition of design thinking, it is often comprehended as application of design methods to solve a broad range of problems by engaging with

multidisciplinary teams. The concept has been applied in the context of S-Cits and is reviewed in subsequent sub-sections.

2.4.1.The Concept of Design Thinking for S-Cits

The concept of design thinking for S-Cits has been pointed out to a great extent in academic literature. Lom and Pribyl (2021) emphasised that S-Cit-Ecos are complex systems that are interconnected with various components such as citizens, businesses, services, government, infrastructure and technology ecosystem. Hence, it becomes imperative to find smart solutions and new approaches for sustainability of S-Cits. In this regard, Nielsen *et al.* (2019) pointed out that design thinking offers an innovative approach to understanding and addressing the challenges of S-Cits and generating knowledge and solutions through a structured open innovation process. This view is also supported by Qaed (2020), who applied design thinking to understand users' needs and involvement in an S-Cit-Eco, and reported that design thinking can add value in the areas of humanising the design of S-Cit, active involvement of the user, sustainable city development, and innovative solutions.

Earlier studies, such as those of Di Bella (2015) and Kumar *et al.* (2016), also proposed solutions for S-Cit betterment through involvement of communities and social engagement among the residents of the S-Cit. However, Zhuhadar *et al.* (2017) also argued that understanding the design thinking approach itself is not sufficient, and the designers need to maintain an open view in order to come out with innovative solutions related to S-Cits. This is primarily due to the reason that the ecosystem of S-Cits can often be too complex and therefore, designers should not get discouraged during ideation phase. The premise of this concept is based on the identification of problems existing in a process, and how these problems can be eliminated in an efficient way (Eleutheriou *et al.*, 2017).

This concept posits a unique perspective of design, which suggests a thinking process that is both analytic and creative. It presents opportunities to experiment, create, and prototype models before gathering feedback and implementing redesigns (Stimmel, 2015). Buchanan (1992) presented the idea that design thinking is most applicable in designing complex systems for a living, working, playing, and learning, and more recent research concluded that the S-Cits concept would entail all of these characteristics (Schilwa, 2019). Based on these characteristics, the design thinking concept remains critically relevant for S-Cit-Ps.

2.4.2.Design Thinking Frameworks

This section explains some general parameters pertaining to design thinking frameworks. Particular design thinking frameworks can be developed according to innumerable particular applications (e.g., this study is chiefly concerned with design thinking as it pertains to S-Cits, as discussed below with regard to related literature), but all particular frameworks are based

on five fundamental pillars (“empathising, defining, ideating, prototyping and testing”), identified by the UN as essential in order to achieve sustainability goals (Figure 2.10):

“Understanding the five stages of Design Thinking: empathising, defining, ideating, prototyping and testing, will empower leaders (of the UN and other organisations) to apply Design Thinking tools and methods not only in their everyday work with their teams and other stakeholders, but to also strategically address the complex challenges of the 2030 Agenda. Although Design thinking is not a linear process, nor do the stages have to be followed sequentially, yet an important place to start is at empathy.” (United Nations System Staff College, 2019)

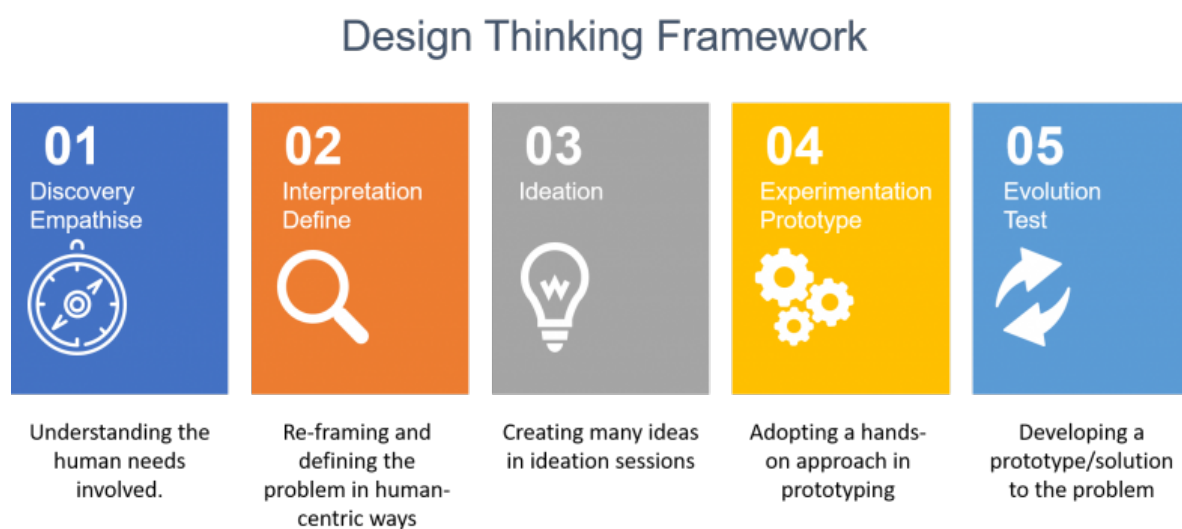


Figure 2.10: “The power of innovation and design thinking in implementing the 2030 Agenda for sustainable development”

Source: United Nations System Staff College (2019)

Design thinking frameworks refer to structured approaches to problem-solving that emphasise creativity, empathy, and iterative processes (Plattner *et al.*, 2010). These frameworks guide teams through stages such as understanding user needs, defining problems, generating innovative ideas, prototyping, and testing solutions (Kumar *et al.*, 2016). The design thinking frameworks supplement the design thinking concept with clear measures that lead to innovative solutions. In the context of S-Cits, such frameworks are useful considering they offer the potential of innovative solutions for the multidisciplinary and complex nature of the issues faced in the S-Cit-Eco.

The complex ways through which S-Cits attend to the pain points and inefficiencies in pre-existing systems require analysis, deliberation, and a process-oriented approach that is complemented by design thinking frameworks (Nielson *et al.*, 2019). This research recognises that since the design thinking process is oriented toward engaging end-users

with the relevant product and service, and it remains a useful tool for governments and administrations to employ. Since issues of metropolises are intrinsically multidisciplinary in their nature, design thinking offers a multidisciplinary response system (Hanzl *et al.*, 2014).

Lee, Hancock and Hu (2014) proposed a conceptual framework for S-Cit-Imp based on the dimensions of urban openness, service innovation, citizen partnership, urban proactiveness, integration of S-Cit infrastructure, and governance. The framework and the dimensions highlight the importance of public and private sector collaboration of their resources on an open innovation platform. Moreover, it includes numerous dimensions which can be utilised for development and betterment of S-Cits. However, there is always the challenge of the dynamic nature of interaction of the participants which requires the designers to relook at the framework for it to be an effective approach.

In another study of the application of design thinking in the context of S-Cits, Andreani *et al.* (2019) proposed a framework comprising of three components which outline the human-centric approach to S-Cit development - grounded vision involving ideation of solutions for specific needs, embraced technology comprising of technologies in augmenting the intelligence enhancement, and urban co-evolution which fosters a mutually constructive interaction between the stakeholders. While this framework can be experimented in S-Cit-Ps to reveal latent scenarios, there is a likelihood that such a framework might not be adequate to address the multidisciplinary nature of S-Cit challenges, especially in terms of the socio-economic environment.

Wang (2022) analysed case studies of Brazilian and European S-Cits based on design thinking processes conclude that the attempt to apply design thinking frameworks provides significant value because the characteristics of design thinking that effectively address confusing and complex issues are very close to the nature of problems found in today's urban agglomerations. Issues such as food supply, waste management, urban traffic, maintenance of infrastructure and services, and improvement in citizens' lifestyles utilised an approach enabled by design thinking to provide adequate solutions (Wang, 2022).

In the context of Qatar, various researchers including Badran (2021) and Sharif and Pokharel (2021a) have discussed design thinking frameworks for S-Cit-Ps. For example, Badran (2021) discussed the implications for citizens' privacy and security due to the sharing of data, as S-Cits rely on data collection and processing to enable the services that they offer. The research proposed that a design thinking framework should be constructed around the principles of regulations that highly regard data privacy and security. Similarly, Sharif and Pokharel (2021a) discussed Qatar's growing proliferation of S-Cit technologies and systems, and the risks associated with them. These risks are expansive and multidisciplinary in nature, as identified.

Research suggests that an efficient design thinking framework would enable such S-Cit-Ps to carefully diagnose and identify any potential risks that may incur in the process (Mensonen and Halstron, 2020). Furthermore, it is argued that design thinking offers a bottom-up approach to problem-solving which can be implemented from the initiation stages of an S-Cits project, rather than being imposed from the top (Ali and Alkirabi, 2021). In addition to that, it is also established that there are two essential ways through which design thinking can enable S-Cit-Ps – firstly, by engaging the untapped potential of innovative urban ecosystems, and secondly, particularly within the scope of the needs and interests that citizens have (Komninos *et al.*, 2014).

An effective design thinking framework would also constitute a cross-industrial and cross-sector approach which would enable the S-Cit-Ps to be executed with increased cohesiveness and efficiency (Cvar *et al.*, 2020). Therefore, the existing literature justifies the importance of the design thinking frameworks in the light of S-Cit-Ps.

2.5. Success Factors for S-Cit-Ps

The problem related to the factors accounting for the success or failure of S-Cit-Ps is another important aspect of the present review that contributes to the thorough understanding of the focal research topic. Success factors for S-Cit-Ps are studied in the works of authors like Chourabi *et al.* (2012), Kogan and Lee (2014), Kim and Kim (2021) and lamtrakul and Klaylee (2019), among others. A significant portion of the existent research, including the works of Peters (2017), Chaiyasoonthorn, Khalid and Chaveesuk (2019), Krishnan, Arumugam and Maddulety (2020), Fahim and El-Gazzar (2017), and Eremia, Toma and Sanduleac (2017) focused on the role of ICT as a critical success factor of S-Cit-Ps.

Nevertheless, Kogan and Lee (2014) argue that even though the role of ICT in S-Cits is important, it is not a sufficient condition for the transformation of a conventional into an S-Cit. Emphasising that the role of intellectual capital is underestimated, Kogan and Lee (2014) point out governance and the engagement of citizens as critical factors for the success of a S-Cit-P. On a similar note, researchers like Novita and Supranoto (2019), Bughin, Chui and Manyika (2010) and Yigitcanlar and Lee (2014) added the importance of the human factor as users of the technologies and agents of change enabling the shift towards S-Cits. In addition to that, establishing and strictly following coherent processes throughout the S-Cit-P has been highlighted as a key determinant of success by Novita and Supranoto (2019).

lamtrakul and Klaylee (2019) investigated S-Cit experiences in 10 countries in Europe, North America, and Asia: the Republic of Ireland, the Netherlands, Denmark, Sweden, Austria, the USA, the UAE, Japan, Singapore, and South Korea, to draw lessons to be employed in the context of Thailand. The authors highlight the initiative and goal of S-Cit development,

government transparency and the government's pioneering role in the S-Cit development, establishing a board to oversee the development of S-Cits, creating a space for testing equipment, and establishing laws protecting personal information and rights as critical success factors for S-Cit-Ps. Anindra, Supangkat and Kosala (2018) pointed out the importance of smart governance as a critical success factor based on a case study of 15 cities in Indonesia. The success factors for a S-Cit-P proposed by Chourabi *et al.* (2012) are presented in Figure 2.11.

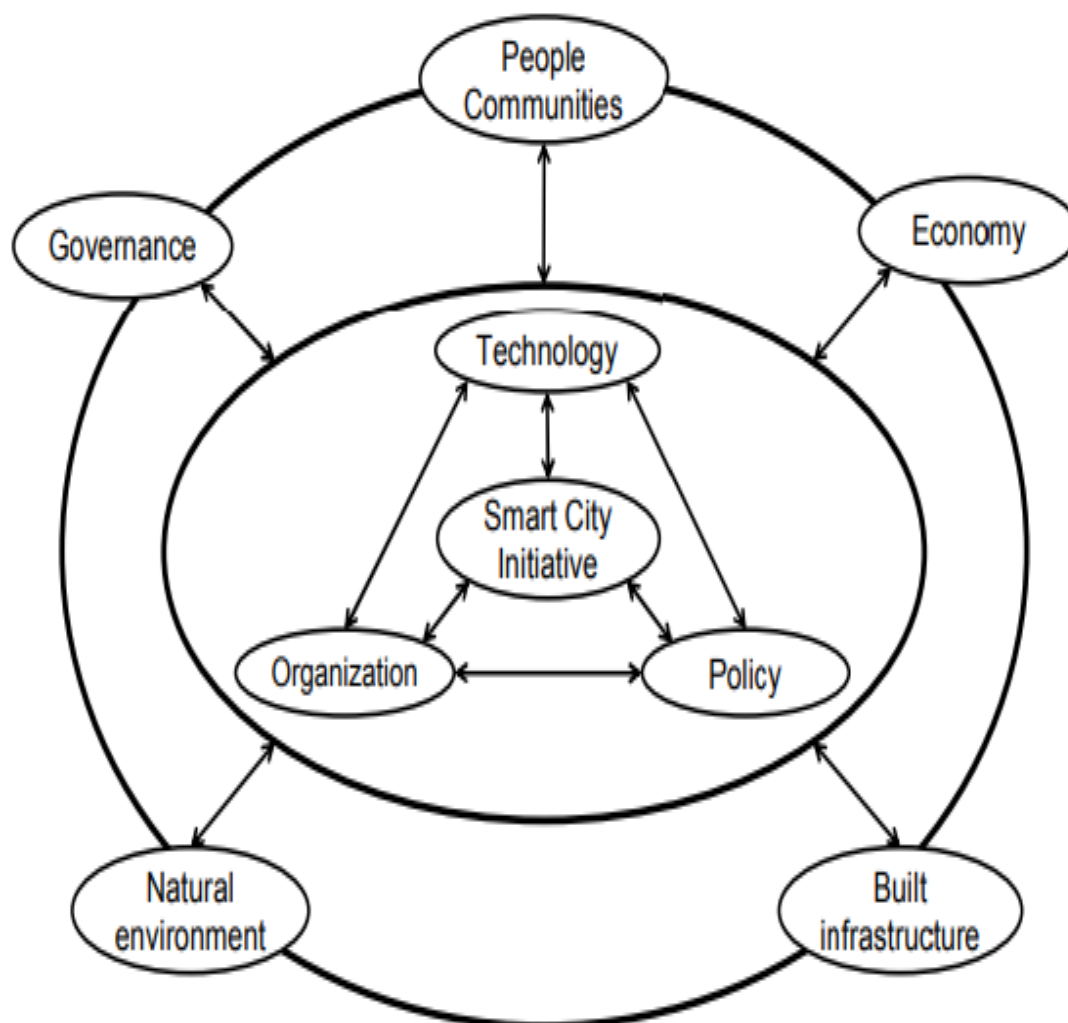


Figure 2.11: S-Cit success factors framework

Source: Chourabi *et al.* (2012, p. 2012)

To a great extent, Patel, Pitroda and Bhavsar (2016) conformed with the view of Chourabi *et al.* (2012) in their representation of S-Cit success factors. In their study, based on an extensive review of previous literature, Patel, Pitroda and Bhavsar (2016) presented a

classification of the factors affecting the design of smart infrastructure in S-Cit-Ps. Their classification groups the identified success factors into six groups:

1. Basic factors, consisting of power, water, and transportation.
2. Smart materials, including fibre-reinforced concrete and sensor-embedded.
3. Smart infrastructure, combining the integration of infrastructures and technology-mediated services with governance for institutional improvement and citizen engagement.
4. Environmental factors (natural resources and their quality and sustainable management, recycling of used resources, greenhouse gas emission and energy consumption, environmental protection and biodiversity).
5. Factors contributing to building a new understanding like technology, management, and organisation, policy context, governance, people and communities, economy, built infrastructure, and natural environment.
6. Physical factors including water and power supply, sanitation, solid waste, and storm-water management, urban development, heritage maintenance, education, and infrastructural facilities, affordable housing.

In contrast, Kim and Kim (2021) emphasise the importance of civic participation, governance including stakeholders, locally based, clear vision and sharing, S-Cit initiative, financial and political support and governance, ICT problem-solving and technical competence, political and institutional net-working served by technologies, the importance of sectors or clusters' selection, sharing success stories, test, demonstration, and living lab, performance measurement index, other-punctuality and culture. A different classification from the perspective of building technology solutions was presented by Biçer and Halicioglu (2021), who grouped S-Cit-Ps' success factors into four core categories of KPIs: technological, socio-cultural, economic, and environment indicators. Furthermore, Krishnan *et al.* (2020) suggest three key factors with a focus on the digitalisation of S-Cits: sustainability, ecosystems, and digital citizens.

The review identified ICT as an unquestionable critical factor for the success of S-Cit-Ps, together with other factors including policy, governance, and stakeholder engagement, among others. Although the problems related to the S-Cit-P's success factors are studied from different perspectives in diverse geo-graphic contexts, no evidence has been identified for the specific case of Qatar. Furthermore, the majority of the presented findings are based on secondary research. These gaps call for the performance of empirical research in the

context of Qatari S-Cits which will enrich the existing academic knowledge about S-Cit-Ps in general, and Qatar in particular.

2.6. Marketing Aspects of S-Cits

The concept of S-Cits emanated from the need to integrate technologically enhanced urban management with the social lives of citizens. While the developments in technology needed no incentive for adoption by citizens, which was already facilitated by the use of smart phones, social media and other aspects of technology, the concept of S-Cits further provided the impetus for an attractive habitable environment using urban infrastructures (Yigitcanlar, 2015). Considering these aspects, it is also important to analyse the profile of people who live in S-Cits and avail the services of such an infrastructure.

In this regard, Cardullo and Kitchin (2019b) conducted a study of S-Cits in Europe, and reported that such S-Cits promote a form of neoliberal citizenship, thereby indicating a shift towards innovative, smart and sustainable ecosystems. Similar findings were reported in the context of S-Cit-Imp in Barcelona, where a significant transformation from traditional city set up to twenty first century metropolitan city was observed (Bakici, Almirall and Wareham, 2013). Needless to say, this transformation was facilitated by the use of IT in the areas of environmental management, mobility, economic opportunities, and governance, among other aspects. However, a counter argument was presented by Lytras and Visvizi (2018) who argued that even though educated and skilled people used the S-Cit-Eco, they were still sceptical about the utility, accessibility, and efficiency of services along with privacy of data of citizens. This marks genuine concern and points towards a more pertinent view that pragmatism needs to be considered when viewing the S-Cit-Adn.

An interesting area of research which can be subject to debate regarding marketing of S-Cits is the needs of citizens which draw them towards S-Cit living. In this regard, Lee and Lee (2014) pointed out that citizen centric services should be the underlying framework for conceptualisation and implementation of any S-Cit. However, it is also important to note that this is a necessary but not in itself sufficient criterion, which can ensure S-Cit-Adn and present it as an attractive proposition. This dilemma can be partly overcome by using open standards which can facilitate public data in an easily accessible, secure and reusable format (Degbelo *et al.*, 2016). The use of open data and standards offers a starting point towards innovation and creativity, and also enables great steps towards enhancing trust among citizens by reducing dependence on proprietary standards which are mostly governed by large conglomerates. The use of open data is justified based on the rationale that it encourages transparency in governance, increases citizen-government interaction and enhances public involvement (Masip-Bruin *et al.*, 2013).

In fact, the use of open standards can be a differentiating factor and unique selling proposition of S-Cits which can present a significant marketing perspective. Another important aspect which can prove to be vital for the marketing of S-Cits is the governance aspect. Several researchers have highlighted the importance of structured and practical governance when conceptualising and implementing S-Cits (De Guimarães *et al.*, 2020; Gil, Cortés-Cediel and Cantador, 2019; Ruhlandt, 2018). However, there is a lack of consensus of the components which constitute the governance framework, thereby leaving much to imagination. This is primarily based on the argument that city governance can be quite complex and whether the S-Cit architecture can comprehensively include all the governance aspects from a technological perspective, and with minimal human intervention. Moreover, the governance ecosystem is composed of multiple stakeholders, often with competing and conflicting interests (Jiang, Geertman and Witte, 2020).

In this regard, Tan and Taeihagh (2020) conducted a study of governance of S-Cits in developing countries, and reported that the success of technology enabled S-Cits can only be ascertained when governments define clear regulatory frameworks which encompass different aspects of the lives of citizens. Support for robust and forwards looking policies for implementation of S-Cits was also evident in the findings of Viale Pereira *et al.* (2017), who conducted a cross-case analysis of S-Cit initiatives in three cities of Brazil, and reported that increased collaboration and participation in S-Cit governance can be facilitated only through robust regulatory framework. Hence, collaborative participation leading to enhanced governance can also be considered from a marketing perspective when evaluating the needs of people choosing to live in S-Cits.

2.7. Readiness to Accept S-Cits

This section reviews literature focused on current academic knowledge related to the readiness of stakeholders to accept S-Cits. This section is divided into two subsections covering the readiness of the state and citizens, in order to present a multi-dimensional understanding.

2.7.1.State Readiness

As discussed in the previous section, governance and policy are identified as critical success factors of a S-Cit-P. This emphasises the important role of the state and its readiness for the success of the smart transformation. Notable investigations of the readiness of the state to accept S-Cits include those by Achmad *et al.* (2018), Berst (2014), Orlowski (2021) and Yigitcanlar *et al.* (2021).

To begin with, state readiness refers to the capabilities of the state institutions represented by the national government, as well as the local authorities to accept S-Cit-Ps and contribute to their effective implementation (Yigitcanlar *et al.*, 2021). Further, Orlowski (2021, p. 9)

defines readiness as “the preparation of the city hall to manage the processes of going through the smart city path”. The S-Cit framework proposed by Berst (2014), as illustrated in Figure 2.12, presents a complex of technology enablers, as well as the city’s responsibilities. This framework evidences that state readiness is a multidimensional construct, combining multiple aspects and capabilities that need to be developed by the state authorities to ensure a successful transformation towards an S-Cit.

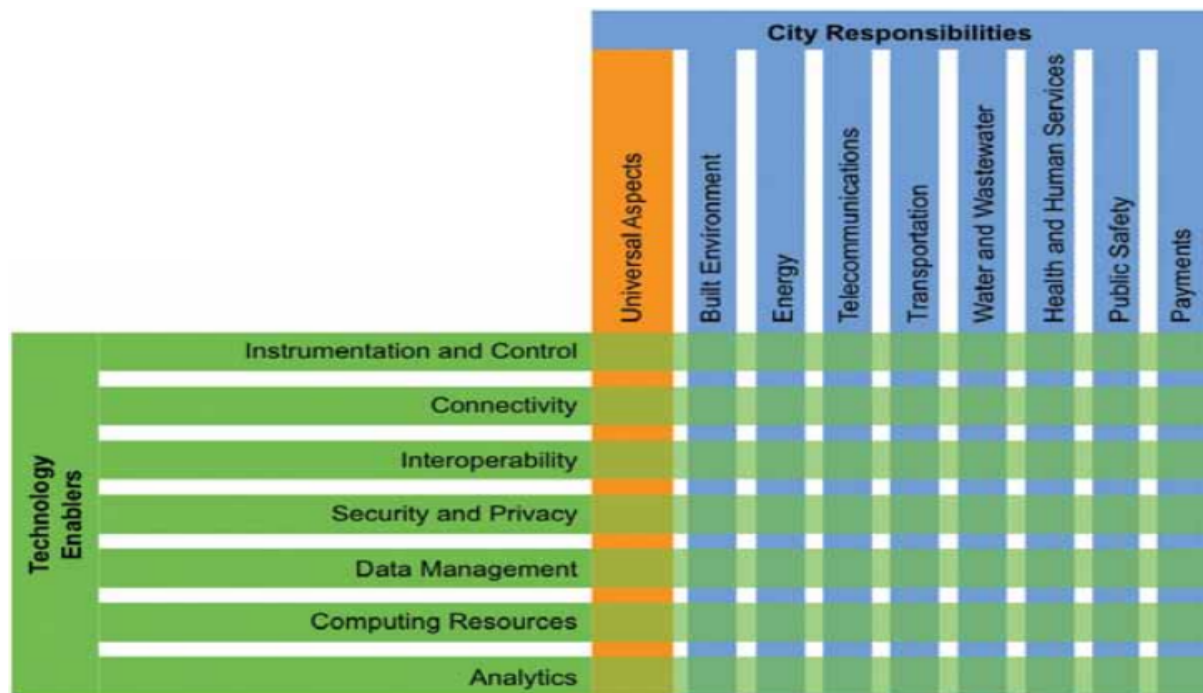


Figure 2.12: S-Cit framework

Source: Berst (2014)

Achmad *et al.* (2018) employed the S-Cit framework by Berst (2014) to study S-Cit readiness of local government institutions in Yogyakarta, Indonesia, and the empirical results showed that state readiness is not sufficient for the effective implementation. Furthermore, the authors recommended the development of a readiness measurement framework going beyond the progress and technological indicators like infrastructure (hardware) and “info-structure” (software), to include non-technical aspects like “supra-structure” (e.g., technical skills and human capital). Arief *et al.* (2020) analysed two case studies in Indonesia and confirmed the need for further improvement in local government readiness for the effective implementation of “smart islands”. However, Orłowski (2021) criticised popular assessment methods for state S-Cit readiness, including rankings and standards, claiming that they are insufficient to cover the multidimensional and complex nature of this concept. Therefore, the author proposed a novel framework for state readiness based on the S-Cit path and the importance of the respective stakeholder (the city, IT companies, NGOs) in the process.

In their study of the readiness of Russian municipalities Kamolov and Kandalintseva (2021) discovered that the digital rate, clear objectives, and targets of the digitisation process, as well as financial and organisational resources, contribute to enhancing the S-Cit readiness of local and national institutions. Furthermore, research by Enwereji and Uwizeyimana (2022) presented that limited financial resources, lack of adequate infrastructure, strategic leadership and investors, inefficient decision-making process, inability to implement the outcomes from research, as well as corruption among the role players are significant factors deterring the readiness of municipalities in South Africa to accept and implement S-Cit-Ps. In addition to that, Chatterjee and Kar (2018) discussed the population shift from rural to urban areas in the case of emerging economies, which requires the state to develop sufficient expertise in educating the potential users of S-Cit services as a critical step toward enhancing the city’s readiness to withstand any possible emerging problems.

Other major factors that impact the readiness of the state to accept S-Cits identified in the scholarly literature and valid for the context of Australian S-Cits (Yigitcanlar *et al.*, 2021) entail proximity to major infrastructure objects (capital, sea and airports), population density (Susanti *et al.*, 2016); remoteness value (Yigitcanlar and Kamruzzaman, 2019); cultural diversity (Lombardi *et al.*, 2012), level of unemployment (Ivars-Baidal *et al.*, 2021) and labour productivity (Richter, Kraus and Syrja, 2015).

The reviewed literature on state readiness to accept S-Cits indicates vast research undertaken on this topic, and the findings represent different national perspectives, including notable research interest in Indonesia, Russia, and Australia. However, no studies related to the readiness of the Qatari state to accept S-Cits were identified during the literature search and review processes. This finding indicates another research gap which needs special attention in the present study. Empirical findings and directions regarding the readiness of

the state of Qatar would be of significant value for both academics, S-Cit practitioners, and policy makers.

2.7.2.Citizens' Readiness

"Citizen readiness" refers to the extent to which citizens are willing to proactively accept change with respect to the different modes of governance in an S-Cit, affected by both technological and non-technological changes envisaged in the context of S-Cits (Achmad *et al.*, 2018). It is important that the citizen readiness is assessed using a variety of parameters. In this regard, Noori, de Jong and Hoppe (2020) studied the S-Cit readiness in the context of Iranian cities, and identified that citizen readiness can be assessed using the parameters of urban transition, technology readiness, socio-economic readiness, and political readiness.

Concerning citizens' readiness, "urban transition" refers to the creation and normalisation of S-Cit urban practices (Ibrahim, El-Zaart and Adams, 2018). For this purpose, significant transformation and system level changes are required to facilitate the transition and create awareness among the citizens when transitioning to the S-Cit-Eco. This view is also supported by Wieczorek (2018), who stated that ecological modernisation of cities requires an alignment of the expectations, resources and interests of the network of actors within this ecosystem. This can also be emphasised as focusing on the linkage between local, regional and national levels to adhere to the vision of the S-Cit and ensure that the different levels are aligned to realise the vision and goals.

The next level of citizen readiness can be explained using the concept of "technology readiness", which refers to the extent of adoption of technology to achieve personal, professional and social goals. In this regard, Setijadi *et al.* (2019) proposed four dimensions of technology readiness: optimism, innovativeness, inconvenience, and insecurity, as shown in Figure 2.13 and described below:

- The optimism dimension relates to positive perception about the technology and the extent to which it is flexible and efficient to achieve the goals of the individual.
- The innovativeness dimension relates to the use of technology towards innovation.
- The inconvenience dimension refers to the extent to which individuals feel that they do not have control of technology and are overwhelmed by it.
- Finally, the insecurity dimension refers to the scepticism regarding the effectiveness and use of technology.

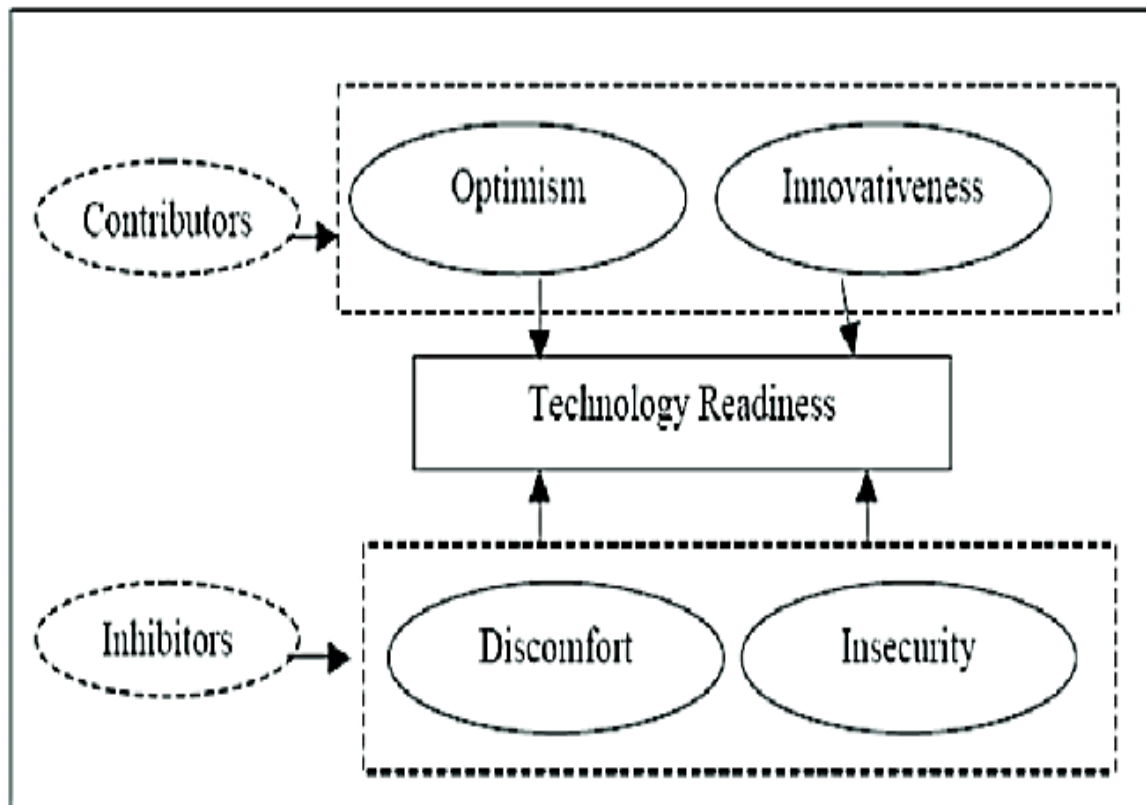


Figure 2.13: Technology readiness model

Source: Setijadi *et al.* (2019, p. 2)

These contributors and inhibitors explain the factors which influence technology readiness and can be evaluated in-depth with respect to the citizen readiness towards technology adoption in S-Cits. These factors also relate to the technology acceptance model (TAM), which considers “perceived usefulness” and “perceived ease of use” of technology with regard to how they influence consumer behaviour and technology adoption and use (Surendran, 2012). However, this model presents a limited picture with respect to assessing the technology readiness in S-Cits where the adoption is evaluated by a number of interrelated systems rather than an isolated system or technology.

The third level of citizen readiness is assessed in terms of the socio-economic adaptability of the citizens in an S-Cit-Eco. In this regard, Khansari, Mostashari and Mansour (2014) pointed out that the creation and normalisation of the urban ecosystem supported by technology interventions also need to be supported by social networks. This entails various facilities like social learning, participation in community events, and adoption of smart application across different fields such as transport, healthcare, education, and citizen-centric governance, among others. This view is also supported by Baltac (2019), who pointed out that the culture and the social dynamics of the citizens often dictate the acceptance of S-Cits and its ecosystem. Another crucial factor relates to the ability to gather knowledge and use of the facilities in S-Cits for improved decision-making (Sharif and

Pokharel, 2021b). This aspect enhances the utility of the technology-enabled systems in S-Cits, and also contributes towards readiness and acceptance of the citizens in an S-Cit-Eco.

The fourth level of citizens' readiness is associated with the policy environment and the political readiness towards S-Cit-Adn (Noori, de Jong and Hoppe, 2020). In this regard, Turovskiy, Aseev and Sokolov (2021) also concurred and highlighted that there must be political will towards transition to an S-Cit-Eco which can act as a catalyst in the transition. However, Gandy and Nemorin (2019) pointed out that this may prove to be a challenging effort due to the divergent interests of the different stakeholders. Nevertheless, Dameri and Benevolo (2016) highlighted examples such as Dubai and Amsterdam where the transition was facilitated by the initiative from local government and was governed by the vision of S-Cit-Imp and supported by the transition policy as well as adequate funding.

2.8. Cyber Security in S-Cits

2.8.1. Threats to Cyber Security in S-Cits

The adoption of technology as an inherent component in the S-Cit-Eco warrants the need to delve into the cyber security aspects. In this regard, Kitchin and Dodge (2020) pointed out that vulnerabilities in the S-Cit infrastructure have the potential to put the entire city at risk. It can not only steal sensitive information but can halt the functioning of S-Cits, primarily due to the interconnectedness of utilities, transport, and healthcare systems, among others. The vulnerabilities in the S-Cit-Eco can be attributed to a number of reasons. Kalinin *et al.* (2021) highlighted a priority pyramid of attack which was conceptualised from the perspective of threat to availability, threat to authentication, and threat to confidentiality (Figure 2.14).

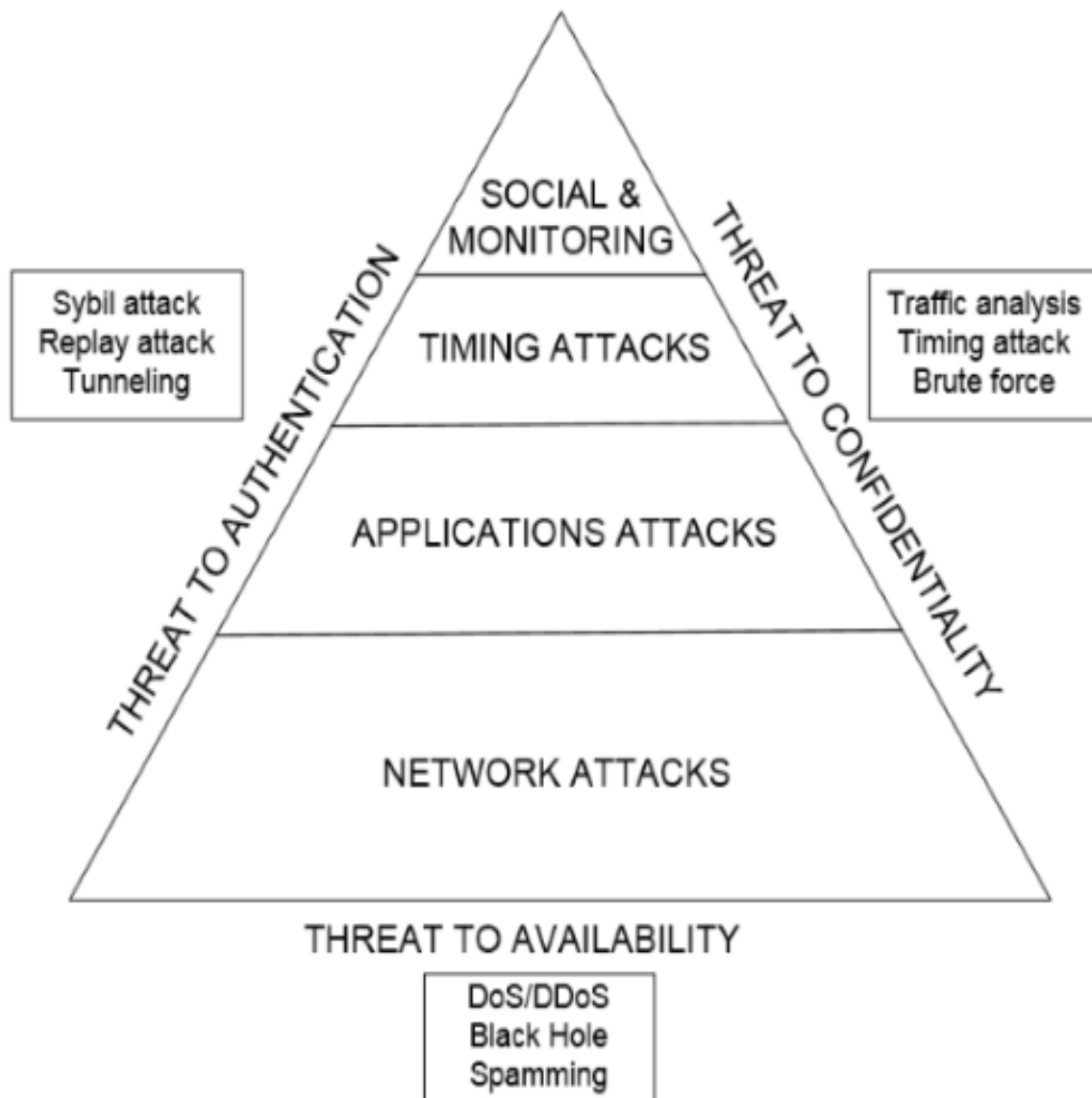


Figure 2.14: Priority pyramid of cybersecurity

Source: Kalinin *et al.* (2021)

In the first layer of the pyramid is the attack of S-Cit networks, which can arise due to vulnerabilities in the network or lack of proper security protocols in network infrastructure (Genge *et al.*, 2015). Mohammadpourfard *et al.* (2021) pointed out that network attacks on smart grids of utilities can have significant social, economic and physical consequences. The second layer is the application attacks which can result due to software vulnerabilities due to different features, challenges in compatibility and different versions of hardware, among others in interconnected devices (Jazi *et al.*, 2017). In such a scenario, an entry point where the defence of the system is weak can give opportunity to malignant actors to enter into the network of connected S-Cit systems and can result in cyber security threats, with the potential to cause large scale damage.

Jazi *et al.* (2017) asserted that such hacking of S-Cit systems can lead to misuse of citizen's sensitive personal information. This view is also supported by Cui *et al.* (2018) who highlighted that security and privacy issues for citizens need to be top priority when designing an S-Cit-Eco for preventing application attacks. The authors cited a few examples such as unauthorised access, Sybil, and illegal data collection, which can be injected into applications for weakening the technology ecosystem. Khatoun and Zeadally (2017) further added that traditional cybersecurity prevention measures may not be effective in an S-Cit environment because of the heterogeneity, scalability and interconnectedness of S-Cit systems. In such cases, advanced protection measures need to be evaluated at individual system level as well as the overall architecture level to incorporate a robust cyber security environment.

The third layer in the priority pyramid is the timing attack in which vulnerabilities to the system are detected based on their response and processing time of different inputs (Kalinin *et al.*, 2021). The vulnerability in S-Cits due to timing attacks was also highlighted by Baig *et al.* (2017), who stated that use of different types of encryption keys and the variables of performance optimisation and processor instructions are often attributed to timing attacks. The authors pointed out an example of use of smart cards which are potential targets of timing attacks. Since smart cards are often used to authenticate the entry to various entry points in physical infrastructure, these are an inherent part of the S-Cit-Eco.

The uppermost layer in the priority pyramid is "social and monitoring attacks", which can arise in the form of attacks on customers' financial and sensitive information (e.g., through phishing links) (Kalinin *et al.*, 2021). Such social engineering attacks are considered most powerful since they threaten all systems, applications and networks and are a threat to availability, authentication, as well as confidentiality. Salahdine and Kaabouch (2019) highlighted the four phases of social engineering attack, which include information collection about the target, developing a relationship with the target, leveraging the relationship to execute the attack, and finally exiting the network, leaving no traces of the origin of the malignant actor.

2.8.2.Elements of Cyber Security Management in S-Cits

There has been considerable research in academic literature with respect to the acknowledgement of cyber security risks and the need to adopt cyber security measures. Mijwil *et al.* (2022) highlighted that, without adequate cybersecurity measures, S-Cits cannot be implemented effectively to fulfil the requirements of the citizens as well as integrating the different aspects of urban living such as mobility, health, governance, economy, and economy, among others. Moreover, Alamer and Almaiah (2021) pointed out the direct relationship between technology adoption and cybersecurity threats and highlighted that the cybersecurity threats need to be addressed on a proactive basis to ensure an effective and

efficient use of technology. In this regard, several elements of cyber security management have been proposed in related academic literature, the most important of which are reviewed in the following sections.

2.8.3.Cyber Security Readiness

Cyber security readiness means that the stakeholders, especially the implementing agencies and government, acknowledge the existence of cyber security threats and undertake proactive measures to reduce these (Hasan *et al.*, 2021). There is a wide acceptance among academic communities regarding incorporating advanced cyber security measures to avoid any malignant activities in S-Cit networks which can threaten the normal functioning (Demertzi *et al.*, 2023; Jo *et al.*, 2019; Khadidos *et al.*, 2022). In this regard, Jo *et al.* (2019) further argued that implementing and oversight agencies need to have a common understanding of key security requirements. While prior studies, such as those of Clinton (2015) and Rizov (2018), have acknowledged the need for addressing shared goals regarding cyber security concerns and navigating complex dynamics of interconnected systems, the risks emerging from S-Cit-Adn warrants further attention.

Similar concerns were also presented by Fang and Shan (2022) in the context of S-Cits in China, where the authors used the Capability–Performance–Experience (CPE) evaluation model to assess the readiness of S-Cits to tackle cyber security threats, and reported a mix of measures such as policy initiatives, adoption of security protocols, knowledge and awareness among citizens, robust attack detection methods, and regular audit of asset inventory as some of the key measures to be prepared to deal with the cyber security threats. However, while these measures may seem to be isolated, a comprehensive framework comprising these components is needed to address the cyber security threats in the S-Cits.

This view is also supported by Shwede *et al.* (2022), who studied the relationship between technology readiness and S-Cit performance in the context of S-Cits in Dubai and reported a significant relationship, thereby emphasising the importance of technology readiness for performance as well as cyber security assessment. However, Tounsi and Rais (2018) also argued that the advancements in technologies have also led to the increase in sophistication of cyber security threats. This is an important consideration, whereby past research in the field of cyber security can be applied in the context of S-Cits.

2.8.4.Policies and Procedures

The intricate architecture of S-Cits comprising interconnected systems requires collaboration among different stakeholders in an S-Cit setup. Habibzadeh *et al.* (2019) highlighted that engaging with different levels of authorities often poses challenges and therefore, it presents the need for common policy and procedures for the use of technologies and systems which enable the S-Cit setup. An example of such an initiative can be cited from the case of S-Cits

in Dubai, where the “Dubai Centre for E-Security” law was enacted and implemented a capability framework which coordinates with all government entities for matters of cyber security and has made implementation of cyber security measures much easier and effective for the authorities (Efthymiopoulos, 2016). An important aspect of this law was the formulation of cyber-security policy which provides guidelines for risk assessment and implementation of protection measures.

Similar evidence of the effectiveness of information security policy was also pointed out by Wu *et al.* (2020) in the context of S-Cits in Taiwan, wherein the authors reported positive relationship between effectiveness of organisational information security policies and information security performance. However, Vitunskaite *et al.* (2019) highlighted the challenge of high levels of interdependence and social and political complexity among different stakeholders, and their competing interests. The authors argued on the need for agreeing on the technical standards, and policies to support the implementation of cyber security measures in the S-Cit-Eco, which is also consistent with the arguments of Habibzadeh *et al.* (2019), as stated above. Furthermore, in the context of managing the privacy of citizens, the need to formulate policies in order to enhance trust among the citizens has been given high priority in academic literature (Almedia, 2023; Bokhari and Myeong, 2023). In view of the above, it can be said that there is considerable support regarding the formulation of cyber security policies in order to implement robust cyber security measures in the S-Cits.

2.8.5. Security Controls

The security controls in cybersecurity refer to the safeguard measures to eliminate or reduce threats to the systems (Atoum *et al.*, 2014). Security measures form an inherent part of the design of the technology framework and are incorporated in the architecture design of the systems. Prior research has delved into the different security controls which need to be incorporated in the technology architecture of S-Cits (Hyman *et al.*, 2019; Nova, 2022; Vitunskaite *et al.*, 2019). One of the security control measures proposed is the automatic asset identification which can help in identifying the vulnerabilities in the security measures and help in fixing these issues (Waedt *et al.*, 2016). The management of IT infrastructure assets is important considering that they form the backbone of the technology ecosystem and are used for the purpose of financial accounting, security assessment, and preventive maintenance, among others.

A similar view was also expressed by Konstantinou (2021), who focused on the energy grid in S-Cits and argued the need for asset management of the grids to prevent both cyber as well as physical risks. However, Sengan (2020) argued for an even more holistic approach towards security controls by conceptualising and implementing security controls at the architecture level. The authors proposed a “Hybrid Smart City Cyber Security Architecture”

that analysed threats as well as ensuring safety of data and systems. This approach helps the authorities to learn from the prior breaches in cyber security and include prevention measures at the architecture level. However, this approach also needs to incorporate the emergent threats from advancements in technology as well as levels of sophistication in cyber-attacks, especially in the complex architecture of S-Cits.

2.8.6. Advanced Technologies for Cyber Monitoring

The advancements in technologies have also led to an increase in sophistication of malignant attacks on systems (Tounsi and Rais, 2018). Since the S-Cit technology infrastructure consists of multiple connected systems, it becomes very complex to monitor such systems on a real time basis. This issue has been highlighted in academic literature and several measures of automation and use of advanced technologies have been proposed (Belgaum *et al.*, 2018; Doku and Rawat, 2019; Lv *et al.*, 2021). In this regard, Andrade *et al.* (2020) highlighted the importance of AI and machine learning for enhancing cyber security measures. This approach is not only useful in automating the security prevention measures, but also develop countermeasures using automated systems consisting of AI and machine learning.

Another security enhancement measure is the use of blockchain to protect the cyber infrastructure of S-Cits while also ensuring privacy of citizens. The use of blockchain technology has found many applications such as digital currencies (Zhang and Huang, 2022), smart contracts (Li and Kassem, 2021; Wang *et al.*, 2019), supply chain management (Cole *et al.*, 2019; Madhwal and Panfilov, 2017), and health record maintenance (Fang *et al.*, 2021; Shahnaz *et al.*, 2019), among others. Hence, the use of blockchain is supported as a viable inclusion in technology infrastructure for preventing cyber threats in S-Cits. Similarly, Abd El-Latif *et al.* (2021) also pointed out that since a majority of hardware devices in S-Cit-Eco will migrate to IoT, it is imperative to address the cybersecurity threats such as authentication, access control, communications, and interfaces, to arrive at a comprehensive solution to mitigate risks in the S-Cit-Eco.

2.9. Data Privacy and Security and the S-Cit-Adn

The S-Cit-Adn by different countries has called for interest in the role played by technology in the S-Cit-Eco. It is well established that creation of an S-Cit-Eco requires sophisticated technological infrastructure consisting of networks, data and applications which are needed for providing different services to the citizens residing in S-Cits (Barns *et al.*, 2017; Caragliu *et al.*, 2011). The use of such interconnected networks and systems also presents the challenge of security and privacy of data. The issue of security and privacy has also been highlighted by several researchers (Braun *et al.*, 2018; Cui *et al.*, 2018; Elmaghraby and Losavio, 2014; Rao and Deepak, 2022).

It is well-recognised that privacy seems to disappear when there is increased digital adoption, and when users provide consent about the capture of their location and activities through various online applications. However, there are genuine and pertinent concerns about illegal access to user information and cyber security threats, which can intrinsically violate users' rights and lead to disruptions in services in an S-Cit-Eco (Baig *et al.*, 2017). This presents a continuous challenge for governments and technological vendors with respect to ensuring a safe S-Cit environment, where the wellbeing of citizens, economic development, and sustainability is prioritised. The following sections discuss the effect of data privacy and data security issues on S-Cit-Adn, and contemplate the magnitude of the impacts of data privacy and security breaches on S-Cits.

2.9.1. Impact of Data Privacy and Security Issues on S-Cit-Adn

S-Cit-Adn has brought significant improvements in the lifestyle of the citizens as well as the improvement of the whole society. However, there are growing concerns about the adoption of smart applications as they are vulnerable to cybercrime such as data theft, spam attacks, and identity attacks, among others (Khatoun and Zeadally, 2017). According to a survey conducted by UC Berkeley (2021), emergency and security alert systems pose the highest rank in technical vulnerability and impact of a successful cyber-attack, followed by street video surveillance and smart traffic lights (Table 2.2).

It is pertinent to note that these three systems are an inherent part of any S-Cit, and the technologies perceived as most vulnerable are the ones that generate significant impact in the event of system breach or cyber-attack. In another study conducted by Deloitte (2019), it was identified that the three key factors which influence cyber risk in S-Cits are convergence of IT infrastructure, interoperability of platforms, and integration of services across domains through IoT and digital technologies (Figure 2.15).

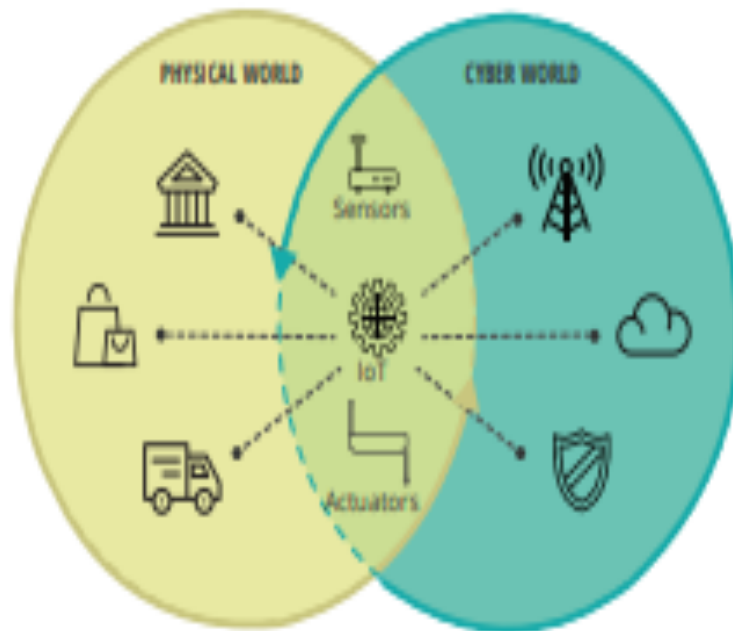
Table 2.2: UC Berkeley experts' assessment of smart city tech security

	RANKING: TECHNICAL VULNERABILITY	RANKING: IMPACT OF A SUCCESSFUL ATTACK	RANKING: INTEREST LEVEL OF NATION-STATE ATTACKERS
Emergency and Security Alert Systems	1	1	1
Street Video Surveillance	2	3	2
Smart Traffic Lights/Signals	3	2	3
Water Consumption Tracking	4	6	5
Smart Tolling	5	7	8*
Public Transit Open Data	6	5	4
Gunshot Detection	7	4	8*
Smart Waste or Recycling Bins	8	9	9
Satellite Water Leak Detection	9	8	6

Source: UC Berkeley (2021)

1. CONVERGENCE

Convergence of IT and OT infrastructures, blurring the divide between the physical and cyber worlds



2. INTEROPERABILITY

Coexistence and frequent interactions between old and new systems and platforms



3. INTEGRATION

Integration and comingling of services across domains through IoT and digital technologies

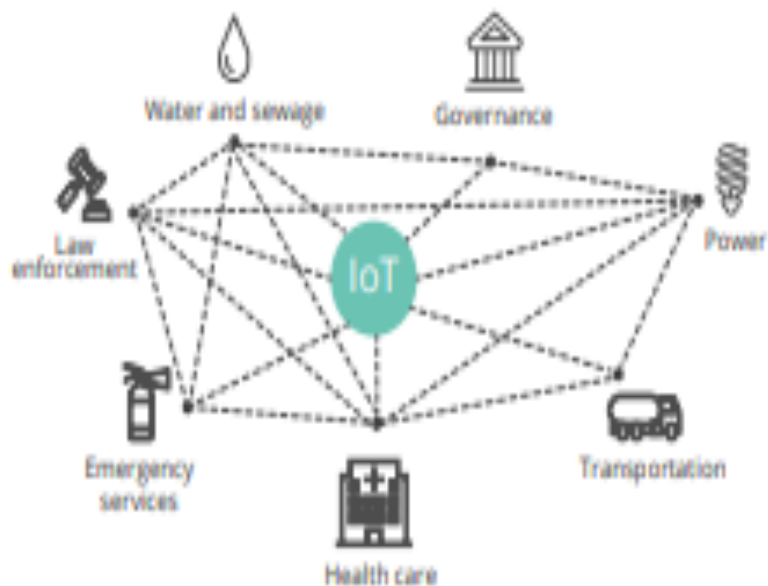


Figure 2.15 Key factors influencing cyber security in S-Cits

Source: Deloitte (2019)

The convergence of IT and operational technology provides the technological ecosystem to control the different systems but also expands the likelihood of cyber threats. Interoperability refers to the protocol which allows integration and data exchange between new digital technologies and legacy systems, and often results in vulnerabilities due to disparate technology platforms.

Finally, the integration of S-Cit services with different interconnected technologies often presents the challenge of cascading effects and catastrophic failures due to vulnerabilities or cyber-attacks in one or more systems. For example, a common feature of S-Cits is the smart mobility system which relies on automated vehicles and technology-controlled transportation systems. The cyber-attacks on such systems have the potential to cause widespread damage and loss of lives. Similarly, for IoT sensors, security threats such as confidentiality of data, non-secure communication, communication interception and communication jamming are ever present on their deployment in an S-Cit environment.

Another key aspect is the digitisation of healthcare records to facilitate a smooth delivery of healthcare services. However, this also presents the vulnerability to hacking or cybertheft of the personal and medical records of the individuals, thereby posing serious concern regarding the resilience of critical digital infrastructure for providing round the clock services to the citizens. These aspects have also been highlighted in academic literature as security threats when relying on a digital ecosystem, especially in a wide range of services in the S-Cit-Eco (Chen *et al.*, 2021; Elmaghraby and Losavio, 2014; Nayyar *et al.*, 2019). Some studies related to cyber security threats in the context of S-Cits also argue for the need for a well-defined regulatory framework which can deter threats to privacy and limitations on collecting personal data (Ismagilova *et al.*, 2019; Kitchin, 2014).

For instance, many national regulations restrict the collection of personal data, and provide guidance on achieving a fair balance between the interests of the users and the technology solution providers. However, there are also challenges arising out of data coming from global positioning systems, cameras and sensors, among other devices which pose a threat to privacy of individuals and expose them to malicious hackers. Such challenges are also present in smartphones used by citizens, wherein personal and financial data could be accessed, which could lead to publishing sensitive information. Moreover, common standards which can be adopted by different countries to ensure that privacy concerns are reduced to a great extent are lacking (Silva *et al.*, 2018). As such, it becomes difficult to agree on the extent to which regulation and control are required and can be useful while using and regulating digital technologies.

As also highlighted above, cybersecurity poses a significant threat to the full-scale S-Cit-Adn. As such, it becomes difficult to establish full scale trust and there is always room for suspicion among the S-Cit citizens. Moreover, the scale of the threat can also be estimated

by the extent to which the systems are interconnected and are used to provide citizen centric services in an S-Cit-Eco.

2.9.2.Addressing Security and Privacy Concerns in S-Cits

There have been various propositions on implementing security measures in an S-Cit environment. Researchers have mostly focused on privacy of citizens, data security, and security measures in the interconnected networks (Allam and Dhunny, 2019; Mehmood *et al.*, 2017; Shakya, 2021). Some of the most commonly used measures for system security include biometric authentication, facial recognition, and multi-factor authentication, among others (Ijaz *et al.*, 2016; Khatoon *et al.*, 2019). Albeit such measures are necessary, more is needed to ensure security in complex systems of interconnected networks, such as those present in S-Cits. A more comprehensive approach to security and privacy of S-Cits was provided by Sookhak *et al.* (2018), which consisted of S-Cit conceptualisation, security requirements, security challenges, privacy challenges, solutions and architectures, and open issues (Figure 2.16).

Sookhak *et al.*'s (2018) roadmap has the benefit of providing an overarching framework which can highlight the different components of the technology ecosystem which needs attention so as to prevent cyber-attacks on systems and data. An additional layer of security can be imposed by the use of blockchain technology which can be integrated with the smart devices to provide a secure communication platform (Biswas and Muthukkumarasamy, 2016). However, it is also important to understand that the exponential rise in computing power brings about challenges in adoption of any system and also exposes the vulnerabilities in these systems which can be exploited with malicious intent.

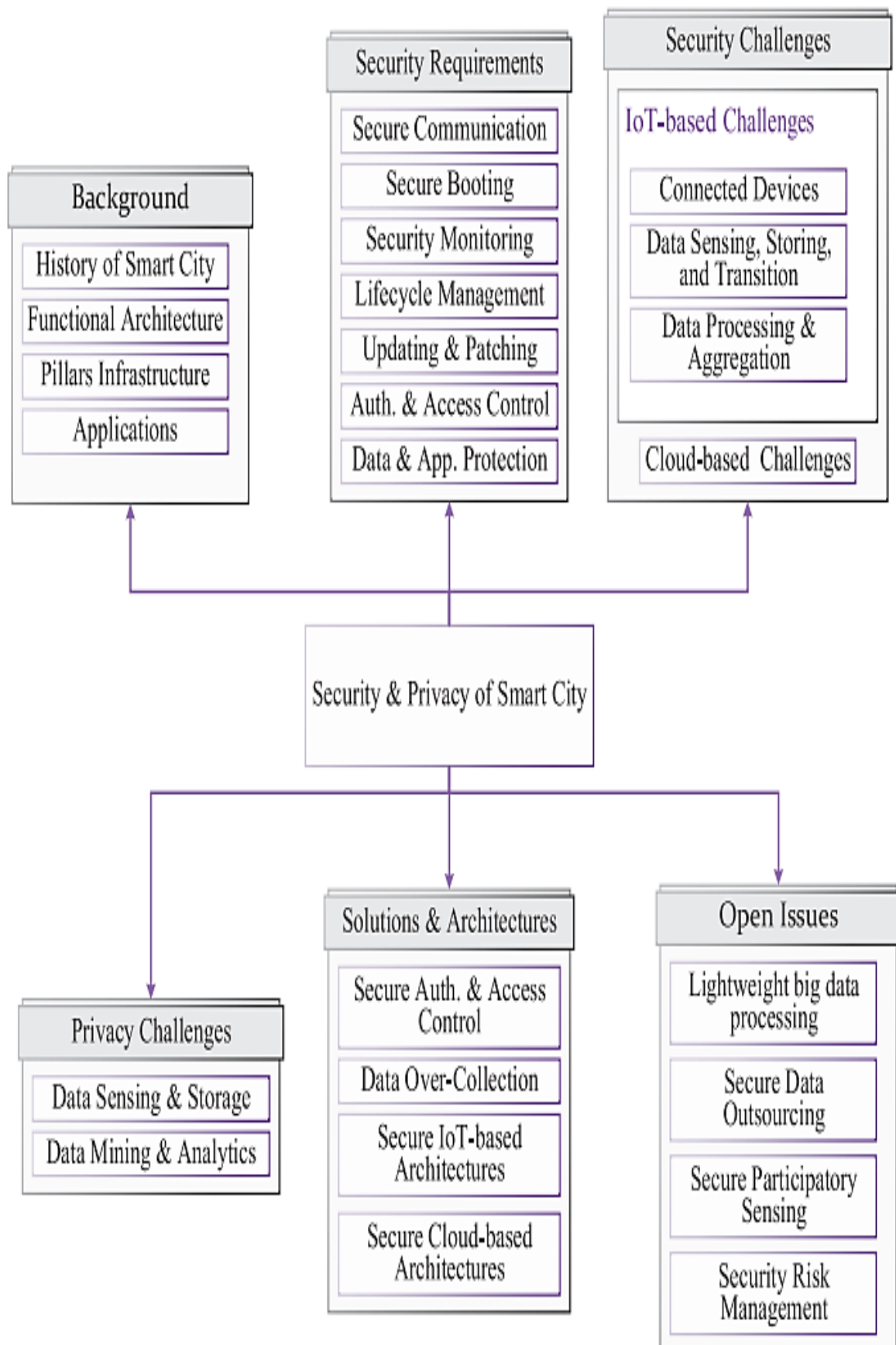


Figure 2.16: Roadmap for cyber security implementation in S-Cits

Source: Sookhak et al. (2018)

2.10. General Benefits and Challenges to S-Cit-Ps

The major benefits and challenges related to S-Cits are summarised in Table 2.3, and are discussed in detail below.

Table 2.3: Benefits and challenges to S-Cits for stakeholders

Dimension	Benefits	Challenges
Government		
Economic	Automation brings cost savings	High capital costs
Managerial	Efficient administration	Skilled labour required
Resource efficiency	Sustainable and environment-friendly eco-system	Privacy concerns in data-collection.
Waste management	Cleaner environment	High capital costs
IT	High quality of services through data analytics	Cyber-security threat
Business		
IT	More opportunities	Competitive environment
Administration	Skilled people available	Rigid policies
Residents		
Transport	Efficient and economical	Dependency on public transport
IT	Better connectivity	High risks of privacy concerns
Services	Efficiency	Prone to internet and privacy related risks

Source: Al Nuaimi *et al.* (2015), Vázquez *et al.* (2018), Glasmeier and Christopherson (2015), Kumar (2020), Park *et al.* (2022), Phan and Qureshi (2017), Pinochet *et al.* (2018), Tanda *et al.* (2017)

2.10.1. Benefits

The reviewed literature has recognised several benefits reaped by states who develop S-Cit-Ps. As these cities are developed on the premise of efficient utilisation of space and resources, the primary idea of enabling data-driven S-Cits is to enable data-driven decisions in allocating and managing these resources (Paiva *et al.*, 2021). Such efficient disposal enables S-Cit-Ps to make effective decisions based on information. Since information has become a critical tool in the digital age, the use of data analytics can enable real-time delivery of services and increase the quality of administration (Zhao and Zhang, 2020). S-Cit-Ps are also characterised by increased interaction between the state and people, and the exchange of valuable information and responses through the collection of feedback data and data patterns via digital mediums can enable governments to make digital cities a more attractive place to live in (Arroub *et al.*, 2016).

For instance, the integration of technologies to detect and mitigate potential criminal actors also enables safer communities. Most S-Cit-Ps have sought to enable safer communities through the use of technology (Routray *et al.*, 2019). Similarly, S-Cit-Ps also rely on smart public transport infrastructures, energy efficient buildings and processes, and sensors for air quality and environmental control to collectively enable a cleaner environment. Therefore, developing S-Cit-Ps can enable governments to mitigate the effects of climate change and simultaneously establish precedence for the future (Vanlı and Marşap, 2018). A major benefit of S-Cit-Ps is the technological infrastructure they present to the population, and the digital equity provided therein. Resultantly, people engaging with applications of the S-Cit can potentially attract new development opportunities with increased technological exposure to people (Lam and Yang, 2017). Moreover, infrastructure failures can be predicted and avoided in S-Cits, and their utilities can be more efficiently managed and resources distributed, thus improving the possibility of the residents (and economically productive workers) to achieve their full potential through improved services (Bjørner, 2021).

Notwithstanding the challenges noted below, residents and businesses in S-Cits in Qatar are expected to derive multiple benefits. According to the Ministry of Transport and Communication (2014), the use of smart transportation is estimated to lower road fatalities, lower car emissions, and provide improved public transportation. In addition, the use of smart healthcare is expected to offer benefits of innovative and connected health technologies. Other benefits include high speed internet connectivity, increased education access, improved health outcomes due to use of smart healthcare, and overall faster access to information for the residents and businesses. In the conceptualisation of S-Cits in Qatar, the focus is on five priority sectors: transportation, healthcare, logistics, environment, and sports. Through initiatives in these sectors, the creation of S-Cits in Qatar is expected to deliver \$11 billion to the economy by 2022 (Maru, 2019). The above goals are also consistent with the four central pillars of Qatar's National Vision 2030, which envisages economic, social, human, and environmental development.

S-Cits offer fundamentally holistic urban experiences for their users, such as the optimisation of more efficient urban travel and transport (Tanda *et al.*, 2017). The urban issue of traffic congestion is expected to be resolved, and S-Cit citizens can experience simplified travelling experiences through simplified routes, easy to understand travel information, and economically viable transport. Therefore, the levels of professional and social competency are expected to be high (Osipov *et al.*, 2018). At the same time, it is also expected that they will contribute to various social development parameters, improving the QoL of citizens (Kumar, 2020). For example, the environmental infrastructure in Lusail is built around the provision of delivering water, electricity, and waste management in a sustainable manner, which intrinsically improves QoL. With educational institutes and workplaces becoming more adaptive and providing a more affluent daily experience, with pain points

being addressed in a smart manner, the living culture of S-Cits is expected to become more harmonious in relation with the people and environment (Vázquez *et al.*, 2018). The experiences enabled by smart governance are also integral in improving the quality of urban experiences.

2.10.2.Challenges

Several prominent challenges have also been identified by the literature on the development of S-Cits. For example, the high reliance on technology and data makes such S-Cit systems and their users more vulnerable to the threats of cyber-security breaches, which are a palpable threat to all contemporary information systems, and S-Cit-Ps face the critical threat of breaches as these would directly affect citizens of the S-Cits (Bawa *et al.*, 2016). This threat can compromise the security, infrastructure, and resource allocation of cities and their users (Al Nuaimi *et al.*, 2015). Furthermore, growing concerns regarding privacy are making citizens more repulsive towards surveillance and information gathering well (Phan and Qureshi, 2017). S-Cit-Ps rely on information gathering and intelligence gathering through data collection, which can have implications based on the privacy concerns identified. Additionally, a more basic challenge is the high costs related to the acquisition of complicated digital equipment and skilled labour for the development of S-Cit-Ps.

The social setup of S-Cits is also expected to consist of technically sound people who can interact with the smart living options enabled in the city, as implied by the slogan “smart cities for smart people” (Pinochet *et al.*, 2018). While the increased competencies present in the social setup of S-Cits are expected to contribute towards improving the city’s QoL and experiences, they can also present a challenge for some people, particularly those who are socio-economically disadvantaged or who cannot use prerequisite technologies and facilities (e.g., people with certain disabilities). On a macroeconomic level, the competitive environment of S-Cits can also have a constraining effect on businesses and ventures which will face the challenges reflecting greater innovative capabilities.

Moreover, while services such as the internet and other smart living services are widely provided in these cities, it is also likely that faults in these systems can render the city ineffective; highly complex technological systems can create equally complex challenges for the city’s people, particularly when malfunctions occur (Park *et al.*, 2022). Sensors and gauges are designed to continually collect and communicate data for appropriate actions to be taken, and the analysis and processing of this data is highly dependent on high-speed internet. Therefore, people living in S-Cits may occasionally face challenges in their day-to-day functions due to lag in the internet and the subsequent effect on the associated services (Ningrum, 2021).

Similarly, the heavy reliance on cloud computing to enable data-driven smart processes can also lead to severe privacy and security implications. The loss of data, and other threats to

privacy and well-being of the residents of S-Cits is a challenge that they should be prepared for with cyber-crime growing as a perpetual threat. This threat is not only aimed at people's personal data and privacy, but it can also effectively disable the city's infrastructure. This means that people could lose access to services such as water, sanitation, or healthcare due to the highly technological nature of S-Cits. Besides the context of privacy concerns, IT-enabled smart services such as transport and healthcare can also lack efficiency due to insufficient internet speeds and any unforeseen factor influencing the steady and seamless provision of the internet (Glasmeier and Christopherson, 2015).

2.11. Information Security Challenges in S-Cits

The conceptualisation of S-Cits across the world is based on the premise of use of advanced technology to create a networked and digital infrastructure to address a range of issues such as service delivery to citizens, resilient infrastructure, smart transportation, sustainability, enhanced transparency, enhanced safety and security measures for the citizens, and growth in the local economy (Letaifa, 2015; Silva, Khan and Han, 2018). These aspects require the use of technological infrastructure in terms of data collection, scalability, performance, processing, and storage of data across multiple servers. Considering these, the issue of information security becomes paramount when conceptualising and executing the project of S-Cits. In this regard, Popescul and Genete (2016) highlighted the issues of hyper-connectivity, complex system architecture and lack of common standard protocols for network optimisation as key issues towards information security. The authors argued that urban management needs to pay close attention to identity management, network protocols, and security and privacy protection in order to leverage the benefits of technology in S-Cit solutions.

This view was also supported by Wu, Sun, and Wu (2020), who argued the need for information security policies to ensure data security and the privacy of sensitive information of citizens and organisations. The main premise put forward by the authors is that the development of S-Cits involves the use of IoT, cloud technology, big data, mobile internet, and predictive technologies, among others, all of which need a large amount of data for efficient use of information systems. Hence, it becomes imperative for defining information security policies for managing the technological infrastructure of S-Cits. Furthermore, Elmaghraby and Losavio (2014) provided an example of intelligent transport that will use interconnected data from GPS location to weather and traffic updates, all of which pose the threat of illegal access and potential disruption in service availability, thereby further strengthening the need for robust data security practices to be incorporated in the technological ecosystem.

The issue of information security arising from the deployment of smart devices and applications in the S-Cits in Qatar is also acknowledged by the regulatory and policymakers

(Badran, 2021). The authors highlighted five main regulatory issues which include licensing and spectrum management, roaming and data interoperability, addressing and numbering, regulating competition, and regulating privacy and security issues. The focus on information security aspects indicates that the regulators are cognizant of the implications of large-scale data use by the technological ecosystem and the need to ensure the successful implementation of S-Cit initiatives (Badran, 2021). Similar observations were also reported by Sharif and Pokharel (2021b), who acknowledged the risks associated with the integration of technology in urban management, leading to security and privacy issues. However, considering that the S-Cits in Qatar are still under development, there is a lack of literature that highlights the implementation of such information security initiatives in the country.

2.12. Challenges in Qatar

Qatar has experienced a rapid economic growth, primarily due to the discovery and production of oil and natural gas reserves. The country is the world's third largest exporter of natural gas, behind Russia and the United States (New York Times, 2022). It was also the fourth richest country in terms of GDP per capita, thereby indicating the well-being of the nation (Ventura, 2022). However, the country also faces few challenges which need attention to ensure that its standard of living is comparable to that of the developed nations across the world. The first challenge that is faced by the country is the limited freshwater resources (groundwater and rainfall) and high consumption (Darwish, 2014).

According to Biswas and Tortajada (2019), an average Qatari national uses 1200 litres per capita per day, with unaccounted losses at 35%. The consumption, as well as loss are very high for a country with water scarcity problems, and it compares unfavourably with Singapore, another country with a water scarcity problem, whose consumption is 143 litres per capita per day, with unaccounted losses of 5%. These figures imply that water resource management is very poor in Qatar. This problem is also supported by research exploring various aspects of water management, such as water treatment (Dawoud *et al.*, 2021), desalination (Mannan *et al.*, 2019), and consumption in the country (Ajjur and Al-Ghamdi, 2022; Ibrahim and Shirazi, 2021).

The second challenge that Qatar faces is the overreliance of the economy on petroleum and natural gas exports. According to the Observatory of Economic Complexity (2020), petroleum and natural gas account for more than 60% of the country's GDP and 85% of exports. Several researchers have highlighted this concern with suggestions including tourism, financial sector, and knowledge-based service industries (Hassen, 2021; Morakabati, Beavis and Fletcher, 2014). An attempt to alleviate this challenge has been made by the Qatari Government in its "Qatar National Vision 2030", which aims for the country to become an advanced society capable of sustaining its development and providing a high standard of living for its citizens. Furthermore, the challenges in volatility of oil and

gas prices have galvanized the national development focus on upgrading infrastructure, with private public participation (Biyygautane, Hodge and Gerber, 2018).

The third challenge faced by Qatar is the development of knowledge workers to contribute to a knowledge-driven society and digital economy (Parcero and Ryan, 2017). Qatar has a vast pool of expatriate labour and a very limited local talent pool (Al Muftah, 2016). While this has contributed to the rapid development of Qatar's economy, the sustainability of the economic growth presents a challenge for the decision makers in the country. The issue of labour availability is further amplified by the low labour force participation of women; 58% of working-age women are in full-time employment, compared to 96% of men (Mohamed, 2021). Furthermore, Babar, Ewers and Khattab (2019) also highlighted the issues of expatriate labourers' human rights, which escalated after Qatar won the bid for hosting the 2022 World Cup. These issues clearly highlight the challenge for Qatar to create a talent pool which can contribute to sustainable development of the country in line with Qatar National Vision 2030.

The fourth challenge that has been widely prevalent and quite often in contrast with other developed nations is the socio-cultural aspects in Qatar, including restrictions posed on women as a result of the culture, due to traditional Arab-Islamic norms. In fact, Mobasher (2016) highlighted that even though the country has outlined its vision for integration into the global world through its 2030 Vision, there are very few efforts from the government for cultural connection between Qatar and global nations (albeit this changed dramatically with local hospitality for World Cup visitors in 2022 attracting global attention). Nevertheless, internal issues remain, and Al-Qahtani *et al.* (2022) conducted a study on the importance of women's entrepreneurship for sustainable economic development and reported that despite constituting a significant percentage of educated and talented population in the country, the full potential of contribution of women is still hindered due to socio-cultural factors. This argument is also based on prior findings indicating that the role of women in economic development has been widely acknowledged to be underrepresented across most countries (Duflo, 2012; Rosca, Agarwal and Brem, 2020; Saravanan and Dash, 2017).

In light of the above-mentioned challenges, it can be inferred that the S-Cit conceptualisation needs to incorporate these aspects to provide a sustainable living which addresses the challenges to a great extent. While it may not involve significant transformation of the cultural aspects, other challenges such as developing skill sets of local workforce, economic sustainability, water resource management, and diversification of economy can be at the forefront of S-Cit conceptualisation. This approach can not only help in addressing the sustainability challenges but can also enhance S-Cit-Adn of citizens.

2.13. Qatar's Context of S-Cits

2.13.1. Overview

The relevance of S-Cits is particularly intriguing in the context of Qatar, as the country's evolution into a knowledge economy presents unique characteristics that qualify Qatar to be a valuable case study (Meraikhi, 2021). The nature of the country's economy, development, and cultural context present various challenges to conventional S-Cit models (Doherty, 2014). This has been highlighted in Altiook's (2021) work focused on investigating the preservation of cultural identity and characteristics in S-Cit-Ps. This study examines an important context, as examples of S-Cit-Ps in the contemporary world include those from culturally diverse countries. The preservation of culture and identity in particular regions, including the Arabic world, is a significant concern of S-Cit development, and indeed urban planning and development in general (Sharif and Pokharel, 2021b). Since Qataris seek to preserve their cultural identities and heritage, it is crucial that cultural values are acknowledged at the core of any S-Cit transformation that occurs (Sharif and Pokharel, 2021b). This was articulated by participants with regard to various aspects, as discussed in Chapter 6. For instance, experts directly articulated that S-Cit development should not be detrimental to Qatari cultural identity (P3, P6), while others gave examples of using S-Cit technologies for historical heritage preservation, and showcasing national cultural identity nationally and internationally (P11, P12).

Similar S-Cit-Ps in Gulf Cooperation Council (GCC) countries, such as Masdar in the UAE and Neom in Saudi Arabia, face similar challenges in terms of cultural integration and preservation in transformed models (Shaaban and Adaibi, 2021). Qatar is currently working on Lusail – a S-Cit-P which will have extremely modern and sophisticated systems for waste management and environmental protection in place (Geropanta, 2020). For countries in the GCC, projects such as Lusail City are a representation of progressiveness and economic competence (Tok *et al.*, 2014). As these countries transform from economic models that relied on finite resources and confined cultural settings to global hubs for knowledge-driven economic activities, there is a persistently growing need for S-Cit-Ps (Tok *et al.*, 2014). Moreover, a unique characteristic of the projects undertaken in the GCC in general, and Qatar in particular, is the interplay between stakeholders and more specifically, the interactions between the state and the people, which remain distinctive due to the dynamic models of governance and the cultural influences (Abdallah, 2020).

The development of S-Cit-Ps in Qatar is generally associated with the pursuit of a sustainable economic model. An early analysis by Ali *et al.* (2014) emphasised that S-Cit initiatives in Qatar remain a part of the sustainable developments that the country is initiating under its Qatar National Vision 2030. Furthermore, Alfdala and Fadli (2020) deconstructed the characteristics of Msheireb Downtown Doha, a S-Cit-P in Qatar, drawing relevance from

models of sustainable public open spaces. They identify various complications occurring from the physical and non-physical, as well as environmental characteristics of the project (Asmyatullin *et al.*, 2020).

As discussed in section 2.12, the challenges associated with Qatar's scant natural water resources and limited human capital include water treatment (Dawoud *et al.*, 2021), desalination (Mannan *et al.*, 2019), and consumption (Ajjur and Al-Ghamdi, 2022; Ibrahim and Shirazi, 2021). Such fundamental needs force the state to reduce costs and increase efficiency, while maintaining a service structure that is more efficient. For this purpose, S-Cit-Ps are a valuable solution. Water management strategies, therefore, have been noted to remain at the core of the country's S-Cit-Ps. As explained by a participant (P6) reported in section 6.6, Qatar's smart water management system has already led to significant reductions in water waste.

Lastly, the use of IoT in Industrial Revolution 4.0 is a defining component of Qatar's S-Cit-Ps (Richer, 2014). Particularly in the transport and healthcare sectors, the country is relying on the extensive use of automated processes to enable an increase in QoL (Sulaiti, 2021).

Other less significant S-Cit-Ps have been identified by Furlan and AlMohannadi (2016), such as "Light Trail Transit" and "Land Use in Qatar", relating to potential of extensive urban planning strategy being implemented through multi-model transportation facilities. The aim of these facilities is to collectively remodel traffic, eradicate the issues existing therein, design compacted transit villages which have mixed-uses, or "Transit Oriented Development". Hassen and Al-Dhaheri (2019) uncovered several projects which are enabling Qatar's transition to a knowledge-based economy, and identified smart transit, smart services, ICT-based infrastructure, sustainable city planning, and mega-projects for sustainable smart living such as Lusail as integral components of Qatar's future.

De Jong *et al.* (2019) explored S-Cit-Ps in the UAE and Qatar, and their potential to transform the country in the post-oil era. This research acknowledges that substantial steps have been taken by Qatar to automate its cities and increase the efficiency of governance and service provision through the use of ICT, led by a futuristic model of convenient living. The S-Cits of Lusail and Msheireb Downtown Doha in Qatar are proposed to be equipped with features like sustainable infrastructure, comprising of utility tunnels, recyclable waste management, gas networks, integrated road networks along with cycling routes, entertainment and residential islands, smart transportation and eco-friendly logistics, real-time insights on city services, green public transportation technologies, and other digitally enabled public services (Ooredoo, 2019; Whittaker, 2021).

The following subsections analyse literature on specific S-Cit-Ps in Qatar and compares them with the experiences of the UAE, followed by identification of the research gaps detected in previous studies related to the research topic that this thesis seeks to address.

2.13.2. Lusail Smart City

Lusail is Qatar's flagship S-Cit-P. It stretches for 38,000,000 square feet, and it is the largest sustainable real estate development of the country (Adalbi *et al.*, 2022). As one of the first S-Cit-Ps in the GCC, and the inaugural one for Qatar, the project has received a lot of attention from researchers. It remains a representation of Qatar's ambitions and potential to transform its economic model to a knowledge-based structure. Lusail has also been featured by several researchers covering case studies of S-Cits from all across the world. Adalbi *et al.* (2022) used Lusail's case study to explore the characteristics of S-Cit-Ps and the strategies that are implied in their development, and identified that the Lusail project was introduced in the momentum of the 2022 World Cup, whose hosting was a transformational experience for Qatar's government and people. Furthermore, it identified the real-life applications that this S-Cit-P is strategically contributing to the context of Qatar's current and future challenges.

In contrast, an earlier study by Asmyatullin *et al.* (2020) explored S-Cits in the GCC from an economic perspective, discussing metrics such as public expenditure on R&D, GDP growth, and national income etc., to determine the qualitative importance and effect of S-Cits such as Qatar's Lusail in the region. While the study did not address thought and design processes, being chiefly concerned with macroeconomic KPIs, it did identify that Lusail's salient features include a tangible focus on efficiency in public services. Moreover, mobile applications and digital certificates have a critical role to play in Lusail's infrastructure. The city features a uniform centralised cooling system across all buildings, and a smart pipe network channels waste directly to treatment plants outside the city, recycling wastewater for irrigation. The city is also characterised by automated projects for transport and other essential services. While the study did not address design thinking directly, the process clearly engaged in the development of Lusail Smart City is concerned with automation as a solution to service gaps.

The discussion of Tok *et al.* (2014) identified various features in Lusail related to living, mobility, environment and governance that are unique, and emphasised the important role of Lusail in national transformation. It was evident from the outset that the costs of the project would be staggering, with initial estimates of approximately \$45 billion over 19 different districts, with 22 hotels and pneumatic tubes for transportation well (Furlan *et al.*, 2018).

In this regard, Satyakrishna and Sagar (2018) reported that public transportation should be at the backbone of any S-Cit and needs to be powered by technology such as IoT to address issues such as auto collision prevention, vehicle blockage and vehicle discharge, among others. This view is also supported by Badii *et al.* (2018) who stated that smart transport is integrated with most S-Cit solutions which are based on the technological architecture consisting of IoT which is driven by big data, machine learning and data analytics, among others. This is also evident in the Lusail tramway transport, which has

been operational since January 2022, offering a multimodal and environmentally friendly transport system (Intelligent Transport, 2022).

2.13.3.Msheireb Downtown Doha

Msheireb Doha is another S-Cit-P example from Qatar, which is the world's first downtown smart regeneration project. It is located in the core of Doha city, and it is a modern and sustainable translation of the pre-existing commercial district with a new architectural language that is characterised by both contemporary features and the essence of Arab and Qatari culture (Al-Hammadi, 2022). The project is described to reverse the pattern of energy-intensive development in Qatar. Despite being a relatively small project both in terms of revenue, size, and scale, the Msheireb Downtown project has secured the interest of various researchers.

For example, Petruccioli *et al.* (2019) explored the case of Msheireb from a placemaking perspective, discussing the design and utilisation of spaces, and the steps taken toward urban conservation. Al-Hammadi (2022) discussed Msheireb from a sustainable tourism perspective, acknowledging that the processes and objectives followed in the Msheireb project are in-line with Qatar's sustainable development approach. The design thinking process of Msheireb was ascertained in early research by Law and Underwood (2012), who identified the importance of land ownership, privatisation, climate, social diversity, and cultural relevance as key components of the master plan for Msheireb Downtown Doha. The alternative approach to urban planning is characterised as one with due consideration to the regeneration of urban spaces to enable an enhanced experience.

Alfadala and Furlan (2018) discussed sustainable neighbourhoods in Qatar with the case study of Msheireb, to explore the practical forms of sustainable urbanism reflected by the development of this project. The research revealed that the project has enabled the Downtown to become more pedestrian-friendly, promoting a higher level of social interaction, and reflecting the use of a modern and sustainable urbanism design process. The overall livability of the downtown has been increased, as its development is designed around practical problem-solving, presenting a significant benefit of this project.

Elsayed (2019) also highlighted that the innovation and rethinking evident in Msheireb Downtown Doha enable maximum social interaction. In the design of the master plan for Msheireb, this research identifies the critical roles of "timelessness", "diversity and unity", "form and geometry", "aspect of home and street", and "designing for climate and environmental concerns". Consequently, the identity of Msheireb is preserved as an S-Cit which reflects Doha's socio-cultural identity and socio-economic objectives.

Sulaiti (2021) conducted primary research in Msheireb to quantitatively assay the effect of the S-Cit development of the city in its relationship to citizen's satisfaction, experience,

usage of services, and record the gaps and limitations that exist in these areas. However, it was revealed that while services were designed with specific objectives, their awareness amongst the citizens remained scarce. As a result, the services are not being used to their fullest extent. The Msheireb Downtown was established in six phases, with an accumulated construction cost of approximately \$5.5 billion (Khalil and Shaaban, 2012).

The S-Cit at Msheireb Downtown Doha is conceptualised to provide quality infrastructure, quality living, and enhanced economy to its citizens. It envisages smart solutions like smart cooling for buildings to counter the hot and humid climate, smart IoT-based air quality monitoring solutions, electric car charging stations, and smart transportation (among others), to develop intelligent, data-driven infrastructure in line with Qatar National Vision 2030 (Time Out, 2020). The development of infrastructure was entering into completion of the fourth phase by 2022 (Gulf Times, 2022). The final phase of the S-Cit involves development of residential blocks, commercial blocks, and retail units to meet the residential and business needs of the people. The features of the S-Cit-P include sustainable buildings, energy efficiency, indoor environment quality, and smart connectivity.

2.13.4. Comparison of S-Cit-Ps in Qatar and the UAE

Due to the similar nature of characteristics that GCC states share, including their shared efforts towards transforming to a sustainable knowledge-based economic structure in addition to their socio-cultural and geographical characteristics, researchers have conducted comparisons of S-Cit-Ps in these locations. The UAE in this regard remains predominant because of the high access to capital and knowledge capital that the country has. In comparison with Lusail and Msheireb Downtown, the UAE's Masdar City and Zayed Smart City Project are more mature (Samad, 2018). The former is a 6km², and aims to be one of the world's most sustainable urban communities. The city is characterised by public spaces, green spaces, and a business free trade activity environment (Samad, 2018). The city applies real world solutions for efficient energy and water usage, mobility, and waste disposal, and is characterised by mobility features that prioritise pedestrians. The city features significant R&D and recreation platforms.

Similarly, the Zayed Smart City Project, alternatively known as the "Abu Dhabi Smart City Pilot Project", aims to transform Abu Dhabi into an S-Cit enabled by IT and IOT (Saxena and Mansour, 2018). This project is based on a 5-year plan which seeks to initially transform the city's infrastructure and incorporate ICT applications to enable an enhanced experience. The specifics of this project are aimed at digitally transforming the social, financial, and environmental aspects of urban life (Awad *et al.*, 2017).

Therefore, it is observed that Lusail from Qatar and Masdar from UAE are similar projects, based on the development of a new city with digitised infrastructure and futuristic aims related to environment, sustainability, and community development. Conversely, the Zayed

Smart City Project is parallel in scale to the Msheireib Downtown project, both of which aim to recreate the traditional social, business, and communal spaces of Abu Dhabi and Doha respectively based on an S-Cit premise. *Analís et al.* (2014) conducted a comprehensive comparison of Lusail and Masdar, and observed that both cities were planned as a result of the countries' realisation of the finite and depleting natural resources. However, while UAE has maintained a distinct Arabic approach in Masdar's design, Lusail has explored an urbanistic and futuristic architectural and infrastructural approach.

Moreover, while Lusail is a reflection of strong urban development values, and sets a precedent for sustainable development in the future, Masdar is optimised to reflect energy efficiency and renewable energy usage as opposed to fossil fuels. However, some challenges are recognised in both cases. Lusail is limited by its dependency on foreign knowledge capital and hiring levels may remain limited (*Littlewood et al.*, 2018). Furthermore, Masdar faces the challenge of egregiously harsh desert conditions, and the efficiency of the deployed technology in the particular environmental context (*Randeree and Ahmed*, 2019). Moreover, Lusail remains an expensive project with extremely high living costs, while Masdar is a more affordable project.

Comparing the Zayed Smart City Project and Msheireb Downtown, several distinct characteristics can be observed for both projects. For example, Msheireb Downtown implies an innovative regeneration of design, while the Zayed Smart City Project is less focused on design and is more focused on utility. Msheireb is also focused on providing its citizens a strong sense of community through the prevalence of public spaces and public interaction opportunities, while Zayed Smart City Project is focused on maintaining energy-efficient systems to make living more sustainable. The major findings from this discussion are summarised in Table 2.4.

Table 2.4: Comparison of GCC S-Cits

	City Development		Re-Development	
	Lusail	Masdar	Msheireb	Zyed Smart City
Country	Qatar	UAE	Qatar	UAE
Launching	2008	2006	2010	2019
Completion	2020	2025	2020	2030
Description	Sustainable urban setting with high-tech infrastructure focusing on efficiency	Sustainable urban setting with focus on environment and sustainability	Development of downtown in Qatar based on superior design and life	Development of Abu Dhabi based on technological incorporation in the
Project cost (USD)	\$45 billion	\$22 billion	\$5.5 billion	\$0.9 billion
Vision	Showcase for urban development, especially in the context of the FIFA	The use of sustainable energy options	Re-develop Doha by decreasing environmental impact and	Re-develop Abu-Dhabi through automation Energy efficiency
Target Segment	Citizens Investors	Citizens Investors	Citizens	Citizens
Competitive Advantage	Integration with Qatar National Vision 2030	Carbon-neutral Zero waste	Integration to Qatar National Vision 2030	Digital transformation of Abu-Dhabi
Challenges	Economic challenges (high-cost) Increasing population Infrastructure differences from the rest of the city	Transferring from natural resources to zero carbon economy Harsh desert conditions Rapid ICT changes	Infrastructure differences from rest of the city Rapid ICT changes	Transferring from natural resources to zero carbon economy Rapid ICT changes
Role of Government	Embodiment of Qatar National Vision 2030 Economic diversification Adoption of renewable energy sources in sustainable development Supporting public-private partnerships (PPPs) and joint ventures	The state has the primary role; power lies with ruling families, who control oil and gas resources The government is diversifying the investment portfolio Supplementary role of the government to invite investors	Embodiment of Qatar National Vision 2030 Creating a model for sustainable development and futuristic communities Economic diversification, reversing the pattern of energy-	The state has the primary role; power lies with ruling families, who control oil and gas resources The state aims to improve smart governance

Source: Ahmed (2018), Ahouzi *et al.* (2020), Alfadala and Furlan (2018), Alzaabi *et al.* (2017), Furlan *et al.* (2019), Hartman *et al.* (2010), Khalil and Shaaban (2012), Mahgoub (2015), Meza *et al.* (2019), Mezher and Park (2012), Riszo (2016), Sankaran and Chopra (2020)

2.14. Research Gaps

This review of related literature has revealed several significant gaps. In the exploration of the elements that construct an effective framework for design thinking, it is recognised that a theoretical framework that universally clarifies the constituents of S-Cits remains absent. Research that attempts to explain the concept mainly adopts a public-policy approach. Even though several characteristics of S-Cits are identified through this approach, there are no prominent discourses that deconstruct the characteristics of S-Cits in light of the problems that they attempt to solve. The limited perspective offered by previous literature has left a gap for theoretical discussions of S-Cit models and projects in light of the various environment, resource-management, life quality, and sustainability issues.

In addition, existing models of S-Cits lack empirical justification in real-world application contexts. Moreover, the discussion of design thinking in its relevance to contemporary S-Cit-Ps is limited. While a relationship is established based on the theoretical relevance of the two concepts, presenting case-specific examples could allow this relationship to be explored more comprehensively. That is why the present research seeks to deconstruct the design thinking principles with relevance to Qatar's S-Cit-Ps. Similarly, it is observed that the discussion of Qatar's S-Cit initiatives is critically limited. While there are several studies expanding the scope of Qatar National Vision 2030, discussions on S-Cit-Ps remain scarce.

The studies that do address the case of Lusail obtain a socio-economic and socio-political perspective, which does not address the core S-Cit concept that has driven the project. Similarly, while researchers have identified unique features of Msheireb in terms of livability, they have not investigated the processes that have enabled this living. Qatar presents a distinct case of S-Cit initiatives not only due to its historically unique socio-cultural contexts that it shares with other GCC states, but due to the success that the country has sustained in its economic remodelling so far. Therefore, the proposed research addresses several gaps in the presently available literature.

There have been few studies conducted with the focus on conceptualising and creating S-Cits. Yin *et al.* (2015) conducted a literature review of S-Cits and emphasised on the data-centric view of S-Cit architectures, whereas Silva, Khan and Han (2018) conducted a review of the trends, architectures and components of S-Cits, although it deals at a generic level. A more precise approach was provided by Achmad, Nugroho and Djunaedi (2018) who used the "Smart City Readiness Framework" provided by the "Smart City Council" to assess the technology enablers and responsibilities of the authorities to conceptualise and create an S-Cit-Eco. However, there is a research gap on the holistic approach to dealing with the intractable problems faced in the urban infrastructure and citizen centric services. Furthermore, the research gap exists with respect to the creation of an S-Cit-Eco in Qatar. This study aims to address the research gap by applying a design thinking framework to

develop a common user-centred understanding of the challenges and potential scenarios for cities aiming for “smartness” in the context of Qatar.

2.15. Chapter Summary

This chapter has reviewed relevant literature concerning S-Cit theoretical and practical development, encompassing related supporting and inhibiting factors, and specifying the profile of Qatar relative to global and local (GCC) contexts, identifying the research gaps addressed by this study. The following chapter expounds the research methodology used to achieve the study aim and objectives.

3.

Research Methodology

3.1. Introduction

In order to achieve the research aim and objectives (section 1.3), the methodology (and methodological choices) explained in this chapter were adopted. The following sections explain the research philosophy and the rationale for the methodological choices made. Based on the conceptualisation of methodology presented in section 3.2, and the subsequent theoretical underpinnings expounded in sections 3.3-3.5, this study applies a mixed-method approach. The details of the methods used are explained in sections 3.6-3.10 (followed by ethical considerations, in section 3.11). The time horizon for the empirical methods is also described, followed by data collection and analysis techniques (e.g., the sampling strategy). The design evaluation procedures are described, along with techniques for ensuring validity and reliability. Finally, the ethical considerations governing this research are presented (i.e., concerning informed consent, voluntary participation, data confidentiality, avoidance of harm, and participant confidentiality).

Due to the conceptual complexity of the wings of this research (including three empirical ones), an overview of the actual methods can offer readers a primer before turning to the underlying methodology. A brief conceptual visualisation of the methods undertaken in this research as a whole is shown in Figure 3.1.

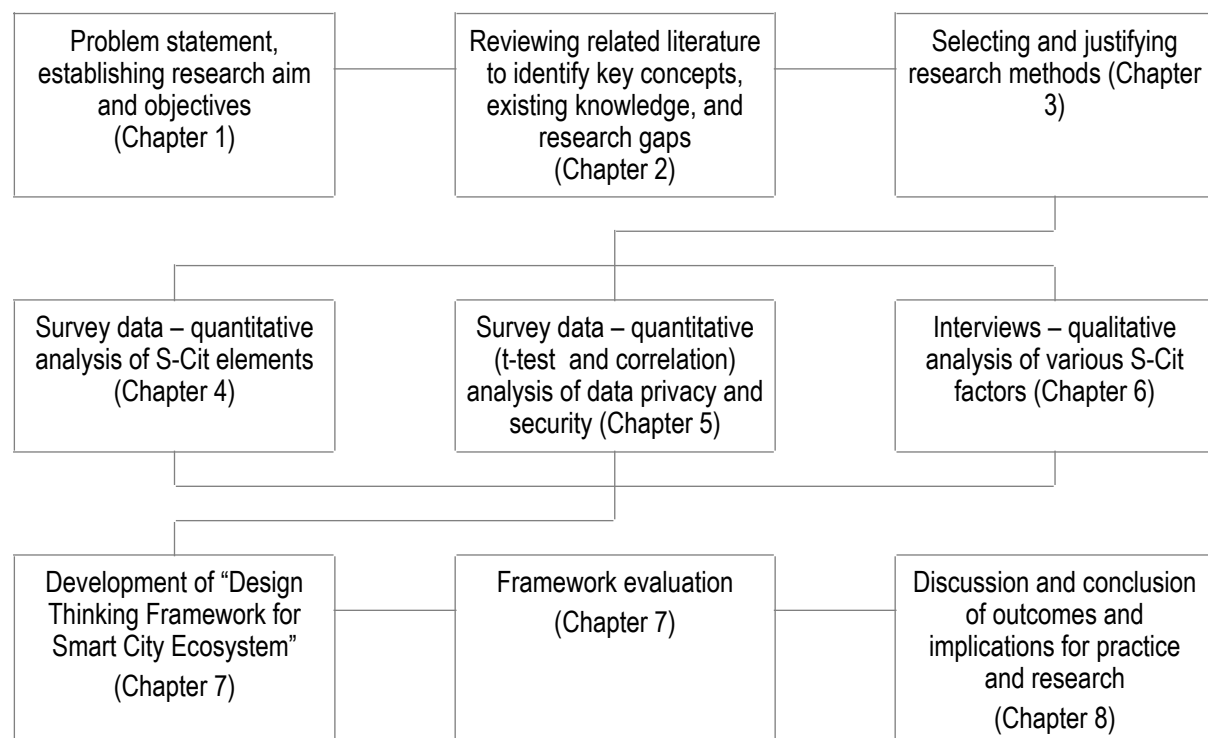


Figure 3.1: Phases of research approach and chapters reporting key tasks

Source: Author

3.2. Research Philosophy

There are lively academic debates about the philosophical basis and implications of various research methodologies, and every individual empirical study must account for its methodological assumptions and choices (Mackenzie and Knipe, 2006; Wahyuni, 2012). All experts in social studies agree that methodological choices *per se* are fundamentally important, but there are wide-ranging possibilities and options for what methodologies and methods might be the most appropriate on a case-by-case basis. While there is a broad categorisation of methodology in terms of positivism and interpretivism (Bell *et al.*, 2022), there is a need to delve into a logical progression, which can guide the researchers towards data collection and data analysis to generate meaningful insights.

In this regard, the “research onion” framework developed by Saunders, Lewis and Thornhill (2016) offers a step-by-step approach of methodology (Figure 3.2), shaping the research methods and guiding the data collection and analysis processes. The research onion framework has gained considerable acceptance in the academic community, primarily due to its simplicity and logical coherence to methodology development with justifiable research design. The framework comprises six layers which guide the study towards achieving the research objectives and answering the research questions, including the “research philosophy, research approach, research strategy, methodological choices, time horizon, and data collection and analysis techniques” (Saunders, Lewis and Thornhill, 2016).

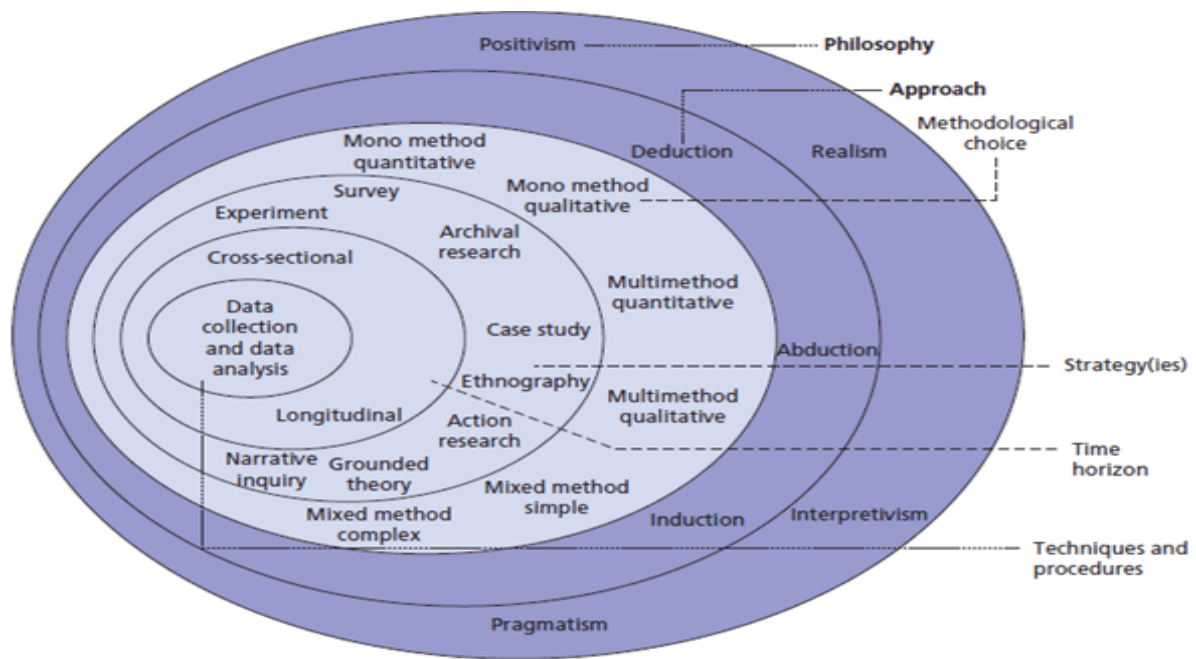


Figure 3.2: Research onion

Source: Saunders, Lewis and Thornhill (2016)

The research philosophy presents the overarching framework which lays down the foundation for the research; it is the outermost layer of the research onion, and deals with the philosophical assumptions which lead to interpretation of the research findings. The three main philosophical assumptions include ontology, epistemology, and axiology. The ontological assumptions refer to the belief regarding the understanding of the world with respect to what exists, how they exist and the relationship between the things (Dinsmore, 2017). The ontological assumptions form the basis for methodologies for various disciplines. On the other hand, epistemological assumptions pertain to the nature and beliefs and principles regarding the nature and scope of the knowledge and how the knowledge is acquired and validated (Saunders, Lewis and Thornhill, 2016). Hence, the epistemological paradigm explores subjective aspects of knowledge and the sources of knowledge. Finally, the axiological assumptions relate to the ethics and values of the knowledge and what can be considered as meaningful knowledge (Killam, 2013).

In line with the above assumptions, the research onion outlines two main research paradigms which have dominated academic research over the last century: positivism and interpretivism (Aliyu *et al.*, 2014). The positivist paradigm adopts an objective approach to investigate research phenomena, typically using numerical data, while the interpretivism paradigm uses a subjective approach to study more complex and subjective research phenomena. The third paradigm is pragmatism, which approaches the research from a practical point of view whereby knowledge undergoes evolution and is constantly questioned and interpreted relative to achieving practical ends (Morgan, 2014). While pragmatism involves subjectivity and researcher involvement to delve into the research phenomenon, it can also be used to investigate objective findings. Hence, pragmatism is not bound by any specific philosophy *per se*.

In the context of this study, pragmatism was found to be the most appropriate paradigm to interpret the S-Cit-Adn, as it is associated with real-life problem-solving, rendering it less doctrinaire and abstract than alternative paradigms preoccupied with describing reality. Hence, pragmatism offers an overarching paradigm wherein the thesis can incorporate the evolving knowledge to generate useful insights on S-Cit-Adn, and help in understanding the real-world challenges in the particular case of Qatar. Considering these aspects, pragmatism was considered best suited to study the multi-layered and complex phenomenon of design thinking based S-Cit-Adn to investigate the influence of different elements of S-Cit on the acceptance of S-Cits by citizens.

3.3. Research Approach

According to Saunders, Lewis and Thornhill (2016), the research approach can be deductive, inductive or abductive. A deductive approach is derived from the positivist paradigm and adopts a “top down” method wherein the study investigates a specific

observation from available theories (Hyde, 2000). On the other hand, an inductive paradigm adopts a “bottom up” approach wherein there is limited knowledge related to the research area and the study proceeds from specific observations to generating theories. The abductive approach implies a combination of theoretically grounded deductive research and inductive observations allowing the development of new conceptual frameworks and theories (Saunders, Lewis and Thornhill, 2016).

In the context of this research, the abductive approach has been chosen, primarily, due to its inherent characteristic of overcoming the limitations of inductive and deductive approach. This approach is based on the pragmatism research paradigm wherein the study starts the research process with “interesting observations” and proceeds to provide explanation for these observations (Saunders, Lewis and Thornhill, 2016). This approach appropriate for mixed research methods (i.e., qualitative and quantitative), which was used to explain the research phenomenon which comprises of investigation of the influence of different elements of S-Cits on the S-Cit-Adn, while exploring unknown areas and contributing to the development of novel academic and practitioners’ knowledge. Hence, the abductive approach was found to be best suited to complement the pragmatist paradigm for exploring the research problem related to design thinking in the context of S-Cits in Qatar.

3.4. Research Strategy

The different research strategies that are proposed in the research onion framework are experimental research, action research, case study research, grounded theory, ethnographic studies, survey research, and archival research (Saunders, Lewis and Thornhill, 2016). Among these choices, case study strategy involving the study of S-Cits in Qatar has the potential to facilitate the study in meeting the research objectives. This research strategy has the strength that it allows for a detailed investigation of the focal research phenomenon in real-life settings (Yin, 2018). Considering this aspect, the case study of S-Cits in Qatar will help the thesis to delve into the different elements of S-Cits which facilitate or inhibit S-Cit-Adn by citizens. Hence a case study strategy based on the case of S-Cits in Qatar was selected to leverage the potential to provide a systematic approach to the study and generate robust research findings.

3.5. Methodological Choices

This layer in the research onion framework highlights the different data types that can be used in the study: mono-, multi-, and mixed-methods (Saunders, Lewis and Thornhill, 2016). In a mono-method, the study uses only a single data type which can be either qualitative or quantitative. In a mixed-methods approach, the research uses both qualitative and quantitative data types, although the findings are derived from either of the research paradigms. Finally, a multi-method approach involves the use of a wider range of

approaches involving qualitative and quantitative data types and the findings are also presented using multiple paradigms.

Among the three methodological choices, mixed-methods was deemed to be the most suitable for this research. This was primarily due to the ease of integrating qualitative and quantitative data type and using the pragmatist paradigm. Moreover, the use of mixed methods research using pragmatism eliminates the dilemma of selecting an appropriate paradigm, considering that the thesis is primarily concerned about generating new knowledge while also conducting objective investigations in parallel (Doyle *et al.*, 2009). In the context of this study, mixed methods have the potential to provide robust findings by investigating the influence of different elements of S-Cits on the S-Cit-Adn by citizens, both from subjective exploration as well as objective investigation. Hence, a mixed methods approach was best suited to achieve the research objectives.

3.6. Time Horizon

The research onion outlines using either of the two time horizons for a research project: longitudinal or cross-sectional. A longitudinal time horizon is used to collect data over a longer duration from the same sample in order to observe changes and arrive at research findings. On the other hand, in a cross-sectional time horizon, the data is collected at a single point of time. For the current study, a cross-sectional time horizon was suited considering the time constraints for conducting the research. The cross-sectional time horizon facilitated collection of both qualitative and quantitative data which will be used to conduct analysis as per the defined objectives.

3.7. Data Collection and Analysis Strategy

This layer of research onion highlights the data collection techniques and the data analysis techniques to be adopted. It is imperative that these steps are aligned with the other layers of research onion in order to generate meaningful results.

In this study, primary data was collected through qualitative and quantitative data collection methods. The quantitative data was gathered through a survey questionnaire to capture specific aspects of S-Cit living, as well as the readiness of the Qatari citizens to adopt S-Cits. The sample for the survey research comprised two categories of Qatari residents – those who have prior experience of living in S-Cits and secondly, those who are aware of S-Cits but have no prior experience of living in S-Cits. The collected primary quantitative data was analysed using SPSS (v. 30). The performed statistical tests of the survey data allowed generating findings which helped the thesis to achieve the research aims and objectives.

In addition to this, two qualitative data collection techniques were employed in this research. First, semi-structured interviews were employed to evaluate project managers' design

thinking skills. The intended data collection method related to this research objective was semi-structured interviews with project managers who can provide detailed insights into the research topic. The second technique employed for the collection of qualitative primary data was focus group discussions with key stakeholders. This component of the research was designed to evaluate the developed framework and draw a conclusion and recommendations for effective adoption of design thinking practices in S-Cits projects in the specific case of Qatar. The qualitative data in the form of semi-structured interviews and focus group discussions was analysed using thematic analysis to look for meaningful patterns across the data.

3.8. Sampling Techniques and Sample Size

Sampling is the process of selecting a subset of a researched population that meets the characteristics of the net population, so that the observations can be recorded from this subset, as it is generally not possible to include the entire population in the research (Thompson, 2012). The main goal of sampling is to make inferences about the population based on the characteristics of the sample. Sampling is divided into two main categories – probability and non-probability sampling.

In probability sampling, a random selection method is used wherein every member of the population has an equal chance of being selected in the sample (Etikan and Bala, 2017). While this sampling technique is more time consuming and expensive, it has the benefit that the sample is guaranteed to be representative of the larger population. The different probability sampling techniques include simple random sampling, stratified sampling, and systematic sampling (Sharma, 2017).

On the other hand, non-probability sampling involves selection of participants based on certain characteristics, rather than going for a random selection. This type of sampling technique is used when the research wants to include participants who possess specific characteristics for providing inputs for the study. The different types of non-probability sampling include convenience sampling, purposive sampling, snowball sampling, and quota sampling.

Among the above different sampling techniques, purposive sampling technique was chosen for the current study. The specific characteristics of participants for inclusion in the data collection using survey questionnaires is that they have lived in S-Cits. This criterion was selected so that there was a targeted representation of the participants who had appropriate experience and background knowledge of the S-Cit-Eco. Furthermore, the cost effectiveness of the survey questionnaire also ensured that the research was able to reach out to a large number of participants and ensure validity and reliability in the study.

For the focus group discussions, the participants were selected based on their prior experience of either implementation of S-Cits or involved in governance or other aspects of S-Cits, so that the response provided is relevant while it also ensures that rich and detailed information pertaining to the design thinking approach of S-Cits can be explored. Hence, it was anticipated that the research would uncover new insights related to the design thinking approach of S-Cits, and thereby contribute to the academic knowledge as well as practical application related to the S-Cit-Eco.

For the first quantitative survey questionnaire on the framework for effective implementation of S-Cits, data was collected from 40 participants with S-Cit experience in Qatar. Data on data privacy and secure concerns and readiness to adopt S-Cits was collected from 120 Qatar citizens and 35 experts, with experience working in S-Cits projects. A key consideration when selecting the number of participants for the qualitative interviews was data saturation. Francis *et al.* (2010) pointed out that saturation happens when the study has collected sufficient data and no amount of additional interviewees or participants will lead to fresh insight, and noted that in qualitative studies, this typically occurs with 12-14 participants. Therefore, in this study, the number of participants for qualitative interviews and focused group discussions for design evaluation was fixed at 12, with the potential to recruit more participants if necessary (although 12 proved adequate during the study process, as presented in Chapter 6).

3.9. Design Evaluation

Design evaluation involves the assessment of the appropriateness of the chosen research design so that they can meet the objectives of the research. Currently, there are concerns regarding security aspects of S-Cits. Design thinking methodology will be used to design an S-Cit model and apply the TAM to increase its acceptability. The prototype will be designed using S-Cits kits like (SMARTHON Smart City IoT Starter Kit), the evaluation of the prototype will be through the TAM, which is widely used in the field of information systems and technology management to explain and evaluate user acceptance of new technologies (Surendran, 2012).

Firstly, qualitative assessments were conducted through surveys, interviews, and focus groups involving stakeholders such as residents, government officials, businesses, and experts. Qualitative feedback considered aspects such as “user satisfaction”, “ease of use”, “perception of innovation”, and “alignment with strategic objectives”, providing valuable insights into the design’s perceived value and usability.

Second, a comparative analysis was undertaken to compare the new design with existing solutions or alternative designs. Benchmarks and industry standards were used to assess the design’s competitiveness, advantages, and areas for improvement, informing decision-

making regarding design enhancements and refinements. The technical evaluation assessed the design's compatibility with existing infrastructure, scalability for future growth, security measures, data privacy compliance, and integration capabilities with other S-Cit components. Technical experts contributed their insights and recommendations to ensure the design meets technical requirements and standards.

Third, domain experts and professionals in relevant fields, such as urban planning, technology, and sustainability, were engaged for an expert review of the design. Their perspectives on feasibility, innovation potential, risk assessment, and alignment with industry best practices enriched the evaluation process and contribute to refining the design iteratively.

Finally, the findings of the design evaluation were presented and communicated in a clear and compelling manner to stakeholders, decision-makers, and project collaborators. Visuals, charts, and narratives were used to convey key insights, recommendations, and the value proposition of the new design for advancing S-Cits projects in Qatar.

The theory of change was then used to develop a framework based on informal relationships, facilitating change as the deployment of S-Cits requires collaboration among different stakeholders from various organisations. Finally, a log frame was constructed to foster deployment of S-Cits in Qatar, easily understood by different stakeholders (Figure 3.3).

Input/Activities

Understanding the privacy and security concerns of people living in smart cities and the readiness of citizens to live in them.

Outputs

Framework to foster the deployment of smart cities in Qatar

Outcome

Practical guide to stakeholders and policy makers

Impact

Better Success for Smart City Projects

Figure 3.3: S-Cits log frame

Source: Author

3.10. Validity and Reliability

Validity and reliability are two important parameters which need to be addressed when collecting and analysing quantitative data. Validity refers to the extent of accuracy of measurement of the parameters that were defined by the research and the extent to which it reflects the phenomena being studied (Roberts and Priest, 2006). In essence, it reflects the extent to which the results really measured what they were supposed to measure. One of the key characteristics of validity is that the results should be reproducible (Lakshmi and Mohideen, 2013). The assessment of the validity is also measured by how well the results are consistent with existing theories.

On the other hand, reliability refers to the consistency and stability in the research results (Mohamad *et al.*, 2015). It essentially measures the extent to which the results can be reproduced when the test is repeated under the same conditions. This consistency is assessed across time intervals and different parts of the test.

In the context of this study, the validity and reliability of the test results were assured by following quantitative data analysis of the survey questionnaire and measuring the constructs which are derived from the extant literature. Initially, a pilot study was conducted wherein few challenges were faced, such as incomplete responses, and the lack of proper information for the participants regarding the survey questionnaire. This was rectified in the final questionnaire, wherein the thesis included a brief description of the scope of the study and the expectation of the participants. Moreover, all the questions were made mandatory in the Google Form, so that required responses were completely captured in the study by default.

3.11. Ethical Considerations

Ethical considerations are inherent to the research process and guide the research to pursue the research in a moral and in ethical manner. This thesis received approval from Brunel University. The researchers followed the key ethical principles which include informed consent, voluntary participation, confidentiality of data, avoidance of harm, and privacy of participants.

3.11.1. Informed Consent

Informed consent refers to seeking consent of the participants after providing them with a comprehensive overview of the scope of the study (Behrend *et al.*, 2011). Providing information to the participants is essential, so that they can assess the procedures involved in the study, and potential risks, if any. In the context of this study, informed consent was sought from different participants, i.e., citizens and project managers, before recruiting them for the study. The participants were sensitised with respect to the different aspects of the

study to ensure that they could understand the purpose, scope and risks associated with the study. Once the participants understood the scope of the study, their consent was sought for participating in the survey questionnaire and focus group discussions for providing primary data in the study.

3.11.2.Voluntary Participation

Voluntary participation refers to the ethical principle that the participant is not coerced for participating in the study (Robinson, 2014). It refers to the free will of participants to decide on whether to participate in the research or not. In the context of the current study, the research gave full freedom to the participants to accept or decline the participation for providing primary data. The participants also had the option to withdraw at any point of the research. Therefore, the ethical principle of voluntary participation was completely honoured in the context of the current study.

3.11.3.Data Confidentiality

In any research, it is important to maintain the confidentiality of the data collected by the participants. Therefore, the ethical principle of confidentiality becomes one of the topmost priorities for researchers to carry out the research in a moral and ethical way. This principle was addressed in the current study by ensuring that the data from the participants is access protected and the data is kept confidential till the conclusion of the research, post which the data were deleted. The research ensured that the data is not shared with anybody, either for commercial benefits or otherwise.

3.11.4.Avoidance of Harm

In any research, the researcher must ensure that there is no harm to the participants due to their involvement in the research, whether physical or mental. To avoid any such harm, the researcher must assess and mitigate the risks to the participants throughout the research process (Traianou, 2014). In the context of the current study, the principle of avoidance of harm was addressed by avoiding physical interaction with the participants to the maximum extent. For this purpose, the research collected data through a survey questionnaire which was sent as an online link to the participants. However, the interaction with the participants could not be totally avoided, considering that the focus of discussion required a certain amount of interaction with the participants for data collection. Therefore, the ethical principle of avoidance of harm to the participants was addressed to a great extent.

3.11.5.Participant Confidentiality

The privacy of participants and the confidentiality of their personal data refers to the ethical principle concerning the concealment of the personal identity of participants and any sensitive data pertaining to them during the data collection, storage, and reporting processes (Fouka and Mantzorou, 2011). In any research, the researcher should take care that any

unnecessary or personally identifying sensitive data is not collected, except where necessary and will fully informed and voluntary participant consent, otherwise they would be violating the principle of privacy.

In the context of the current research, the researcher collected basic demographic data and inputs related to the research specific questions. Hence, the survey questionnaire did not include any data which can violate the privacy of the participants, or personally identify them. Similar characteristics prevailed when collecting qualitative data through focus group discussions, wherein only basic demographic characteristics of the participants were recorded, and the participants were also instructed to neither reveal any personal and sensitive data about themselves, nor ask any such questions during the exercise of focus group discussion. Hence, the ethical issue of privacy of the participants was addressed to the maximum extent.

In addition to the above ethical issues identified for the research, the research also ensured that the basic principles of academic integrity such as giving credit where it is due and avoiding plagiarism in any form are adequately addressed. Finally, the researcher has sought regular feedback from the supervisor to ensure proper progression, as well as adhere to the University guidelines for completion of the doctorate program.

Hence, considering the above, the researcher has identified the appropriate ethical issues and has presented the steps to address the ethical issues.

3.12. Chapter Summary

This chapter presented and justified the research methodology that guided data collection and subsequent analysis in this research, contextualised in relation to the research onion methodology, which provides a structured approach to navigating the different stages of research and selecting the most appropriate choices which can help in achieving the research aim and objectives. The thesis also highlighted the most appropriate sampling technique along with proper justification for the choice. Finally, ethical issues related to the study have also been identified and the steps to be taken to address the potential ethical issues have been explained. In the next chapter, the thesis presents the qualitative data collected from the participants through interviews and focus group discussions and carries out data analysis using qualitative techniques.

4.

Citizen Readiness for Smart City Adoption in Qatar

Nowadays, S-Cits are becoming increasingly popular in a wide range of socio-cultural settings. As such, the research problem associated with the various dimensions of S-Cit-Ps is increasingly becoming an area of study interest for most academic researchers and practitioners. Research shows that technologies like mobile-based services, analytics, and the IoT, can enhance the QoL of citizens throughout their daily lives (Suzuki, 2017; Syed *et al.*, 2021). Building on the underlying research methodology explained in the previous chapter, this chapter presents the specific methodological framework designed to assess citizens' willingness to embrace the various components of S-Cits in the studied context of Qatar, and analyses the results of the quantitative survey applied to key stakeholders.

4.1. Methodology

This study employed a survey approach to establish participant experiences, opinions and attitudes towards S-Cit-Ecos. The aim of collecting data was to build evidence that could be used in developing a design thinking framework that will accelerate the S-Cit-Adn in Qatar. Primary data was collected using an online Google Forms questionnaire shared via Qatari social media groups. The participants included individuals interested in smart living and S-Cits. The survey questionnaire was divided into demographic details and research-relevant questions. The latter are categorised into parameters of economy, people, governance, mobility, environment, and living S-Cit opinions, as well as people's willingness to accept S-Cits and their general perceptions of such developments.

Despite technical challenges associated with online data collection, this method was chosen for its flexibility, cost-effectiveness, and speed of administration (Andrade, 2020). Following Giffinger and Gudrun's (2010) proposal, the survey was divided into seven sections:

- Smart Economy (8 items)
- Smart People (5 items)
- Smart Governance (4 items)
- Smart Mobility (7 items)
- Smart Environment (5 items)
- Smart Living (10 items)
- Citizen Readiness (10 items)

This chapter focuses on various aspects of S-Cits, from competitiveness and social capital to governance quality and natural resource management. Internal consistency was assessed using Cronbach's alpha coefficient (Bonett and Wright, 2014), showing good consistency across all scales.

The study adopted a non-probability, purposive sampling approach, due to the specialised knowledge required for the topic. While this approach does not allow for generalisations to the entire population, it serves the research purpose by being flexible and relatively easy to implement (Etikan *et al.*, 2015). Inclusion criteria for participants were age 18 or above, interest in participation, and internet accessibility. 75 potential participants were randomly contacted from the social media groups, with 40 successfully completing the survey, resulting in a 53% response rate.

4.2. Sample Demographics

This information is presented in Table 4.1. It shows that the majority of participants were male (65%), married (67%), and had never lived in an S-Cit (63%). All of the latter (100%) were currently living in an S-Cit, and 47% had done so for 1-3 years (the remaining 53% of S-Cit residents had lived in an S-Cit for less than a year). The largest cohort were aged 26-34 (35%), followed by similar proportions aged 35-45 (25%), over 45 (22%), and 18-25 (18%). Most (60%) lived in households with over three inhabitants, while a quarter (25%) lived in two-person households; it can be speculated that the latter may comprise young married couples (given the ancillary data; 67% of participants were married, while 30% had no children in the home), although this was not asked in relation to this question. Only 5% specified three household members, while 10% of participant lived alone. The largest cohort (37%) lived in homes with one child, while almost a quarter (23%) specified two children. The same lower proportions lived in homes with three or more than three children (5% each).

Table 4.1: Participants' socio-demographic characteristics

Demographic Characteristics	Options	Frequency	% Response
Gender	Male	26	65%
	Female	14	35%
	Prefer Not to Share	0	0%
Age	18–25	7	18%
	26–34	14	35%
	35–45	10	25%
	More than 45	9	22%
Marital Status	Single	9	23%
	Married	27	67%
	Divorced	2	5%
	Other	2	5%
How many people live in the household?	1	4	10%
	2	10	25%
	3	2	5%
	More 3	24	60%
How many children live in the household?	0	12	30%
	1	15	37%
	2	9	23%
	3	2	5%
	More than 3	2	5%
Have you ever lived in a smart city?	Yes	15	37%
	No	25	63%
How Long have you lived in a smart city?	Less than 1 year	8	53%
	1–3 years	7	47%
Do you currently live in a smart city?	Yes	11	100%
	No	0	-

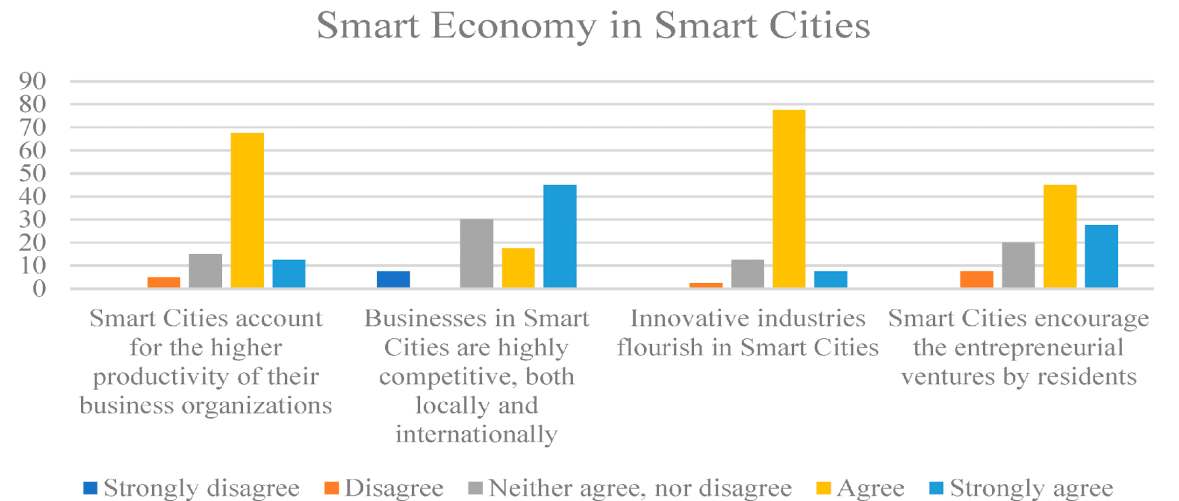
Source: Author

4.3. Survey Analysis

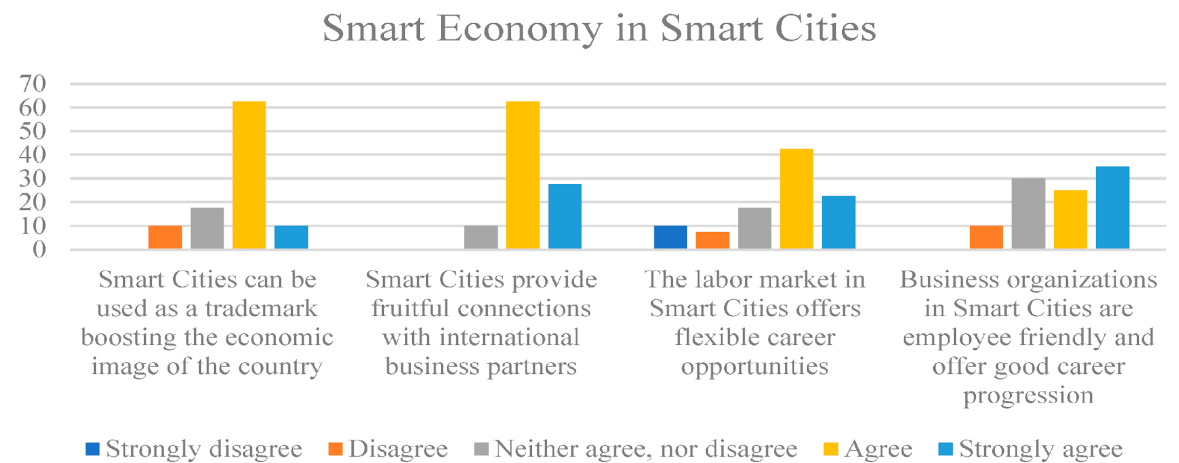
As described in section 3.7, this study triangulates primary data was collected through qualitative and quantitative data collection methods, linked with existent literature reviewed in Chapter 2. The quantitative survey (based on themes identified from reviewed literature) explored S-Cit living and Qatari citizens' readiness to adopt S-Cits, including participants with and without S-Cit residential experience. Based on analysis using SPSS, statistical testing generated quantitative findings that formed a springboard for the in-depth qualitative data collection techniques (semi-structured interviews to evaluate project managers' design thinking skills and focus group discussions with key S-Cit stakeholders), as expounded in the following chapters.

4.3.1.Smart Economy

Obtained responses regarding smart economy offerings in S-Cits comprise acknowledgement of elevated productivity, innovative industries, entrepreneurship, boosted economic image, and facilitated networking with business partners as shown in Figure 4.1. According to the responses obtained in the survey, increased productivity is considered by the majority of the research participants in relation to S-Cits, as agreed by 67.5% of the participants. S-Cits, based on 77.5% of the respondents, are perceived as potential areas where innovative industries can grow. A proportion of 62.5% of the subjects believe in the usage of S-Cits as trademarks presenting a better connection to international partners. Thus, S-Cits are attributed to the fundamental components of efficient international trade. However, albeit respondents scored high on the positive end of the scale, 30% were indecisive as to the competitive advantage on the local and international level of businesses being run in S-Cits. According to the study subjects, 30% of them are still sceptical about better business organisation treatment within S-Cits and employment opportunities offered. The findings prove that while S-Cits are considered to be positive environments for running businesses, these positive impacts are not necessarily reflected uniformly across the entire chain of stakeholders.



(a)



(b)

Figure 4.1: Smart economy in S-Cits (% frequency distribution)

Source: Author

4.3.2.Smart People

Smart “people” are individuals or communities in urban settings who actively contribute to innovation, collaboration, and decision-making processes to improve their city (Allam and Dhunny, 2019). They are characterised by high levels of education, creativity, adaptability, and civic engagement, often leveraging digital tools and platforms to participate in shaping their environment. The findings obtained from the research participants support the affirmation that smart people are an important foundation of S-Cits in Qatar. Figure 4.2 shows responses as a percentage over the five aspects of the smart people scale—opportunity for qualification upgrading, lifelong education, diversification, openness, and the potential of S-Cits to help empower the creativity of citizens.

According to the responses obtained from the participants, the majority of the respondents support the statement that S-Cits provide assistance to improve the qualifications of their residents as well as provide lifelong education chances. Respondents' positive perceptions of the openness of S-Cit residents are shown by 78% of the participants who agreed with the statement. In addition, nearly more than half (55%) have a very strong positive attitude towards diversity as one of the defining features of smart people in S-Cits. Nevertheless, the neutral perception concerning the possibility of S-Cits to boost creative thinking amongst citizens is fascinating.

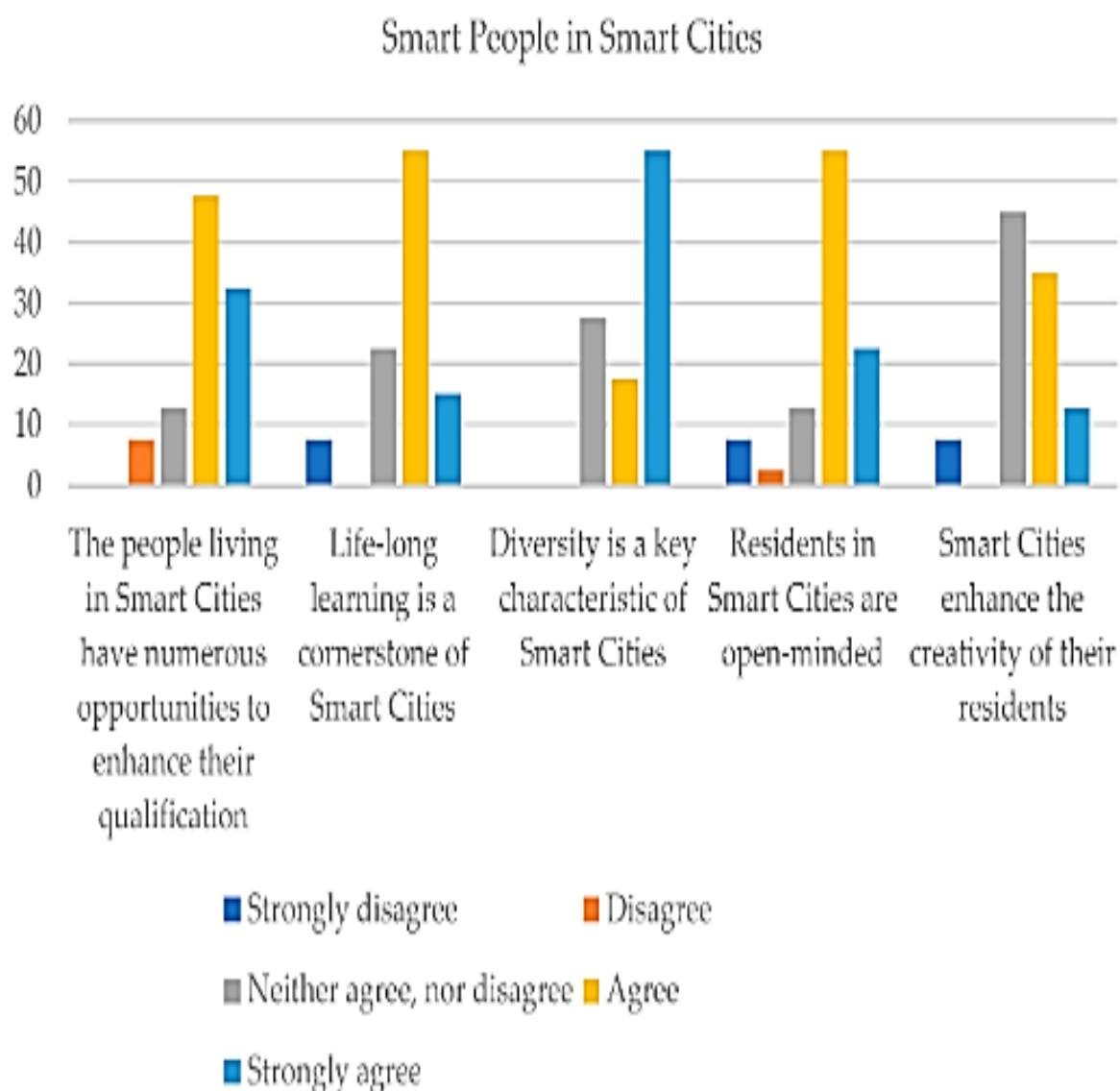


*Figure 4.2: Frequency distribution (%) of “smart people” in S-Cits
(opportunities for life-long learning, diversity, open mindedness, creativity)*

Source: Author

4.3.3.Smart Governance

The distribution of the research participants in percentage (%) by the investigated aspects of smart governance—effective governing methods, unbiased policies, fairness among the residents, and enhanced engagement of citizens and the government is shown in Figure 4.3. The response analysis of the research participants shows that governance is one of the significant components of the S-Cit environment. Altogether, respondents' answers suggest that the majority finds that due to S-Cit governance, regulatory mechanisms are useful. However, the sentiment analysis points out that the respondents' perceptions are almost neutral on the capacity of S-Cits to deliver policies that support equity or enhance engagement between citizens and the government.

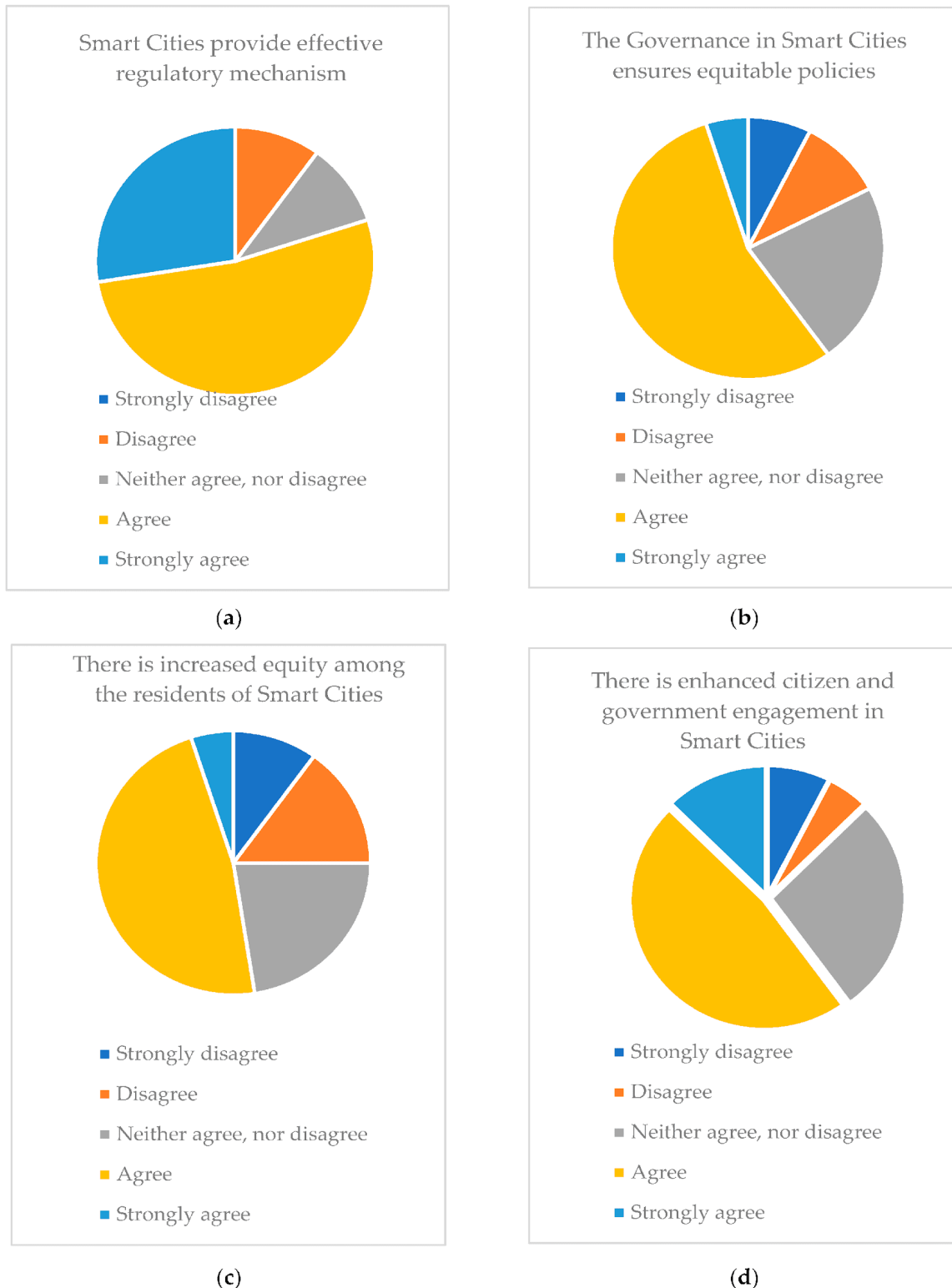
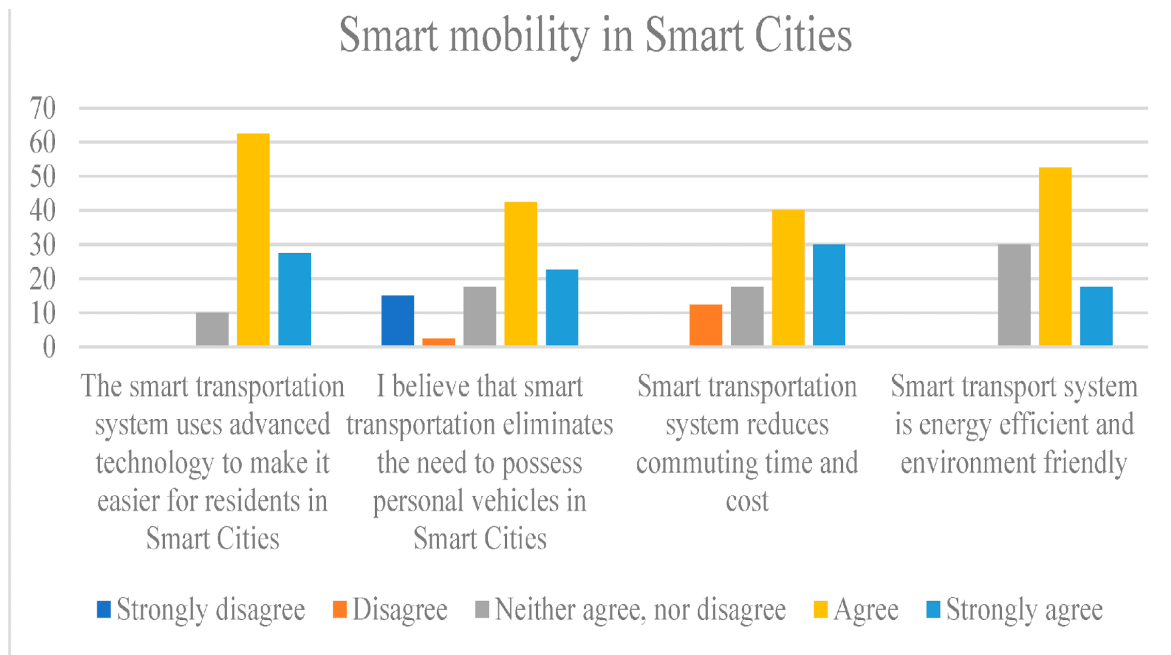


Figure 4.3: Frequency distribution of smart governance in S-Cits;
(a) appropriate regulatory frameworks; (b) fair policies; (c) fairness to other residents; (d)
better interaction between citizens and government and S-Cits

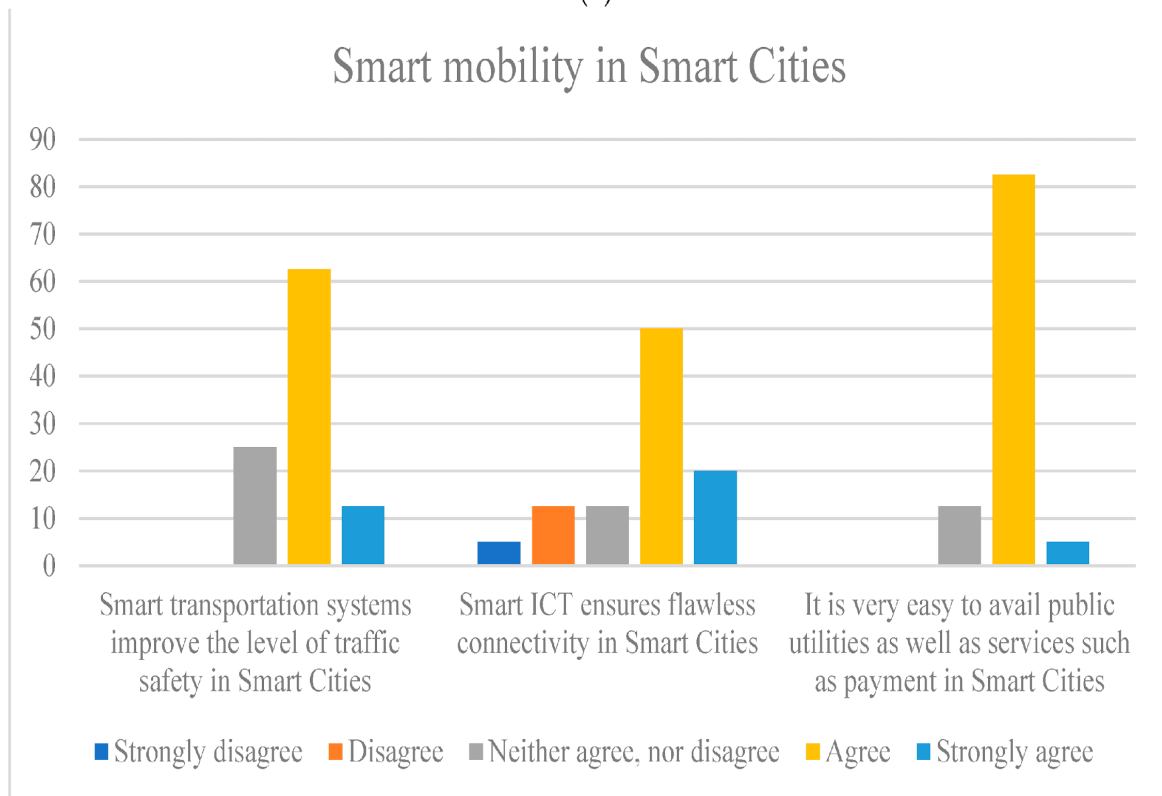
Source: Author

4.3.4.Smart Mobility

Smart mobility refers to the use of innovative technologies and sustainable practices to enhance the efficiency, safety, accessibility, and environmental sustainability of transportation systems. Figure 4.4 different aspects of smart mobility in S-Cits based on the responses obtained and percentage distribution. The results that have been assessed also depicted positive attitudes among the participants of this research. About 83% of the participants support the notion that S-Cits offer 'efficient' public transport, including payment services which are considered supporting. Nonetheless, 63% of the respondents from the given sample (i.e., 25 out of 40 respondents) state that the transportation systems of S-Cits provides convenience through enhanced mobility. The current proportions of the respondents depicted that smart mobility provides advantages such as decreased travel time, use of energy-efficient transport, and optimisation of traffic flow. However, despite the positive spectrum of prevailing responses, 15% of the subjects in the study have a strong opinion that smart mobility in S-Cits does not eradicate the need for private cars for citizens.



(a)



(b)

Figure 4.4: Smart mobility in S-Cits

(a) smart transportation's sophisticated technology to avoid the use of own car, cut down time and fare for commuting, effectiveness in energy use; (b) enhanced traffic safety, seamless connectivity through ICT, easy access to public services.

Source: Author

4.3.5.Smart Environment

Smart environment refers to the use of advanced technologies and data-driven solutions to monitor, manage, and improve environmental sustainability (Al-Hader and Rodzi, 2009). It also refers to the physical environment in a smart system (Allam and Dhunny, 2019). Figures 4.5-4.7 show the distribution of the responses obtained on a percentage basis regarding the component of the smart environment of S-Cits. According to the survey, 92% of the sample is convinced that infrastructure in S-Cits is sustainable and environmentally friendly, while 75% are of the opinion that, in general, S-Cits meet the challenges of climate change and environmental problems. Despite 90% having a positive answer to the question regarding the awareness of S-Cit citizens about the environmentally friendly concept and the long-term impact of the carbon footprint, about 16% of the respondents disagreed.

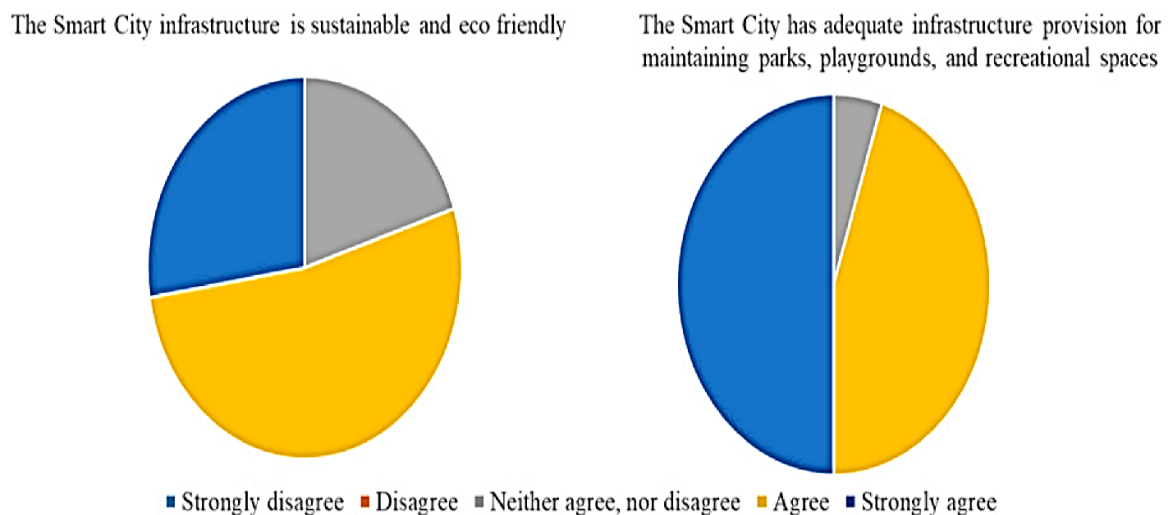


Figure 4.5: Smart mobility in S-Cit – ecologically-friendly infrastructure, parks, playground, and adequate physical structures for play and leisure

Source: Author

The resources are wisely managed in Smart Cities

The Smart City citizens are aware of the environment friendly concept and long term effect of carbon footprint

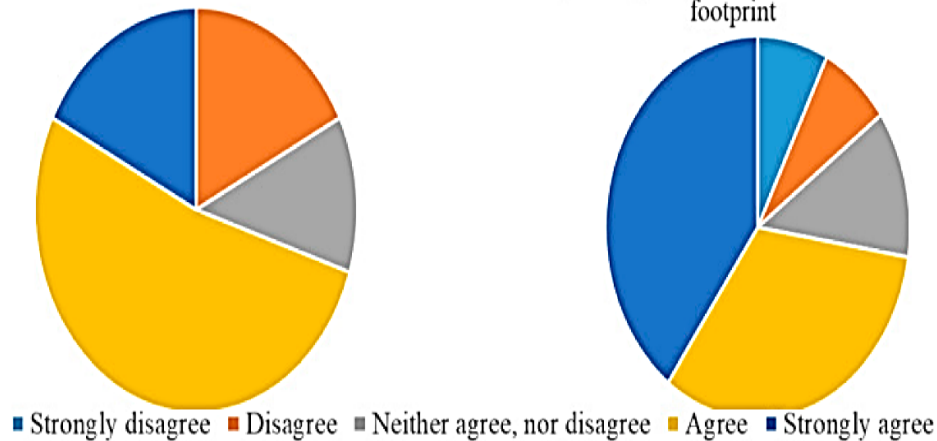


Figure 4.6: Smart mobility in S-Cit – efficient use and utilisation of resources and the enhancement of citizenship environmentally friendly concept, and cumulative impact of carbon emissions

Source: Author

Smart Cities have the ability to effectively address climate change and environmental issues

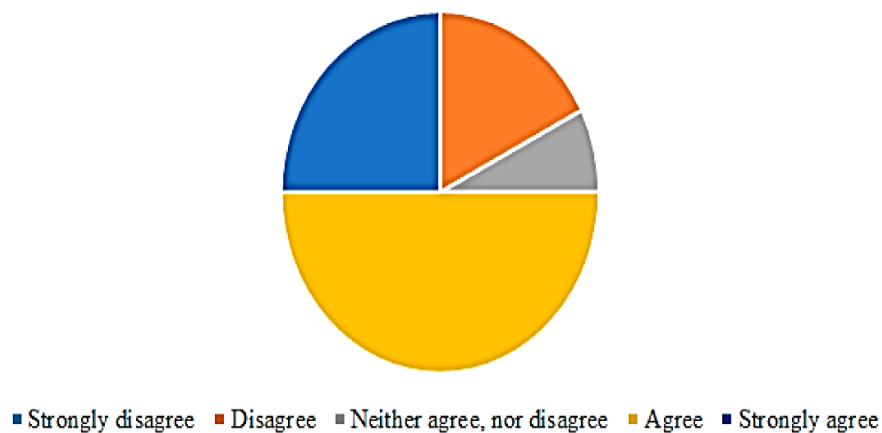


Figure 4.7: Smart mobility in S-Cit – capacity to respond to matters regarding climate change and the environment

Source: Author

4.3.6.Smart Living

The next question assessed the concept of smart living, which refers to the integration of technology and data-driven solutions into daily life to enhance comfort, convenience, safety, and sustainability in urban environments (Abdallah, 2020). A summary of the responses received in % based on 7 aspects of smart living is shown in the bar chart in Figure 4.8. Like the other four aspects of S-Cits, the attitude towards smart living is predominant amongst

the sampled research respondents. The vast majority of respondents (92.5%) revealed a positive attitude to comfortably explore shopping options that are available in the retail facilities of S-Cits. However, the replies reveal that 23% of respondents perceived privacy and security as threats to residents of S-Cits. Besides, a quarter of the respondents had doubts about the fact that housing in S-Cits is of higher quality compared to traditional housing. Moreover, 16 respondents, representing 40% of the sample do not agree with the assertion that utilisation of technology in healthcare elevates the health outcomes of S-Cit residents. The results demonstrate that, while contemporary technologies and other infrastructural developments of S-Cits are considered vital, the respondents align their personalities in the context of health and housing to challenge the S-Cit status.

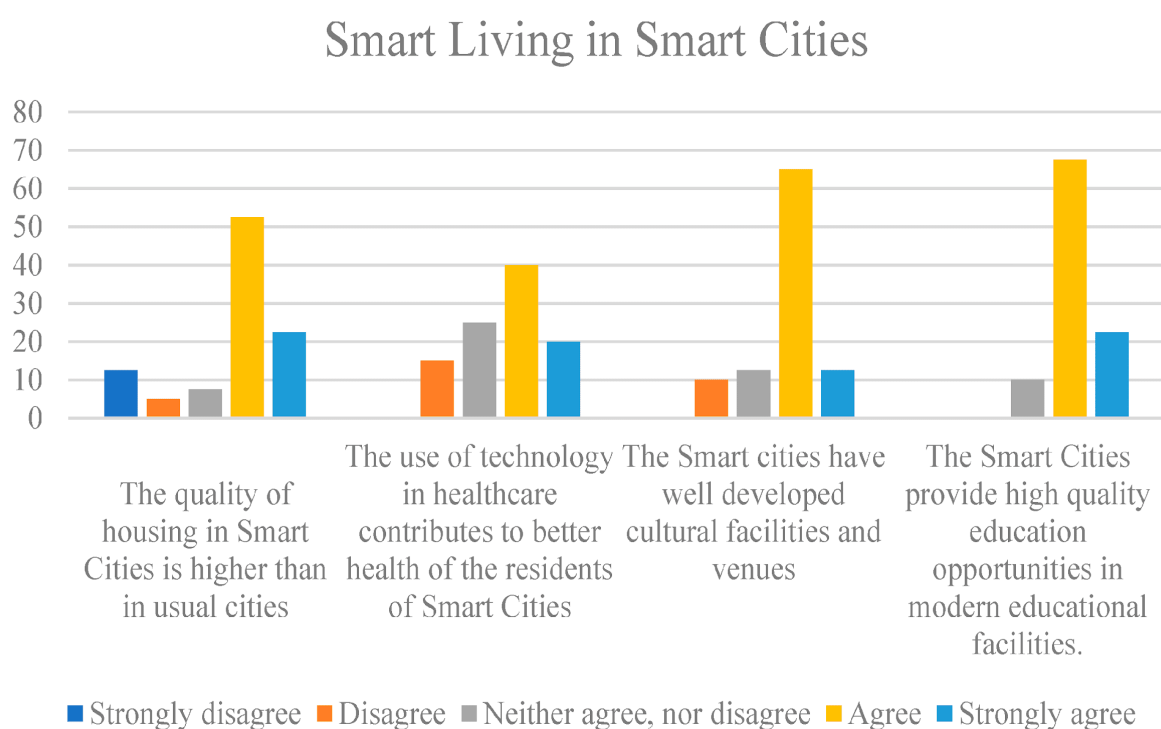


Figure 4.8: Smart mobility in smart living

(a) better quality housing, technology-facilitated health care, worship and cultural amenities, quality education; (b) befitting accommodation and infrastructural facilities to attract tourism, safety when driving, integrity of the citizens; (c) simple and pleasant shopping environment, experiencing the different from other shopping experiences, efficient service delivery.

Source: Author

4.3.7.Citizen Readiness

The percentage distribution of the responses concerning the readiness of respondents to accept various components or aspects of S-Cits is shown in Figure 4.9. Some of the components of S-Cits are willingness to live in an S-Cit, start a business, participate in lifetime learning, engage in public incentives and governance, accept the smart mobility

system and smart housing in order to embrace the shift to environmentally friendly habits for an S-Cit, and finally, ability to embrace the use of self-organised learning readiness of citizens measured by a four-point Likert scale, with responses ranging from 1 (“lesser extent”) to 4 (“greater extent”).

Most responses are on the positive end of the scale, evidencing that a higher proportion of survey respondents are willing to accept different facets of S-Cits. Applying the same approach, half of the participants are reasonably receptive to gaining the experience of living in S-Cits. Contrastingly, 15% of the respondents were unwilling to attempt and gain the living experience in S-Cits. According to the data, 65% of the research participants are ready to consider changing to environmentally friendly behaviour. However, the study noted that the willingness of the respondents to engage in governance involvement and public incentives in S-Cits is minimal. Despite 70% of the respondents displaying readiness to start a new business in an S-Cit, 15% of the participants are not willing. In line with the mentioned attitudes, most participants who engaged in the survey are ready to accept smart housing while only 15% were not ready for such an initiative.

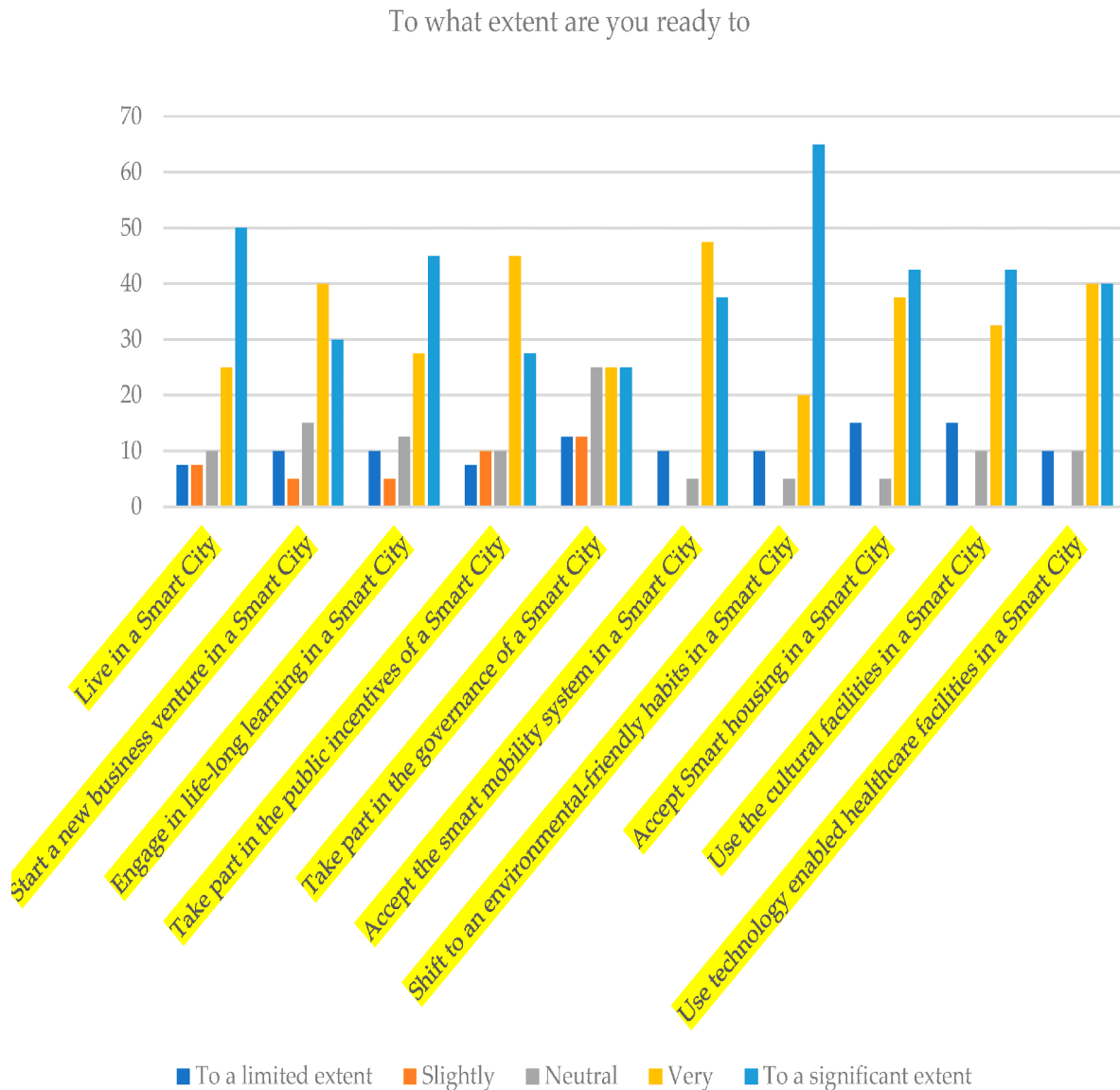


Figure 4.9: Frequency distribution (%) of the scale used for the assessment of the Citizen Readiness to accept S-Cits

Source: Author

4.4. Chapter Summary

The quantitative survey undertaken to explore the perceptions of key stakeholders (i.e., citizens) concerning Qatar's S-Cits and their willingness to accept them has revealed new insights. The results confirm the importance of a smart economy as a segment of S-Cits, with respondents perceiving positive economic value additions. These results align with previous perceptions favouring commerce-enabling roles and economic parameters in S-Cit conceptualisation (Orbok, 2016). Other scholars have also focused on socio-economic background and innovation as inherent S-Cits features (Neirotti *et al.*, 2014). However, participants in this survey did not perceive businesses within smart ecosystems as

increasingly competitive locally or internationally, albeit they expressed appreciation for opportunities to connect with international business partners. Surprisingly, participants claimed limited flexible career choices. It remains unclear whether the business nature and labour force in S-Cits can enhance participants' skills to fulfil dynamic business models. Kogan and Lee (2014) similarly concluded that while ICT is crucial in developing S-Cits, it is not a necessary condition for transforming conventional cities into smart ones.

S-Cits are viewed as sources of learning, diversity, and openness. However, their contribution to boosting inhabitants' creativity was not highlighted in this research. The effective exchange of valuable information and feedback through digital media is considered a success factor for S-Cits (Zhao and Zhang, 2020). The absence of community engagement and inhabitants' use of digital services could explain the lack of creativity emphasis. The roles of governance and citizen participation in S-Cit success are discussed in literature by Kogan and Lee (2014) and Novita *et al.* (2016). Anindra *et al.* (2018) identified smart governance as a significant success factor in case studies of 15 Indonesian cities. Participants opined that S-Cit-Ecos can offer efficient and appropriate regulatory approaches.

Smart mobility is viewed as a strength supported by ICT integration (Yigitcanlar and Kamruzzaman, 2017). Participants perceived that smart transportation simplifies commuting, reduces time and energy use, manages traffic congestion, and facilitates public transport use. However, there was a contradiction regarding whether smart mobility can eradicate the need for private vehicle ownership. Participants were inclined towards better cultural amenities, quality education, tourism infrastructure, shopping centres, and improved service quality. These concepts align with literature emphasising technology integration in citizens' daily activities (Patel *et al.*, 2016). However, findings regarding healthcare facilities and housing qualities require additional research due to their integral nature in S-Cit environments (Harrison and Donnelly, 2011; Dameri, 2013).

Based on the empirical findings, the model shown in Figure 4.10 displays citizens' attitudes in the context of the six elements of S-Cits identified by Giffinger and Gudrun (2010) to visualise citizens' willingness to accept S-Cits in Qatar. This model will be used in further empirical research on Qatar's S-Cits. Although causal relations between elements are unknown, the model offers a systemic view of S-Cits and citizens' preparedness, representing a current social innovation as discussed by Cosgrave *et al.* (2013) and Bifulco *et al.* (2017).

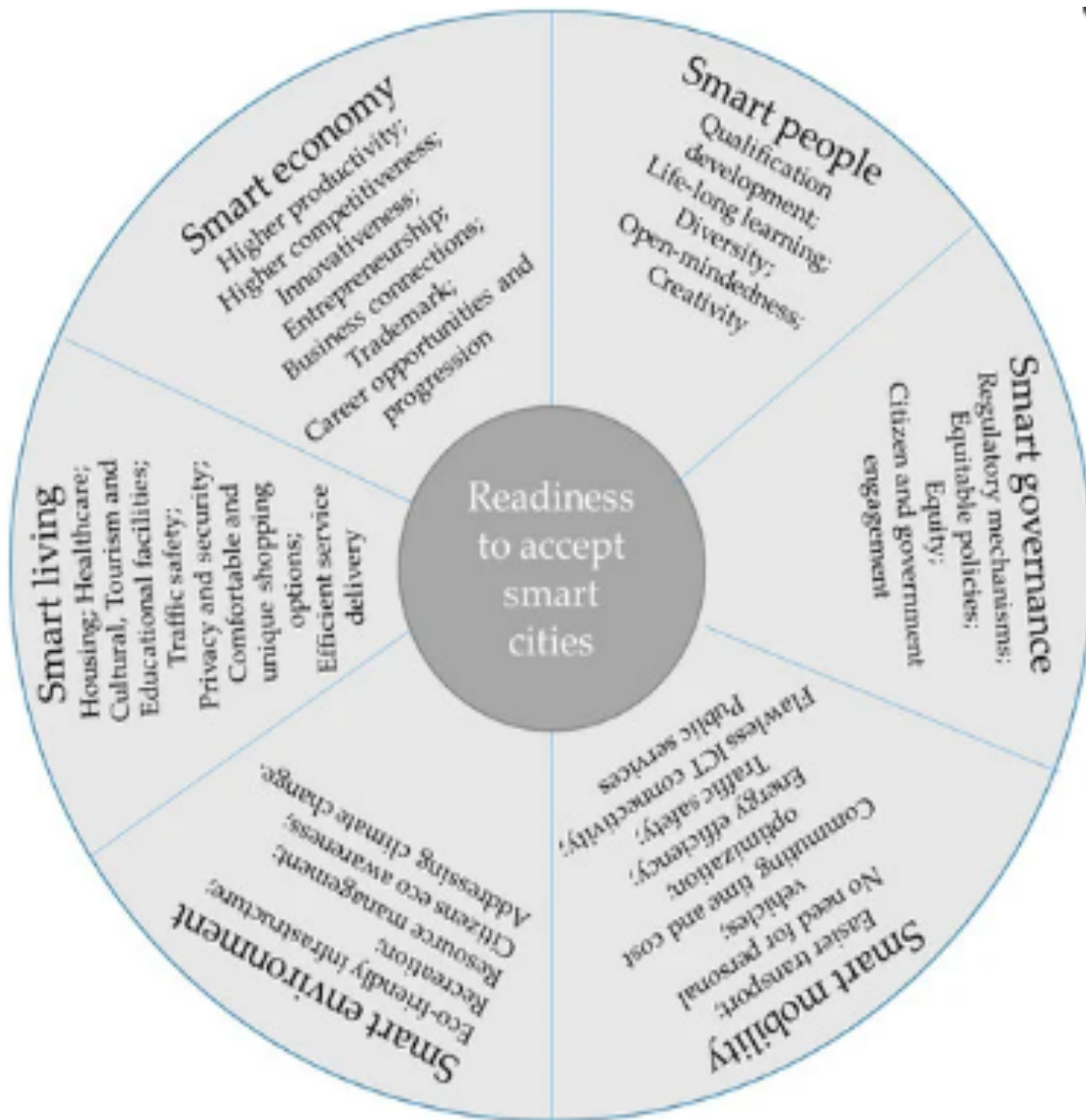


Figure 4.10: Conceptual model of smart city readiness

Source: Author

The findings suggest that successful S-Cit-Imp relies on citizens, businesses, and government adoption. While citizens may experience S-Cit living, inadequate governance can limit its full potential. The findings support the argument that while ICT is crucial in S-Cits, it is insufficient to transform conventional cities into smart ones. The following chapter explores the key issues of data privacy and security, which are highly instrumental in citizen willingness to adopt and use new technologies.

5.

Data Privacy and Security Concerns

Research shows that developing S-Cits requires advanced technological infrastructure (Barns *et al.*, 2017; Caragliu *et al.*, 2011), and the commensurate complex and interconnected networks gathering, storing, and transmitting large volumes of user data have raised significant security concerns. Previous research (Braun *et al.*, 2018; Cui *et al.*, 2018; Elmaghraby and Losavio, 2014; Rao and Deepak, 2022) has shown that data privacy can compromise digital adoption, since the technologies can capture critical user data, such as their personal identification information, causing perceived and actual risks to sensitive user data that inhibits adoption and use. As presented in the previous chapter, issues of privacy and security of the use of data are palpable concerns for Qatari citizens, and they present a significant challenge to the government and other stakeholders in ensuring a safe and secure S-Cit environment. Therefore, it is important for the government to ensure it adequately addresses the issue of data security, privacy and confidentiality when developing an S-Cit environment. A breach in the data security and privacy could lead to lower trust from the citizens. Therefore, the primary aim of this chapter is to investigate the relationship between issues related to data security, privacy and confidentiality and citizens willingness to accept the S-Cit-Eco.

5.1. Methodology

The data was collected using a survey questionnaire with experts (i.e., people working in S-Cit-Ps, including engineers, designers, architectures etc.) and general Qatari citizens. The survey questionnaire was designed to gather responses on areas such as actual use of behaviour in adopting cyber security, availability of cyber security measures, behavioural intention in adopting cyber security, confidentiality of information, effort expectancy, facilitating conditions, integrity of cyber security, performance expectancy, and resilience of cyber security, safety, and social influence of cyber security. Individual respondents representing Qatari citizens were identified and recruited through social media groups related to S-Cits in Qatar.

The study identified and approached the experts using gatekeepers from companies working on S-Cit-Ps in Qatar. All communication related to the research was performed through the respondent's personal email addresses outside working hours. The primary inclusion criteria for the citizen group was that the person must be an adult (aged 18 and over) citizen of Qatar, including both S-Cit residents and non-residents, willing to participate in the online survey. The inclusion criteria for experts specified that the person had to be a professional working in developing the S-Cit-Eco in Qatar. These experts included designers, architects,

engineers etc. Before being included in the study the individual had to sign a consent form after getting assurance of their privacy and confidentiality.

5.2. Demographic Characteristics of Sample

Table 5.1 presents data on the demographic characteristics of the citizen survey. It can be seen that the age distribution is fairly balanced, with a slight majority (60%) over 35. Sex breakdown shows 60% male and 33% female, while 7% preferred not to share. Most respondents (61%) are married, while 23% are single. Household sizes tend to be larger, with 54% having more than 3 people. Child presence in households varies, with 28% having no children and 22% having more than 3. Regarding S-Cit experience, only 19% have ever lived in one, with 13% currently residing in an S-Cit.

Table 5.1: Socio-demographic characteristics of citizen participants

Question	Options	Number	Percentage
What is your age? (years)	18-25	24	20%
	26-34	25	21%
	35-45	33	28%
	46+	38	32%
What is your sex?	Male	72	60%
	Female	40	33%
	Prefer not to say	8	7%
What is your marital status?	Single	27	23%
	Married	73	61%
	Divorced	10	8%
	Other	10	8%
How many people are there in your household?	1	15	13%
	2	14	12%
	3	26	22%
	>3	65	54%
How many children live in your household?	0	33	28%
	1	24	20%
	2	30	25%
	3	7	6%
	>3	26	22%
Have you ever lived in a smart city?	Yes	23	19%
	No	97	81%
How long have you lived in a smart city? (years)	<1	9	8%
	1-3	5	4%
	4-6	5	4%
	>6	4	3%
	Not lived in S-Cit	97	81%
Do you currently live in a smart city?	Yes	16	13%
	No	7	6%
	Not lived in S-Cit	93	78%

Source: Author

Table 5.2 shows the demographic characteristics for the expert survey. The respondents are primarily seasoned professionals, with 83% aged 35 or older, and a slight male majority (57%). Most are married (63%) and hold diverse positions across design, construction, project management, and managerial roles. The standout finding is the extensive involvement in S-Cit initiatives: 91% have worked on such projects, with a significant portion (54%) having 4 or more years of experience. Currently, 69% are actively involved in S-Cit-Ps. This data suggests a mature, experienced workforce with substantial exposure to S-Cit concepts and implementation. The high percentage of professionals currently working on these projects indicates a robust and ongoing trend in S-Cit development, reflecting the growing importance of integrating technology and urban planning in the construction industry.

Table 5.2: Socio-demographic characteristics of expert participants

Question	Options	Number	Percentage
What is your age? (years)	18-25	2	6%
	26-34	4	11%
	35-45	17	49%
	46+	12	34%
What is your sex?	Male	20	57%
	Female	14	40%
	I prefer not-share	1	3%
What is your marital status?	Single	6	17%
	Married	22	63%
	Divorced	3	9%
	Other	4	11%
What is your position in your organisation?	Designer	7	20%
	Construction Worker	10	29%
	Project Manager	8	23%
	Managerial Position	10	29%
Have you ever worked on a smart city project?	Yes	32	91%
	No	3	9%
How long have you worked on a smart city project? (years)	<1 year	4	11%
	1-3 years	9	26%
	4-6 years	11	31%
	>6 years	8	23%
	Not worked in a S-Cit-P	3	9%
Do you currently work on a smart city project?	Yes	24	69%
	No	8	23%
	Not worked in a S-Cit-P	3	9%

Source: Author

5.3. Statistical Testing for Data Analysis

5.3.1.Independent Sample T-Test

The t-test is helpful for assessing whether observed differences between groups are statistically significant rather than due to random variation (Peck *et al.*, 2020). The test measures whether there is a statistically significant difference in the mean of two groups.

The table presents the results of an independent sample t-test comparing the perceptions of citizens and experts regarding various characteristics of S-Cits. The test examined ten different aspects, including privacy, data security, behavioural intentions, and readiness to accept S-Cits.

The results show statistically significant differences between the two groups (citizens and experts), as indicated by the Sig. (2-tailed) values being less than 0.05. This suggests that citizens and experts have distinct perceptions of S-Cit features. The negative mean differences across all characteristics indicate that experts consistently rated these aspects higher than citizens. The largest mean differences were observed in “Resiliency of privacy and data security” (-0.66079) and “Availability of privacy and data security” (-0.64152). The test was conducted assuming both equal and unequal variances.

As shown in Table 5.3, in most cases, Levene’s “test for equality of variances” showed no significant difference in variances (Sig. > 0.05), except for “Citizens’ readiness to accept smart cities”, where unequal variances were assumed. These results led to the rejection of the null hypothesis, which stated that there was no significant difference in perception between the citizens and experts. The study concludes that experts and citizens have significantly different understandings of S-Cit-Ecos.

Table 5.3: Independent sample t-test

	Equal variance	F	Sig.	t	df	Sig. (2- tailed)	Mean Differe	Std. Error
Actual use of behaviour in adopting privacy and data security in smart cities	Assumed	.664	.417	-2.570	153	.011	-.52727	.20515
	Not			-2.751	61.676	.008	-.52727	.19168
Availability of privacy and data security	Assumed	2.856	.093	-3.106	153	.002	-.64152	.20652
	Not			-3.509	68.061	.001	-.64152	.18280
Behavioural intention in adopting privacy and data security in smart cities	Assumed	.784	.377	-2.732	153	.007	-.56817	.20796
	Not			-2.842	58.833	.006	-.56817	.19992
Confidentiality of privacy and data security	Assumed	.070	.791	-3.042	153	.003	-.63095	.20743
	Not			-3.055	55.735	.003	-.63095	.20653
Effort expectancy	Assumed	.135	.714	-2.670	153	.008	-.57026	.21359
	Not			-2.708	56.548	.009	-.57026	.21062
Facilitating conditions	Assumed	.807	.370	-2.325	153	.021	-.47317	.20355
	Not			-2.441	59.742	.018	-.47317	.19384
Integrity of privacy and data security	Assumed	.656	.419	-2.717	153	.007	-.55982	.20608
	Not			-2.819	58.600	.007	-.55982	.19860
Performance expectancy	Assumed	1.246	.266	-2.843	153	.005	-.60417	.21249
	Not			-2.958	58.857	.004	-.60417	.20422
Resiliency of privacy and data security	Assumed	.044	.833	-3.243	153	.001	-.66079	.20373
	Not			-3.273	56.133	.002	-.66079	.20188
Citizens' readiness to accept smart cities	Assumed	11.615	.001	-3.132	153	.002	-.64893	.20720
	Not			-3.712	75.033	.000	-.64893	.17482

Source: Author

5.3.2. Correlation Analysis

Correlation analysis is a statistical technique used to measure and evaluate the strength and direction of the relationship between two or more variables (Peck *et al.*, 2020). It determines whether, and how strongly, variables are related to each other, without assuming causation. The most common measure of correlation is Pearson's correlation coefficient (denoted as r), which ranges from -1 (strong negative) to 1 (strong positive) (Peck *et al.*, 2020). The study conducted a Pearson correlation to test the linear association between the different parameters of S-Cit-Eco and readiness to accept S-Cits using SPSS software. The correlation test was conducted in two parts - one for citizens and the other for experts. Table 5.4 summarises the findings, while Table 5.5 presents detailed findings from the correlation analysis for the expert group.

Table 5.4 shows the test results for the citizens' dataset show strong positive correlations between all parameters of the S-Cit-Eco and citizens' readiness to accept S-Cits. The strongest correlations (0.926) are between "confidentiality of privacy and data security" and "behavioural intention in adopting privacy and data security in smart cities", and between "facilitating conditions" and "confidentiality of privacy and data security". "citizens' readiness to accept smart cities" correlates positively with all other variables, with coefficients ranging from 0.714 to 0.842. Its strongest correlation is with "performance expectancy" (0.842), followed by "facilitating conditions" (0.814). The weakest correlations, though still strong, are between "citizens' readiness to accept smart cities" and "availability of privacy and data security" (0.714), and between "citizens' readiness to accept smart cities" and "actual use of behaviour in adopting privacy and data security in smart cities" (0.745).

As shown in Table 5.5, "actual use behaviour" shows the strongest correlation with "integrity of privacy and data security" (0.940). There is also a strong correlation between "effort expectancy" (0.937) and "availability of privacy and data security" (0.922). Regarding "citizens' readiness to accept smart cities", the strongest correlations are with "performance expectancy" (0.893), "confidentiality of privacy and data security" (0.891), and "resiliency of privacy and data security" (0.888). The relationship between "citizens' readiness" and "actual use behaviour" (0.851) is notably strong, implying that increased actual use behaviour is associated with higher readiness to accept S-Cits.

Table 5.4: Pearson correlation test – citizens

	1	2	3	4	5	6	7	8	9	10
1.Actual use of behaviour in adopting privacy and	1	.82 ***	.83 ***	.86 ***	.81 ***	.85 ***	.83 ***	.82 ***	.84 ***	.74 ***
2.Availability of privacy and data security	.82 ***	1	.89 ***	.87 ***	.83 ***	.85 ***	.82 ***	.83 ***	.80 ***	.71 ***
3.Behavioural intention in adopting privacy and data	.83 ***	.89 ***	1	.92 ***	.87 ***	.88 ***	.82 ***	.85 ***	.80 ***	.75 ***
4.Confidentiality of privacy and data security	.86 ***	.87 ***	.92 ***	1	.90 ***	.92 ***	.87 ***	.88 ***	.88 ***	.79 ***
5.Effort expectancy	.81 ***	.83 ***	.87 ***	.90 ***	1	.91 ***	.85 ***	.85 ***	.80 ***	.75 ***
6.Facilitating conditions	.85 ***	.85 ***	.88 ***	.92 ***	.91 ***	1	.87 ***	.92 ***	.88 ***	.81 ***
7.Integrity of privacy and data security	.83 ***	.82 ***	.82 ***	.87 ***	.85 ***	.87 ***	1	.87 ***	.87 ***	.77 ***
8.Performance expectancy	.82 ***	.83 ***	.85 ***	.88 ***	.85 ***	.92 ***	.87 ***	1	.89 ***	.84 ***
9.Resiliency of privacy and data security	.84 ***	.80 ***	.80 ***	.88 ***	.80 ***	.88 ***	.87 ***	.89 ***	1	.79 ***
10.Citizens' readiness to accept smart cities	.74 ***	.71 ***	.75 ***	.79 ***	.75 ***	.81 ***	.77 ***	.84 ***	.79 ***	1

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author

Table 5.5: Pearson correlation test – experts

	1	2	3	4	5	6	7	8	9	10
1.Actual use of behaviour	1	.92 ***	.88 ***	.91 ***	.93 ***	.88 ***	.94 ***	.90 ***	.91 ***	.85 ***
2.Availability of privacy and data security	.92 ***	1	.88 ***	.90 ***	.89 ***	.86 ***	.91 ***	.87 ***	.91 ***	.86 ***
3.Behavioural intention	.88 ***	.88 ***	1	.92 ***	.92 ***	.92 ***	.94 ***	.89 ***	.92 ***	.83 ***
4.Confidentiality of privacy and data security	.91 ***	.90 ***	.92 ***	1	.93 ***	.89 ***	.95 ***	.90 ***	.91 ***	.89 ***
5.Effort expectancy	.93 ***	.89 ***	.92 ***	.93 ***	1	.93 ***	.95 ***	.92 ***	.93 ***	.87 ***
6.Facilitating conditions	.88 ***	.86 ***	.92 ***	.89 ***	.93 ***	1	.93 ***	.90 ***	.91 ***	.84 ***
7.Integrity of privacy and data security	.94 ***	.91 ***	.94 ***	.95 ***	.95 ***	.93 ***	1	.93 ***	.96 ***	.87 ***
8.Performance expectancy	.90 ***	.87 ***	.89 ***	.90 ***	.92 ***	.90 ***	.93 ***	1	.95 ***	.89 ***
9.Resiliency of privacy and data security	.91 ***	.91 ***	.92 ***	.91 ***	.93 ***	.91 ***	.96 ***	.95 ***	1	.88 ***
10.Citizens' readiness to accept smart cities	.85 ***	.86 ***	.83 ***	.89 ***	.87 ***	.84 ***	.87 ***	.89 ***	.88 ***	1

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Author

5.4. Chapter Summary

The findings of this study confirm that performance expectancy has a strong influence on app-use intentions and S-Cit service adoption. Hou *et al.* (2020) reported its highest influence on app-use intentions in a mid-sized US city, while Habib *et al.* (2020) found that it positively influenced intentions to use S-Cit services. This suggests that citizens familiar with and regularly using S-Cit services are more likely to continue using them. Previous studies (Cui *et al.*, 2018; Elmaghraby and Losavio, 2014; Zhang *et al.*, 2014) had noted that data privacy and security were key to the success of a smart system ecosystem and this study confirmed the same results in the Qatar context. The interconnectedness in S-Cits requires continuous protection of citizens' privacy and data security (Elmaghraby and Losavio, 2014). Despite significant differences in perceptions between citizens and experts regarding S-Cit characteristics, there is a strong and positive correlation between S-Cit variables and citizens' readiness to accept S-Cits. This suggests that improvements in any of these areas could positively influence overall acceptance of S-Cits. The strong correlations across different variables indicate that a holistic approach to S-Cit development, considering all these factors, is likely to be most effective in gaining citizen acceptance and participation.

6.

Qualitative Research Findings

This chapter summarises the findings from the qualitative semi-structured interviews with 12 managers. The interviews focused on the current state of S-Cit initiatives as perceived by them in their customary roles (i.e., based on their experience as S-Cit stakeholders, as described in Table 6.1). It considers the challenges they have faced, and potential strategies they envisage for successful implementation. The discussions centred around key themes including citizen readiness, privacy and security concerns, implementation strategies, and the role of design thinking in S-Cit development. The thesis anonymised the identity of the participants as P1 to P12 to protect their privacy and confidentiality. Table 6.1 shows the salient characteristics of the expert interviewees.

Table 6.1: Profile of interviewees

No.	Sex	Age	Role/Expertise	Years of Experience (S-Cit-Ps)
P1	Male	45	S-Cit Planner	12
P2	Female	38	Data Security Specialist	8
P3	Male	50	Citizen Engagement Expert	14
P4	Male	42	Engineer	9
P5	Male	47	Engineer and S-Cit Planner	13
P6	Female	35	Cultural and Social Analyst	6
P7	Male	40	Urban Infrastructure Developer	10
P8	Female	39	S-Cit Planner	7
P9	Male	44	Cybersecurity and Data Privacy Expert	11
P10	Female	37	Designer	5
P11	Male	52	Government Policy Advisor	14
P12	Female	41	Designer	4

Source: Author

6.1. Citizen Readiness and Acceptance

A recurring theme throughout the interviews was the importance of citizen readiness and acceptance in the successful implementation of S-Cit initiatives. Most managers agreed that while there is general enthusiasm for technological advancements, there are also concerns and hesitations among some segments of the population. This dichotomy presents both

opportunities and challenges for S-Cit planners and implementers, as noted by the following participants.

“We’ve found that younger generations are typically more excited about smart city technologies, but older citizens often need more convincing. It is crucial to demonstrate tangible benefits to daily life”. (P3)

“The key is to show how smart city solutions can make life easier and more efficient. When people see practical applications, like reduced traffic congestion or improved healthcare access, they’re more likely to embrace the changes”. (P7)

The interviewees emphasised the need for targeted communication strategies to address different demographic groups. P1 noted:

“We’ve developed a multi-faceted communication plan that includes social media campaigns for younger citizens, community workshops for families, and one-on-one sessions with elderly residents. It is about meeting people where they are and addressing their specific concerns and interests”. (P1)

However, P5 cautioned against assuming uniform readiness across the population:

“We need to recognise that Qatar’s population is diverse, with varying levels of technological literacy. Our approach needs to be inclusive and considerate of all segments of society”. (P5)

This point was further emphasised by P10, who shared:

“In our citizen engagement sessions, we’ve identified a need for extensive education and awareness programs. Many people are interested but don’t fully understand what a smart city entails”. (P10)

The interviews revealed that citizen readiness is not just about willingness to adopt new technologies, but also about the capacity to use them effectively, as highlighted by the following participants:

“We’re not just introducing new systems; we’re asking citizens to change their behaviours and daily routines. This requires a significant investment in digital literacy programs and ongoing support”. (P8)

“We’re exploring partnerships with educational institutions to integrate smart city concepts into school curricula” (P12)

The goal is to cultivate a generation of citizens who are not just users of S-Cit technologies, but active contributors to their development and improvement.

The managers also discussed the importance of early wins in building citizen confidence and acceptance. P4 shared an example:

“We launched a smart parking app in one of our busiest districts. The immediate reduction in traffic congestion and user-friendly interface quickly won over sceptics” (P4)

The interviewees believe these tangible improvements will help build momentum for larger initiatives.

6.2. Privacy and Data Security Concerns

Privacy and data security emerged as critical concerns for both citizens and project managers. All interviewees acknowledged the importance of addressing these issues to gain public trust and ensure the long-term success of S-Cit initiatives. The discussions revealed a nuanced understanding of the challenges and potential solutions in this area. P2 emphasised the seriousness of the situation:

“Data security isn’t just a technical issue; it is fundamental to the entire smart city concept. If citizens don’t trust that their data is secure, the whole system falls apart”. (P2)

This view was supported by P8, who stated:

“We’re dealing with sensitive information – from traffic patterns to energy usage in homes. Ensuring this data is protected is our top priority”. (P8)

The managers discussed the complex nature of data security in S-Cits. P6 explained that it is not just about protecting data from external threats. Stakeholders also need to ensure that data is not misused internally. This involves strict access controls, audit trails, and clear policies on data usage. P11 added:

“We’re also grappling with questions of data ownership. Who owns the data generated by citizens as they interact with smart city systems? How can we ensure that this data is used for the public good while respecting individual privacy?” (P11)

The interviewee discussed specific measures being taken to address these concerns. P4 noted that his organisation has implemented state-of-the-art encryption protocols and is:

“Working with international cybersecurity experts to ensure our systems are robust”. (P4)

P11 added that transparency is key and her team were developing clear policies on data collection, usage, and storage, and communicating these to the public. The interviewees

noted that they are not just focusing on technical solutions but also on building a culture of data responsibility:

“We’re training all our staff, from top management to ground-level operators, on the importance of data privacy and security. It is about creating a mind-set where data protection is everyone’s responsibility”. (P9)

Interestingly, P6 pointed out a cultural dimension to privacy concerns. He observed that in Qatar, there is a strong emphasis on personal privacy in the traditional sense. The interviewee pointed out the need to bridge the gap between this cultural value and the data-driven nature of S-Cits. This cultural consideration was echoed by P9:

“We’re not just implementing technology; we’re navigating a cultural shift. It is a delicate balance”. (P9)

Most organisations face the challenge of balancing data collection needs with privacy concerns. P3 explained:

“Some of our most promising smart city applications require extensive data to function effectively. For example, optimising traffic flow requires real-time data on vehicle movements. We’re constantly seeking ways to anonymise and aggregate this data to protect individual privacy while still deriving useful insights”. (P3)

According to P7, it is important to give citizens control over their data:

“Most organisations are developing user-friendly interfaces that allow citizens to see what data is being collected about them and how it is being used. They can opt out of certain data collection programs if they choose. This transparency and control are crucial for building trust”. (P7)

6.3. Implementation Strategies and Challenges

The interviews revealed different strategies being employed to implement S-Cit-Ps, as well as numerous challenges faced by the managers. The discussions provided insights into the complex ecosystem of stakeholders, technologies, and processes involved in bringing S-Cit concepts to life. P1 highlighted the importance of a phased approach:

“We’ve found success in starting with smaller, pilot projects. This allows us to demonstrate value quickly and learn from any issues before scaling up”. (P1)

This strategy was also favoured by P12, who added:

“Pilot projects help us gauge public reaction and adjust our approach accordingly. It is a way to minimise risk while maximising learning”. (P12)

The managers emphasised the need for flexibility and adaptability in implementation strategies. They agreed that the S-Cit landscape is evolving rapidly and developers need to be agile in their approach, ready to pivot when new technologies emerge or when they encounter unexpected challenges. P10 provided an example:

“We had initially planned to roll out a city-wide sensor network for air quality monitoring. But after a pilot, we realised that a hybrid approach using both fixed sensors and mobile sensors on public transport vehicles was more effective and cost-efficient. Being open to such adjustments is crucial”. (P10)

Integration of various systems emerged as a significant challenge. One of the biggest hurdles is ensuring interoperability between different S-Cit systems. Creating an integrated S-Cit-Eco is complex. It requires collaboration across multiple government departments and private sector partners. The interviews revealed that managers are grappling with both technical and organisational challenges in system integration. P8 elaborated:

“It is not just about API integrations and data formats. We’re also dealing with different organisational cultures, priorities, and ways of working. Building a cohesive smart city team across these boundaries is as much a challenge as the technical integration”. (P8)

Given this challenge, some interviewees highlighted the importance of PPPs:

“The government can’t do this alone. We need the innovation and expertise of private companies, but also need to ensure that public interests are protected”. (P5)

“Balancing public good with private sector involvement is an ongoing challenge. We’re constantly refining our partnership models”. (P10)

Related to such multi-stakeholder involvement, discussions also touched on the financial aspects of S-Cit-Imp, as explored by the following participants:

“Securing funding for long-term projects can be challenging. We’re exploring innovative financing models, including public-private partnerships and performance-based contracts”. (P2)

“We’re also focusing on demonstrating the return on investment for smart city initiatives. This isn’t always straightforward, as some benefits are intangible or long-term, but it is crucial for sustaining support and funding”. (P11)

The conclusion from the interviews is that implementing an S-Cit-Eco is costly and therefore, it is important to ensure the benefits outweigh the costs. The managers also discussed the challenge of managing public expectations. There is a lot of hype around S-Cits, and sometimes this creates unrealistic expectations. They pointed out the need to be clear about

what is achievable in the short term and what a longer-term vision is. As a result, organisations involved in S-Cit development have been working on a narrative that emphasises continuous improvement rather than a sudden transformation. It is about taking steps towards a smarter city, not flipping a switch.

6.4. The Role of Design Thinking

The application of design thinking principles in S-Cit development was a topic that elicited varied responses from the managers. While some were enthusiastic about its potential, others were less familiar with the concept or sceptical about its applicability. Some participants were eager advocates for design thinking, as in the following excerpts:

“Design thinking allows us to approach smart city challenges with a human-centred perspective. It helps us focus on the actual needs of citizens rather than getting caught up in technology for technology’s sake”. (P2)

“We’ve used design thinking workshops to involve citizens in the ideation process. It is been incredibly valuable in uncovering needs we hadn’t considered”. (P8)

The managers who had experience with design thinking highlighted its ability to foster innovation and creative problem-solving. P1 shared an example:

“We used design thinking techniques in developing our smart waste management system. By empathising with both citizens and sanitation workers, we came up with solutions that not only improved efficiency but also enhanced the working conditions for our staff”. (P1)

However, P4 expressed some reservations:

“While I see the value in design thinking, integrating it into our existing processes has been challenging. There’s a learning curve, and not everyone is convinced of its benefits yet”. (P4)

P11 offered a balanced view:

“Design thinking has its place, particularly in the early stages of project conceptualisation. But we also need to balance it with technical and economic considerations”. (P11)

P6 highlighted an interesting application of design thinking principles. His organisation uses elements of design thinking in the citizen engagement strategies. The emphasis on empathy and understanding user needs has helped the organisation communicate more effectively about S-Cit initiatives. However, there is a challenge in reconciling the iterative nature of

design thinking with the often rigid planning and budgeting processes of government projects. He noted that design thinking encourages rapid prototyping and iteration, which can be at odds with traditional project management approaches. Currently, they are working on finding a balance that allows for flexibility without compromising accountability. P10 raised an important point about the cultural fit of design thinking:

“We need to be mindful of cultural nuances when applying design thinking. Some aspects, like open brainstorming and embracing failure as part of the learning process, may need to be adapted to fit our cultural context”. (P10)

Despite the challenges, most managers saw value in incorporating elements of design thinking into their S-Cit approaches. They agreed that even though they have not adopted design thinking in totality, its emphasis on empathy, user-centricity, and iterative problem-solving is influencing how they approach S-Cit challenges. It is becoming part of their toolkit, alongside more traditional planning and engineering approaches.

6.5. Roadmap for Smart City Implementation (S-Cit-Imp)

When discussing the development of a roadmap for S-Cit-Imp, the managers emphasised the need for flexibility, stakeholder engagement, and a long-term vision. P1 stressed the importance of adaptability and argued that any roadmap developed needs to be flexible:

“Technology is evolving rapidly, and there is a need to be able to incorporate new innovations as they emerge”. (P1)

This point was reinforced by P12, who stated that they are not just planning for the next five years; they are also laying the groundwork for the next several decades. This means the roadmap needs to be visionary yet adaptable. In this context, the managers discussed the challenge of balancing short-term deliverables with long-term goals. As P5 explained:

“Our roadmap includes quick wins that can demonstrate value and build momentum, as well as more ambitious long-term projects. It is about maintaining enthusiasm and support while working towards transformative change”. (P5)

Stakeholder engagement was also consistently mentioned as a critical component of any implementation roadmap. P9 argued that the roadmap development process involves continuous dialogue with citizens, businesses, and various government entities. It is complex, but essential for creating a shared vision. P5 also noted that her organisation has found that involving stakeholders early and often leads to better outcomes and smoother implementation. They agreed that managers are thinking beyond technology in their roadmap development, and that the roadmap is not just about rolling out new technologies; rather, it ought to include plans for capacity-building, policy development, and cultural

change management. These are crucial for the long-term success of smart initiatives. Participants therefore highlighted the need for a phased approach in the roadmap:

“Our roadmap is divided into short-term, medium-term, and long-term goals. This allows us to show progress quickly while working towards more ambitious long-term objectives”. (P3)

“We’ve structured our roadmap to deliver ‘quick wins’ that build momentum and public support, while simultaneously working on more complex, transformative projects”. (P7)

The importance of aligning S-Cit initiatives with Qatar’s broader national vision was emphasised by multiple managers:

“Our smart city roadmap isn’t developed in isolation. It is carefully aligned with Qatar National Vision 2030 and other national strategies”. (P10)

“We’re not just building a smart city ; we’re contributing to the overall development and diversification of Qatar’s economy. This broader perspective informs every aspect of our roadmap”. (P4)

6.6. Sustainability and Cultural Considerations

The interviews revealed a strong emphasis on sustainability and the need to balance technological advancement with cultural preservation. P8 highlighted the environmental aspect and argued that sustainability is at the core of our S-Cit vision. Stakeholders are looking at how technology can help us reduce energy consumption, manage water resources more efficiently, and minimise the environmental impact. This sentiment was echoed by P2, who stated that S-Cit technologies offer the opportunity to achieve more sustainable urban solutions. Some organisations are implementing smart grid systems that optimise energy distribution and encourage renewable energy adoption.

In addition to reducing the carbon footprint of cities, this also improves energy security. For example, the smart water management system has already led to significant reductions in water waste. According to P6, they are looking at expanding this to include predictive maintenance of water infrastructure. Alongside this prosaic and practical focus, the same participant was also keenly aware of the importance of cultural sensitivity and considerations:

“We’re conscious that smart city development shouldn’t come at the cost of our cultural identity. We’re looking at ways to use technology to preserve and promote our heritage”. (P6)

P11 provided an example of how augmented reality can be used to enhance historical sites, providing information to visitors while preserving the physical structures. P3 noted that it is not about choosing *between* tradition and technology, and said they are finding ways to use S-Cit solutions to enhance and showcase the cultural heritage. These include developing apps that provide virtual tours of historical sites, interactive genealogy services, and platforms for preserving oral traditions. It is about using technology to bridge the past and the future. P12 summarised the approach to balancing technology and culture:

“Our smart city isn’t just about implementing cutting-edge technology. It is about creating a city that reflects our values, preserves our heritage, and enhances the quality of life for all our citizens”. (P12)

Participants clearly conceived S-Cit technology to be a means to this end, and not an end in itself.

6.7. Chapter Summary

Citizen readiness and acceptance emerged as a critical factor for successful S-Cit-Imp, affirming the earlier findings of Noori *et al.* (2020), who emphasised the importance of measuring S-Cit readiness. Managers noted a general enthusiasm for technological advancements, particularly among younger generations, but also recognised hesitations among some segments of the population. This dichotomy presents both opportunities and challenges for S-Cit planners. Privacy and data security concerns were identified as critical issues, supporting the findings of Al Nuaimi *et al.* (2015) regarding the challenges of big data applications in S-Cits. Managers acknowledged the complex nature of data security in S-Cits, emphasising the need for robust encryption protocols, clear policies on data collection and usage, and transparency in communicating these policies to the public.

Implementation strategies emphasised the importance of a phased approach, starting with smaller pilot projects to demonstrate value quickly and learn from issues before scaling up. This approach is consistent with the success factors identified by Kogan and Lee (2014) in their exploratory research on S-Cit-Ps. There is a need for flexibility and adaptability in implementation was stressed, given the rapidly evolving nature of S-Cit technologies. The role of design thinking in S-Cit development elicited varied responses from the managers. Some were enthusiastic about its potential to foster innovation and creative problem-solving, while others expressed reservations about integrating it into existing processes. This reflects the ongoing debate in S-Cit literature about the balance between technological and human-centred approaches (Yigitcanlar, 2017). When discussing the roadmap for S-Cit-Imp, managers emphasised the need for flexibility, stakeholder engagement, and a long-term vision. The importance of balancing short-term deliverables with long-term goals was

highlighted, as was the need to align S-Cit initiatives with the broader national vision in Qatar.

Overall, while there is general enthusiasm for the potential of S-Cits, managers are facing significant challenges in areas such as citizen acceptance, data privacy, system integration, and cultural preservation. The findings highlight the need for a holistic, flexible approach to S-Cit development that balances technological innovation with social and cultural considerations. As Qatar moves forward with its S-Cit ambitions, the insights from these interviews underscore the importance of continuous stakeholder engagement, adaptive implementation strategies, and a clear focus on delivering tangible benefits to citizens while preserving cultural identity and addressing privacy concerns, aligning with the success factors identified in S-Cit literature.

Figure 6.1 summarises the key qualitative insights gained from the analysis unpacked in this chapter.

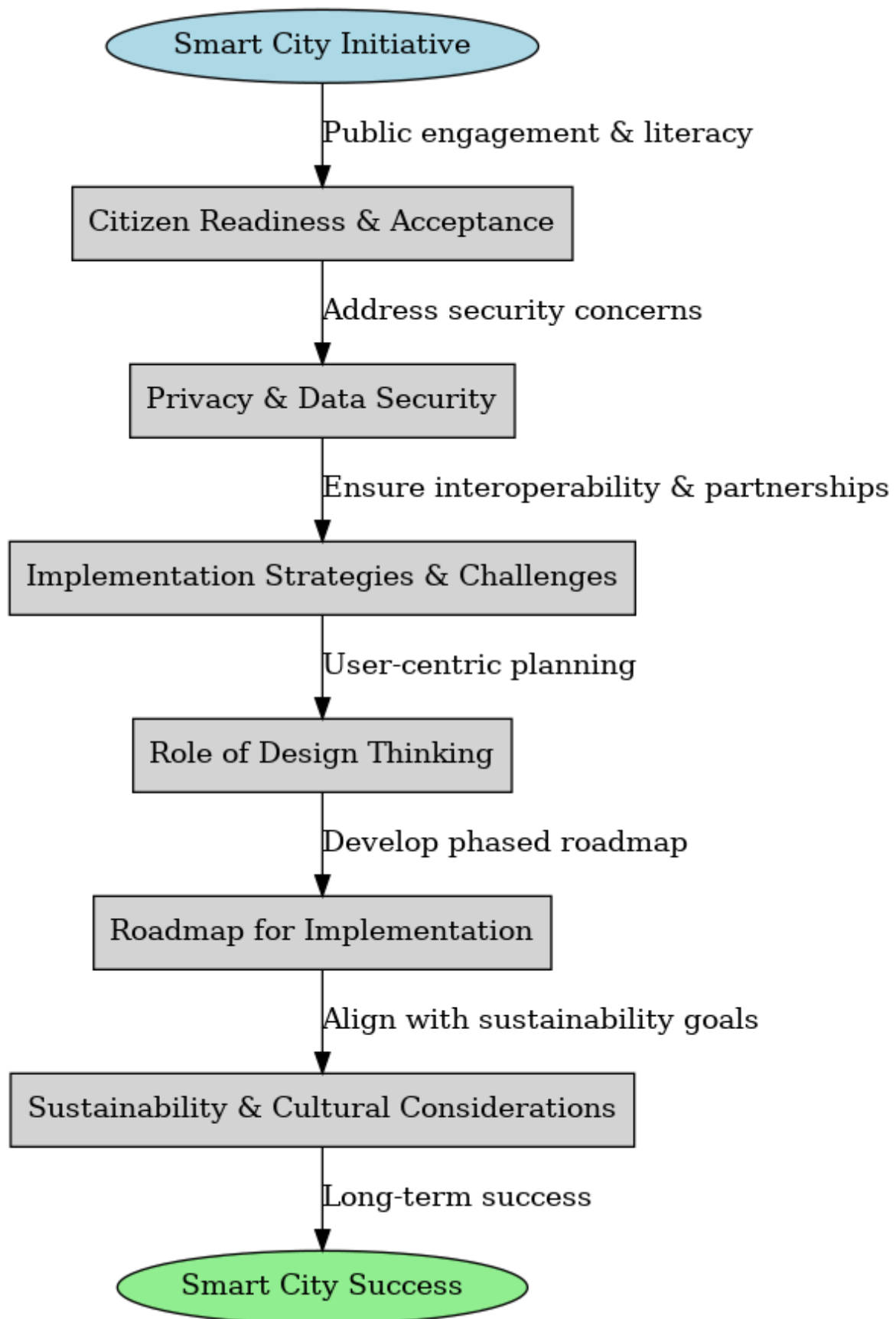


Figure 6.1: Summary of key results

Source: Author

7.

Development of the Conceptual Framework

7.1. Introduction

This chapter discusses the collected and analysed primary quantitative and qualitative data, and compares the emergent empirical findings in relation to existing literature.

Empirical findings highlight considerable latent support for S-Cit-Adn among participants, which is attributable to various S-Cit-Eco parameters. Economic and business environment support is related to increased productivity and innovation, entrepreneurialism, career development, networking opportunities, and long-term QoL improvement associated with S-Cit-Eco.

Awareness of perceived governance support for S-Cits in Qatar was also palpable, manifest in the holistic approach of investing in digital literacy, partnership with educational institutions, and public awareness campaigns for S-Cit-Adn. Citizen engagement toward S-Cit-Eco was familiar to participants, which is an essential prerequisite according to the literature, along with technological infrastructure, mobility, living environment, resource management, healthcare facilities, educational institutions and cultural sensitivity. Reduced traffic, cleaner environments, and improved healthcare access are often highly conducive to citizen approbation of an S-Cit-Eco, as seen in Japan and Seoul.

Nevertheless, known challenges exist, including citizens' cultural and behavioural aspects, government commitment, and current and future citizen needs and capabilities (i.e., human-centric factors, which are of equal importance to digital and other technological factors, but which are commonly overlooked worldwide). Similarly, cyber security factors were found to be highly important according to participants), corroborating extensive literature. Data privacy and security when collecting, storing, and communicating data must be transparently addressed.

Based on these emergent findings arising from the analysis presented in Chapters 1-6, this study offers a design thinking framework for an S-Cit-Eco tailored to the context of Qatar, which is conceptually presented and discussed in detail. This new conceptual framework for understanding the pertinent factors relating the S-Cit-Adn in the context of Qatar is the most significant outcome arising from this study.

7.2. Discussion of Findings and Comparison With Extant Literature

The findings of the study indicate considerable support for S-Cit-Adn by the participants, and can be explained based on the various parameters of S-Cit-Eco. In terms of economy and business environment support, the support was visible when the participants replied that S-Cit-Eco provided them with higher productivity for their organisations, support for innovative industries, encouraged entrepreneurial growth, flexible career opportunities, and networking opportunities to support the business. Moreover, the participants also replied that the long-term focus on the improvement of QoL is also what draws citizens to the S-Cit-Eco.

In fact, the high correlation of the facilitating conditions with the citizen's readiness to accept S-Cits also provides considerable support for acceptance of smart citizens by citizens. This finding supports the results of Lam and Yang (2017), who reported that people associating with S-Cits can potentially attract new development opportunities with increased technological exposure to people as well as new business opportunities. It also shows that business environment can be enhanced in the S-Cit-Eco with favourable conditions such as those of innovative industries, entrepreneurship support, career opportunities and networking opportunities.

In terms of the governance aspect of S-Cits, considerable support was observed from the qualitative as well as quantitative data collected from the participants. The participants acknowledged the equity in policies and enhanced engagement with the government in an S-Cit-Eco. Moreover, the holistic approach by the government such as investment in digital literacy, partnership with educational institutions, and campaigns highlight the sincere and inclusive approach to enhance the facilitating conditions and promote effective and efficient governance towards S-Cit-Adn. Evidence for engagement with citizens was also reported in the primary data, thereby highlighting the efforts undertaken to promote smart governance. This aspect is also consistent with the smart governance as a crucial factor for S-Cit-Adn as pointed out in the findings of Anindra *et al.* (2018). Moreover, Kim and Kim (2021) also emphasised the importance of civic participation and governance factors towards acceptance of S-Cits.

In terms of the ecosystem of S-Cits, the responses indicated that an environment supported with the technological infrastructure comprising of mobility, living environment, resource management, healthcare facilities, educational institutions and cultural facilities, among others, provides for a larger acceptance among the citizens. In fact, the response pointed out that tangible benefits such as reduced traffic, cleaner environment, and improved healthcare access often presents a convincing argument for citizens to adopt the S-Cit-Eco. This finding is also supported in academic literature, as Noori *et al.* (2020) reported that citizen readiness can be assessed using the parameters of urban transition, technology

readiness, socio-economic readiness and the factors are crucial towards acceptance of S-Cits by the citizens.

The findings of this study resonate with the context of Kashiwanoha in Japan, where it was reported that that smart health strategies facilitated through the S-Cit-Adn, coupled with monitoring and education have the potential for behavioural change and work towards tackling social problems (Trencher and Karvonen, 2019). Moreover, the case study of the Smart Seoul 2015 project also highlighted that focus on human-centric experience is a key towards S-Cit-Adn ecosystem, which was evident in a more inclusive approach by strengthening governance, administration, economy, and overall QoL for the citizens (Yoo, 2021).

Even though the above factors of S-Cits have seen considerable support towards acceptance by citizens, the participants also highlighted the challenges related to implementation of S-Cit-Eco. In this regard, the participants pointed out that the culture, behavioural aspects of citizens, and commitment from the government played a crucial role to ensure success in S-Cit-Imp. Furthermore, the expectations of the prospective residents are also a crucial factor for adoption of digital technologies in S-Cits, considering that the citizens have become technology savvy due to the widespread adoption of ICTs, especially with the use of smartphones on a daily basis. This calls for a thorough assessment of the human-centric factors which can impede the implementation of the S-Cits.

This was also highlighted by Kogan and Lee (2014) who argued that even though the role of ICT in S-Cits is important, it is not a sufficient condition for the transformation of a conventional into an S-Cit. The authors highlighted that the governance and the engagement of citizens as critical factors for the success of a S-Cit-P. Moreover, other researchers have also pointed out the importance of the human factors as users of the technologies and agents of change enabling the shift towards S-Cits (Bughin *et al.*, 2010; Novita and Supranoto, 2019; Yigitcanlar and Lee, 2014s). These findings clearly assert the importance of the confluence of the technological and human centric aspects to enhance the readiness as well as S-Cit-Adn.

While the different factors of S-Cits, such as the economy and business environment, governance, mobility, and environment, are crucial for implementation and acceptance of S-Cits, the most important aspect highlighted by the participants were the cyber security factors. This was reflected in the positive correlation of the different variables related to cyber security such as availability of privacy and data security, behavioural intention in adopting privacy and data security practices, confidentiality of data and privacy, and resilience of privacy and data security with the variable of citizens' readiness to accept S-Cits for both the datasets. Notably, the correlation of the above factors of cyber security with the variable of citizens' readiness to accept S-Cits was higher for experts' groups, thereby

indicating that experts advocated higher cyber security measures for enhancing citizen readiness to adopt S-Cits.

The qualitative data from the research participants also provided evidence of the concerns related to sensitive data generated from various data sources such as sensors, applications, and other user interfaces and the need to safeguard the sensitive data. Moreover, the participants also highlighted the need for creating an ecosystem where information security becomes a responsibility for all the stakeholders. These findings have also found considerable support in academic literature where it has been pointed out that security and privacy issues for citizens need to be top priority when designing an S-Cit-Eco for preventing application attacks (Cui *et al.*, 2018; Khatoun and Zeadally, 2017).

It should be noted that the issue of privacy and security is not merely a perceptual one; cyber threats are indeed existential *threats*, and pose significant social, economic and physical risks, as attested by actual cyber security breaches, as described by Baig *et al.* (2017) and Mohammadpourfard (2021). In addition, the interconnected systems also present significant challenge for S-Cit-Imp, considering that any breach at a vulnerable point can impact the whole system (Braun *et al.*, 2018; Elmaghraby and Losavio, 2014; Rao and Deepak, 2022). The participants also highlighted the need for robust policies and regulatory framework to deter privacy and security related breaches, which affirms previous empirical studies' findings (Ismagilova *et al.*, 2019; Kitchin, 2014).

7.3. Design Thinking Framework for Smart City Ecosystem

The design thinking approach was found to be a prominent theme in the response provided by the participants. The participants (primarily managers) acknowledge that the use of design thinking can help them to conceptualise the S-Cit-Eco by adopting a confluence of technological as well as human centric perspective. The participants also replied that the use of design thinking can help in innovation and problem-solving approach towards various aspects of S-Cits such as waste management, transportation, and healthcare. Moreover, the participants also acknowledged that the non-linear and iterative process of design thinking helps in understanding the challenges to S-Cit-Imp and tackle the requirements which are not clearly defined. The use of design thinking for S-Cit is logical, considering that S-Cit-Eco comprises of various interconnected systems and multiple interacting stakeholders, such as citizens, government, businesses, and service providers, among others.

However, it is also pertinent to note that even though design thinking offers innovative approach to understanding the challenges related to the implementation of S-Cits, the stakeholders involved in conceptualisation of the S-Cits need to keep an open mind to address the different challenges in the process of enhancing the acceptance of S-Cits. Moreover, the stakeholders can encourage an open innovation process which encompasses

involvement of multidisciplinary teams to identify and address the broad range of issues related to the S-Cit-Adn. In essence, the findings highlighted that the design thinking approach provides a high learning curve and a flexible approach to conceptualisation of S-Cits. Nevertheless, the challenges to adopting the design thinking approach such as too much focus on ideation, time consuming process, and challenges in stakeholder buy-in were also crucial points highlighted in the data collected from the participants.

The S-Cit conceptualisation from the perspective of design thinking is also acknowledged in academic literature. For instance, Lom and Pribyl (2021) pointed out that S-Cit-Ecos are complex systems that are interconnected with various components such as citizens, businesses, services, government, infrastructure and technology ecosystem. Hence, the authors assert the need for innovative solutions to the challenges faced in implementation of the S-Cits. Furthermore, the human centric perspective is also studied and reported by researchers who have argued the need for S-Cit betterment through involvement of communities and social engagement among the residents of the S-Cit (Di Bella, 2015; Kumar *et al.*, 2016). Hence, the findings of the study with respect to the different aspects of S-Cit-Imp and its acceptance can be viewed from the perspective of design thinking, thereby proffering useful insights, as supported by the extant literature.

7.4. Presentation of Framework

7.4.1.Overview

Building on the emergent empirical findings of this research, situated in the context of previous literature, the formulation of this study's conceptual framework followed a logical progression, as adumbrated below and presented in Figure 7.1:

- Identify the aim and objectives of the research in order to define the boundaries and bring focus to the research.
- Carry out a literature review to understand the prior research done in the chosen field of investigation.
- Use a structured research methodology and identifying the appropriate choices within the framework comprising of research paradigms, research approach, research strategy, methodological choice, time horizon, and data collection techniques.
- Analyse primary data and presentation of research findings, thereby leading to the formulation of conceptual framework for S-Cit-Imp.

The primary focus of this study has been to understand the various aspects of S-Cits and to assess the extent of adoption by the citizens by using the design thinking framework. For

this purpose, qualitative and quantitative data was collected, and data analysis was carried out respectively to explore the key elements of an S-Cit-Eco and assess their influence on the acceptance of S-Cits among citizens in Qatar, with a specific focus on privacy and data security concerns. Based on the findings, the following framework (Figure 7.2) is presented to cover the essential elements of S-Cit-Eco using the design thinking framework.

The proposed framework comprises three interrelated elements that mirror the stages of the design thinking process: “the art of possible”, “user experience and empathy”, and “adoption and future vision”. Each component emerged through a rigorous and iterative research process combining an extensive literature review, quantitative survey analysis, qualitative interviews with stakeholders, and case study insights from S-Cit initiatives in Qatar (particularly Lusail and Msheireb). Each of the six preceding chapters helped to define the framework components, as shown in Table 7.1, and described in the following section.

Table 7.1: Framework components in relation to thesis chapters

Framework Component	Description	Related Chapters
The Art of Possible	Reviewing international S-Cit case studies (Amsterdam, Seoul, and Japanese projects), establishing the importance of integrated systems, proactive governance, and sustainability-focused technology strategies	Chapter 2
	Empirical results confirmed the mapping of citizen opinions to key domains as per the Giffinger and Gudrun (2010) framework (Smart Economy, Smart People, and Smart Governance)	Chapter 4
	Privacy-related apprehension is highly important, especially concerning data collection and storage; robust cybersecurity assessments and trust are essential from the ideation phase.	Chapter 5
	Expert interviews affirm that the roadmap provides a clear, action-oriented strategy for moving from ideation to design, balancing ambition with feasibility.	Chapter 6
User Experience and Empathy	Relating to “prototype” and “test” stages of design thinking, qualitative S-Cit stakeholder interviews emphasised the importance of empathy-driven design and stakeholder engagement; advanced technological infrastructure; and mixed levels of citizen readiness, particularly concerning trust and awareness of S-Cit benefits.	Chapter 6, Chapter 4
Adoption and Future Vision	Relating to the “implement” phase of design thinking, long-term sustainability and adaptability were highlighted by empirical and literature findings. According to survey and interview data, trust is essential for data security and service reliability. Citizens and S-Cit managers consider transparent data governance frameworks to be critical for sustained adoption. S-Cits must <i>evolve</i> dynamically, alongside technological advancements and shifting societal needs. Interviewees emphasised the need for continuous feedback loops and governance adaptability (cf. Seoul’s updated strategy), with agile governance incorporating feedback and reviewing performance metrics. Learning from Qatar’s practical experiences (e.g., Lusail’s digital divide and Msheireb’s branding sustainability) can to shape sustainable policies, with knowledge-sharing structures and policy documentation.	Chapter 5, Chapter 6

Source: Author

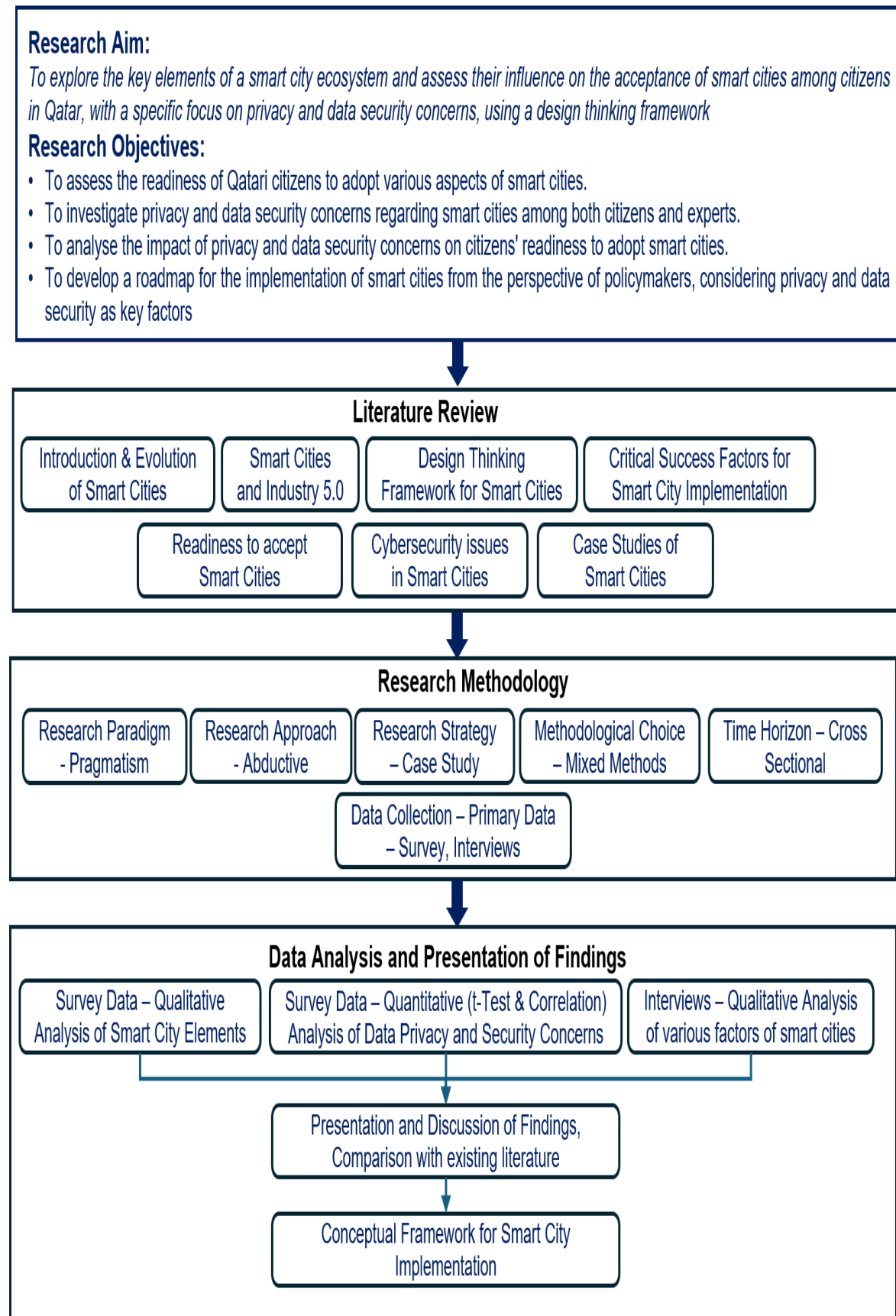


Figure 7.1: Steps in developing the conceptual framework

Source: Author

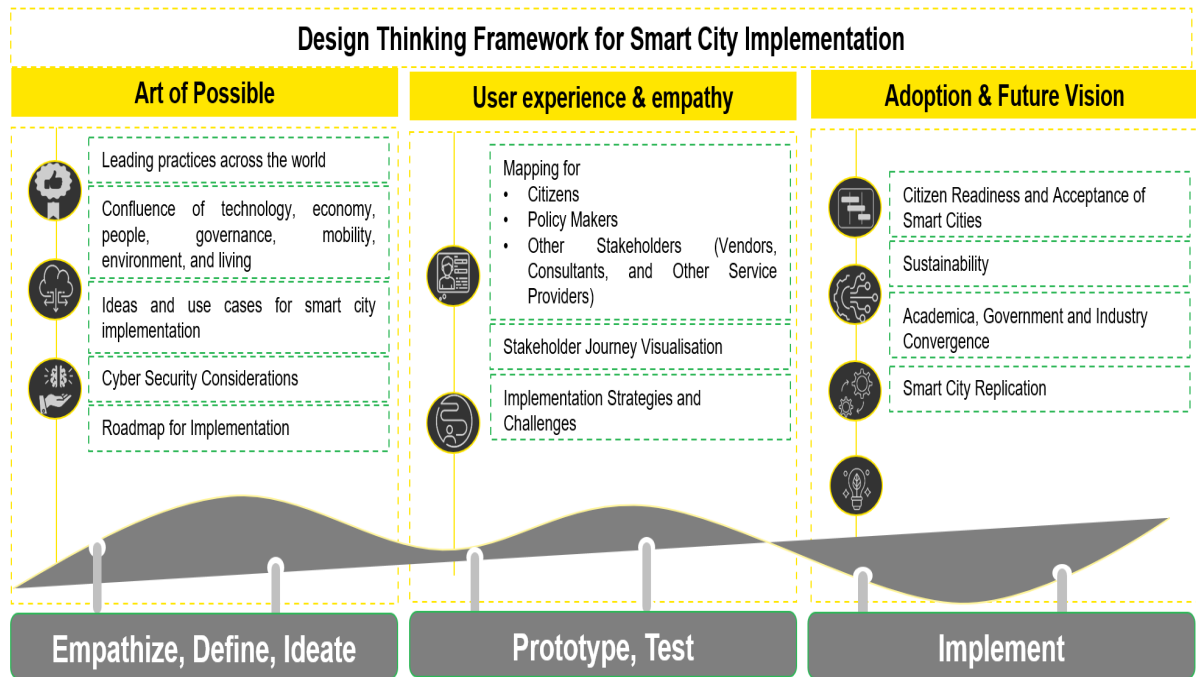


Figure 7.2: Proposed framework

Source: Author

7.4.2. Framework Components

7.4.2.1. *The Art of Possible*

This element aligns with the “empathise”, “define”, and “ideate” stages of the design thinking framework. Its foundation was established through a dual approach—synthesising global best practices and interpreting local contextual needs, as revealed in both the literature and early stages of data collection. Reviewing international S-Cit case studies, such as the cases of Amsterdam, Seoul, and various Japanese projects (as reviewed in Chapter 2), helped establish the importance of integrated systems, proactive governance, and sustainability-focused technology strategies. Primary research further reinforced these findings. Interviews with Qatari S-Cit planners and project managers highlighted that the initial phase of any S-Cit-P in Qatar must begin with benchmarking—examining and adapting international models to local needs.

The Giffinger and Gudrun (2010) framework, which defines key domains such as Smart Economy, Smart People, and Smart Governance, proved to be an effective baseline. These domains were confirmed through the survey results in Chapter 4, where citizens rated various dimensions of S-Cit development and their perceived readiness for engagement. Moreover, participants frequently emphasised cybersecurity and data privacy as foundational concerns. As detailed in Chapter 5, privacy-related apprehensions—particularly regarding data collection and storage—were viewed as early determinants of trust. These insights informed the need to include robust cybersecurity assessments within the ideation phase.

Contextual findings from Msheireb underscored the complexity of embedding advanced technological solutions within the bounds of local culture and existing infrastructure. Stakeholders pointed out that high-tech solutions without cultural sensitivity could hinder acceptance and use. Therefore, this phase culminates in the development of a strategic roadmap—a deliverable that incorporates benchmarking, contextual adaptation, legal considerations, and visionary planning. As suggested in multiple expert interviews (Chapter 6), this roadmap provides a clear, action-oriented strategy for moving from ideation to design, balancing ambition with feasibility.

7.4.2.2. *User Experience and Empathy*

The second element corresponds to the “prototype” and “test” stages of design thinking. This phase was shaped primarily by findings from the qualitative interviews with stakeholders involved in S-Cit initiatives (Chapter 6), which consistently emphasised the importance of empathy-driven design and stakeholder engagement. While the technological infrastructure in Qatar was perceived as highly advanced, survey responses showed a mixed level of citizen readiness, particularly in relation to trust in digital services and awareness of S-Cit benefits (section 4.3). This gap in perception and expectation illuminated the need for a

more inclusive and iterative engagement process. Through qualitative data, a strong case emerged for the implementation of persona development and stakeholder journey mapping as tools to better understand the goals, behaviours, and pain points of diverse user groups—including both Qatari nationals and expatriate communities. The diversity of user experience in Qatar necessitates a design approach that is nuanced, adaptive, and transparent.

In response, this framework element includes co-design sessions, workshops, and prototype testing to bridge understanding between planners and users. These practices allow stakeholders to engage with conceptual models before full implementation, facilitating early feedback and buy-in. The theoretical basis for this approach is drawn from Lee *et al.* (2014), who stressed the importance of citizen partnership in urban innovation. Moreover, the shift in Seoul's S-Cit strategy—from a purely technological to a human-centric approach—serves as a model for integrating empathy into urban planning.

7.4.2.3. Adoption and Future Vision

The final element aligns with the “implement” phase of design thinking and focuses on long-term sustainability and adaptability. This element was heavily influenced by both empirical findings and literature concerning the challenges of maintaining momentum in S-Cit initiatives. Survey data and interviews revealed that adoption is contingent on continued citizen trust, especially in areas like data security and service reliability. As documented in Chapters 5 and 6, citizens and S-Cit managers alike identified transparent data governance frameworks as critical to fostering and sustaining adoption. Furthermore, this phase recognises that S-Cits must evolve alongside technological advancements and shifting societal needs.

Interviewees emphasised the need for continuous feedback loops and governance adaptability, echoing Seoul's updated strategy and iterative policy model. Agile governance, as defined by the ability to incorporate new stakeholder feedback, review performance metrics, and revise services accordingly, is a cornerstone of this element. This element also draws from Qatar's practical experiences (e.g., Lusail's issues with digital divide and Msheireb's success in branding sustainability), to shape policies that are both aspirational and grounded in reality. Adoption and future vision must therefore be supported by knowledge-sharing structures and policy documentation that allow future projects to replicate success while avoiding prior pitfalls.

7.5. Chapter Summary

This chapter has collated and analysed the findings emerging from the quantitative and qualitative survey and focus group data presented in previous chapters, discussing them in relation to reviewed literature. Based on the emergent findings, the chapter presented the conceptual framework for S-Cit-Imp in Qatar arising from this research. The following

chapter evaluates the initial design thinking framework for S-Cits and validates it based on the research findings.

8.

Framework Evaluation

8.1. Introduction

This chapter evaluates the proposed framework for S-Cit-Imp, which is based on the empirical quantitative and qualitative insights derived from the analysis unpacked in the previous chapters. The evaluation was carried out from the perspective of existing literature, empirical findings, and expert evaluation with respect to the different elements of S-Cits considered for the study.

8.2. Overview

8.2.1.Theoretical Underpinning

The theoretical framework for S-Cit-Imp presents a holistic approach to navigate the different stages of conceptualisation, testing and implementation of S-Cits, by adopting a mixed methods approach involving quantitative data through surveys and qualitative data through interviews of the participants. The three elements of the framework provide insights on the steps needed to ensure smooth implementation of S-Cits. The first stage of “art of possible” creates a conceptual image of S-Cits by studying the leading practices, and visualising the confluence of different elements of technology, economy, people, governance, mobility, environment, and living standards.

This was also pointed out by Giffinger and Gudrun (2010) who identified smart economy, smart people, smart governance, smart mobility, smart environment, and smart living as essential components of S-Cit-Eco. The consideration of these elements is essential as these form core elements in the S-Cit-Eco and any conceptualisation of S-Cits would require the dynamics of these elements to be studied thoroughly for ensuring S-Cit-Adn ecosystem by the different stakeholders. Furthermore, the researcher also highlights the confluence of these elements presents a comprehensive view of conceptualising S-Cits. This aspect is also supported by De Santis *et al.* (2014), who pointed out that the balance between the characteristics ensures that the S-Cit provides benefits for both the people and the environment while contributing positive effects for the country in economic and social aspects.

8.2.2.Case Analysis

Moreover, the need for studying the leading practices also ensures that lessons from successes and failures of S-Cits across the world are incorporated. This was reflected in the study of S-Cits in Japan such as Tokyo, Yokohama, Osaka, and Kyoto, as well as Seoul in South Korea (Khatoun and Zeadally, 2016; Lai *et al.*, 2020; Yoo, 2021). Learning from each

of these cases helped to identify the success factors that lead to S-Cit-Adn, hence the study of leading practices is included in the proposed framework.

8.2.3.Cybersecurity and Data

Another key element and area of focus is the cybersecurity consideration, primarily due to the reason that technology will be the main catalyst in the S-Cit-Eco and hence, vulnerabilities in technologies, especially related to privacy and data security needs to be highly prioritised. This will not only provide confidence to the citizens to adopt the different services of S-Cits but will only assert the capabilities of the governance team to ensure that there are no loopholes in the system. The inclusion of cyber security in the framework was warranted considering its importance in modern day technology adoption, and more specifically in the S-Cits.

The risk of interconnected S-Cit was also discerned by Kitchin and Dodge (2020), who reported that vulnerabilities in the S-Cit infrastructure have the potential to put the entire city at risk. It can not only steal sensitive information but can halt the functioning of S-Cits, primarily due to the interconnectedness of utilities, transport, and healthcare systems, among others. Furthermore, Cui *et al.* (2018) also highlighted that security and privacy issues for citizens need to be top priority when designing an S-Cit-Eco for preventing application attacks, as traditional cybersecurity prevention measures may not be effective in an S-Cit environment. This is because of the heterogeneity, scalability, and interconnectedness of S-Cit systems themselves, in addition to the volume and nature of data collected by smart sensors and systems.

In addition, Mijwil *et al.* (2022) highlighted that without adequate cybersecurity measures, S-Cits cannot be implemented effectively to fulfil the requirements of the citizens as well as to integrate the different prerequisite aspects of urban living, such as with regard to mobility, health, governance, and economic production, among others. Similarly, Alamer and Almaiah (2021) also pointed out the direct relationship between technology adoption and cybersecurity threats and highlighted that the cybersecurity threats need to be addressed on a proactive basis to ensure an effective and efficient use of technology. These findings from academic literature assert the inclusion of the different elements in the “art of possible” stage in the proposed framework.

8.2.4.Stakeholders

The second element in the framework is essential to involve the users in the S-Cit experience by providing an overview of the services and the need to shift to an S-Cit-Eco. This aspect is important to identify the needs and perceptions of the different stakeholders such as citizens, policy makers, and businesses and their expectations from S-Cits. The main purpose of this element is that the stakeholders should have an idea of the S-Cit-Eco, and the policy makers need to ensure active citizen participation in prototype phase.

Moreover, this element will also bring out the challenges in implementing various aspects in S-Cit-Eco based on the prior experience, skills and knowledge of the stakeholders.

In this regard, Kamolov and Kandalintseva (2021) reported that the digital literacy, clear objectives, and targets of the digitisation process, as well as financial and organisational resources, contribute to enhancing the S-Cit readiness of local and national institutions when viewed from the perspective of the policy and lawmakers. Moreover, Chatterjee and Kar (2018) also pointed out that population shift from rural to urban areas in the case of emerging economies requires the state to develop sufficient expertise in educating the potential users of S-Cit services as a critical step toward enhancing the city's readiness to withstand any possible emerging problems. This requires a concerted effort among the decision makers to involve citizens and apprise them about the S-Cits to ensure success in adoption.

From the citizen's perspective, Noori, de Jong and Hoppe (2020) identified that citizen readiness can be assessed using the parameters of urban transition, technology readiness, socio-economic readiness, and political readiness. This view is also supported by Wieczorek (2018) who stated that ecological modernisation of cities requires an alignment of the expectations, resources and interests of the network of actors within this ecosystem. This can also be emphasised as focusing on the linkage between local, regional and national levels to adhere to the vision of the S-Cit and ensure that the different levels are aligned to realise the vision and goals. Hence, the collaboration of the different stakeholders and the stakeholder journey becomes an inherent part of S-Cit conceptualisation and implementation. These findings from academic literature assert the inclusion of the different elements in the "user experience and empathy" stage in the proposed framework.

8.2.5.Implementation and Sustainability

The final element in the framework essentially relates to the implementation and sustainability of the S-Cits. The issue of sustainability has long been discussed in academic literature. In fact, studies between 2000-2005 where S-Cits were termed as "ubiquitous cities" and focused on solving urban problems with a key focus on sustainability of these services. However, it was not until the 2000s that the sustainability issues were reported by studying from the perspective of convergence of interdisciplinary approach related to human and social capital, environmental aspects, and community psychology to ensure that sustainable S-Cits could be created (Andrisano *et al.*, 2018; Dameri, 2017).

Subsequent research has also emphasised on the convergence of various factors such as infrastructure, economy, society, community, environment, and governance act as pillars of S-Cits and should be focused on sustaining the S-Cit-Eco. Moreover, Kasinathan *et al.* (2022) also highlighted the need for convergence of academia, industry and government to ensure success in S-Cit-Adn and ensure that they provide sustainable solutions to citizens.

These findings from academic literature assert the inclusion of the different elements in the “adoption and future vision” stage in the proposed framework.

8.3. Empirical Evaluation

The empirical evaluation of the proposed framework for S-Cit-Adn was undertaken by analysing the primary data collected from the participants. For this research, primary data was collected through qualitative and quantitative data collection methods. The quantitative data was gathered through a survey questionnaire to capture specific aspects of S-Cit living, as well as the readiness of the Qatari citizens to adopt S-Cits. The collected primary quantitative data was analysed using statistical package SPSS. In addition, qualitative data was collected through semi-structured interviews.

The survey analysis revealed positive perceptions of S-Cit-Adn among Qatari citizens. The survey analysed the key components of S-Cit-Eco such as smart economy, smart people, smart governance, smart mobility, smart environment, and smart living along with the citizen readiness. The positive response is aligned with the elements which emphasize the confluence of technology, economy, people, governance, mobility, environment and living within the “art of possible” phase of the proposed framework. Moreover, the statistical test of independent sample t-test and correlation reveal a strong and positive correlation between S-Cit variables and citizens’ readiness to accept S-Cits. The strong correlations across different variables indicate that a holistic approach to S-Cit development, considering all these factors, is likely to be most effective in gaining citizen acceptance and participation.

Another key finding is that performance expectancy has a strong influence on app- use intentions and S-Cit service adoption. This implies that involvement of the stakeholders to understand the expectations and accordingly offer the services in the S-Cit-Eco becomes crucial towards ensuring S-Cit-Imp. These findings assert the need for user experience and empathy and providing stakeholder visualisation of the S-Cit-Eco. Hence, the findings from the study are aligned with the “user experience and empathy” phase of the proposed framework and is asserted by the empirical findings of the study.

Finally, the analysis of qualitative data reveals that citizen readiness and acceptance are critical factors for successful S-Cit-Imp. Moreover, the findings indicate the importance of a phased approach, starting with smaller pilot projects to demonstrate value quickly and learn from issues before scaling up to ensure sustainability of S-Cit-Eco. The findings also emphasise the importance of delivering tangible and meaningful benefits to citizens, thereby contributing to citizen readiness and acceptance. In addition, the adoption of design thinking framework for implementation of S-Cits was the underlying framework based on which the researcher has proposed this framework. Hence, the findings from the study are aligned with

the “adoption and future vision” phase of the proposed framework and is asserted by the empirical findings of the study.

8.4. Expert Evaluation

Building on the consistent theoretical framework used to gather and analyse data in this research, the developed conceptual framework was evaluated by experts to cross-verify its applicability with respect to S-Cit-Imp. The study engaged a team of five experts with experience in different aspects of S-Cit-Imp, such as planning, governance, data privacy, design thinking approach, and social experts and conducted an interview to understand the success factors of S-Cit-Imp. Table 8.1 summarises the salient issues raised by the expert panel evaluators concerning S-Cit conceptualisation involving the design thinking framework.

Table 8.1: Expert involvement and evaluation responses for the proposed framework

Expert	Key Points from Interview
1 Urban Planning	✓ Technology must support scalability and real-life scenarios. ✓ Integration of various S-Cit dimensions (technology, governance, economy, mobility, and people) is a major challenge. ✓ Learning from past implementations is crucial. ✓ Trust and cybersecurity are critical. ✓ Stakeholder involvement across all stages ensures inclusiveness and accountability.
2 Cybersecurity	✓ Data privacy and cybersecurity are essential for building trust. ✓ Regulatory frameworks must address vulnerabilities and align with international standards. ✓ Risk management should go beyond technical measures to include audits, education, and policy collaboration. Cybersecurity should be embedded in design, not added later.
3 Enterprise Architecture	✓ S-Cits require unified, interoperable systems rather than isolated technologies. ✓ Flexibility and adaptability of technology platforms are key. ✓ The framework is praised for its modular, iterative nature. ✓ Enterprise architecture should also align with policy and governance needs.
4 Policy Planning	✓ Effective planning starts with clear policy goals aligned with national strategies. ✓ Cross-ministerial and regulatory coordination is vital. ✓ Siloed initiatives often fail. ✓ The stakeholder-driven nature of the framework supports cross-domain alignment.
5 Stakeholder Consultation	✓ Localisation is crucial—projects must reflect regional socio-economic and cultural contexts. ✓ Stakeholder engagement should be continuous and meaningful. ✓ The design thinking approach supports adaptive, people-centric planning. ✓ Solutions must be scalable, cost-effective, and clearly beneficial to citizens. ✓ Prototyping and testing reduce implementation risks.

Source: Author

In the interview with Expert 1, an urban planning professional, the discussion centred on the practical aspects of integrating various dimensions into the conceptualisation and implementation of S-Cits. He emphasised that while technology plays a pivotal role, its architecture must be designed to accommodate real-life scenarios and ensure scalability. A key concern raised was the challenge of integrating diverse elements—such as technology, governance, economy, mobility, and people—into a cohesive plan. According to the expert, success in integration often hinges on the ability to learn from previous S-Cit-Imps. Trust, particularly in data use and system security, emerged as a recurrent theme, where he advocated for robust cybersecurity infrastructure. Stakeholders—including government bodies, citizens, consultants, and vendors—must be involved across all stages, ensuring both inclusiveness and accountability.

Expert 2, specialising in cybersecurity, highlighted the critical role of data privacy and security in S-Cit-Ecos. She pointed out that as S-Cits collect and process vast amounts of citizen data, establishing trust through robust cyber governance is non-negotiable. There was a clear emphasis on developing regulatory frameworks that address potential vulnerabilities and ensure compliance with international standards. Additionally, she underlined the need for proactive risk management strategies that go beyond technical safeguards, calling for regular audits, stakeholder education, and collaborative policy development. The proposed framework, in her view, is most effective when cybersecurity is embedded from the design phase rather than being an afterthought.

Expert 3, whose background is in enterprise architecture, discussed the alignment between technical systems and S-Cit goals. He argued that S-Cits cannot function as disconnected technological islands; rather, they require a unified architecture that supports interoperability and data exchange across domains. The challenge, as identified, lies in orchestrating various technology platforms to work harmoniously while remaining flexible enough to evolve over time. He praised the proposed framework for its modular and iterative nature, noting its potential to accommodate both legacy systems and emerging technologies. Enterprise architecture, in this context, must not only consider technical infrastructure but also policy alignment, governance protocols, and long-term adaptability to new urban needs.

Expert 4, with expertise in policy planning, approached the S-Cit discourse from a governance and regulatory standpoint. According to her, effective S-Cit planning must begin with clearly defined policy objectives that are aligned with national development strategies. One of the main insights from this conversation was the importance of cross-ministerial coordination and the inclusion of various regulatory bodies in the early design phase. She noted that many S-Cit initiatives fail because they operate in silos, lacking an overarching governance structure. She found the design thinking-based framework compelling due to its stakeholder-driven approach, which naturally encourages alignment across policy domains.

Finally, Expert 5, an S-Cit consultant with global experience, emphasised the need for localisation in S-Cit-Ps. Drawing from experiences in diverse contexts, the expert highlighted that S-Cit success depends on how well the project is tailored to the unique socio-economic and cultural characteristics of a region. The expert stressed the importance of stakeholder engagement not just as a formality, but as a continuous process that shapes the evolution of S-Cit initiatives. From his perspective, the proposed framework's grounding in design thinking allows for adaptive and people-centric planning, which is crucial in dynamic urban environments. He also pointed out that innovation in S-Cits must be balanced with practicality—solutions must be scalable, cost-effective, and clearly communicate benefits to citizens. For this reason, he endorsed the framework's emphasis on prototyping and testing, which was viewed as an essential tool for reducing implementation risk.

The experts agreed that technology is a necessary but not a sufficient criterion for S-Cit-Imp. The experts highlighted that a practical approach was needed to visualise the S-Cit-Eco which involved learning from the previous experience of S-Cits across the world and analysis of the use cases for the S-Cit conceptualisation. The expert from the planning domain highlighted that the technology architecture must be scalable due to the need for increasing the service offerings to the citizens. Other experts also concurred that a range of use cases need to be considered before preparing the technology architecture and visualisation of the entire S-Cit-Eco.

The experts from various departments also pointed out the need to consider various elements such as technology, economy, people, governance, mobility, environment and living when designing S-Cits. The need for a robust cybersecurity mechanism was highlighted by the data privacy expert who highlighted the integrated nature of the S-Cit-Eco and the need to protect the privacy and security of citizens, especially where personal and sensitive information is involved such as healthcare records. The involvement of the users when designing the S-Cit-Eco was highlighted by almost all the experts.

This aspect was more emphasised by the social expert, who pointed out that engaging the stakeholders including the citizens leads to a collaborative approach wherein all the participants can share their experiences as well as expectations from the S-Cit-Eco. This helps in visualising the functioning of smart ecosystem as well as identifying the challenges that can be faced during implementation. Therefore, the need for stakeholder collaboration and discussion of the various aspects of S-Cit-Eco is consistent with the second element of the proposed framework for S-Cit-Imp.

Finally, there was a consensus among all the stakeholders for the need for sustainability in the services of the S-Cit-Eco. This was emphasised more from the governance expert, who highlighted that the government and the policy makers have large stakes towards the success of S-Cit-Eco, considering the huge investment and the accountability of the

taxpayer funds. Therefore, a sustainable S-Cit-Eco was among the top priorities of all the stakeholders. In light of the above response by the different experts, the different elements of the proposed framework of S-Cit-Imp were asserted by the different experts.

The proposed framework of S-Cit using the design thinking framework presents a robust framework which can contribute to the conceptualisation and implementation of S-Cits in the future. Prior S-Cit-Ps such as those of Lusail and Masdar were characterised by high costs (Adalbi *et al.*, 2022; Petruccioli *et al.*, 2019). Therefore, it is imperative that a robust framework is used which can give a realistic estimate of the costs and the timelines without compromising on the quality of the ecosystem. Moreover, these S-Cits had also faced the challenge of adopting to the rapidly changing technological advancements. Hence, a robust architecture which is derived from a well-established framework such as design thinking framework can contribute towards reducing the challenges faced by the stakeholders in an S-Cit-Imp.

The proposed framework provides the integration of the design thinking framework as well as the roadmap and the elements that need to be incorporated when conceptualising an S-Cit-Eco. This framework can also prove useful for the redevelopment projects where the government can consider implementing the technological ecosystem as observed in the cases of Msheireb Downtown and Zayed Smart City Project (Alfadala and Furlan, 2018; Samad, 2018). While all these projects were driven by government initiatives such as Qatar National Vision 2030 and Digital transformation of Abu-Dhabi, it is to be understood that not all projects can be considered as being a part of government initiatives. Hence, it is important that the visualisation of the S-Cit-Ps is carried out from the sustainability perspective while considering the importance of the role of the different stakeholders.

Overall, the proposed framework can prove to be useful, especially for policy makers, government agencies contemplating S-Cits, consultants, urban planning bodies, and implementing agencies, among others. The evaluation of the framework is based on the combine the methods involving qualitative data as well as supporting findings from the existing literature. Each of the elements of the design thinking framework was evaluated to assess its suitability for the S-Cit-Imp, both from a conceptual perspective as well as a practical perspective. Hence, this framework can be proposed to the stakeholders for deliberation and subsequent adoption when considering the proposal of S-Cit-Imp. However, it is also imperative to carry out a due diligence on the feasibility of such a framework before implementing it in the context of the chosen S-Cit.

8.5. Chapter Summary

This chapter has evaluated the proposed framework of the S-Cit-Imp and situated it in the context of existing literature, collating the empirical findings from this study, including input

from key experts and stakeholders with knowledge and experience related to S-Cit-Imp. The next chapter concludes the entire research and presents the recommendations based on the findings of the study, and discusses the extent to which the research objectives have been met. In addition, it highlights the contribution of the study and its limitations, and identifies potential areas for future research to build on the emergent framework.

9.

Conclusion and Recommendations

9.1. Introduction

This final chapter summarises and concludes the entire research project presented in this thesis, and presents the emergent recommendations based on the findings. In this chapter, the researcher also discusses the extent to which the research objectives have been met by relating to literature review, data collection and analysis, and presentation of findings. Finally, the researcher highlights the contributions of this study, acknowledges its limitations, and identifies potential areas for future research in similar areas.

9.2. Contributions to Knowledge

This research makes a number of contributions to knowledge, which address the identified research gaps, as summarised in Table 9.1, and discussed below.

Table 9.1: Summary of contributions to knowledge

Research Gap	Contribution
Lack of theoretical framework universally clarifying S-Cits constituents	This thesis presents a theoretical framework of S-Cit models and projects in light of various environmental, resource-management, life quality, and sustainability issues.
Existing S-Cits models lack empirical justification in real-world application contexts, and design thinking related to contemporary S-Cit-Ps is limited	This study deconstructs the design thinking principles with relevance to with relevance to Qatar's S-Cit-Ps, and presents case-specific examples to explore this more comprehensively.
Discussion of Qatar's S-Cit initiatives is critically limited	While several studies pontificate on the scope of Qatar National Vision 2030, this study makes an extensive contribution to analyse S-Cit-Ps in the context of Qatar, and its historically unique socio-cultural contexts.
Few studies have explored the conceptualisation and creation of S-Cits with a holistic approach, to deal with the intractable problems faced in the urban infrastructure and citizen centric services, and the creation of an S-Cit-Eco in Qatar	This study applies a design thinking framework to develop a common user-centred understanding of the challenges and potential scenarios for cities aiming for "smartness" in the context of Qatar.

Source: Author

Rapid advancements in technology in recent years and the need to provide more sustainable living environments in cities have attracted significant attention from academia, industry practitioners, and the governments, including seeking to explore and apply the S-Cit-Eco. This research was undertaken with the objective of addressing the research gap on the holistic approach to dealing with the intractable problems faced in the urban

infrastructure and citizen-centric services, with a specific focus on the S-Cits in Qatar. Therefore, the findings of this study can contribute towards theoretical as well as practical perspectives.

From the theoretical perspective, the findings of the study have contributed to the existing literature by providing a framework which can potentially help the stakeholders to understand the different stages of an S-Cit-Imp using the design thinking framework, along with the various factors which influence the S-Cit-Adn. From the practical perspective, the findings of the study can be useful for stakeholders such as policymakers to understand the different elements of S-Cits as well as incorporate the framework which has been proposed in this research. The framework can potentially help companies implementing S-Cit systems to identify stakeholders and their interaction with the S-Cit-Eco.

In addition to the framework, this research has also proposed six key recommendations that can be considered by policymakers and other stakeholders (section 9.4). These recommendations provide practical guidance for improving policy, planning, and implementation of S-Cit initiatives. The benefits to the citizens from the practical perspective can be in the form of improved and robust architecture of S-Cits as well as enhanced privacy and security measures. Finally, the findings of the study can also be used to enhance the maintenance and management of existing S-Cits.

9.3. Limitations of the Research

This research project has achieved its main aim of exploring the key elements of an S-Cit-Eco and assess their influence on the acceptance of S-Cits among citizens in Qatar, with a specific focus on privacy and data security concerns, using a design thinking framework. In addition, the researcher has also achieved the defined objectives and has proposed a framework which can be used for S-Cit-Imp. However, the research entails a few limitations, as summarised below:

- The focus is limited to the context of Qatar, which intrinsically limits the generalisation of the findings.
- The sample size is relatively small (with 40 participants for survey questionnaire, and 12 participants for interviews) which could have been better.
- The ability to conduct interviews and collect quality data depends significantly on the skills of the researcher, and the empirical data collection in this study was undertaken by a novice doctoral researcher.

9.4. Conclusions

This study was carried out with the main aim of exploring the key elements of an S-Cit-Eco and assess their influence on the acceptance of S-Cits, with a specific focus on Qatar's S-Cits. This aim was determined by identifying the research gap, which entailed adopting a holistic approach to dealing with the intractable problems faced in the urban infrastructure and citizen centric services, and especially with respect to S-Cits in Qatar. The main conclusions arising from this analysis are summarised below.

- The research gaps were addressed by applying a design thinking framework to develop a common user-centred understanding of the challenges and potential scenarios for cities aiming for S-Cit-Eco in the studied national context (as summarised in section 9.2).
- The research aim and objectives (section 1.3) were achieved by developing and presenting a framework for S-Cit-Imp, via a structured approach comprising a literature review, research methodology, data collection, data analysis, presentation of findings, and conceptual framework for S-Cit-Imp.
- Economic and business environment support was manifest as S-Cit-Eco offered participants higher productivity, support for innovative industries, encouraged entrepreneurial growth, flexible career opportunities, and networking opportunities to support the business.
- Long-term focus on the improvement of QoL attracted citizens to the S-Cit-Eco. The findings confirm the importance of a smart economy as a segment of S-Cits, with respondents perceiving positive economic value additions.
- Considerable governance support was indicated by the qualitative as well as quantitative data. Participants acknowledged the equity in policies and enhanced engagement with the government in an S-Cit-Eco.
- S-Cit acceptance is facilitated by supportive technological infrastructure relating to mobility, living environment, resource management, healthcare facilities, educational institutions, and cultural facilities.
- Citizens' culture and behaviour and governmental commitment are crucial to ensure S-Cit-Imp.
- Data security concerns are vitally important, and safeguarding must be applied relating to sensors, applications, and other user interfaces.

- Successful S-Cit-Imp relies on citizens, businesses, and government adoption. While citizens may experience S-Cit living, inadequate governance can limit its full potential.

Overall, the findings support the argument that while ICT is crucial in S-Cits, it is insufficient in itself to transform conventional cities into smart ones without commensurate supporting factors.

9.5. Future Work

In light of the limitations discussed in section 9.3, there are certain areas where the scope of the study can be further extended, as described below.

- The study can be replicated in the context of other S-Cits in different countries to understand the key elements and assess their influence on the acceptance of S-Cits among citizens. This can be followed up with a comparative analysis to identify the best practices and shortcomings of different S-Cits in order to propose recommendations for S-Cit-Imp.
- The sample size can be considerably increased, in order to have a clearer understanding of the different elements of the S-Cits.
- The S-Cit-Adn can also be studied from other theoretical framework to assess the effectiveness of implementation of S-Cits.
- Interested researchers can also include more sets of participants such as policy makers, experts, vendors, and consultants to have a comprehensive understanding of the expectations related to S-Cit-Eco.

Further research in these proposed areas has the potential of contributing to both academic literature as well as practical recommendations for S-Cit-Imp, in order to improve life for urban residents and humanity and the planet as a whole, by enabling sustainable socio-economic development.

9.6. Achievement of the Research Objectives

This research was initiated based on the four key objectives, which guided the researcher for the completion of different stages. The extent to which these objectives have been fulfilled are discussed sequentially below.

9.6.1.Citizen Readiness

- ❖ “To assess the readiness of Qatari citizens to adopt various aspects of S-Cits”

This objective was identified to assess the readiness of Qatari citizens for adopting the different aspects of S-Cits. To achieve this objective, a two-pronged approach was undertaken. Firstly, the researcher carried out a literature review in the area of readiness of accepting S-Cit-Eco from the perspectives of citizens' readiness and state readiness. The review of literature indicated that the citizen readiness can be assessed using multiple parameters, some of which include urban transition, technology readiness, socio-economic readiness, political readiness, extent of adoption of technology to achieve personal, professional and social goals, social learning, participation in community events, and adoption of smart application across different fields such as transport, healthcare, education, and citizen centric governance, among others (Khansari et al., 2014; Noori, de Jong and Hoppe, 2020; Setijadi *et al.*, 2019; Surendran, 2012; Wieczorek, 2018).

The findings were then used to formulate the questionnaire to collect and analyse primary data to assess the readiness of Qatari citizens to adopt various aspects of S-Cits. The analysis of the primary data reveals new findings regarding Qatari citizens' perceptions of S-Cits and their willingness to accept them. The findings confirm the importance of a smart economy as a segment of S-Cits, with respondents perceiving positive economic value additions. The readiness was supported by the perspective of the citizens that S-Cits are sources of learning, diversity, and openness. Participants perceived that smart transportation simplifies commuting, reduces time and energy use, manages traffic congestion, and facilitates public transport use.

Overall, the findings suggest that successful S-Cit-Imp relies on citizens, businesses, and government adoption and the participants reiterated that that even though information and communication technologies are the backbone of S-Cits, they are necessary but not sufficient criteria in themselves to transform conventional cities into smart ones. Hence, based on the review of academic literature and the presentation of findings, it can be said that the objective of “To assess the readiness of Qatari citizens to adopt various aspects of S-Cits” has been achieved.

9.6.2.Privacy and Data Security Concerns – Citizens and Experts

- ❖ “To investigate privacy and data security concerns regarding S-Cits among both citizens and experts”

This objective was identified to understand the privacy and data security concerns related to the implementation of S-Cits. To achieve this objective, a critical review of literature was carried out to understand the data privacy and security related concerns related to S-Cit-Adn. It was revealed that several researchers had highlighted the growing concerns about the adoption of smart applications as they are vulnerable to cybercrime such as data theft,

spam attacks, and identity attacks, among others. Reviewed literature highlighted that cyber-attacks on S-Cit systems have the potential to cause widespread damage and loss of lives (Ismagilova *et al.*, 2019; Khatoun and Zeadally, 2017; Nayyar *et al.*, 2019). Similarly, for IoT sensors, security threats such as confidentiality of data, non-secure communication, communication interception and communication jamming are ever present on their deployment in an S-Cit environment. Moreover, Chen *et al.* (2021) also pointed out that the digitalisation of the health records presents the vulnerability to hacking or cybertheft of the personal and medical records of the individuals, thereby posing serious concern regarding the resilience of critical digital infrastructure for providing round the clock services to the citizens.

In addition to the literature review, primary data collection and analysis was also carried out which revealed positive correlation of the different variables related to cyber security such as availability of privacy and data security, behavioural intention in adopting privacy and data security practices, confidentiality of data and privacy, and resilience of privacy and data security with the variable of citizens' readiness to accept S-Cits for both the datasets. The qualitative data from the research participants also provided evidence of the concerns related to sensitive data generated from various data sources such as sensors, applications, and other user interfaces and the need to safeguard the sensitive data.

Hence, based on the review of academic literature and the analysis of primary data, as well as the presentation of findings, it can be said that the objective of "To investigate privacy and data security concerns regarding S-Cits among both citizens and experts" has been achieved.

9.6.3.Privacy and Data Security Concerns: Impact on Citizens' Adoption

Readiness

- ❖ "To analyse the impact of privacy and data security concerns on citizens' readiness to adopt S-Cits"

This objective was identified to investigate the relationship between privacy and data security concerns in S-Cits with the citizens' readiness to adopt the S-Cit-Eco. To achieve this objective, quantitative data in the form of survey was collected and the data analysis was carried out using statistical test of correlation. In addition, the researcher also carried out qualitative analysis of the interview data to analyse the perception of the participants with respect to privacy and data security concerns and that readiness to accept the S-Cits. The quantitative test of correlation revealed a high correlation of availability of privacy and data security with the citizens' readiness to accept S-Cits. Similar findings were reported between the relationship of resiliency of privacy and data security with the citizens' readiness to accept S-Cits.

The qualitative data from the research participants also provided evidence of their concerns related to sensitive data generated from various data sources such as sensors, applications, and other user interfaces and the need to safeguard the sensitive data. Moreover, the participants also highlighted the need to create an ecosystem in which information security becomes a shared responsibility among all stakeholders involved. In addition, the participants also highlighted the need for robust policies and regulatory framework to deter privacy and security related breaches, which is also highlighted in the findings in academic literature (Ismagilova *et al.*, 2019; Kitchin, 2014).

Hence, based on the analysis of primary data and the review of academic literature, it can be said that the objective of “To analyse the impact of privacy and data security concerns on citizens’ readiness to adopt S-Cits” has been achieved.

9.6.4.Implementation Roadmap Development

- ❖ “To develop a roadmap for the implementation of S-Cits from the perspective of policy makers considering privacy and data security as key factors”

This objective was identified to develop a framework which can help in preparing the roadmap for implementation of S-Cits from the perspective of policymakers, while considering privacy and data security as key factors. To achieve this objective, the comprehensive research findings were collated and a design thinking framework for S-Cit-Imp was prepared. This framework highlighted the three phases for policy makers to consider during implementation of S-Cits: “art of possible”, “user experience and empathy”, and “adoption and future vision”. This framework was based on the lines of design thinking framework and incorporates the findings of the study with a special focus on privacy and data security in S-Cits.

Phase 1: Art of Possible. This phase is characterised by studying leading practices across the world, confluence of technology, economy, people, governance, mobility, environment and living, ideas and the use cases for S-Cit-Imp, and cyber security considerations.

Phase 2: User Experience and Empathy. This phase is characterised by mapping for citizens, policymakers, and other stakeholders, stakeholder journey visualisation, and identification of implementation strategies and challenges.

Phase 3: Adoption and Future Vision. This phase encompasses citizens’ readiness and acceptance of S-Cits, sustainability, convergence of academia, government and industry, and replication of S-Cits based on the learnings of implementation.

Hence, the presentation of the framework for S-Cit-Imp has led to the achievement of the objective of “To develop a roadmap for the implementation of S-Cits from the perspective of policy makers considering privacy and data security as key factors”.

9.7. Recommendations for Smart City Implementation

The findings of the study have provided useful insights with respect to the implementation of S-Cits from various perspectives. Based on the findings of the study, the recommendations described below can be provided for S-Cit-Imp, covering the dimensions displayed in Figure 9.1.

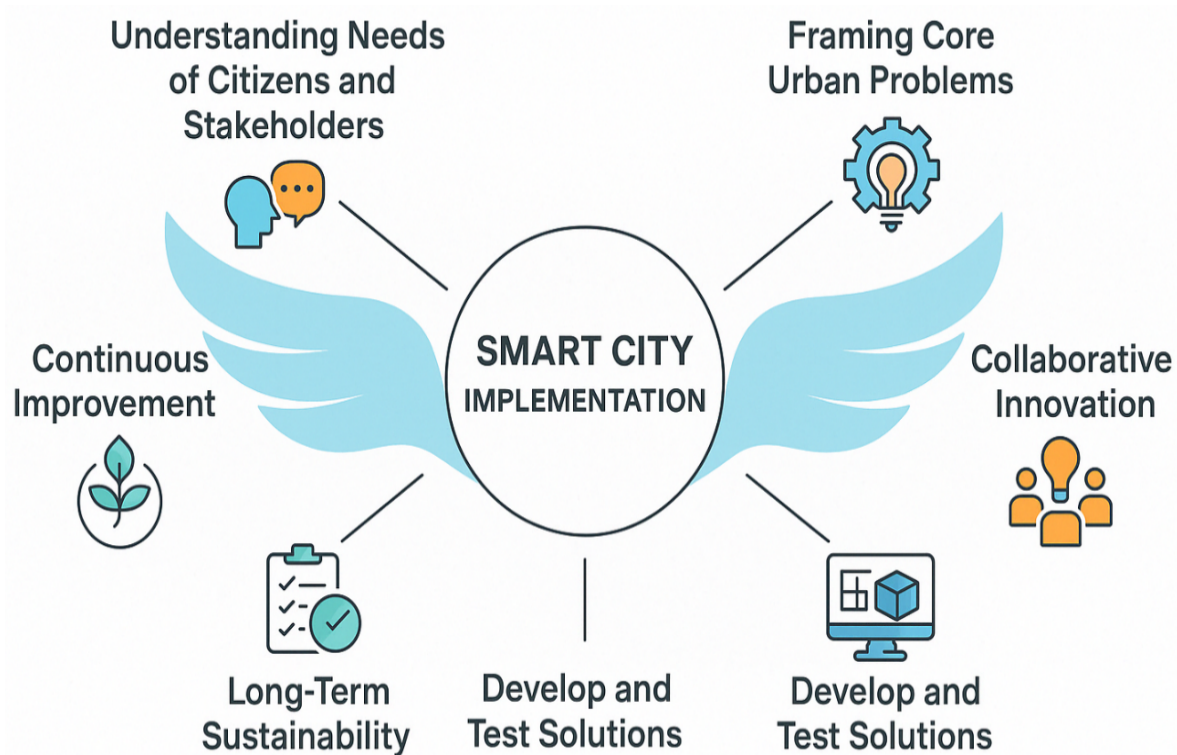


Figure 9.1: Key recommendations

Source: Author

9.7.1. Focus on Understanding Stakeholder Needs

The findings clearly highlight the need for a smart ecosystem, including the economy and business environment, governance, mobility, infrastructure, healthcare, environment, and educational and cultural facilities dimensions, among others. This highlights that identifying the key urban challenges such as mobility, housing, waste management, environment preservation, and efficient governance should be at the heart of conceptualizing and implementing an S-Cit-Eco. For this purpose, a strategic approach of stakeholder engagement can be taken up by engaging with the public and general stakeholders through public surveys and stakeholder interviews, to understand the diverse needs of different types of stakeholders, including residents, businesses, vendors, and government agencies, among others.

A proper time horizon can be allocated for stakeholder engagement so that there is adequate time for engagement with the different types of stakeholders and ensuring that

their response is thoroughly analysed. This approach can be implemented by conducting citizen centric workshop wherein the different stakeholders such as urban planners, entrepreneurs, consultants, citizens, and government representatives can exchange ideas and include them in the implementation plan. Moreover, different digital feedback platforms, such as web portals, mobile apps, and kiosks can be provided to citizens for providing feedback on their requirements of S-Cits. These recommendations are a part of empathise phase of the design thinking framework and have been proposed for the policy makers. This approach can contribute towards effective citizens requirement gathering for the S-Cits.

9.7.2.Framing the Core Urban Problems

The second recommendation is related to the framing of the core urban problems, which can help in increasing the S-Cit-Adn. Some of these problems include sustainability, housing, energy efficiency, data security and privacy, and QoL in the S-Cit-Eco. This can be implemented by the use of advanced technologies such as AI driven data analytics and use of big data to solve urban problems, such as traffic congestion, availability of healthcare facilities, and citizen service delivery, among others. For this purpose, a prioritisation framework of the urban problems can be created which can be reviewed on regular basis to address the problems of the different stakeholders such as citizens and businesses based on the impact on these stakeholders and the feasibility of the proposed solutions. This recommendation is proposed for the policy makers and the consultants and can be included in the define stage of the design thinking framework.

9.7.3.Collaborative Innovation

The third recommendation for the S-Cit-Imp is to encourage collaborative innovation from different stakeholders, such as the academic community, technology businesses, entrepreneurs, and government agencies. The government can provide incentives for such innovation, and it can contribute to increase in efficiency of service delivery in the S-Cit-Eco. For this purpose, public private partnerships can be encouraged where government can provide incentives for private companies to propose solutions for S-Cits and proprietary knowledge can be protected through robust intellectual property laws. This recommendation is for the policy makers and can be included in the ideate stage of the design thinking framework

9.7.4.Develop and Test Solutions

The fourth recommendation is related to the development of prototypes of the various services proposed in the S-Cit-Eco. This can be done by adopting an agile approach to build and refine solutions based on stakeholder feedback. The government and the implementing agencies can work towards conceptualising and implementing modular S-Cit solutions which can be scaled up for the entire city. For this purpose, it is recommended that advanced technologies, such as augmented and virtual reality, can be considered to visualise the

model of S-Cit before proceeding for implementation. This recommendation is for the implementing agencies and can be included in the prototype stage of the design thinking framework.

9.7.5. Continuous Improvement

The fifth recommendation is related to the monitoring of the performance of the S-Cit-Eco by defining the performance metrics focused on efficiency, adoption and QoL. It is also recommended that the governance of the S-Cit is modelled around the performance parameters to ensure that the citizen's QoL is the top priority in all stages of S-Cits. This can be implemented by real time dashboards and feedback mechanisms which contribute towards the continuous improvement in the S-Cit-Eco. This recommendation is for the implementation agencies and can be included in the test and iterate stage of the design thinking framework.

9.7.6. Long-Term Sustainability

The final recommendation is related to the scalability and sustainability of S-Cit-Eco. For this purpose, a strategic approach would be to arrange knowledge sharing sessions regarding the key learnings in the S-Cits across the world. In addition, the governance mechanism needs to integrate the circular economy principles in the S-Cit for enhancing the efficiency. For achieving long-term sustainability, the entire technological infrastructure can be hosted in the cloud platform, which will address the issues of scalability, resource pooling, multi-tenancy, availability, and cost efficiency, among others. Moreover, the technological infrastructure should be compatible so that any upgrade does not lead to disruption of the services. This recommendation is for the policy makers and can be included in the scale and sustain stage of the design thinking framework.

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