DEVELOPING AN INTEGRATED FRAMEWORK TO ASSESS SOUTH AFRICAN SMALL AND RURAL MUNICIPALITIES' READINESS FOR SMART CITY IMPLEMENTATION

by

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DECLARATION

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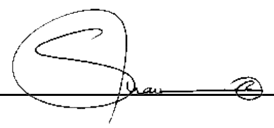
I declare that "**Developing an Integrated Framework to Assess South African Small and Rural Municipalities' Readiness for Smart City Implementation**" is my own work and that all sources quoted in the study have been acknowledged by means of full references.

I further declare that I submitted the thesis to originality-checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.



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Date

ABSTRACT

In South Africa, small and rural municipalities are engulfed in service delivery issues. This affects large municipalities severely because people migrate from small and rural municipalities to big cities to access basic service delivery, resulting in population growth for these big cities. As the population increases, resources become constrained and thus limited in providing basic services in big cities, which, in turn, triggers endless protests about basic service delivery.

Small and rural municipalities need to manage their resources effectively for such municipalities to provide basic service delivery to their citizens. The literature postulates that municipalities can transform their cities by implementing the smart city concept. The smart city concept has been around for more than a decade; the term was coined around 1991.

However, small and rural municipalities have a low implementation of a smart city due to the lack of an integrated framework for assessing small and rural municipalities' readiness for smart city implementation. This study mainly aims to develop an integrated framework as an artefact for assessing small and rural municipalities' readiness for smart city implementation. Hence, the study followed a design science research methodology. During the design science research process, a systematic literature review is conducted to develop a conceptual framework, which is then revised through empirical work.

This study revised a proposed conceptual framework using interview data. During that stage, an assessment tool to gauge the readiness of small and rural municipalities for smart city implementation was also developed. The revised framework and assessment tool were evaluated through participatory design and later validated through expert review. Chapter 6 presents the final integrated framework. The finalised integrated framework and assessment tool can be used to assess the readiness of small and rural municipalities to gauge their levels of preparedness for implementing a smart city. Furthermore, municipal authorities can utilise this framework to identify areas needing improvement towards smart city implementation. This study also serves as a basis for future studies.

Keywords: integrated framework, readiness, small and rural municipalities, smart city, smart city implementation.

DEDICATION

I would like to dedicate this thesis to the following people:

- My late father, Vho-Tshikonelo Wilson Mashau (Vhadau) and
- My son, Rovhavhona Rialivhuwa Mashau

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List of Acronyms

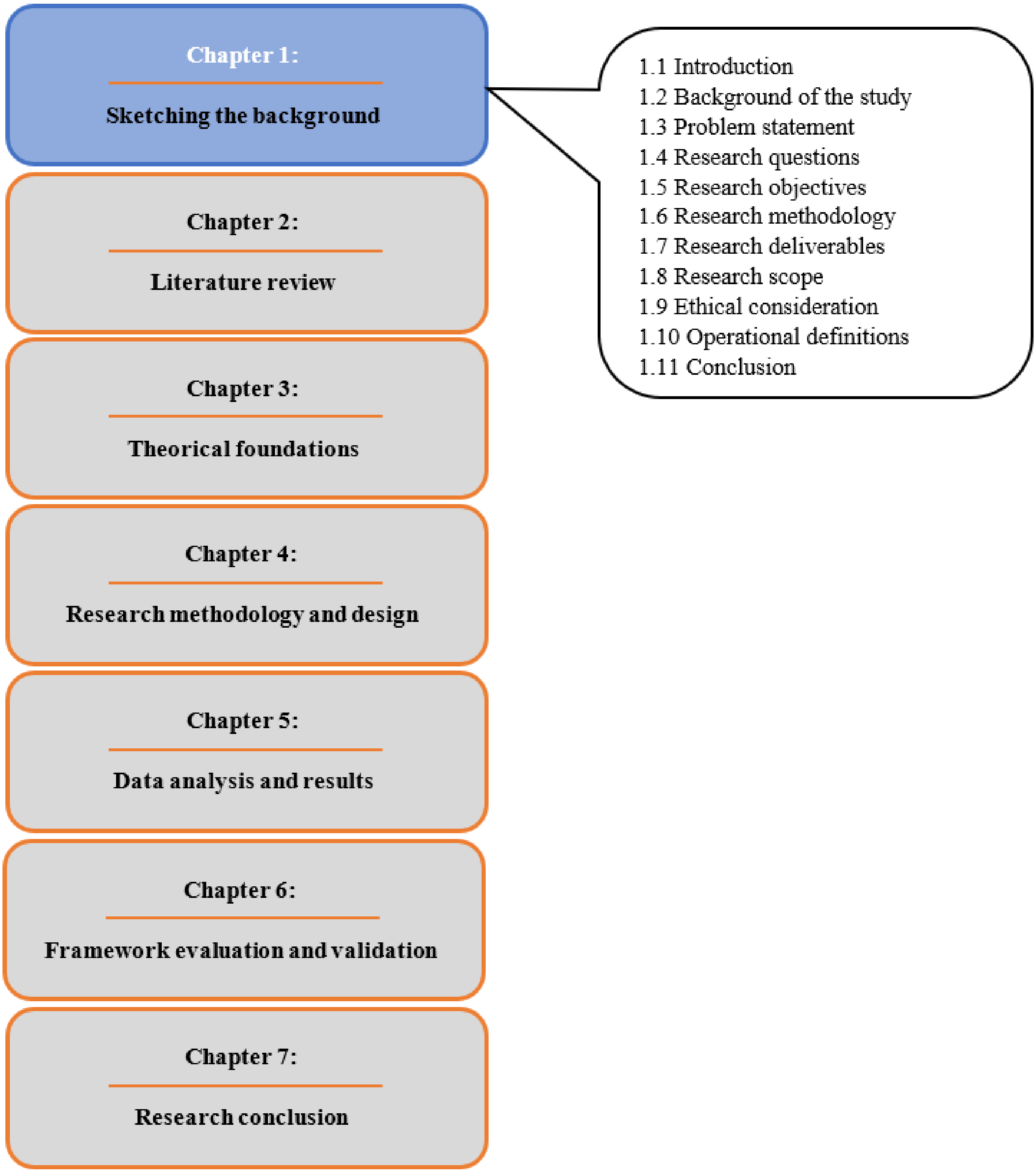
Acronyms	Descriptions
CSET	College Of Science, Engineering and Technology
DG	Distribution Generation
DOI	Diffusion of Innovation
DSR	Design Science Research
DSRM	Design Science Research Methodology
DSRP	Design Science Research Process
ERL	Environmental Readiness Level
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GPS	Global Positioning System
HCS	Healthcare Cloud Server
HRL	Human Readiness Level
ICT	Information and Communication Technology
ICITL	International Conference of Innovative Technologies and Learning
ITIL	Information Technology Infrastructure Library
IDP	Integrated Development Planning
IDT	Innovation Diffusion Theory
IOT	Internet of Things

IS	Information System
ISRG	Information System Research Group
LED	Light-Emitting Diode
LNCS	Lecture Notes in Computer Science
MIIF	Municipality Infrastructure Investment Framework
MRL	Municipality Readiness Level
NFC	Near-Field-Communication System
OCR	Optical Character Recognition
ORL	Organisational Readiness Level
PDF	Portable Document Format
POPI	Protection Of Personal Information
RFID	Radio Frequency Identification
SAICSIT	South African Institute of Computer Scientists and Information Technology
SALGA	South African Local Government Association
SOE	State Organisation Entities
SWOT	Strength, Weakness. Opportunities And Threats
TOE	Technology, Organisation and Environment
TRI	Technology Readiness Index
TRL	Technology Readiness Level

UNISA	University of South Africa
UNIVEN	University of Venda

CHAPTER 1

SKETCHING THE BACKGROUND



1.1 Introduction

The goal of this chapter is to establish the foundation for the research. This is achieved by sketching the background, as well as by presenting the problem statement of the research, the research questions, the research objectives, the research outcomes and the research scope. In addition, the chapter explains where the research was conducted, how it was executed and the reasons why it was undertaken.

This chapter identifies information technology and information as important elements for municipalities to manage their resources effectively. This leads to the importance of the smart city concept since it uses various information system (IS) components to collect and analyse data. Such data generate real-time information that can be used for decision-making towards improving quality of life and service delivery. In turn, this information enables municipalities or cities to manage their resources effectively.

There is a need for integrating existing frameworks for the development of an integrated framework to assess small and rural municipalities' readiness for smart city implementation (Desdemoustier et al., 2019b; Erastus et al., 2020; Moravcova-Skoludova & Chocholousova, 2019). In this study, readiness is defined as a level of preparedness to execute specific tasks. Thus, determining small and rural municipalities' readiness is defined as a mechanism with which to measure infrastructure, technologies, skills and capacity availability to digitally integrate information systems components for collecting digital data and analysing it in real time to monitor and manage city infrastructure. Assessing a readiness level is important because it could help small and rural municipalities to identify deficiencies and areas needing special attention before the commencement of smart city implementation.

This thesis is based on the development of an integrated framework that can be used to assess small and rural municipalities' readiness for the implementation of a smart city. Said framework may help both local and national municipalities to allocate resources effectively, cut costs, grow their economies and improve the quality of the lives of their citizens, along with improving service delivery. In this study, the researcher develops, evaluates and validates an integrated framework to assess small and rural municipalities' readiness for smart city implementation.

The chapter continues with the background of the study; thereafter, the problem statement, research questions and research objectives are addressed. Subsequently, a summary of the research methodology, deliverables, scope and ethical considerations is presented.

1.2 Background of the study

The national government in South Africa has municipalities that act as single administrative departments with power over a jurisdiction demarcated by the national and provincial governments. South African municipalities are divided into three categories, namely metropolitan, district and local municipalities. Additionally, the South African Local Government Association (SALGA) employed the Municipality Infrastructure Investment Framework (MIIF) to divide these municipalities into seven groups (National Treasury, 2011; SALGA, 2015). These groups are categorised as follows:

- Metros: These municipalities fall under Category A. They are referred to as “big municipalities” in provinces.
- Secondary cities: These municipalities fall under Category B1. This group comprises all metro municipalities with good institutional capacity and generating sufficient revenue to sustain their operations.
- Large towns: These municipalities fall under Category B2. They comprise all local municipalities with an urban area at its core.
- Small towns: These municipalities fall under Category B3. They are also known as small or rural municipalities. They do not have large towns as their core urban settlements. Typically, they have a relatively small population, and their local economy is based on agriculture.
- Mostly rural: These municipalities fall under Category B4. They have, at most, one or two towns in their areas. The villages and dwellings are located in the former ‘homelands’.
- Districts: These municipalities fall under Category C. This category has two secondary categories, namely C1 and C2. District municipalities categorised as C1 are not water service providers, while municipalities categorised as C2 are water service providers. In addition, municipalities under categories C1 and C2 collect less revenue compared to municipalities under categories B1, B2, B3 and B4 (National Treasury, 2011).

It is estimated that 15.9 million people in South Africa live in poverty, of which 11 million citizens, representing 69 per cent, reside within small and rural municipalities. These municipalities depend on either financial subsidies or grants from the national government for their budgets and sustainability (National Treasury, 2011; SALGA, 2015).

In addition, the biggest challenge in South African small and rural municipalities affecting citizens is service delivery (Beyers, 2016). In due course, most people move from small and rural municipalities to larger municipalities for basic service delivery. When people move to these large municipalities, their population growth increases exponentially. Consequently, urbanisation is a reality for big municipalities globally, with more than half of the world's population already living in urban areas in 2010 (Farago, 2019; Nam & Pardo, 2011). This tendency is expected to increase by approximately 75 per cent by 2050 (Alawadhi et al., 2012).

The exponential growth of South African cities presents many challenges, such as providing housing, health, education, welfare, security and public transport for its citizens (Cilliers & Aucoin, 2016; Henderson, 2002; Mbazira, 2013; SALGA, 2015). Nevertheless, during a time of universal rights and high life expectancy for all, small and rural municipalities should devise ways to curb the relocation of people to large municipalities, improve service delivery and provide citizens with a high quality of life (SALGA, 2015). In these municipalities, the economy, high quality of life and service delivery thus depend on digital information and knowledge (Dameri, Benevolo, Veglianti, & Li, 2019).

Information about citizens is essential for enabling governing bodies to be proactive when rendering various services to their citizens (Alawadhi et al., 2012; Dameri et al., 2019; Nam & Pardo, 2011; Shafiee, 2017). The SALGA reports state that a lack of information hampers decision-makers' ability to allocate resources accurately at the small and rural municipality levels (SALGA, 2015). This dilemma poses service delivery challenges to small and rural municipalities that are supposed to deliver services to their citizens. To compound the service delivery problem, in some instances, there seems to be no political will to address the problem, with political leaders on various municipal levels seemingly uncaring and corrupt, using money meant for service delivery for personal gain (Alexander, 2010; Davis, 2004; Joshi, 2013). It has been reported that corrupt political leaders influence their subordinates to allocate contracts without following the due tender processes. This may lead to unqualified service providers, without the necessary expertise, delivering services to the public (Gaventa & McGee, 2013; Poister, 2010; Rasul & Rogger, 2016).

Information is an integral part of planning because it enables planners and budgeters to allocate sufficient funds and resources to address municipality issues (Hartley, 2015; Hartley & Seymour, 2011; Teixeira, Afonso, Oliveira, Portela, & Santos, 2014). Information in a digital format is created by collecting and analysing raw data (Dumais et al., 2003; Hanseth & Lyytinen, 2010), which effectively means using people as well as technology to source the data to be transformed into information. Once the data are collected, it can be analysed using various analytical tools. Then, information can be generated and presented to decision-makers via different reporting channels (Dameri & Ricciardi, 2015; Matos, Vairinhos, Dameri, & Durst, 2017).

Several authors have noted that information and communication technology (ICT) is essential and can provide the tools and systems needed for the improvement of small and rural municipalities in administering their day-to-day affairs (Beloglazov, Banerjee, Hartman, & Buyya, 2014; Wixom, Yen, & Relich, 2013). Thus, the South African government has invested in ICT infrastructure (such as free Wi-Fi) and solutions rollouts, primarily in large municipalities. However, much still needs to be done to improve access to ICT in South African small and rural municipalities (SALGA, 2018).

Using ICT, physical objects and the Internet of Things (IoT) to connect services that use servers, software systems, network infrastructure and client devices is known as a smart city concept (Shafiee, 2017). The smart city concept is not novel; indeed, it has been around for some time (Eremia, Toma, & Sanduleac, 2017). The term ‘smart city’ was coined around 1991 (Deakin & Al Waer, 2011). It can be considered an economic driver for a city’s development; the city’s economic competitiveness could improve because it would be using its resources effectively by collecting real-time data using smart city technologies (Alawadhi et al., 2012; Dameri et al., 2019).

The smart city concept is a process of automating the collection of digital data, analysing it and sharing digital information within the city to improve citizens’ quality of life, government services, city operations and meeting basic resource demands, managing city resources and improving service delivery. The requisite technologies and physical objects include electronic sensors, social media and geographic information systems (GIS), to name a few (Eremia et al., 2017). Recently, smart city implementation has become the preferred mechanism for gathering and providing information because it is perceived as an enabler of service delivery, compared to other procedures for collecting and analysing data with less human intervention. Yet again, it enables cities to save resources in collecting and analysing information (Crous, Palmer, & Griffioen, 2017).

The successful implementation of smart city technologies will give citizens and city managers access to rich, real-time information that could be used for decision-making in small and rural municipalities (Jin, Gubbi, Marusic, & Palaniswami, 2014). Real-time information would enable such municipalities to address service delivery deficiencies (Alawadhi et al., 2012; Alexander, 2010; Bakici, Almirall, & Wareham, 2013; Dameri & Ricciardi, 2015). Information sourced from citizens is essential for municipal planning and operations (Niculescu & Wadhwa, 2015; SALGA, 2015; Sofronijevic, Milicevic, & Ilic, 2014).

Some scholars argue that the smart city concept emerged from the importance of managing resource allocation, budgets and infrastructure. It further indicates that an increased population affects several services such as water, housing, sanitation, electricity, security, transport, disaster management and natural resources utilisation (Da Silva et al., 2013). Others have described the concept as a system that positively addresses issues, such as traffic congestion, crowding, crime, waste management, pollution, overconsumption, energy, housing, waste removal and electricity (Alawadhi et al., 2012; Nam & Pardo, 2011).

The smart city concept comprises various components: organisation, technology, governance, policies, people and communities, the economy, built infrastructure and natural environments (Chourabi et al., 2012). These components are crucial for a city to implement the smart city concept (Nam & Pardo, 2011; Niculescu & Wadhwa, 2015). The implementation of smart city concepts requires devices and systems to be interconnected and 'aware' of each other to provide useful information (Balakrishna, 2012; Zubizarreta, Seravalli, & Arrizabalaga, 2016).

In South Africa, a few smart city initiatives exist in big cities, namely in the City of Johannesburg, the City of Ekurhuleni, the City of Cape Town, the eThekwini Metropolitan Municipality and the City of Tshwane (Musakwa & Mokoena, 2018; SALGA, 2015). Most of these initiatives revolve around smart services; for example, eThekwini municipality was the first municipality to implement smart services known as smart technology (Aucamp, Pearton, & Jansen Van Rensburg, 2016). To date, there seems to be a lack of smart city implementation in South African small and rural municipalities. Then again, the implementation of a smart city concept in small and rural municipalities globally is also still low (Desdemoustier, Crutzen, & Giffinger, 2019b).

If a small and rural municipality decides to implement the smart city concept, its management should first ensure that the foundational building blocks are in place. A proposed conceptual integrated framework could assist small and rural municipalities in assessing their readiness level for smart city implementation. This conceptual framework would assist a municipality with identifying the building blocks that require attention. A municipality that is ready to implement the smart city concept should be able to communicate with its citizens (through, for example, social media), have access to geographical information systems, have sensors and devices in place (such as traffic lights) that communicate with each other and have access to big data, which allows predictive analytics as one of its building blocks (González-Zamar, Abada-Segura, Vázquez-Cano, & López-Meneses, 2020).

In summary, small and rural municipalities must be considered when delivering services to citizens (SALGA, 2015). These municipalities require contemporaneous information to deliver effective and efficient basic services. Hence, information systems are indispensable in small and rural municipalities; therefore, the implementation of the smart city concept in small and rural municipalities is inevitable.

1.3 Problem statement

The implementation of a smart city concept can help small and rural municipalities to improve the lives of their citizens; however, the literature shows that there is a low level of implementation of the smart city concept in small and rural municipalities (Desdemoustier et al., 2019b). The literature in the smart city field presents numerous smart city frameworks currently used to assess city readiness. Most of the existing frameworks consider the global context (Chourabi et al., 2012; Cilliers & Flowerday, 2017; Das, Emuze, & Das, 2014; Monzon, 2015; Nam & Pardo, 2011; Szabo et al., 2013). Despite the availability of these frameworks, small and rural municipalities are failing to implement smart city concepts successfully because the existing frameworks do not expose sufficient indicators that can be used to assess their readiness levels (Desdemoustier, Crutzen, Cools, & Teller, 2019a; Desdemoustier et al., 2019b). The literature indicates that a framework should be focused, failing which it would be difficult for organisations to use correctly (Berst, 2013; Desdemoustier et al., 2019b). Cities or municipalities are unlikely to use a framework that does not address their specific issues because it would be difficult to follow (Desdemoustier et al., 2019a).

Another challenge with existing frameworks is the absence of a framework that holistically assesses small and rural municipalities' readiness for smart city implementation (Berst, 2013; Chichernea, 2015; Madakam & Ramaswamy, 2015). The frameworks used to assess local context regard technological, organisational, environmental, infrastructure and data factors as major indicators (Arief et al., 2019; Dewi, Hidayanto, Purwandari, Kosandi, & Budi, 2018). Frameworks using technological factors as indicators view technology as an integral part when assessing readiness, while other frameworks regard infrastructure or the IoT as prerequisites (Berst, 2013). In contrast, Desdemoustier et al. (2019b) and Erastus, Jere and Shava (2020) agree that there is a need for a study that would appraise individual or human, and cultural and societal factors indicators to assist cities in conducting comprehensive assessments to measure local context readiness for smart city implementation (Erastus et al., 2020). Evidently, there is a lack of a single framework (Moravcova-Skoludova & Chocholousova, 2019) that uses technological, institutional, environmental, cultural, human and societal factors as indicators to assist small and rural municipalities in conducting comprehensive assessments to measure their readiness levels for smart city implementation.

As mentioned, most of the smart city frameworks evaluating readiness within the local context were developed on other continents. Those frameworks use technological factors, environmental factors and organisational factors as indicators for assessing city readiness for smart city implementation (Dewi et al., 2018); other studies suggest that human factors are essential to assessing city readiness for smart city implementation (Mazurek, 2018; Nam & Pardo, 2011; Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014).

These studies assume that all municipalities' contextual aspects are the same (Desdemoustier et al., 2019b; Nam & Pardo, 2011; Neirotti et al., 2014). However, municipalities are not all the same; they differ in size and features (SALGA, 2015). Studies conducted in Africa on the assessment of city readiness indicate that African countries that benchmarked from advanced cities like Barcelona are failing to implement the smart city concept because of societal and cultural differences (Erastus et al., 2020; Gobin-Rahimbux et al., 2020). Studies by Dewi et al. (2018), Erastus et al. (2020) and Noori, De Jong and Hoppe (2020) suggest that there is a need for a study that will consider cultural and societal factors as indicators in assessing local context readiness for smart city implementation.

Thus, the existing frameworks used to assess municipalities' readiness for smart city concept implementation should be integrated and amended, with a specific focus on small and rural

South African environments. This study seeks to develop an integrated framework to assess small and rural municipalities' readiness for smart city implementation. The factors identified as important indicators may help small and rural municipalities conduct comprehensive assessments in measuring their readiness levels for the implementation of a smart city.

In addition, more subproblems are addressed in the existing literature. One such remaining problem is the absence of a study uncovering essential aspects of the implementation of a smart city concept in South African small and rural municipalities. To reiterate, only a few studies suggest that future investigations should sample decision-makers from various disciplines as participants to obtain a different perspective (Dewi et al., 2018; Erastus et al., 2020). The sample for this study consisted of decision-makers: mayors, deputy mayors, councillors, municipality managers, senior managers, middle managers, junior managers and information technology officials. Lastly, it appears there is a lack of a framework that integrates cultural and societal factors as indicators for assessing readiness for smart city implementation in a local context.

1.4 Research questions

The main research question is:

- How can South African small and rural municipalities' readiness for smart city implementation be assessed from an IS perspective?

The secondary research questions are:

- Why is the assessment of South African small and rural municipalities' readiness important for smart city implementation?
- What are the South African factors that influence small and rural municipalities' readiness for smart city implementation?
- What are the information systems drivers for smart city development, and why are they important?
- How can an integrated framework to assess small and rural municipalities' readiness for smart city implementation be developed and evaluated?

1.5 Research objectives

This study aims to develop an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation. The main aim of this study is divided into eight specific objectives:

- Establishing the importance of assessing South African small and rural municipalities' readiness for smart city implementation.
- Identifying influential aspects to measure South African small and rural municipalities' readiness for smart city implementation from an IS perspective.
- Exploring available aspects critical for small and rural municipalities' readiness for smart city implementation.
- Identifying information system drivers important for smart city implementation.
- Determining responsible stakeholders important for smart city implementation in South African small and rural municipalities.
- Identifying required aspects important for South African small and rural municipalities' readiness for smart city implementation.
- Evaluating the developed integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

1.6 Research methodology

This study followed the design science research (DSR) methodology to answer the research questions and achieve the research objectives. Design science research is often used for innovation production, problem-solving and the development of new artefacts (Herselman & Botha, 2020). In DSR, artefacts are considered constructs, design principles, architectures, models, frameworks, instantiations and methods (Herselman & Botha, 2020; Mettler, Eurich, & Winter, 2014; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

Design science research is considered suitable in IS research when a study aims to develop artefacts that address real-world problems (Kuechler & Vaishnavi, 2008; Vaishnavi & Kuechler, 2015). Herselman and Botha (2020) suggest that a study seeking to develop an artefact should follow the following stages, namely development, refinement and validation. This study followed the design science research process model by Peffers et al. (2007), depicted in **Figure 24** in Chapter 4. This process was followed to ensure that an integrated framework to assess small and rural municipalities' readiness for smart city implementation is developed, refined, validated and presented as an artefact that would include several factors.

1.7 Research deliverables

The outcome of this study is a validated framework to assess South African small and rural municipalities' readiness for smart city implementation. It will contribute to the academic IS knowledge base by explicating how the smart city concept can be applied to improve service delivery in South African small and rural municipalities.

1.8 Research scope

This study is limited to small and rural municipalities in South Africa. Therefore, the researcher elicited data from small and rural municipalities' personnel using interviews to improve the proposed framework presented in Chapter 3. Thereafter, the framework was validated by experts in the smart city domain. It was limited to aspects relevant to the IS perspective, such as technologies, digital infrastructure, data, etc.

1.9 Ethical consideration

Research involving human participants is reviewed by an ethics committee to determine whether the research should be allowed to proceed (Olivier, 2004). The research ethics of this study is discussed in more detail in Chapter 4. The application for ethics clearance to the Research Committee of the University of South Africa (UNISA) was successful. The clearance certificates are attached in **Annexures B and C**.

1.10 Operational definitions

Small and rural municipalities are local government units serving communities with relatively low populations and limited resources, often located in less densely populated or remote areas (Beyers, 2016).

The **smart city concept** is defined as a digital integration of information systems components to elicit digital data and analyse such data in real time to monitor and manage city infrastructure and allocate resources effectively, thereby improving service delivery and the quality of life of the citizens (Maccani et al., 2020).

Smart technology refers to advanced technological systems, devices and solutions that incorporate digital intelligence and connectivity to automate processes and provide improved services and functionality in various industries or institutions (Galal & Elariane, 2022).

A **readiness assessment** is a systematic and structured process of examining and evaluating an organisation or individual's preparedness in terms of resources, capacity and capability to execute a specific project or initiative (Kamolov & Kandalintseva, 2020).

A **living lab** is a real-world environment in which new technologies, products, services or systems are tested, evaluated and co-created by users, researchers, businesses and other stakeholders (Artto et al., 2016).

1.11 Conclusion

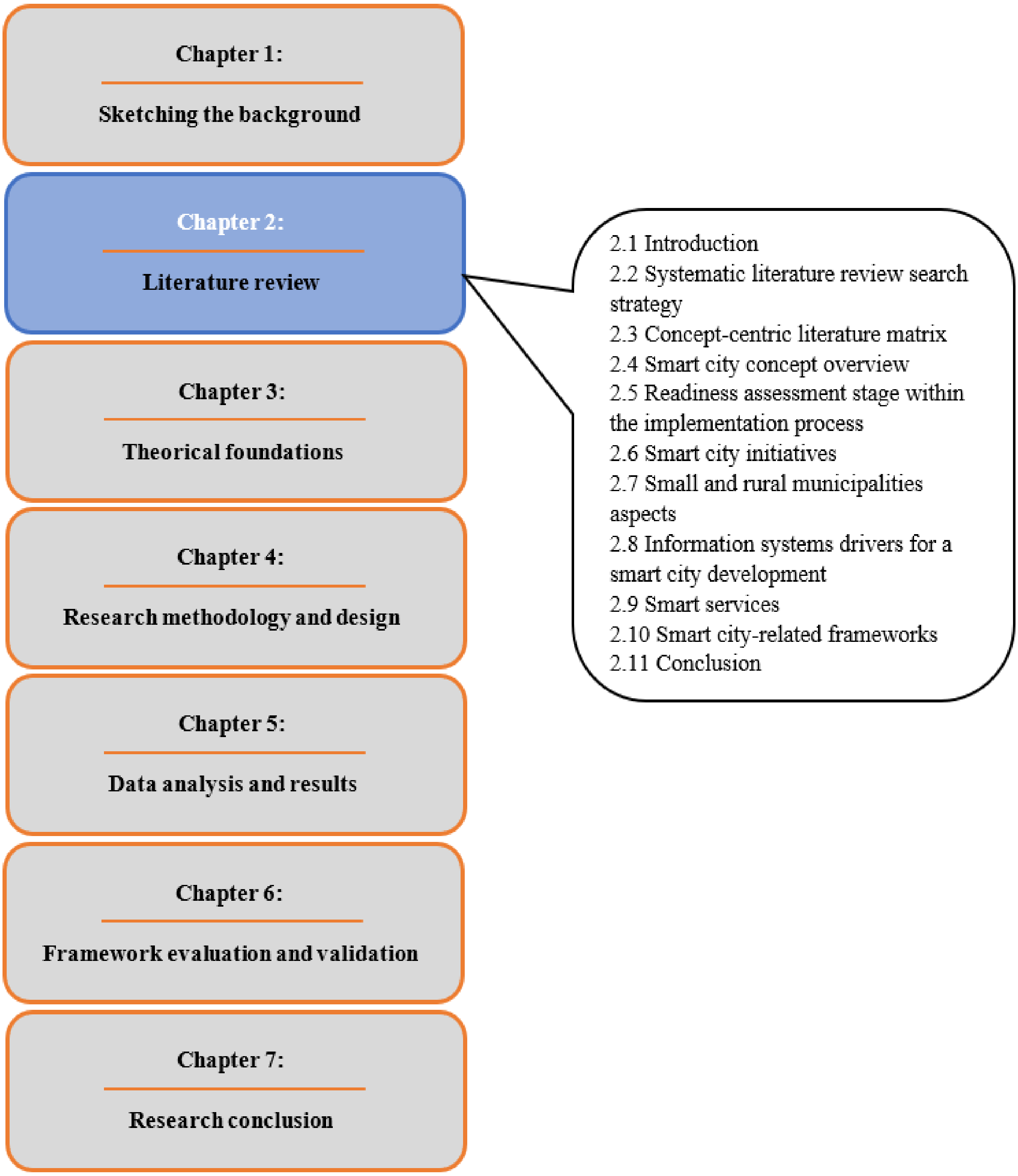
This chapter presented the South African municipal categories and the challenges confronting small and rural municipalities. The researcher identified a lack of information as one of the contributing factors to these challenges. As mentioned, the smart city concept was identified as a possible option to assist these municipalities in solving their challenges. It was, however, noted that there is a low implementation of the smart city concept in small and rural municipalities; indeed, the literature confirms that for a city to manage its resources effectively it needs information. Thereafter, the chapter highlighted that the smart city concept uses various IS components to collect and analyse data to generate real-time information.

This chapter also achieved its objectives by sketching the background and context of this research; and formulating the problem statement, research questions, research objectives, research outcomes and research scope. Chapter 1 presented a brief overview of the research site, how it was conducted and the reasons why it was undertaken.

In conclusion, the smart city concept is significant for transforming a traditional city into a smart city. As such, this chapter postulated that there is a need for an integrated framework to assess small and rural municipalities' readiness for smart city implementation. This study seeks to develop an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

CHAPTER 2

LITERATURE REVIEW



2.1 Introduction

This chapter presents a systematic literature review approach whereby the study analysed substantive literature. A literature review is an essential component of any academic research project (Levy & Ellis, 2006b; Webster & Watson, 2002) and is typically conducted before initiating any research project (Hart, 1998). Therefore, this chapter mainly aims to review literature pertinent to the research topic (Webster & Watson, 2002) to uncover any knowledge deficits (Hart, 1998) and to avoid duplicating any existing study (Ruhlandt, 2018). Furthermore, the chapter seeks to develop a theoretical base through a systematic literature review (Levy & Ellis, 2006b) to provide foundational knowledge about the topic and identify research gaps in support of the problem statement of the research.

According to Webster and Watson (2002), a complete, high-quality literature review should also focus on concepts. This chapter used a concept-centric approach to present an analysis of the literature review. The first concept in the concept matrix is a smart city *concept overview*. This concept is used to present different smart city definitions and also exposes general knowledge about the smart city concept by presenting the perceptions on the smart city implementation, as well as ways to improve smart city sustainability. The second concept is *smart city initiatives,* which is used to explore smart city projects in South Africa and other countries to justify the research problem. The third concept is *aspects of small and rural municipalities*. This concept seeks to answer the following research questions: "*Why is the assessment of South African small and rural municipalities' readiness important for smart city implementation?"* and *"What are the South African factors that influence small and rural municipalities' readiness for smart city implementation?"* The concept exposes critical influential aspects when assessing small and rural municipalities' readiness for smart city implementation.

The fourth concept is *information systems drivers* for smart city development. This concept is used to answer the research question "*What are the information systems drivers for smart city development and why are they important?"* and to expose information systems drivers that are significant in the development and implementation of a smart city. The fifth concept is *smart services*. This concept is used to critically analyse essential smart services that have to be implemented for the success of a smart city project. The sixth concept is *smart city-related frameworks*. This concept is used to critically analyse and synthesise existing smart cities and related frameworks to determine if any frameworks can be used to assess small and rural municipalities' readiness for smart city implementation in developing countries such as South Africa.

In this chapter, the fundamental concepts of the research are discussed with references from relevant literature. This chapter commences with an introduction, followed by the justification for using a systematic literature review approach. The subsequent section presents sections based on the concepts identified above, namely the smart city concept overview, small and rural municipalities aspects, smart city initiatives, information systems drivers for smart city development, smart services and smart city-related frameworks. This discussion provides an understanding of how a smart city concept can be significant in transforming a traditional city into a smart city to improve the standard of living and service delivery. Then, the study presents a conclusion based on the concepts stated above.

2.2 Systematic literature review search strategy

A systematic literature review is employed to guide the researcher in performing a rigorous literature review and to avoid duplicating existing research work done by other researchers (Kitchenham, 2004). This is facilitated by following a sequential, reproducible and explicit strategy to identify, assess and synthesise the existing relevant literature produced and recorded by other scholars, researchers and practitioners (Okoli & Schabram, 2012).

A systematic literature review aims to present a robust theoretical foundation for a research problem and topic (Levy & Ellis, 2006a). To achieve such a foundation, the researcher in this study undertook a systematic literature review to justify the research problem and address some of the research questions and objectives (Hart, 1998). The question "*What are the information systems drivers for smart city development and why are they important?*" is addressed in Section 2.8. Another reason for employing a systematic literature review is to avoid any possible duplication of previous research projects as well as to counteract prejudice, bias or disparities when searching the literature. The use of a systematic literature review is appropriate in the smart city research domain since it assists in identifying deficiencies and searching for published scholarship (Ruhlandt, 2018).

This study followed a structured process of searching the literature using a systematic literature review. This process began by formulating keywords. The keyword formulation was based on the research topic, problem and objectives. Keywords related to the research topic and the research problem are essential when searching existing literature (Levy & Ellis, 2006b; Okoli

& Schabram, 2012). The researcher used the relevant keywords to retrieve any literature relevant to the research topic and problem statement (Klopper & Lubbe, 2012). The initial search started with “smart city” and “smart municipality” as keywords for preliminary literature review to map out the problem statement of the study. Thereafter, the search scope was expanded to include related terms, synonyms, alternative spelling, abbreviations and plurality (Kitchenham, 2004).

The study used the formulated keywords to search electronic literature from search engines and databases. These databases include *Proquest* (*ABI/INFORM* collection), *ScienceDirect* or *Elsevier*, *AIS eLibrary* (*AISeL*), *JSTOR* and *Ebscohost*. The searches were executed by using the University of South Africa (UNISA) and the University of Venda (UNIVEN) libraries as gateways to access academic databases as well as the *Google Scholar* search engine.

To search literature from these databases, the keywords “smart city” AND “readiness” were used to search the literature. When searching the literature, each search could potentially retrieve numerous literature records. The study employed inclusion and exclusion criteria to reduce the number of retrieved literature records (Levy & Ellis, 2006b). As such, the researcher focused on studies that examined smart city readiness. Furthermore, the researcher considered studies that clearly articulated factors critical when assessing readiness for smart city implementation. Lastly, for inclusion criteria, the researcher selected studies focusing on important factors for smart city development.

This study excluded all sources published before January 2015 or after December 2022. The study also excluded all non-peer-reviewed sources and sources not written in English or irrelevant to the smart city concept. The search extracted 1141 results from the listed databases (see **Table 1**).

Subsequently, the researcher assessed all retrieved records relevant to the purpose of this chapter for eligibility by checking whether the sources were relevant to the research topic, problem, questions and objectives. Further assessment was undertaken by examining each literature source by reading its title, abstract, keywords, preamble and conclusion to determine its relevancy to the research problem. Intending to read the documents entirely, the researcher saved all relevant literature in the review pool; judgement regarding their relevancy was based on researcher discretion (Floridi, 2008). The researcher also checked the journals’ reputations against the ‘predatory’ journal websites https://fidelior.com/ or https://0-www2-cabellscom.oasis.unisa.ac.za/predatory. A total of 303 sources remained (see **Figure 1**). Therefore, a systematic literature review was significant in identifying concepts and discovering new knowledge (Levy & Ellis, 2006a, 2006b).

Table 1: *Search results*

Databases	Initial search results	Final reviewed results
Proquest (ABI/INFORM collection)	306	78
ScienceDirect	624	134
AIS eLibrary (AISeL)	66	37
JSTOR	73	31
Ebscohost	72	23
Forward and backward search results	0	16
Total	**1141**	**319**

In research, it is also important to search literature beyond the keywords search approach (Levy & Ellis, 2006a, 2006b; Webster & Watson, 2002). The researcher accomplished this by identifying literature through a backward and forward search, employing a backward search to find relevant literature by using references identified from the review pool of the literature and saved from the keywords search. The backward search assisted this study in finding quality and relevant literature from the references. A forward search was also used through two sub-steps: a forward authors search and a forward references search. The forward references search was used to find relevant literature by reviewing the literature that had cited the research papers in the review pool (Levy & Ellis, 2006a). The backward and forward searches were effective in identifying relevant literature of good quality for the study to create a sound theoretical foundation.

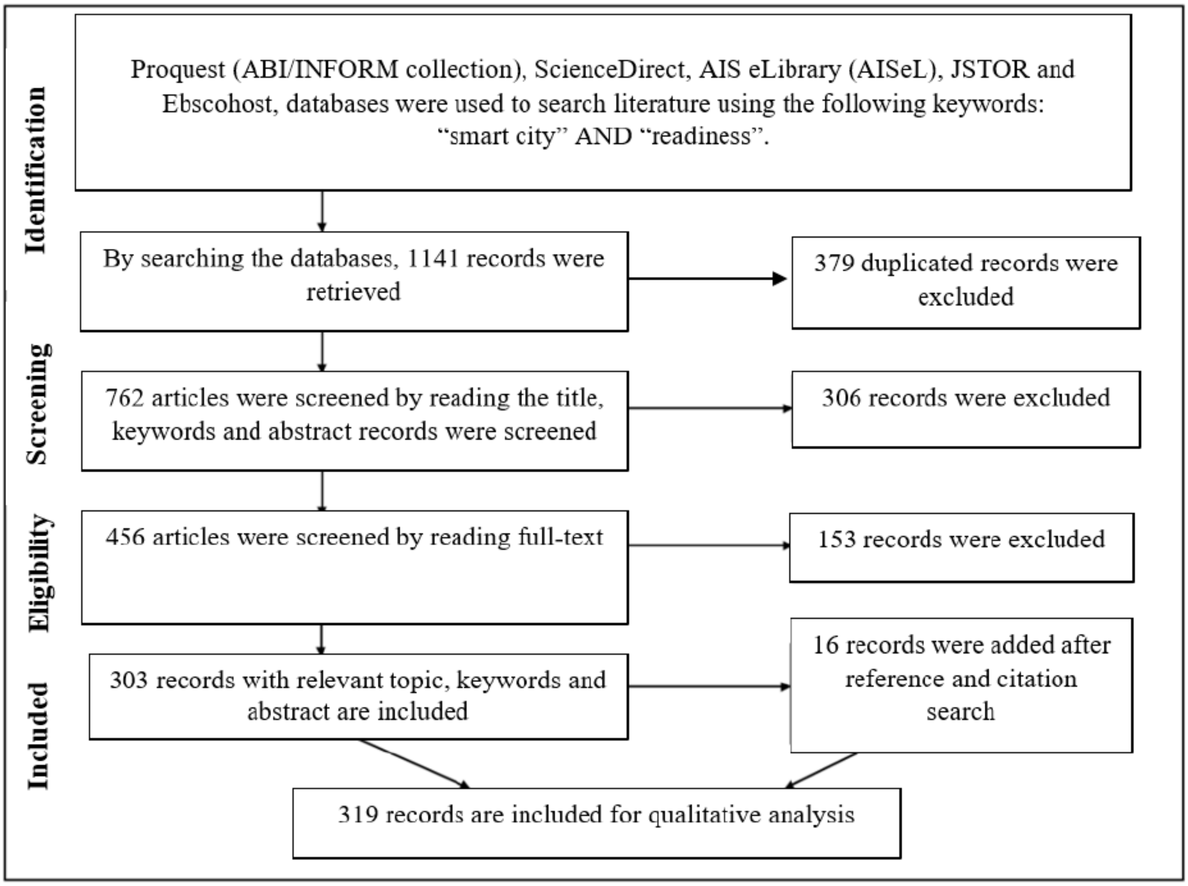


Figure 1: Literature identification diagram

All literature identified through the backward and forward searches was scrutinised to determine its relevance. To this end, the researcher read the titles, abstracts, keywords, introductions and conclusions. All relevant research articles were also checked to ensure that they were not from predatory journals; thus, the researcher reviewed pertinent (not predatory) sources.

2.3 Concept-centric literature matrix

Klopper and Lubbe (2012) submit that it is effective to analyse literature relating to a research topic, problem and questions using a concept-centric literature matrix since it enables a high-quality review (Webster & Watson, 2002). This process uses the dominant phrases to identify the central concept or theme of every source and its citations. All the sources were grouped based on the identified concepts (Levy & Ellis, 2006a; Webster & Watson, 2002). The literature review—using a concept-centric approach—commenced with the researcher reading the literature while identifying the concepts relevant to this study. These concepts helped to identify, evaluate, categorise, describe, discuss, analyse and synthesise the relevant literature (Webster & Watson, 2002). The smart city concept-centric literature matrix presents a table with the concepts as headings, which contains the author(s), date and publisher, as well as all concepts relevant to the research topic and problem statement. The results of all the reviewed articles are categorised in **Annexure A**. The information on the concepts is reviewed and synthesised in the rest of this chapter.

2.4 Smart city concept overview

This section focuses on the smart city concept and explains a contemporary urban city within the context of the smart city concept. The section starts by presenting different definitions and general knowledge of the smart city concept. Furthermore, this section is significant for revealing the benefits, barriers and challenges when implementing the smart city concept. The objective of Section 2.4 is to determine the importance of contextual aspects when assessing municipalities' readiness for smart city implementation.

2.4.1 Smart city definitions

The smart city concept is not novel and has existed for some time (Dixon, Eames, Britnell, Watson, & Hunt, 2014; Lopez-Carreiro & Monzon, 2018; Perätalo & Ahokangas, 2018). This concept was devised around the 1990s when it had a definite meaning that signified the adoption of new information technology in cities (Albino, Berardi, & Dangelico, 2015; De Falco, Angelidou, & Addie, 2019; Hosseini, Frank, Fridgen, & Heger, 2018). Since the 1990s, the smart city concept has evolved to the point where its scope is broader (Lopez-Carreiro & Monzon, 2018; Perätalo & Ahokangas, 2018). Presently, the smart city concept is regarded as a more expansive term covering information systems (IS) components (Lai & Cole, 2022; Megahed & Abdel-Kader, 2022; Michelucci, De Marco, & Tanda, 2016).

Academic scholars and practitioners from the IS industry have attempted to produce definitions to describe the smart city concept (Chauhan, Agarwal, & Kar, 2016; De Jong, Joss, Schraven, Zhan, & Weijnen, 2015; Ismagilova, Hughes, Dwivedi, & Raman, 2019), using different terms interchangeably. These terms include digital city, information city, intelligent city, knowledge-based city, ubiquitous city and wired city (Chauhan et al., 2016; Matheus, Janssen, & Maheshwari, 2018; Schuurman, Baccarne, De Marez, & Mechant, 2012; Silva, Khan, & Han, 2018b). These terms refer to cities using the latest information technologies to achieve their goals (Gontar, Gontar, & Pamula, 2014; Mashau, Kroeze, & Howard, 2021; Yigitcanlar et al., 2019b). **Table 2** depicts some of the definitions of the smart city concept by various scholars.

Table 2: *Smart City Definitions*

No.	Definitions of the smart city concept	Authors
1	A smart city essentially encompasses connected sensors, real-time data, smart devices and integrated ICT in every area of people's lives.	(Bibri, 2021b; Cretu & Cuza, 2012)
2	A smart city is the development of an urban city to integrate ICT and IoT solutions safely to manage municipal resources.	(Leong, Ping & Muthuveloo, 2017; Ma & Ren, 2017)
3	A smart city focuses on its essential ICT infrastructure to deliver improved services to citizens.	(Farago, 2019)
4	A smart city stresses the value of investing in ICT and infrastructure to gain competitive advantages over other cities, improve citizens' quality of life and achieve smartness.	(Sauer, 2012; Silva et al., 2018b)
5	A smart city is defined in the context of a high-performing city, where city dwellers are interconnected as well as connected to the city itself to provide a continuous stream of data linked to users' needs and preferences.	(Calderoni, Maio & Palmieri, 2012; Suryotrisongko, Kusuma & Ginardi, 2017)
6	A smart city is where networks and traditional services are used more efficiently through digital technologies to address the needs of citizens and businesses.	(Neagu, 2018)
7	A smart city is the outcome of a dynamic process being executed step-by-step in parallel with six dimensions: smart people, smart environment, smart economy, smart living, smart mobility and smart environment.	(Chichernea, 2015; Galal & Elariane, 2022)
8	A smart city is a process driving operations within the city, using data and technology to enhance the quality of life while not being constrained by geographic or population metrics.	(Lam & Givens, 2018; Lam & Ma, 2018)

9	A smart city digitally integrates all key infrastructure, such as railways, roads, tunnels, bridges, water, communications, main buildings, energy and harbours, to optimise its resources and to increase services offered to citizens.	(Maccani et al., 2020; Nagy, Tóth, Szendi, Dóra, & Tóth, 2016;)
10	A smart city is a geographic area where information systems components are used to create benefits for city dwellers to provide a good quality of life, environmental quality, intelligent development and participation and inclusion.	(Khomsi, 2016)
11	A smart city is an information technology innovation managing city life and functions to move city consumption and production from the global to local space and invention from the competitive to the collaborative point of view.	(Öberg, Graham, & Hennelly, 2016; Wray, Olstad, & Minaker, 2018)
12	A smart city is a proactive, modern and digital networked city uncovering deficiencies based on geographical area and then generating opportunities.	(Santos, 2018)
13	A smart city is a conception of using digital tools and technologies to improve city smartness.	(Angelidou, 2017; Sharifi, 2019)
14	A smart city is several independent combined systems utilised to implement an urban development plan based on information technology.	(Peto, 2019)
15	A smart city is a complex system representing the need to enhance urban networks, infrastructure and human behaviour using sensors and information systems.	(Qingyun, Zhongliang, You & Lin, 2018)
16	A smart city is a concept using information and communication technology to improve the quality of life of citizens.	(Neirotti et al., 2014)

The smart city concept has many definitions (Currin, Flowerday, De la Rey, Van der Schyff, & Foster, 2022; Neagu, 2018; Peto, 2019), with no consensus on a specific definition (Albino et al., 2015; Camero & Alba, 2019; Capdevila & Zarlenga, 2015; Hosseini et al., 2018; Mora, Deakin, & Reid, 2019). This has caused more confusion in truly understanding the smart city concept (Albino et al., 2015; Mashau et al., 2022; Scholtz & Van Der Hoogen, 2022). Below, the essential elements of the various definitions are extracted and synthesised into a new, comprehensive definition to be used in the thesis as the comprehensive description of the concept.

Each of these definitions' points to the need for information systems components to use city infrastructure and resources more efficiently. These definitions demonstrate the importance of information systems in monitoring and integrating infrastructure to enhance citizens' quality of life. Most definitions in a smart city concept domain—formulated in the past two decades—describe the smart city concept as the use of information and communication technology to collect and analyse data from various objects and share information within the city to optimise government services and provide real-time monitoring (Caporuscio & Ghezzi, 2015; Cretu & Cuza, 2012; Dixon et al., 2014)

Therefore, this study defines the smart city concept as a digital integration of information systems components to elicit digital data and analyse it in real time to monitor and manage city infrastructure and allocate resources effectively, thereby improving service delivery and the quality of life of the citizens. Tilley and Rosenblatt (2017) identify five IS components, namely human (people), software, hardware, processes and data.

2.4.2 Perceptions on smart city implementation

The implementation of a smart city concept presents possible solutions to reducing the problems and challenges that are triggered by urban population growth (Enwereji & Uwizeyimana, 2022; Pau et al., 2018; Sikora-Fernandez, 2018) affecting healthcare, water provision, education, waste management, transportation, energy, climate change, public safety and inclusive infrastructure services (Bhide, 2017; Schaffers, Ratti, & Komninos, 2012; Smith, 2017). The implementation of a smart city concept is important for helping cities to improve service delivery with less disruption, resource usage and optimisation, minimising resource consumption and curtailing costs (Alsaig, Alagar, Chammaa, & Shiri, 2019; Söderström, Blake, & Odendaal, 2021; Yigitcanlar, Degirmenci, Butler, & Desouza, 2021).

Furthermore, the implementation of a smart city concept would provide potential benefits, such as improved infrastructure capacity, lower resource consumption and improved water, energy and transport consumption (Antoni, Arpan, & Supratman, 2020; Kumar, Singh, Gupta, & Madaan, 2020; Pettit et al., 2018). The implementation of this concept would enable cities to manage their resources effectively for them to provide efficient basic services, which include the provision of housing, water, energy, sanitation, schools, libraries, safety and health services. Thus, it will help cities improve their turnaround times and service delivery. The implementation of this concept could also have social and economic benefits, as listed below (Das, 2020; Vitunskaite, He, Brandstetter, & Janicke, 2019; Yigitcanlar, Foth, & Kamruzzaman, 2019a). The smart city concept can be used to:

- Help a city reduce resource utilisation (in particular, fuel) to improve air quality;
- Improve the lives of citizens by providing efficient transport that alleviates waiting time at bus stations and taxi ranks;
- Reduce traffic congestion;
- Improve safety and security for citizens;
- Ensure the availability of online services for citizens (i.e., checking and paying municipality bills online);
- Create opportunities for citizens (i.e., the publication of real-time knowledge about municipality services);
- Boost urban investment (Neagu, 2018; Prendeville, Cherim, & Bocken, 2018; Zhang et al., 2019a); and
- Monitor the impact of safety, efficiency, climate change, mobility, ladders of opportunity, clean energy and suitability (Hatuka & Zur, 2020; Smith, 2017).

The smart city concept can be considered a guide to help cities find solutions to address urban challenges caused by urban immigration, air pollution and socio-demographic problems (Brandt, 2018; Hosseini et al., 2018; Sharifi, 2020b). Population growth includes senior citizens, immigrants, people with disabilities, veterans and low-income groups. When implementing a smart city, municipalities should accommodate all these groups (Bhide, 2017; Maye, 2019; Zhang et al., 2019b).

However, the implementation of a smart city may be challenging (Gobin-Rahimbux et al., 2020; Mayangsari & Novani, 2015), ranging from a lack of funds, old digital infrastructure and information technology to other limitations that depend on the environmental, political and socioeconomical aspects of each city (Hajduk, 2016; Mosannenzadeh, Bisello, Diamantini, Stellin, & Vettorato, 2017). When examining the different small and rural municipalities, these issues are considered serious problems that hamper the implementation of the smart city (Mosannenzadeh et al., 2017). This may hamper cities in achieving their implementation objectives, which could lead to a loss of time and money (Mosannenzadeh et al., 2017; Yu & Zhang, 2019).

The issue of funds is influenced by a lack of financial backing from metropolitan municipalities and support from local entrepreneurs, designers, citizens and others (Galal & Elariane, 2022; Kshetri, Alcantara, & Park, 2014). Sufficient available funds are important when implementing the smart city since it is costly to implement an operational smart city (Ruhlandt, 2018; Silva et al., 2018b). The financial factor is one of the reasons why most smart city projects fail because it affects the acceleration of the innovation and acquisition, development and implementation of new technology (Dameri et al., 2019; Lu, De Jong, & Ten Heuvelhof, 2018).

When implementing a smart city, the most recent digital infrastructure is required to allow for extensive data collection and analysis (Chauhan et al., 2016; Lim, Kim, & Maglio, 2018). In a smart city, digital infrastructure is considered an ‘engine’ (Camboim, Zawislak, & Pufal, 2019; Veselitskaya, Karasev, & Beloshitskiy, 2019). The use of outdated information technology infrastructure while implementing a smart city concept would cause compatibility problems (Veselitskaya et al., 2019). Through information technology infrastructure, spatial intelligence is produced by using electronic sensors and embedded digital devices to collect large datasets to generate real-time information for decision-makers (Anthopoulos, 2017; Komninos, Pallot, & Schaffers, 2013).

Furthermore, the successful implementation of a smart city requires digital data from citizens who are willing to contribute such data (Alkhatib, El Barachi, & Shaalan, 2019; He, Weng, Mao, & Yuan, 2017; Kumar et al., 2020). This can also pose challenges because the city needs to certify that privacy, safety, security, veracity and a variety of measures are in place to make sure that the collected data are protected (Moustaka, Theodosiou, Vakali, Kounoudes, & Anthopoulos, 2019; Zhang et al., 2019a). Collecting data from citizens may also require an open data strategy and policy (Bibri, 2021b; Ma & Lam, 2019); this requires support from different stakeholders. Subsequently, it may cause conflicts of interest between citizens, stakeholders or municipal authorities, which could lead to information security problems and may become a hindrance to the development of a smart city (O’Grady & O’Hare, 2012; Veselitskaya et al., 2019).

A smart city also requires skilled citizens and government support (Du Plessis & Marnewick, 2017; Mashau et al., 2022) because users must understand the data to avoid an incorrect interpretation of the outcomes. Skilled citizens will enable the collection of high-quality data in executing extensive analysis to produce helpful predefined views (Mashau et al., 2021; Matheus et al., 2018).

Another challenge when developing and implementing the smart city could be an inflexible method or model since cities differ in their features like size, economy, infrastructure, etc. (Antoni et al., 2020; Khomsi, 2016). There is a lack of tailored models or solutions that may be used to implement the smart city in disadvantaged cities (Dameri & Ricciardi, 2015; Gobin-Rahimbux et al., 2020) because information systems components are expensive and complex to implement. The use of a generic model or approach would inflate the cost and time required to realise the investment. A generic approach will cause cities to rush the implementation of a smart city while ignoring important factors, which, in turn, may result in frustration and project failure (Lam & Givens, 2018; Mosannenzadeh et al., 2017). A tailor-made approach should look at information technology, businesses, economy, institutions, stakeholders and innovation (Grab & Ilie, 2019; Khomsi, 2016) while acknowledging municipality population size, business support, skills and budget (Das, 2020; Lam & Givens, 2018).

Therefore, cities intending to implement the smart city will need support from metro, local, district and national governments (Hielkema & Hongisto, 2013). Thus, a lack of support may hinder progress since cities have to use the smart city concept as a guide for developing urban plans and policies (Joss, Cook, & Dayot, 2017; Veselitskaya et al., 2019; Yu & Zhang, 2019). Implementing a smart city successfully requires a city to have an implementation plan as a guide that fits its local setting and aligns with the national implementation plan (Colding & Barthel, 2017; Kamil, 2018).

These and other unknown obstacles place immense pressure on current urban information systems components (Capdevila & Zarlenga, 2015; Csukás & Szabó, 2018). Cities intending to implement a smart city concept have to deal with all these challenges to understand and design tools that support collaborative working environments and enable online deliberation since online platforms draw citizens together and motivate them to participate in government decisions by giving feedback on municipal policies online (Pedro & Bolívar, 2018).

2.4.3 Smart city sustainability

Sustainability is a complicated term covering economic, societal and environmental issues (Brandt, Ketter, Kolbe, Neumann, & Watson, 2016, 2018). Some scholars describe sustainability as the responsible preservation, reuse and deployment of resources (Blanck, Ribeiro, & Anzanello, 2019; Malhotra, Ross, & Watson, 2013). Academic literature highlights that information technology and other resources must be sustainable for a city to be considered a smart city (Yigitcanlar et al., 2018). Thus, sustainability issues in cities are increasingly becoming a concern in protecting economic and natural resources (Ahvenniemi, Huovila, Pinto-Seppä, & Airaksinen, 2017; Yamagata & Seya, 2013).

Most sustainability issues stem from rapid population growth (Cretu & Cuza, 2012; Dixon et al., 2014) and the lack of utilisation of digital data to enable shared services (Popescu, 2015). This contributes to the lack of efficient transport, sufficient fresh water, a cleaner environment, employment, energy, security, sustainable development, quality of life and food. These are all key concerns that are difficult to manage in many cities (Leong et al., 2017; Schaffers et al., 2012; Shichiyakh, Klyuchnikov, Balashova, Novoselov, & Novosyolova, 2016). Therefore, if public transport is not sustainable, it affects citizens because they have to stand in long queues for hours, causing them to arrive late at their destinations (Delponte & Ugolini, 2011; Lopez-Carreiro & Monzon, 2018).

Moreover, unsustainable digital infrastructure, information technology and basic services negatively affect the quality of life and the economy (Pasolini et al., 2018; Stratigea, Papadopoulou, & Panagiotopoulou, 2015). Accordingly, for cities to be sustainable, they must be able to preserve their environments and resources to improve societal issues and economic status (Ahvenniemi et al., 2017; Weber & Podnar Žarko, 2019). This can be achieved through information systems responsive to basic service matters and environmental issues like climate change, pollution, etc. (Brandt et al., 2016; Malhotra et al., 2013; Stratigea et al., 2015).

The advent of the smart city concept proposed to address problems emerging from the movement of people from rural to urban areas, resulting in high city population growth (Dameri et al., 2019; Pinochet, Romani, De Souza, & Rodríguez-Abitia, 2018; Silva et al., 2018b; Yigitcanlar et al., 2018). However, it is also useful for driving governmental agendas for improving the standard of living, reducing poverty, creating opportunities and improving service delivery (Angelidou, 2017; Yigitcanlar et al., 2021). The process driving the government's agenda should also consider local context, the citizens, innovation and smart solutions as problem-solving factors to enable a sustainable smart city (Hosseini et al., 2018; Szabo et al., 2013).

A city must understand decision-making and human behaviour regarding the environment within their political, spatial and cultural contexts to create a sustainable smart city (Passe, Anderson, Brabanter, Dorneich, & Krejci, 2016; Roy, 2016). This could assist cities in becoming sustainable as they would be able to respond to any challenges emanating from those factors (Blanck et al., 2019; Brandt et al., 2016). In general, the main objective of a smart city concept is to improve sustainability through the use of information systems components (Ahvenniemi et al., 2017; Maccani et al., 2020).

2.5 Readiness assessment stage within the implementation process

A readiness assessment is defined as a systematic and structured process of examining and evaluating an organisation's or individual's preparedness in terms of resources, capacity and capability to execute a specific project or initiative (Kamolov & Kandalintseva, 2020). According to Ajami, Ketabi, Isfahani and Heidari (2011), six stages must be followed when implementing an innovation. These stages are Stage 1, Assessment; Stage 2, Planning; Stage 3, Selection; Stage 4, Implementation; Stage 5, Evaluation; and Stage 6, Improvement (Ajami et al., 2011).

On the other hand, Kamolov and Kandalintseva (2020) suggest that a municipality should set a goal before conducting a readiness assessment. However, all the aforementioned authors agree that an assessment must be undertaken before the planning stage (Ajami et al., 2011; Kamolov & Kandalintseva, 2020). Consequently, the researcher in this study agrees that an assessment of small and rural municipalities' readiness for smart city implementation should be conducted before the planning stage.

2.6 Smart city initiatives

The smart city concept focuses on exposing various smart city initiatives, successes and pitfalls. Smart city initiatives are significant because they can assist cities in avoiding the same mistakes made by other cities when engaging in smart city projects. In this study, the concept is used to explore smart city projects conducted in South Africa and other countries to justify the research problem by looking at the initiatives that can be used to assess small and rural municipalities' readiness for smart city implementation in other developing countries.

A smart city initiative is when a municipality or city engages in a project to transform its city from a traditional city into a smart city (Khomsi, 2016; Yu, Wen, Jin, & Zhang, 2019). The smart city initiative is also called smart city projects and is often funded and supported by city municipalities (Hýllová & Slach, 2018; Van Winden & Van den Buuse, 2017). Recently, most cities worldwide have engaged in smart city projects (Camboim et al., 2019; Dameri & Ricciardi, 2015; Komninos et al., 2013).

Smart cities are considered a global phenomenon since they have expanded throughout the world and produced similar interdependencies and features on a global level (Apostolopoulos et al., 2022; Dameri et al., 2019). The present study views smart cities as a local phenomenon because each city is distinct and has different features, challenges, resources, policies and problems, requiring specific solutions for addressing them (Chichernea, 2015; Du Plessis & Marnewick, 2017).

Most cities are engaged in smart city initiatives to address sustainability issues and to improve the quality of the city's inhabitants' lives as well as the effectiveness of its services (Galal & Elariane, 2022; Lakshmanaprabu et al., 2019). Thus far, most studies on the smart city and smart city initiatives mainly focused on congested areas like big cities while excluding small suburbs, towns and rural areas (Hosseini et al., 2018; O'Grady & O'Hare, 2012).

In the past, most smart city initiatives focused on social elements and sustainability while paying less attention to information technology hardware and data (Maier, 2016; Öberg et al., 2016; Vanolo, 2016). Additionally, those initiatives followed top-down approaches to diffuse technology (Capdevila & Zarlenga, 2015; Matos et al., 2017; Vanolo, 2016).

A city needs strong leaders like mayors with the vision and will to advocate for smart city strategies towards executing a smart city project (Enwereji & Uwizeyimana, 2022; Lam & Givens, 2018; Scholtz & Van Der Hoogen, 2022). However, most of such initiatives have involved citizens because they are regarded as valuable and, therefore, must be able to access the improved services and systems (Bakici et al., 2013; Scholtz & Van Der Hoogen, 2022). Thus, to develop a competitive city, municipalities and public sector institutions are required to introduce a new way of management and the utilisation of innovations (Mazurek, 2018; Roy, 2016).

The smart city concept is the future of improvement to the traditional city, where the utilisation of tangible resources (for example, natural resources, energy distribution and transport infrastructure) and intangible resources (for example, organisational capital in public administration bodies, human capital and the intellectual capital of companies) are improved digitally (Bibri, 2018b; Popescul & Radu, 2016; Yigitcanlar et al., 2019b). All these resources require ICT when transforming a traditional city into a smart city, but this must be undertaken while ensuring that tangible and intangible resources are protected to enhance the citizens' quality and standard of living (Alsaig et al., 2019; Li et al., 2017; Söderström et al., 2021).

At present, these resources are supposed already to be or becoming smart (Mak & Lam, 2021; Zait, 2017); cities should be able to control all resources by using information technology to manage resources effectively to provide a better quality of life (Dameri & Ricciardi, 2015; Suryotrisongko et al., 2017). This is difficult to accomplish because when engaging in a smart city project, cities should consider their local contexts, complexities, government bureaucracies, jurisdiction laws, resource allocation and innovation capabilities linked to a particular smart city initiative since these projects are not one-size-fits-all (Adapa, 2018; Mak & Lam, 2021).

Moreover, a smart city initiative can be used as a mechanism with which to deal with cities' challenges (economic restructuring and energy shortages) posed by the increased population in cities (Ivars-Baidal, Celdrán-Bernabeu, Femenia-Serra, Perles-Ribes, & Giner-Sánchez, 2021; Lam & Ma, 2018). These initiatives seem to differ around the world since modern cities have complicated ecosystems with different management of discrete economic, environmental and social issues (Adapa, 2018; Bibri, 2021a; Qayyum, Ullah, Al-Turjman, & Mojtahedi, 2021). Most studies on smart city initiatives suggest that when addressing the challenges faced by municipalities, an ecosystem must be created, and public sector information must be reused to achieve smart city goals (Walravens, Breuer, & Ballon, 2014). Furthermore, municipalities or cities aiming to ensure social and environmental sustainability should prioritise the innovation of ecosystems from traditional urban characteristics to modern urban characteristics in their smart city projects (De Jong et al., 2015; Maye, 2019; Zygiaris & Sotiris, 2012).

The majority of smart city initiatives emphasise that the problems traditional cities face can be addressed by improving collaborative innovation (Dameri et al., 2019; Kamolov & Kandalintseva, 2020; Noori et al., 2020; Ojasalo & Kauppinen, 2016). This depends on the management and collection of the correct type of data for pattern discovery and optimising system performance (Arief et al., 2020; Chauhan et al., 2016; Erastus et al., 2020; Maccani et al., 2020).

In addition, more studies show that open innovation is an efficient and effective method to address the issues that are part of a traditional city (Desdemoustier et al., 2019a; Hosseini et al., 2018). This is because innovative technologies can be used to integrate and monitor the condition of all crucial infrastructure—from major buildings, roads and bridges to improve its resources, monitor security features (Desdemoustier et al., 2019b) and design its precautionary maintenance tasks to maximise services to citizens (Cretu & Cuza, 2012; Dixon et al., 2014; Kummitha & Crutzen, 2017).

2.6.1 Smart city initiatives in South Africa

In South Africa, big municipalities have engaged in various smart city initiatives. These municipalities are the City of Johannesburg, the City of Ekurhuleni, the City of Cape Town, the eThekwini Metropolitan Municipality and the City of Tshwane. These cities regard the smart city concept as using information technology to advance city objectives and support the processes that are key to their operations. They intend to use the smart city concept to support the growth and development of a strategy that will help their cities accomplish more with fewer resources and become more efficient and innovative (Musakwa & Mokoena, 2018; SALGA, 2015).

In Gauteng province, three metropolitan municipalities have embarked on smart city initiatives. These municipalities are the City of Johannesburg, the City of Tshwane and the City of Ekurhuleni. The City of Johannesburg’s smart city initiative effected the rollout of broadband to enable digital innovations. The city provided cost-effective broadband connectivity through the creation of wireless hotspots at government facilities. In another smart city initiative, the city installed smart meters in households to curb electricity losses, manage energy consumption and increase profits (Musakwa & Mokoena, 2018; SALGA, 2015).

In the City of Tshwane, free public internet connectivity is considered an enabler of the smart city initiative. The city initiated a project known as *Isizwe* that implemented four hundred Wi-Fi sites serving two million people (SALGA, 2015). This free internet connection enables citizens to access e-Services without having to spend a lot of money (Musakwa & Mokoena, 2018). Citizens use this internet connectivity to access the municipality portal to report cases related to service delivery (Aucamp et al., 2016; Musakwa & Mokoena, 2018).

In 2004, the City of Ekurhuleni embarked on a project to transform Ekurhuleni into a smart city (Musakwa & Mokoena, 2018); they considered ICT networks to be drivers in this journey. The city started by maintaining and ensuring that its wireless grid and fibre optic networks were properly connected (SALGA, 2015). Additionally, they installed electronic metering to enable citizens and businesses to monitor and manage their consumption. These meters were for measuring water as well as electricity consumption and their installation was envisaged to improve the efficiency of billing and service delivery (Musakwa & Mokoena, 2018; SALGA, 2015).

The eThekwini Metropolitan Municipality, situated in the KwaZulu-Natal province, is also engaged in becoming a smart city. This is the first municipality to use one of the smart services known as 'smart technology' or 'application'. The application is a smart mobile application that runs on smartphones and tablets. It enables customers to interact with the municipality remotely in real time; this tool has proven to be responsive to service delivery issues. Furthermore, utilising information technology saves time for customers who don't have to go to municipality offices and stand in long queues (SALGA, 2015).

Another smart city initiative at the eThekwini Metropolitan Municipality was developed by the eThekwini Transport Authority. This initiative seeks to make eThekwini a liveable and caring city. It uses digital data as the key element in making the eThekwini Metropolitan a smart city. The municipality engaged in this smart city initiative to manage some of its operations and maintenance better by using an application with global positioning system (GPS) capabilities. This application enables customers to report service delivery problems with their exact location (Aucamp et al., 2016).

The City of Cape Town embarked on a smart city initiative in 2003 called the SmartCape Access Project. In this initiative, the internet was regarded as a key element for enabling its smart city project (SALGA, 2015). This project started with the installation of modern information technology infrastructure, improving internet access in libraries and creating several Wi-Fi hotspots around the city (Musakwa & Mokoena, 2018; SALGA, 2015). The City of Cape Town further established a smart mobility known as the MyCiti bus. This smart service provides an integrated bus system that links different routes to the airport (Musakwa & Mokoena, 2018). This simplified the lives of citizens and tourists because they could travel effortlessly anywhere in the city (SALGA, 2015).

2.6.2 Smart city initiatives in countries other than South Africa

Various cities are engaged in smart city initiatives globally, most of which are in Europe, the United States, Belgium and India, including Santander (Spain), Busan (South Korea), Milton Keynes (United Kingdom) and Chicago (United States) (Desdemoustier et al., 2019b; Ismagilova et al., 2019; Ramos et al., 2021). The top five cities to implement the smart city successfully are Barcelona, Masdar City in the United Arab Emirates, Nice in France, New York, London, and Singapore (Çelikyay, 2017; Vitunskaite et al., 2019). Their governments had good strategic planning regarding the development and implementation of smart city initiatives and elicited suggestions and opinions from stakeholders (Camboim et al., 2019; Pedro & Bolívar, 2018). Below are some of the global smart city initiatives.

In Europe, Nice (France) was the first city to embark on a smart city initiative. The Nice smart city initiative commenced by using a near-field communication system (NFC) to process payments in buses, galleries, trams, shops, etc. Later on, their smart city initiatives were divided into four projects: smart environment monitoring, smart transport, smart lighting and smart waste management. The city deployed three thousand monitoring sensors in the west of Nice. These monitoring sensors collected data about the environment, energy and waste management, which were utilised to improve the city's services (Kumar et al., 2020; Silva et al., 2018a).

Barcelona (Spain) is one of the most advanced smart cities. Its smart city journey started gaining traction in 2011 (Gascó-Hernandez, 2018; Vitunskaite et al., 2019), evolving from e-government projects to smart city initiatives. The transformation of the traditional city centred around information technology (Bakici et al., 2013; Gascó-Hernandez, 2018; Silva et al., 2018b). Such technology was also used to expand the economy and improve the quality of the lives of the citizens (Gascó-Hernandez, 2018).

The Barcelona smart city initiative was divided into eighty-three single projects that used fibre-optic internet to enable integrated IoT devices (Vitunskaite et al., 2019). These integration and technological innovations were significant in creating smart services such as smart homes, smart parking, a smart bicycle-sharing system, smart lighting and smart metering (De Falco et al., 2019). The city created an application for smartphones and other devices available to users to enable the usage of these smart services (Vitunskaite et al., 2019).

Another smart city initiative conducted in Natal City (Brazil) was decentralised. These smart city initiatives focused mostly on developing information technology applications and platforms in phases (Cacho et al., 2016a; Cacho, Lopes, Cavalcante, & Santos, 2016b). These applications included an open data portal, public safety, social media, non-emergency services and a mobile tourism guide, implemented to improve city connectivity among citizens, government, objects and other services (Cacho et al., 2016b).

The mobile tourist guide is called the *Find Natal* application and was developed by Planet Smart City. This application collects, cleans, shares, saves and analyses data on the activities of tourists (Cacho et al., 2016a). The main purpose of this initiative was to enhance tourists' experiences through information technology (Cacho et al., 2016a; Gretzel, 2018).

Most smart city initiatives, locally and globally, are centred around free internet connection, data, sensors and information technology (Bell et al., 2018). The literature demonstrates that smart city initiatives and digital innovations depend on technology (Turetken, Grefen, Gilsing, & Adali, 2019). Cities must be able to collect and share relevant information to implement a smart city concept successfully (Schuurman et al., 2012) because several existing smart city initiatives used technology-driven developments to improve the transparency, efficiency, accountability and effectiveness of interaction between citizens and the municipalities (Aguilera, Peña, Belmonte, & López-De-Ipiña, 2017; Marsal-Llacuna & Wood-Hill, 2017). Therefore, internet connectivity and the latest technologies are significant for enabling a smart city concept (Bhide, 2017).

2.7 Small and rural municipal aspects

Small and rural municipalities reside under local, district and regional governments or authorities (Giovannella, 2014). They are also known as places where a relatively large number of people live (Das et al., 2014; Gontar et al., 2014; Matheus et al., 2018) and could be considered economic hubs (Dittrich, 2017; Yavuz, Cavusoglu, & Corbaci, 2018) because they contribute 70 per cent of the world's gross domestic product (GDP) (Dixon et al., 2014; Walravens et al., 2014). A small or rural municipality's economy plays a significant role in the administration of national systems and in shaping their future formats (Veselitskaya et al., 2019). Therefore, most cities need to implement the smart city concept to contribute to world GDP. For cities to accomplish this, they should assess aspects of small and rural municipalities (Desdemoustier et al., 2019b). Based on an analysis of the literature review, such aspects could include population size, stakeholders, the economy, budgets and policies—depending on their settings.

2.7.1 Population size

Most cities find it challenging to provide basic services because of rapid population growth (Hasbini, Eldabi, & Aldallal, 2018; Leong et al., 2017; Tachizawa, Alvarez-Gil, & Montes-Sancho, 2015). Cities are responsible for the provision of basic services to their citizens. Indeed, population growth is normally linked to the provision of basic services, social elements, the economy and the standard of living (Dixon et al., 2014; Russo, Rindone, & Panuccio, 2016). Globally, the populations of cities are growing at a fast pace; more than 2.5 billion people are expected to be residing in cities by 2050 (Brandt, 2018; Camero & Alba, 2019; Gomez & Paradells, 2015; Sun, 2012). Such population growth places pressure on municipalities and their resources (Roche, 2014; Veselitskaya et al., 2019; Zhang, Huang, Zhu, & Qiu, 2013).

Furthermore, cities are considered educational pools, where most students go to further their studies in higher institutions to obtain qualifications (Dixon et al., 2014; Marsal-Llacuna & Wood-Hill, 2017). After completing their higher education, most of these students would likely remain in the city (Giovannella, 2014; Marsal-Llacuna & Wood-Hill, 2017). Thus, most eventually buy or rent a house or even erect an informal dwelling. Accordingly, these informal settlements have to be addressed later on through urban planning and renewal (Dittrich, 2017). Informal settlements result in high population growth in cities. The smart city concept can be used to manage and provide services to the citizens in these areas.

Again, a municipality's socioeconomic development and digital infrastructure (Brandt et al., 2018) attract businesses, talent, investments, innovation and ideas (Dameri & Ricciardi, 2015; Ismagilova et al., 2019; Lakshmanaprabu et al., 2019) that contribute to population growth (Russo et al., 2016). As more people move to cities either seeking a better quality of life or greener pastures (Bosha, Cilliers, & Flowerday, 2017; Brandt et al., 2016), the demand for resources grows (for example, information infrastructure, new technology, networks and transport), which would likely exceed available resources (Maier, 2016; Marek, Campbell, & Bui, 2017) and this, in turn, will affect service delivery and the environment (Bifulco, Tregua, Amitrano, & D'Auria, 2016). This situation requires a smart city concept to help such cities manage people's needs effectively and enable the city to allocate existing resources efficiently. Implementing a smart city concept requires resources that exceed the demand and may require the deployment of expensive tracking and sensing infrastructure (Csukás & Szabó, 2018; Yigitcanlar & Lee, 2014).

2.7.2 Budget

Funding or budget is another aspect of small and rural municipalities affecting the development of a smart city concept (Dupont, Morel & Guidat, 2015). Issues concerning old information technology infrastructure and the lack of the latest technologies and innovations emanate from financial factors and budgetary constraints (Mosannenzadeh et al., 2017). It can be difficult to adjust a budget since most government entities have to wait for the financial year-end to do so. Thus, most cities fail to implement a smart city because of insufficient funds allocated to the smart city development budget (Bosha et al., 2017; Wray et al., 2018). Little literature exists about the budget as a significant aspect in small and rural municipalities when assessing their readiness for smart city implementation. This aspect is important because, without sufficient funding, it is difficult to procure the latest information technology infrastructure.

2.7.3 Stakeholders

In this study, the stakeholders are municipalities and their staff, citizens, government departments, private companies, businesses, service providers, tourists, universities, software companies, state-owned entities, research communities and application developers (Artto et al., 2016; Bhide, 2017; Calderoni et al., 2012; Oomens & Sadowski, 2019; Pau et al., 2018; Sauer, 2012). Several smart city studies identify stakeholders as enabling factors (Maier, 2016; O'Dwyer, Pan, Acha & Shah, 2019). They are also progressively considered representatives of change and collaborators. This is because stakeholders have to present their needs and work hand-in-hand with the government to address various issues using participatory methods (Angelidou, 2017; Kandappu, Misra, Koh, Tandriansyah & Jaiman, 2018).

Municipalities and both private and public companies as stakeholders play a significant part, namely promoting the smart city concept as an innovation to transform a city into becoming smart (Grossi & Pianezzi, 2017). When pursuing a smart city project, private and public companies should be equally involved throughout the smart city project process because these companies offer different kinds of assistance, while others contribute by sponsoring smart city initiatives and donating resources (Bilbil, 2017; Khomsi, 2016). Sometimes, these companies act as service providers by rendering system design, development and maintenance services to ensure urban sustainability (Pedro & Bolívar, 2018).

Moreover, when implementing a smart city concept, it is imperative that stakeholders, especially municipality mayors, understand the objectives and provide the necessary support to the smart city project (Bhide, 2017; Bifulco et al., 2016). Municipality involvement in a smart city project may attract innovative investments and opportunities (O'Dwyer et al., 2019). However, city leaders with contradictory expectations make it challenging for a city to implement a smart city (Enwereji & Uwizeyimana, 2022; Kummitha & Crutzen, 2017; Scholtz & Van Der Hoogen, 2022).

In addition, a smart city needs more young, professional and educated citizens (Keta, 2015) because citizens are considered to be the users, consumers and testers of information technology applications instead of just being creators and innovators (Capdevila & Zarlenga, 2015; Mashau et al., 2021, 2022). Thus, young people play an important role using living labs in the smart city since they are more regularly engaged in new technologies to find solutions that allow the building of a resilient and sustainable city to accommodate growth and adversity (Khomsi, 2016; Pinochet et al., 2018).

Professionals, the youth and educated citizens are also instrumental during the operational phase (Calderoni et al., 2012; Dadashpoor & Yousefi, 2018; Mosannenzadeh et al., 2017; Pedro & Bolívar, 2018) because they use smart applications to generate data and access information (Matos et al., 2017; Scholtz & Van Der Hoogen, 2022). Municipalities depend on such generated data because the success of a smart city project depends on high-quality data (Bennati, Dusparic, Shinde & Jonker, 2018).

Additionally, community engagement can be significant in collecting data from different stakeholders through crowdsourcing and crowdsensing to enable connected urban solutions (Bhide, 2017; Corsini, Certomà, Dyer & Frey, 2019). A lack of community participation affects the generation of data, its analysis and subsequent decision-making (Corsini et al., 2019; Marine-Roig & Clavé, 2015). This can also be achieved through collaboration with universities. The collaboration between municipalities and universities needs to be diversified to expand cities' sustainability (Dupont et al., 2015) because municipalities and government departments play an important role in the leadership and funding of town development (Lu et al., 2018).

City managers rely on the data produced by different stakeholders to generate trends, patterns, measures and indicators for setting targets to monitor performance, assess risk and make decisions (Alawadhi et al., 2012; Huovila, Bosch & Airaksinen, 2019). Municipal management is responsible for ensuring the safety and quality of life of its citizens, which could be accomplished through the use of information technology and innovative ideas to manage most of the activities within the city in real time (Bosha et al., 2017; Dameri & Ricciardi, 2015; Delponte & Ugolini, 2011; Khomsi, 2016; Shichiyakh et al., 2016). Municipalities must promote the spirit of digital innovation internally among employees to align the goals between public and private partners to reduce risk and increase creativity (Scuotto, Ferraris & Bresciani, 2016).

The process of transforming a city into a smart city starts with stakeholders, technology and ICT infrastructure (Bilbil, 2017; Lim et al., 2018; Popescu, 2015; Roche, 2014). The utilisation of information, electronic technologies and computing by stakeholders and businesses may improve city productivity (Faisal, Usman & Murtaza Zahid, 2018). Most researchers agree that this aspect is essential to establishing a smart city (Alawadhi et al., 2012; Huovila et al., 2019; Khomsi, 2016).

In addition, a smart city should create an ecosystem to connect various stakeholders (Chatfield & Reddick, 2019). A smart city ecosystem in small and rural municipalities aims to leverage technology and data to address the unique challenges faced by stakeholders, such as service delivery, agricultural needs, healthcare access and economic development (Appio, Lima, & Paroutis, 2019; Khomsi, 2016). Furthermore, it also seeks to improve the overall quality of life, sustainability and economic opportunities of citizens in rural areas (Appio, Lima & Paroutis, 2019; Khomsi, 2016).

2.7.4 Economy

Most cities are driven by economic factors (Martin et al., 2019; Schuurman et al., 2012) because they improve the standard of living (Enwereji & Uwizeyimana, 2022; Ismagilova et al., 2019) by unlocking opportunities like high-quality infrastructure, new business opportunities, growing ecosystems, competitiveness and many more for their citizens (Mora, Deakin, & Reid, 2019; Ojasalo & Kauppinen, 2016).

A strong economy promotes digital innovation and development as well as the management of a smart city (Alawadhi et al., 2012; Chourabi et al., 2012; Kitchin, 2014). For a city to become smart, it needs a strong economy, which could be achieved through utilising information technology, social growth and sustainability. Becoming a smart city could be brought about by initiating new, innovative fields of trade and digital technologies that would increase production and reduce costs and environmental impact (Bosha et al., 2017; Chauhan et al., 2016). Digital innovation also requires an information technology infrastructure aligned with the economy (Bakici et al., 2013; Silva et al., 2018a).

2.7.5 Policies

A well-defined policy should have clear expectations and action plans for how to address issues like quality of life, mobility, accessibility, health, education and overall urban operations and services (Prendeville et al., 2018; Yigitcanlar et al., 2019a). Nevertheless, when crafting these policies, policymakers should reconsider the structures and rules that delay digital innovation and the implementation of a smart city concept (Oomens & Sadowski, 2019; Schiavone, Paolone & Mancini, 2019).

Policies are critical when developing a smart city because they serve as guidelines when acquiring information systems components and services. These policies could help a city mitigate future problems timeously since they serve as a guide for everyone involved in the development phase (Cledou, Estevez & Soares Barbosa, 2018; Mayangsari & Novani, 2015; Pincetl & Newell, 2017). Without these policies, regulations and laws may hinder the progress of smart city initiatives (Alawadhi et al., 2012; Bilbil, 2017; Chourabi et al., 2012; Zawieska & Pieriegud, 2018).

2.8 Information systems drivers for a smart city development

Section 2.8 focuses on smart city drivers. The section mainly aims to evaluate significant IS drivers for smart city development. This section investigates information technology infrastructure, information and communication technology, data, the IoT, living labs, information security, geographic information systems and real-time monitoring as drivers of smart city development.

The literature confirms that information and communication technology, stakeholders (citizens), policy (Camboim et al., 2019; Shang, Wang, Li, Chen, & Li, 2018; Yigitcanlar et al., 2018), the IoT, data and big data, geographic information systems, infrastructure, information security (Apostolopoulos et al., 2022; Ma & Ren, 2017; Megahed & Abdel-Kader, 2022) and people are the thresholds for determining if a city is ready to implement a smart city (Bifulco et al., 2016; Lai & Cole, 2022).

A smart city uses information and communication technology to improve all aspects of urban life (Brandt et al., 2016, 2018). However, the main drivers of a smart city concept comprise broad utilisation of ICT, the IoT (Mashau et al., 2022; Pasolini et al., 2018), an established information technology infrastructure, stakeholder involvement and partnership between private and public organisations (Joss, Sengers, Schraven, Caprotti, & Dayot, 2019; Veselitskaya et al., 2019).

A smart city could integrate the IoT, cloud computing, edge computing, big data and other novel technologies (Currin et al., 2022; Peng et al., 2018; Ushakov, Dudukalov, Mironenko, & Shatila, 2022). Edge computing is an assigned, open information technology design that accommodates distributed processing power that is used to administer data. The data is processed by a local computer, server or device rather than sending information to a data centre (Ushakov et al., 2022). These latest technologies focus on sharing, utilisation, integration and dealing with information resources and emphasise the coordination of city management. This is performed to enable the IoT and mobile computing. (Farago, 2019; Peng et al., 2018).

There is a growing need for municipalities to use smart technologies to elicit data and analyse it in real time for extracting information (Roche, 2014; Zhang et al., 2019b). Information and communication technology, the IoT, big data and analytics enable the connection between people, infrastructure and services in the smart city (Badii, Bellini, Difino, & Nesi, 2018; Brandt et al., 2016, 2018). These factors are aimed at improving cities' efficiency (De Falco et al., 2019; Mashau et al., 2021; Yigitcanlar et al., 2021). The factors discussed below are required for small and rural municipalities' readiness to implement a smart city concept successfully.

The development of a smart city is not the adoption of information technologies alone; it also encompasses information systems drivers for smart city development, which are information technology infrastructure, data, novel governance methods and public participation, to name a few (Enwereji & Uwizeyimana, 2022; Eremia et al., 2017). The development process of a smart city is complex and involves various aspects (Cacho et al., 2016b; Kim & Kim, 2021) depending on the small and rural municipalities context (Desdemoustier et al., 2019a). Furthermore, intelligent and strategic decisions are important for its development (Eremia et al., 2017).

2.8.1 Information technology infrastructure

Based on the smart city initiatives discussion in this study, smart city projects require information technology infrastructure to be successful. Other studies view an information technology infrastructure as a hardware component used in a computer-based information system (Calvillo, Sánchez-Miralles, Villar, & Martín, 2017; Calzada & Cobo, 2015). Hardware is the physical component of the information system, according to Calvillo et al. (2017) and Bibri (2021a). These physical components include servers, computers, sensors, mobile phones, etc. Therefore, information technology infrastructure is a significant aspect of smart city development (Calzada & Cobo, 2015; Lopez-Carreiro & Monzon, 2018) that should be implemented by cities and private entities to enable the creation of intelligent cities (Matos et al., 2017; Scholtz & Van Der Hoogen, 2022).

In addition, several scholars indicate that smart city projects should start with a physical infrastructure since it is the foundation for the innovation of ecosystems (Appio et al., 2019; Shang et al., 2018). In the implementation of a smart city, ICT infrastructure is essential but needs the requisite software running on it to execute the logic and instruct the hardware on performing its functions (Aina, 2017; Lopez-Carreiro & Monzon, 2018; Qayyum et al., 2021).

Thus, municipalities must be committed to investing in the acquisition and improvement of infrastructure (Bibri, 2021b; Hamilton & Zhu, 2017). Improving infrastructure is significant because it requires much capital and time (Hamilton & Zhu, 2017; Shang et al., 2018). Hamilton and Zhu (2017) proffer that investment in the infrastructure could be achieved through public and private partnerships, fiscal policies and a performance-based framework as long-term value creations for a city, citizens and businesses.

Moreover, Hamilton and Zhu (2017) argue that investing in and modernising infrastructure would not only improve the condition of the infrastructure and the quality of life but would also yield positive economic returns for a city. In this case, infrastructure would serve as a support structure for managing city resources such as energy distribution, consumption and production (Chourabi et al., 2012; Cledou et al., 2018; Corsini et al., 2019; Martin et al., 2019).

The infrastructure in most cities is seriously at risk due to a lack of maintenance, standard deterioration and natural disasters (Alavi & Buttlar, 2019; Alawadhi et al., 2012; Martin et al., 2019). Therefore, the maintenance and upgrade of infrastructure are essential as it leads to an efficient, effective, competitive and sustainable city (Antoniou et al., 2019; Esmaeilian et al., 2018); indeed, cities should prioritise the maintenance and upgrade of their infrastructure to meet the demands presented by population growth, environment, technology and industries (Mekhdiev, Prokhorova, Makar, Salikhov, & Bondarenko, 2018). These upgrades may differ based on the city's needs (Calderoni et al., 2012), although most cities globally are engaging in several projects to upgrade their infrastructure (Chourabi et al., 2012; De Jong et al., 2015; Offenhuber & Schechtner, 2018).

Therefore, a city that prioritises the maintenance and upgrade of its infrastructure has a high probability of improving the quality of the lives of its citizens (Heaton & Parlikad, 2019). The smart city concept requires a stable infrastructure to create and run innovative technological solutions to assist in managing natural resources properly (Adapa, 2018; Bibri, 2018b; Chourabi et al., 2012) and to address common infrastructure problems in the development of the smart city (Calderoni et al., 2012). However, this may require the entire country to become dedicated to investing in infrastructure and technology (Adapa, 2018; Alawadhi et al., 2012; O'Dwyer et al., 2019).

2.8.2 Information and communication technology

The advent of ICT has empowered citizens to participate in the innovation dynamics of their cities (Capdevila & Zarlenga, 2015; Yigitcanlar et al., 2018). Technologies do not need to be the latest to support the processes and systems that enable municipalities to be smart (Bibri, 2018b; Huovila et al., 2019; Mayangsari & Novani, 2015; Yigitcanlar et al., 2019b).

Scholars view information and communication technology as a pillar of the creation of a sustainable city (Dadashpoor & Yousefi, 2018; Galán-García, Aguilera-Venegas, & Rodríguez-Cielos, 2014). Information technology is essential in dealing with the real-life problems citizens face (Adapa, 2018; Bibri & Krogstie, 2017; Chourabi et al., 2012; Oomens & Sadowski, 2019) because it can be used to innovate intelligent digital solutions (Li et al., 2017).

Therefore, it is crucial to have intelligent digital solutions to improve the quality of the lives of citizens (Hosseini et al., 2018; Li et al., 2017). Scholars emphasise that technologies are significant when a government wants to transform a city into a smart city (He et al., 2017; Mazurek, 2018). A smart city uses technology to enhance the local economy, environment, transport, traffic management, interaction with the government and the quality of the lives of city dwellers (Alawadhi et al., 2012; Bibri, 2018a; Hopkins & Mckay, 2019; Ismagilova et al., 2019).

The use of information and communication technology in government entities is also known as electronic government (e-government). In most cases, government entities use e-government to improve their day-to-day activities. It is considered to be an enabler of social transformation, economic growth, service delivery, political and organisational change, and also to connect all services and objects (Dadashpoor & Yousefi, 2018; Pereira, Macadar, Luciano, & Testa, 2017). When building a connected city, technology is the ‘brain’ linking these objects (Leong et al., 2017).

Information and communication technology can add value by enabling a community to have real-time interaction with the city through their devices. This might curb protests or demonstrations (Alawadhi et al., 2012; Chourabi et al., 2012; Lyons, 2018; Pinochet et al., 2018) because municipalities would be able to improve service delivery in collaboration with its citizens and stakeholders through the exploitation of ICT (Aguilera et al., 2017; Capdevila & Zarlenga, 2015; Pereira et al., 2017).

Hence, intelligent network technologies are required to offer quality public services and economic growth in support of a sustainable green city and ensure its sustainability (Bakici et al., 2013; Delponte & Ugolini, 2011). This requires a digital innovation approach characterised by citizen involvement in all industries of the economy and the collaboration between municipalities, companies, universities and research institutions (Chourabi et al., 2012; Komninos et al., 2013).

Smart cities are fundamentally built by utilising a set of innovative information and communication technologies (Ojasalo & Kauppinen, 2016) that include mobile networks (for example, Wi-Fi, 3G, 4G, 4G+ and 5G networks), smart hardware devices (for example, smartphones, wireless sensors, smart vehicles and smart meters), software applications (for example, mobile apps, back-office control systems and analytical tools) and data storage technologies (for example, operational databases, data warehouse and cloud storage) (Matos et al., 2017; Peng, Nunes, & Zeng, 2017).

Information and communication technology can be utilised in various areas such as road safety, public health and energy, e-commerce, economy, governance and mobility to transform city services and infrastructure (Bakici et al., 2013; Mayangsari & Novani, 2015; Pinochet et al., 2018). This can be achieved by installing electronic sensors on the roads to collect data, analyse it and provide real-time information to road users to navigate traffic congestion and, so doing, avoid excessive harm to the environment. Information and communication technology play a significant role in enabling smart services for the transformation of a traditional city into a smart city (Chichernea, 2015; Esmaeilian et al., 2018; Ma, Lam, & Leung, 2018).

Although these modern cities are connected and technologically advanced, they must ensure continuous development for the benefit of their occupants and the improvement of the quality of their lives (Faisal et al., 2018; Lam & Ma, 2018). Furthermore, to protect and preserve urban cities' environments and improve the health of citizens, new technologies can be used to ensure that citizens live in a healthy environment (Chichernea, 2015). Moreover, cities can use digital or mobile technology, as explicated below.

- **Digital technology**

  Digital technologies have transformed the way of performing actions (Steenbruggen, Nijkamp, & Van Der Vlist, 2014); digitalisation should be a prerequisite for local development since it facilitates interaction between participants (Öberg et al., 2016; Steenbruggen et al., 2014). Moreover, for towns to become smart require digital technologies which can be used to create a new generation of transport systems, energy networks and buildings, all of which are vital in addressing a collapsed environment and climate change (Mora, Deakin, & Reid, 2019; Prendeville et al., 2018). Such a new generation would enable a city to curtail operational costs through automated processes that would enable citizens to request services wherever they are using digital technologies (Steenbruggen et al., 2014).

  In the current era, cities should take advantage of digitisation (Lyons, 2018; Scuotto et al., 2016) since data are regarded as a strategic weapon for any organisation. Yet more data are contained in physical documents, which could be used to alleviate poverty, protect ecosystems and prevent environmental degradation (Marrone & Hammerle, 2018). This data can be digitised using technologies like optical character recognition (OCR). Digitisation can transmit this data faster to different devices (Santos, 2018). The intensive utilisation of digital technologies to improve a city's ecosystem can become the strength of a smart city (Komninos, Kakderi, Panori, & Tsarchopoulos, 2019; Mora, Deakin, Reid, & Angelidou, 2019).

- **Mobile technology**

  The mobile technology sector has undergone a major transformation in past years, as commercial and public sectors were attempting to find a strategic fit (Camboim et al., 2019; Canıtez & Deveci, 2018; Walravens, 2012). Furthermore, mobile technologies are indispensable, especially for a city gaining a competitive advantage since it connects everyone at any time and place via the internet (Caporuscio & Ghezzi, 2015; Lee, Lee, & Woo, 2014).

  These mobile technologies could be any application able to run on (mostly) smartphones and tablets (Calderoni et al., 2012; Dacko, 2016; Lopez-Carreiro & Monzon, 2018). Globally, smartphones and tablets that support mobile technologies have become progressively affordable (Schaffers et al., 2012); people can use these technologies to request, track and receive services (Bell et al., 2018; Moustaka et al., 2019; Yigitcanlar & Lee, 2014). These technologies include any transport application to request transportation or a parking application to reserve parking (Adapa, 2018; Iványi & Bíró-Szigeti, 2019; Lyons, 2018).

  Mobile technologies are also crucial to the tourism industry (Cledou et al., 2018; Gretzel, 2018; Iványi & Bíró-Szigeti, 2019), the hotel industry, catering and transport industries as well as the government (Walravens, 2012). In these industries, they are used for checking and paying bills, loading tags and many more (Komninos et al., 2013) but have been viewed as a risk from a user perspective (Leong et al., 2017). In a smart city, tourists should be able to request all these services using mobile technology (Gretzel, 2018).

  Some smartphones have sensors, and although smartphone sensing is relatively new, it has the prospect of dominating the smart city (Alavi & Buttlar, 2019). Customers can use their devices to access city services through sensing capabilities (Chaves-Diéguez et al., 2015). For example, when there is a service fault, a smartphone would detect and report it automatically. This would enable a city to sense the demand for basic services and resources and analyse such data to assist with the allocation of resources and services.

  Thus, for a city to be smart, its actors have to connect with mobile actors (Marsal-Llacuna & Segal, 2016; Roche, 2014). This is achieved by connecting all role players with smart services, comprising smart homes, smart lights, smart traffic, smart grids and smart energy, to name a few (Alkhatib et al., 2019; Dameri & Ricciardi, 2015). These mobile actors should be equipped with communication capabilities, onboard digital memory and various sensors (Alavi & Buttlar, 2019).

In most cities, mobile technologies are regarded as useful tools (Almuraqab & Jasimuddin, 2017; Iványi & Bíró-Szigeti, 2019); most citizens use mobile technologies such as social media to extract information that could be significant for identifying trends and patterns (Costa, Duran-Faundez, Andrade, Rocha-Junior, & Peixoto, 2018). These trends and patterns can be used to enable a wide range of smart services (Ma et al., 2018; Marsal-Llacuna & Segal, 2016). Additionally, citizens and mobile application clusters benefit from the development of smart services (Hielkema & Hongisto, 2013). Hence, mobile technologies are regarded as one of the pillars of the smart city concept.

The use of information and communication technology in the smart city bears many benefits that enrich human capital and the governance of citizens that improve the planning and execution of smart city initiatives (Aina, 2017; Kummitha & Crutzen, 2017). Municipalities need technological innovation to address contemporary challenges in a smart city since this improves the environment and raises the intensity of competitive advantage (Abella, Ortiz-de-Urbina-Criado, & De-Pablos-Heredero, 2017; Gascó-Hernandez, 2018; Kamil, 2018; Kuk & Janssen, 2011).

Smart cities universally aim to enhance city sustainability through the use of information and communication technology (Ahvenniemi et al., 2017; Erastus et al., 2020; Zang et al., 2017). Information and communication technologies play a pivotal role in advancing cities towards becoming more open, accessible and smarter (Malandra & Sansò, 2018; Sánchez-Corcuera et al., 2019; Sánchez, Elicegui, Cuesta, Muñoz, & Lanza, 2013). The utilisation of the latest information technologies fosters communication between people and objects, which may promote digital innovation within the community and businesses (Hosseini et al., 2018; c).

2.8.3 Data

For innovative technologies to work effectively, they need to generate information through input, processing and output processes. The knowledge discovery process typically includes data collection, cleaning, loading, analysing and presentation (Liu, Heller, & Nielsen, 2017). At this stage, stakeholders create and consume data using different digital infrastructures and technologies. Thus, citizens, municipalities, and private and public entities are expected to generate, manage, collect, process and deliver data that would be useful for decision-makers and citizens (Huovila et al., 2019; Matos et al., 2017). A lack of data means that there would be neither information nor knowledge (Liu et al., 2017; Marrone & Hammerle, 2018; Ushakov et al., 2022).

Accordingly, cities and companies worldwide depend on data to improve their services (Lim et al., 2018; Lyons, 2018; Witanto, Lim, & Atiquzzaman, 2018). They collect large amounts of data from different sources, including stakeholders (citizens, users, public and the private sector), infrastructure (personal computers or laptops, servers, mobile devices and wireless sensors), and information and communication technology (social media, retail applications, electronic commerce applications and government applications) (Liu et al., 2017; Pincetl & Newell, 2017).

Data from different sources must be ‘cleaned’ because ‘uncleaned’ data present quality issues. Cleaning data originating from different sources is challenging because it frequently comes in different formats, types, meanings and sizes (Kousiouris et al., 2018; Liu et al., 2017). However, Liu et al. (2017) state that data quality is essential because poor quality data may lead to incorrect analytical results and compromise the results or information that would affect knowledge workers’ decisions.

Most data are derived from social media, sensors, security cameras and weather stations. This data can be used to provide services to a city’s consumers (such as city dwellers, public transport and ambulances) with real-time road traffic information for determining possible routes based on a city route network (Calderoni et al., 2012; Hopkins & Mckay, 2019; Steenbruggen et al., 2014).

One significant aspect of the smart city concept is the creation of sophisticated data analytics to assist in planning, understanding, organising and supervising the city (Kim & Kim, 2021; Martin et al., 2019; Popescu, 2015). Thus, cities have to collect large amounts of public data for use in predictive analysis towards establishing a proactive city that ensures that citizens’ needs are met (Bosha et al., 2017; Witanto et al., 2018). Cities can collect open and big data from various sources, as listed below:

- **Open data**

  Open data is freely available and can be accessed, used, republished and shared by everyone as they wish, without any restrictions, patents or copyright. This method is mostly used by public organisations (such as government departments, state organisation entities (SOEs) and municipalities) to become more transparent and enhance their interactions with their stakeholders (Capdevila & Zarlenga, 2015; Pereira et al., 2017). Through open data, cities can access and store various kinds of data from public services; however, manipulating this data should be overseen to protect any personal information that could expose citizens to possible cybersecurity risks (Hamilton & Zhu, 2017).

  Open data could play a significant role in the smart city context as a way to promote innovation. Users could use this data to develop innovative solutions that might help a city to be alert to what is happening within their jurisdiction (Walravens et al., 2014). This data is mostly utilised as big data for various digital services (Ojasalo & Kauppinen, 2016; Ushakov et al., 2022).

  Furthermore, this data is essential for city development and decision-making and offers government entities the control to monitor and provide efficient tools for managing their cities effectively (Kitchin, 2014; Ojasalo & Tähtinen, 2016). Thus, a smart city requires information to function optimally (Bosha et al., 2017; Heaton & Parlikad, 2019).

- **Big data**

  Big data is a concept referred to as the accumulation of a myriad of data from various sources (Marine-Roig & Clavé, 2015; Pincetl & Newell, 2017). Heaton and Parlikad (2019) also describe it as large amounts of structured and unstructured data that are complex to process and manage using traditional software tools and databases. However, big data is sensitive to dimension requirements such as volume, velocity, value, valence, veracity and variety (Canıtez & Deveci, 2018; Erastus et al., 2020; Neagu, 2018). Volume refers to the size of data; velocity refers to how data flows and the speed required to process it; value refers to the ability to transform big data into information that an organisation can use to support their decisions; valence is a way to show how the data are connected; veracity refers to the quality of the data, while variety refers to data containing various layers with different meanings. These dimensions are significant when dealing with big data; a city should ensure all of them to realise its vision of a smart city (Chauhan et al., 2016; Kamolov & Kandalintseva, 2020; Khan et al., 2020).

The latest information technologies are required when collecting big data. These technologies help with processing speed, decision-making and information awareness and present different opportunities for social interaction (Botta, De Donato, Persico, & Pescapé, 2016; Chauhan et al., 2016). If an entity utilises the latest information technologies, processing would be sufficient for storing big data in the cloud to save resources and for convenience (Wu, Wang, Kumar, & He, 2017). Big data is the foundation for creating real-world applications or services for smart cities (Lim et al., 2018; Pincetl & Newell, 2017).

Most big data are generated through technologies and entities, including mobile phone operators (generating the frequency of application use, location and behaviour data); utility companies (generating the use of water, gas, lighting and electricity); transport providers (generating traffic flow and location data); travel and accommodation websites (generating consumption, reviews and location data); government departments (generating personal information, surveys, services and performance data); social media sites (generating personal information, photos, opinions and location data); and data science tools (generating local knowledge, urban incidents, maps and weather data) that are transmitted through a mobile device using a wireless network (Pincetl & Newell, 2017; Popescul & Radu, 2016; Silva et al., 2018b).

The IoT also generates big data from various sources using sensors. These sensors can be installed in public and private institutions to elicit big data on how citizens utilise city resources (Abella et al., 2017; Araujo, Mitra, Saguna, & Åhlund, 2019; Garcia-Font, Garrigues, & Rifà-Pous, 2018).

Smart objects are another source of big data. In most cases, smart objects collect unstructured data. This data fit the description of big data because it is analysed in real-time to assist the city in understanding, planning, regulating and monitoring how its resources are utilised (Kitchin, 2014). A city increases its chances of implementing a smart city successfully if it makes progress in accessing big data (Zhao et al., 2018).

Therefore, data collected using both the IoT and smart objects are analysed using big data analysis tools to obtain different predictions. Accordingly, applications and analyses are crucial for knowledge discovery (Pincetl & Newell, 2017). These tools use effective and efficient algorithms capable of dealing with complicated data (De Maio, Fenza, Loia, & Orciuoli, 2017). The IoT and smart objects are both capable of collecting real-time data (Sikora-Fernandez, 2018). Hence, cities can potentially gain valuable insight into the needs of citizens early on (Chauhan et al., 2016; Pincetl & Newell, 2017). This capability will help a city accelerate service delivery to meet the needs of its citizens (Zhao et al., 2018). Data analysis tools could also be used to highlight major trends and provide more information that may be helpful when making decisions (Camero & Alba, 2019; Chauhan et al., 2016; Pincetl & Newell, 2017).

Data privacy and security are major concerns when collecting data for a smart city concept (Pedro & Bolívar, 2018); indeed, open data and big data present data privacy and protection issues (Chauhan et al., 2016; Gobin-Rahimbux et al., 2020; Liu et al., 2017). For this reason, data privacy and protection are classified into three categories, namely non-sensitive data, quasi-sensitive data and sensitive data (Liu et al., 2017).

- **Non-sensitive data:** Data that can be accessed by anyone who needs to use it (Liu et al., 2017). This type of data does not have any privacy issues or copyright restrictions. Non-sensitive data can originate from government documents, the population, environmental or urban development plans and city transport, mostly related to the lives of citizens (Liu et al., 2017; Vitunskaite et al., 2019).
- **Quasi-sensitive data:** This type of data can be used to link an object to external sources like bank accounts, social networks, etc. It includes data on gender, date of birth and zip code (called postal codes in South Africa) (Liu et al., 2017) and is less revealing when not linked to sensitive data. Thus, this data can be shared and managed over a considerably loose environment like a cloud platform, using appropriate user authentication to limit its use and to protect the public (Chauhan et al., 2016; Liu et al., 2017).
- **Sensitive data:** This category of data comprises confidential information. Access to this data is restricted to people who are authorised by law. Ma et al. (2018) and Moustaka et al. (2019) warn that this data could compromise personal, system, application or business security; and privacy, information and functions. Therefore, to

realise its full benefits without compromising data authenticity, it is critical to find registered users who can access and analyse data to extract valuable information (Chauhan et al., 2016).

Smart city data should be available for applications to analyse and present new opportunities to decision-makers (Antoniou et al., 2019; Liu et al., 2017). Sharing these sets of data across smart cities is a challenge because of information disclosure policies (Liu et al., 2017; Marsal-Llacuna & Segal, 2016, 2017); indeed, some cities eventually breach these privacy regulations to promote digital innovation (Liu et al., 2017).

2.8.3.1 Data collection techniques in a smart city

Collecting open data and big data in a smart city requires different data collection techniques. Hence, a smart city should exploit various techniques to collect data from its citizens and stakeholders for usage during decision-making (Passe et al., 2016; Sharifi, 2020a). These techniques include *crowdsensing* and *crowdsourcing* as follows:

- **Crowdsensing:** Crowdsensing is a method used to collect and share data from a large group of individuals using mobile devices containing sensors. Such mobile devices include smartphones, tablets, computers and wearable devices (Bosha et al., 2017; Cilliers & Flowerday, 2017; Zhang et al., 2019a). Crowdsensing depends on the power of the particular device's battery to collect data; consequently, the device battery has to be recharged constantly to prevent its power from becoming depleted and, thus, the device from switching off. Crowdsensing is a cheap method compared to crowdsourcing. Crowdsensing collects data using wireless sensors (Asensio, Blanco, Blasco, Marco, & Casas, 2015; Jabeur, Moh, Yasar, & Barkia, 2017) to extract data from users' objects automatically, share the data and transform it into information (Liu et al., 2017; Peng et al., 2018). These sensors can collect high-quality data from light sensors, camera sensors and GPS sensors. Thus, collecting data using crowdsensing could curtail time and financial costs significantly since it does not require human interaction (Calderoni et al., 2012; Leong et al., 2017).

  This approach is also used to collect extensive data from smartphones (Alavi & Buttlar, 2019), known as mobile crowdsensing. Mobile crowdsensing depends on the active involvement of citizens in the collection of appropriate data using sensors in smartphones and smart devices (Alavi & Buttlar, 2019; Leong et al., 2017). Crowdsensing is an interesting aspect of a smart city because it uses mobile phones to collect data about location and time (Calderoni et al., 2012).

- **Crowdsourcing:** Crowdsourcing is a method used to collect ideas or information from a large group of individuals through the internet, social media, emails and mobile applications (Bosha et al., 2017; Cilliers & Flowerday, 2017). It can also use open data platforms and e-participation platforms (Pedro & Bolívar, 2018). In crowdsourcing, participation is voluntary. Hence, when employing crowdsourcing, cities ask citizens to provide personal information using different systems like web applications or emails (Liu et al., 2017; Peng et al., 2017).

  Therefore, large-scale crowdsourcing implementation relies on the characteristics of the citizens and their preferences in addressing matters that are too challenging to be handled by machines (Kandappu et al., 2018; Marsal-Llacuna, 2020; Sharifi, 2020b). These matters could be collecting personal information and sentiment analysis; however, the institution receiving this data must ensure that such information is protected to avoid privacy issues (Caporuscio & Ghezzi, 2015; Zhang et al., 2019a).

  Crowdsourcing is effective when used along with crowdsensing to collect data in a smart city (Caporuscio & Ghezzi, 2015; Das, 2020; Schuurman et al., 2012). When combined, they can collect large amounts of data from citizens via platforms like emails, the internet and social media (Bosha et al., 2017; Moustaka et al., 2019; Witanto et al., 2018). This cooperation promotes effective and efficient city management through participation and collaboration (Pedro & Bolívar, 2018).

  Thus, when used together, these two techniques work correctly because data collection using crowdsensing is automatic; participants do not control when, what or where data are collected and stored. Conversely, crowdsourcing is voluntary; data are collected freely from participants via emails, surveys, etc. Nevertheless, cities must obtain permission from participants before using their personal information (Cilliers & Flowerday, 2017).

2.8.4 The Internet of Things

Most countries that successfully implemented a smart city used the IoT to collect digital data (Antoniou et al., 2019; Heaton & Parlikad, 2019; Liu et al., 2017; Pettit et al., 2018). Leong et al. (2017) assert that the IoT is one of the enabling factors in the implementation of a smart city. The advent of the IoT throughout the world makes it possible for a traditional city to be transformed into a smart city (Kuk & Janssen, 2011; Saleem, Shijie, & Sharif, 2019; Sodhro, Pirbhulal, Luo, & De Albuquerque, 2019). Moreover, the IoT is one of the interfaces used for data collection by employing various technologies and objects (Asensio et al., 2015; Dittrich, 2017; Roy, 2016); it presents a unified platform to connect objects and people to simplify citizens' lives (Bibri, 2018a; Bibri & Krogstie, 2017; Esmaeilian et al., 2018; Farahani et al., 2018).

Several past studies have linked the IoT and the smart city concept (Pau et al., 2018; Strasser & Albayrak, 2016). The IoT is complex (Caporuscio & Ghezzi, 2015; Faisal et al., 2018; Heaton & Parlikad, 2019; Vitunskaite et al., 2019) and requires an ICT infrastructure when developing a smart city (Bibri, 2018b; Chatfield & Reddick, 2019). This is based on the connectivity between the relevant objects, including software, technologies and electronic equipment to sense, control and transfer data; and, in addition, information with less human involvement to simplify complex problems in the city (Faisal et al., 2018; Ma et al., 2018). This could be used to improve efficiency, effectiveness and accuracy in managing the creation of an ecosystem that would ensure an acceptable quality of life (Bibri, 2018b; Chatfield & Reddick, 2019; Farahani et al., 2018; Ma & Ren, 2017; Scuotto et al., 2016).

The IoT uses sensors to connect different devices (Marrero, Macías, Suárez, Santana, & Mena, 2019); therefore, most cities can realise connected cities by using such sensors (Bhatti, Shah, Maple, & Islam, 2019; Chaturvedi & Kolbe, 2019). These sensors are also known as wireless network sensors or smart sensors and are usually predominantly installed to collect and send real-time data (Bestepe & Yildirim, 2019; Garcia-Font et al., 2018; Qiu, Liu, Pereira, & Seo, 2017). Smart sensors are normally used to manage and improve city operations by managing the performance of utility systems, tracking traffic and public transport, and monitoring masses at events (Callaghan, Avery, & Mulville, 2017).

IoT sensors are embedded into physical spaces, such as roads, buildings, bridges, transports, devices and other infrastructure linked to the latest set of technologies (Caporuscio & Ghezzi, 2015; Komninos et al., 2013; Poslad, Ma, Wang, & Mei, 2015). Sensors can also be embedded in smart homes, smart grids, smart health, smart businesses, smart traffic and other smart services (Bestepe & Yildirim, 2019; Tang et al., 2013). These sensors enable real-time sensing that helps with unlocking the digital transformation of a city to enable service delivery that could address citizens' interests (Chatfield & Reddick, 2019; Kousiouris et al., 2018).

Consequently, cities are progressively becoming interconnected through objects and technologies (Silva et al., 2018b; Zhang et al., 2013, 2019b). All these interconnected objects and technologies require global wireless connectivity to function (Valenzano, Mana, Borean, & Servetti, 2016) since, without wireless connectivity, it would be difficult for a city to send and receive data (Asensio et al., 2015; Santos, 2018; Valenzano et al., 2016). Furthermore, these sensors are used to collect data from different objects (Otero-Cerdeira, Rodríguez-Martínez, & Gómez-Rodríguez, 2014; Poslad et al., 2015). These objects include homes, parking, healthcare institutions, logistics, energy, transportation and universities, and their campuses (Araujo et al., 2019; Guo, Lu, Gao, & Cao, 2018).

The sensors send data to servers for usage by big data analytical tools to discover human behaviours and patterns (Costa et al., 2018; Marrero et al., 2019). Connecting smart services is an integral part of the IoT (Costa et al., 2018; Harold, Arata, & Hale, 2018; Menne, 2019). Many technologies and wireless sensors are created and implemented in cities globally (Granlund, Holmlund & Åhlund, 2015; Sagl, Resch & Blaschke, 2015). The IoT is designed to use intelligent sensor nodes for smart city services (Akhter, Khadivizand, Siddiquei, Alahi, & Mukhopadhyay, 2019) to address issues such as global warming and the economy (Fernández-Güell, Collado-Lara, Guzmán-Araña & Fernández-Añez, 2016; Nižetić, Djilali, Papadopoulos & Rodrigues, 2019). **Figure 2** below depicts how objects are connected within smart services using the IoT.

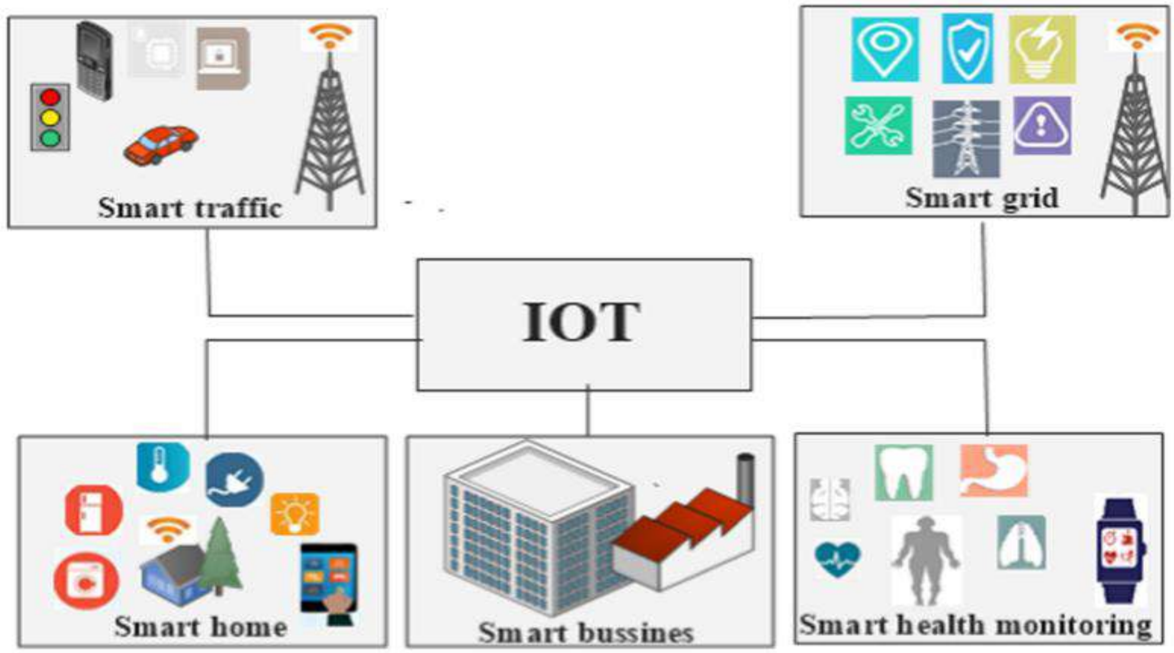


Figure 2: The Internet of Things for different smart services (Saleem et al., 2019: p. 249)

The literature indicates that the number of interconnected devices will increase to over 50 billion by 2028 (Saleem et al., 2019). **Figure 2** demonstrates that the IoT should be the central component integrating all data processing objects and smart services alongside their objects with embedded sensors, which enable them to send and receive data (Caporuscio & Ghezzi, 2015; Saleem et al., 2019). The smart city is based on the use of interconnected smart objects (Chatfield & Reddick, 2019; Esmaeilian et al., 2018). The IoT is anticipated to support sustainable smart cities (Mišák, Stuchí, Platoš & Krömer, 2015) by integrating information systems components to enhance and deliver significant city services (Faisal et al., 2018; Strasser & Albayrak, 2016). Many scholars point to the growing need for municipalities to use these smart objects to collect and analyse data for real-time information (Botta et al., 2016; Heaton & Parlikad, 2019; Pau et al., 2018).

A smart city using the IoT for its day-to-day operations gain the intelligence to forecast and cut operational cost with less human interaction (Botta et al., 2016; Silva et al., 2018b) due to the integration of advanced digital applications and devices (Faisal et al., 2018; Scuotto et al., 2016) that enable the essential building blocks for application handling, data management and data generation (Scuotto et al., 2016; Silva et al., 2018b).

2.8.5 Living labs

A living lab is a real-world environment in which new technologies, products, services, or systems are tested, evaluated, and co-created by users, researchers, businesses and other stakeholders (Artto et al., 2016). Living labs are collaborative and participatory spaces that aim to bridge the gap between innovation and its practical implementation (Sauer, 2012; Schuurman et al., 2012). They provide a platform for user-centred innovation and can be deployed in various domains, including urban planning, healthcare, education and sustainability (Artto et al., 2016; Komninos et al., 2013).

A living lab concept is typically user-centred around citizens and public or private institutions, where they form partnerships and collaborate to innovate new business ideas, digital technologies, markets and services in a real-life context (Komninos et al., 2013). In living labs, users are involved before the commencement of the research and development process to co-create value (Hielkema & Hongisto, 2013). This concept normally follows a bottom-up digital innovation approach, giving users first preference (Sauer, 2012).

Most studies in Europe further highlight that living labs are significant in the development of a smart city because they aim to engage user-centric design practices in which citizens are involved as digital innovators (Sauer, 2012; Schuurman et al., 2012). Hielkema and Hongisto (2013), Komninos et al. (2013) and Sauer (2012) emphasise that when developing a smart city, users play a crucial role in creating, testing and using new digital technologies in living labs. As creators, users are allowed to exploit facilities that are being designed for them (Artto et al., 2016). The living lab concept is working effectively in China and Brazil (Hielkema & Hongisto, 2013), where it enables smart cities to find innovative solutions to problems quickly (Artto et al., 2016).

2.8.6 Information security

Data privacy is an integral aspect of any smart city setting (Silva et al., 2018b) because strong information security is pivotal to the protection of infrastructure and information in smart cities (Hasbini et al., 2018). Thus, city executives should pay close attention to security, the protection and privacy of mostly confidential information, identity management, network protocols, trusted architecture and standards because the violation of security could compromise the city and its people (Ma et al., 2018; Popescul & Radu, 2016).

To secure user privacy, data should be collected with an audit trail without exposing the user's location and personal information that could enable the identification of the user (Kandappu et al., 2018). This includes information like identity numbers, images, contact details and IP addresses because these are indicators that hackers could use to attack citizens and municipalities. Popescul and Radu (2016) caution that hackers in possession of such information could compromise cities or municipalities.

According to Hasbini et al. (2018), information security is significant in the development and implementation of a smart city due to the interconnectivity of objects and users presenting security issues (Lam & Ma, 2018; Popescul & Radu, 2016). Thus, all security factors must be taken seriously when developing or implementing a smart city concept because if ignored, they could pose serious security threats (Bibri & Krogstie, 2017; Hasbini et al., 2018).

2.8.7 Geographic information systems

About two decades ago, geographers devised a sophisticated terminology for technology able to obtain data, examine spatial data and provide different kinds of geographical information, namely *geographic information systems* (GIS) (Ma & Ren, 2017; Roche, 2014). Smart cities need location information on citizens, businesses and government to manage and organise their activities (Galán-García et al., 2014; Pinochet et al., 2018; Roche, 2014). GIS is dynamically updated through data collected from sensors for location determination (Matos et al., 2017). The extensive geographic information systems are based on a data inventory that promotes infrastructure capital and planning advancement initiatives (Erraguntla, Delen, Agrawal, Madanagopal, & Mayer, 2017).

2.8.8 Real-time monitoring

Real-time monitoring occurs when data are collected and analysed instantly to determine the current state of something by presenting the information in real-time (Bakici et al., 2013; Cretu & Cuza, 2012). Real-time monitoring is a crucial component of a smart city (Dameri et al., 2019; Dameri & Ricciardi, 2015). It enables decision-makers to proactively address warning signs of a problem timeously (Caporuscio & Ghezzi, 2015; Dixon et al., 2014; Matos et al., 2017).

2.9 Smart services

Section 2.9 presents the importance of smart services when implementing a smart city concept. This section explores how smart services can add value to establishing a smart city. The importance of smart services when implementing a smart city is well established; thus, it is impossible to implement a smart city project successfully without smart services.

Smart services are also known as smart applications (Ma & Ren, 2017) enabled by progressive information technologies that rely on user engagement, which has been historically considered problematic (Peng et al., 2017). Ma and Ren (2017), Mayangsari and Novani (2015) and Peng et al. (2017) regard smart services as a strategic tool to deal with emerging universal challenges, such as ageing infrastructures, climate change, energy shortages, pollution and ageing populations.

The implementation of smart services or applications through information technology is indispensable in dealing with these challenges (Apostolopoulos et al., 2022; Çelikyay, 2017; Ma et al., 2018). Thus, using smart services daily may lead to environmental and economic benefits, resource usage reduction, a reduction of CO_2 emissions and cost savings (Peng et al., 2017; Sikora-Fernandez, 2018; Steenbruggen et al., 2014; Zawieska & Pieriegud, 2018). Accordingly, such attainable benefits depend on the support of smart services to establish a more responsible, stable, efficient and effective city (Mayangsari & Novani, 2015; Zhang et al., 2019a). This goal can be achieved through convergent methods that deal with all smart services (Chichernea, 2014, 2015; Guenduez & Mergel, 2022; Kamolov & Kandalintseva, 2020).

There is a lack of awareness of smart services in most cities, which presents significant barriers to achieving a potentially sustainable environment along with economic benefits (Marsal-Llacuna & Wood-Hill, 2017; Peng et al., 2017). Therefore, various academic scholars, such as Nagy et al. (2016), Peng et al. (2017) and Yigitcanlar et al. (2018), have identified different smart services, including smart technology (Galán-García et al., 2014; Ullah, Qayyum, Thaheem, Al-Turjman, & Sepasgozar, 2021).

2.9.1 Smart technology

Smart technology refers to advanced technological systems, devices and solutions that incorporate digital intelligence and connectivity to automate processes and provide improved services and functionalities in various industries or institutions (Galal & Elariane, 2022). These technologies use real-time data processing and connectivity to enhance their capabilities to adapt to changing environments and improve their performance (Aghimien et al., 2020; Yavuz et al., 2018).

Smart technology is only gaining traction slowly because it is not prioritised in most cities, which is why cities are not investing in smart technologies (Angelidou, 2017; Galal & Elariane, 2022). However, the growth of smart technology innovation might create opportunities to integrate information system components and smart energy into any potential city (Bibri, 2021b; Kocs, 2016; Quraishi & Siegert, 2011). In truth, smart technology is key to integrating most municipal services (Aghimien et al., 2020; Ismagilova et al., 2019; Yigitcanlar & Lee, 2014). When these services are integrated, cities can use smart technology to monitor population growth to improve their standards of living (Yavuz et al., 2018).

Moreover, smart technology would assist cities in improving their competitiveness as well as enhancing or protecting a sustainable future for their citizens (Appio et al., 2019; Nagy et al., 2016). Other scholars also contend that smart technology has the potential to deal with the challenges that emanate from population growth (Nižetić et al., 2019; Sun, Li, Zhang, Zhu, & Gaire, 2019) and to improve city service delivery and quality of life (Angelidou, 2017; Li et al., 2017; Van Winden & Van den Buuse, 2017) because citizens would be able to access or request some services using smart technologies through their smartphones (Asensio et al., 2015; Jabeur et al., 2017; Yavuz et al., 2018).

2.9.2 Smart buildings

Smart buildings are significant when implementing a smart city concept. Matos et al. (2017) explain that a smart building uses technology to collect and share information about activities inside such a building. Furthermore, it uses technology to collect data from any physical building structure through an automated digital process (Yigitcanlar et al., 2018). The smart building uses microchips, actuators and sensors to collect and manage data (Aghimien et al., 2020; Leong et al., 2017; Yigitcanlar & Kamruzzaman, 2019). This is done to ensure assets' performance and reliability by reducing energy usage and water loss and improving public services to allow productivity while ensuring that the expenditure is economically viable (Peng et al., 2017).

2.9.3 Smart energy

Matos et al. (2017) explain that smart energy uses sensors to save energy and reduce costs, as well as limit energy outages through the smart grid. Energy is a significant resource in performing any operation; smart energy uses different energy sources, such as renewable energy (solar, geothermal generation and wind) or non-renewable energy (fossil fuels, earth minerals and metal ores) (Silva et al., 2018a; Zaidi et al., 2016). Kocs (2016) and Yavuz et al. (2018) posit that smart energy could help cities solve complicated issues affecting the global environment since it can reduce the carbon footprint and make city highways and streets 'greener'.

Daily, human actions affect the environment either positively or negatively. Cars and waste, in particular, pollute the environment. However, smart energy could help improve energy consumption and create an environment conducive to reducing pollution (Marrero et al., 2019). When utilising energy smartly, cities could enjoy various benefits and the use of renewable energy resources (Coelho et al., 2017). Moreover, citizens would be able to use smart energy supplied through a smart grid, smart buildings, smart water, smart public services, smart light, smart mobility, smart waste management and smart meters (Matos et al., 2017).

2.9.4 Smart grid

A smart grid consists of interconnected devices that automate an electricity delivery system that revolutionises the traditional system of delivering electricity to citizens (Gontar et al., 2014; Tuballa & Abundo, 2016). Smart grid concepts are evolving very quickly, using items like microgrids, distribution generation (DG) grids and renewable energy (Colmenar-Santos, Molina-Ibáñez, Rosales-Asensio, & López-Rey, 2018).

A smart grid further uses complex information technology applications to manage, load and allocate power to the location where it is needed and at a particular time (Chaturvedi & Kolbe, 2019; Coelho et al., 2017; Kocs, 2016). A city should be able to differentiate between technology that runs on a smart grid from that which runs on smart metering to understand the capability of technologies that run on a smart grid (Quraishi & Siegert, 2011; Soares, Borges, Fotouhi Ghazvini, Vale, & De Moura Oliveira, 2016). Smart metering uses an electronic device containing the requisite technology to record information on the power consumption, while smart grid incorporates digital technology that permits two-way communication between customers and the utility, with sensing capabilities on the transmission lines (Quraishi & Siegert, 2011).

It follows that cities should have an appropriate vision for investing in a smart grid and stipulating the new grid features and infrastructure considerations for a local context to maximise its benefits (Gontar et al., 2014; Mišák et al., 2015). For a smart grid to work properly, it needs an energy storage system (Colmenar-Santos et al., 2018). When a smart grid is operating optimally, it can perform real-time monitoring of the electricity grid and give real-time warnings to municipalities about any possible issues regarding power supply systems (Calderoni et al., 2012).

2.9.5 Smart light

Smart light is also known as sensory network light. This smart service is a lighting technology designed to improve energy security, efficiency and convenience. It uses light-emitting diode (LED) lights with the capability to automatically sense objects, environments, temperature, parking spaces and air space (Hamilton & Zhu, 2017). It uses sensors embedded in these lights to collect data and analyse it to conserve city energy when not in use (Yigitcanlar et al., 2018).

2.9.6 Smart traffic

In developing countries, traffic control is a major concern. Hence, cities should implement ‘smart traffic’ during the development of a smart city to address traffic issues. Smart traffic is one of the smart services (Antoni et al., 2020; Hell & Varga, 2018; Niu et al., 2015) using smart traffic lights (Galán-García et al., 2014) with an intelligent surveillance camera system that detects and identifies the movements of any objects and analyses them towards controlling traffic (Baba, Gui, Cernazanu, & Pescaru, 2019; Iqbal & Khan, 2018). Intelligent surveillance camera systems record videos and are designed to minimise transmission and processing (Qi & Guo, 2019). When these videos are analysed, they provide accurate traffic information; furthermore, the deployment of these cameras may help by improving safety and security in a smart city (Calavia, Baladrón, Aguiar, Carro, & Sánchez-Esguevillas, 2012). Smart traffic can also be used to decrease environmental pollution and congestion within cities (Hopkins & Mckay, 2019; Peng et al., 2018).

2.9.7 Smart parking

Smart parking can be used to reduce the time spent by drivers searching for parking spots (Menne, 2019). Delponte and Ugolini (2011) and Peng et al. (2017) explain that this service often uses a smartphone application and the sensors installed inside parking bays. These sensors provide information on which parking spaces are empty and a real-time parking map for drivers to locate and reserve available parking spaces (Peng et al., 2018; Steenbruggen et al., 2014).

Smart parking technologies typically utilise the following algorithms: The first algorithm examines the number of open parking areas and the distance between parking spaces to determine empty parking spaces. The second algorithm uses parking price, driver location, unoccupied area and the distance between a car and an empty parking space (Menne, 2019; Peng et al., 2017). This system is used to allocate parking to a driver in a parking area (Menne, 2019).

2.9.8 Smart eHealth

Smart eHealth systems are crucial components of smart city development. These systems include three aspects: patients, doctors and a healthcare cloud server (HCS) (Ming & Wang, 2019). Smart eHealth makes private patient data available to authorised users (i.e., clerks, nurses, doctors and laboratory technicians) to make informed decisions regarding patients' conditions (Caporuscio & Ghezzi, 2015; Ming & Wang, 2019).

Silva et al. (2018a) state that centralised smart e-Health systems promote real-time decision-making based on the latest integrated information. These systems mostly purport to monitor pensioners' health parameters (heart rate, blood pressure and weight), including their daily activities (walking, eating and sleeping) and present real-time notifications when something concerning or catastrophic is about to happen regarding a patient's daily activities and health parameters, like when the patient's blood pressure rises or falls (Caporuscio & Ghezzi, 2015).

2.9.9 Smart transport

To fully implement a smart city concept, a city must have 'smart transport' in place (Çelikyay, 2017) as it provides real-time information about transportation movements (Yigitcanlar et al., 2018; Zawieska & Pieriegud, 2018). Smart transport uses GPS to coordinate the distance between a current and destination point (Zawieska & Pieriegud, 2018). Smart transport applications could assist commuters significantly since they can monitor where transport is in real time, using commuters' smartphones to help manage their time effectively. Transport administrators or managers can also use the same information to allocate transport accurately (Smith, 2017). Zawieska and Pieriegud (2018) hold that smart transport can play a significant role in solving issues around transport emissions.

2.10 Smart city-related frameworks

This section deals with contemporary smart city frameworks and their relevance to the assessment of small and rural municipalities' readiness for smart city implementation. Frameworks are significant for explaining and understanding phenomena and expanding existing knowledge (Çelikyay, 2017; Prendeville et al., 2018). Nam and Pardo (2011) consider these frameworks pertinent because they help with the interpretation of the results of a study. **Table 3** presents a list of existing smart city and related frameworks:

Table 3: Smart City and Related Frameworks

No	Authors	Frameworks	Explanations
1	Adapa (2018) Alawadhi et al. (2012) Berst (2013) Chichernea (2015) Chourabi et al. (2012) Bashynska and Kaplun (2018)	Smart city	These models look at smart city dimensions as an enablers of a smart city concept. All these models indicate that for a city to be considered a smart city, it must have smart people, smart living, smart mobility, smart economy, smart governance and smart environment dimensions in place. If a city has only some of these dimensions, it is not considered a smart city, nor is it ready to implement a smart city concept, i.e., all

	Lim et al. (2018) Du Plessis and Marnewick (2017) Schiavone et al. (2019) Yigitcanlar et al. (2018) Zawieska and Pieriegud (2018)		dimensions must be present, unlike with smart services.
2	Farago (2019) Hopkins and Mckay (2019) Nam and Pardo (2011) Picatoste et al. (2018)	Fundamental concepts of a smart city	These frameworks focus on the institutional, technological and human factors to explore the features that are important for the implementation of a smart city concept. They consider the technological factor as the main driver.
3	Firmanyah et al. (2018) Supangkat et al. (2018)	Smart city maturity frameworks	These frameworks are employed to assess if a city is ready to implement the smart city concept. When assessing city readiness for smart city implementation, they appraise the human, organisational and environmental contexts while ignoring the technological

			context. Most academic scholars have emphasised that technology is the main driver in the smart city concept.
4	Ahn et al. (2016)	Smart city interoperability framework	This framework uses a city's service flow and the city's information flow layer to connect stakeholders, the economy, smart services, business, data and infrastructure to enable city operations, markets, enterprises and other fields. However, the framework does not clarify the small and rural municipal aspects that could influence smart city implementation.
5	Madakam and Ramaswamy (2015)	IoT technologies in a smart city	This framework regards the IoT as an enabler of the smart city. Internet of Things technologies in a smart city framework use infrastructure and control, interoperability, connectivity, security and privacy, data management, computing resources and analysis to enable a smart city. However, it does not consider smart city readiness.

The current study primarily aims to develop an integrated framework that can be used to assess South African small and rural municipalities' readiness for smart city implementation. The upcoming subsections present the relevant frameworks based on the reviewed literature.

2.10.1 Smart city model

Subsection 2.10.1 illuminates the critical pillars or dimensions of a smart city model. The existing smart city model has six dimensions that can be used to manage and optimise resources within a city effectively. These dimensions play a major part in transforming a traditional city into a smart city; accordingly, Section 2.10.1 aims to explicate and expose the capabilities of all six smart city dimensions.

For a city to be considered a smart city, it should perform well in all six dimensions (see **Figure 3**) (Chichernea, 2015; Mazurek, 2018; Noori et al., 2020), which comprise smart people, smart economy, smart mobility, smart environment, smart governance and smart living (Appio et al., 2019; Çelikyay, 2017; Chauhan et al., 2016; Dacko, 2016; Zygiaris & Sotiris, 2012).

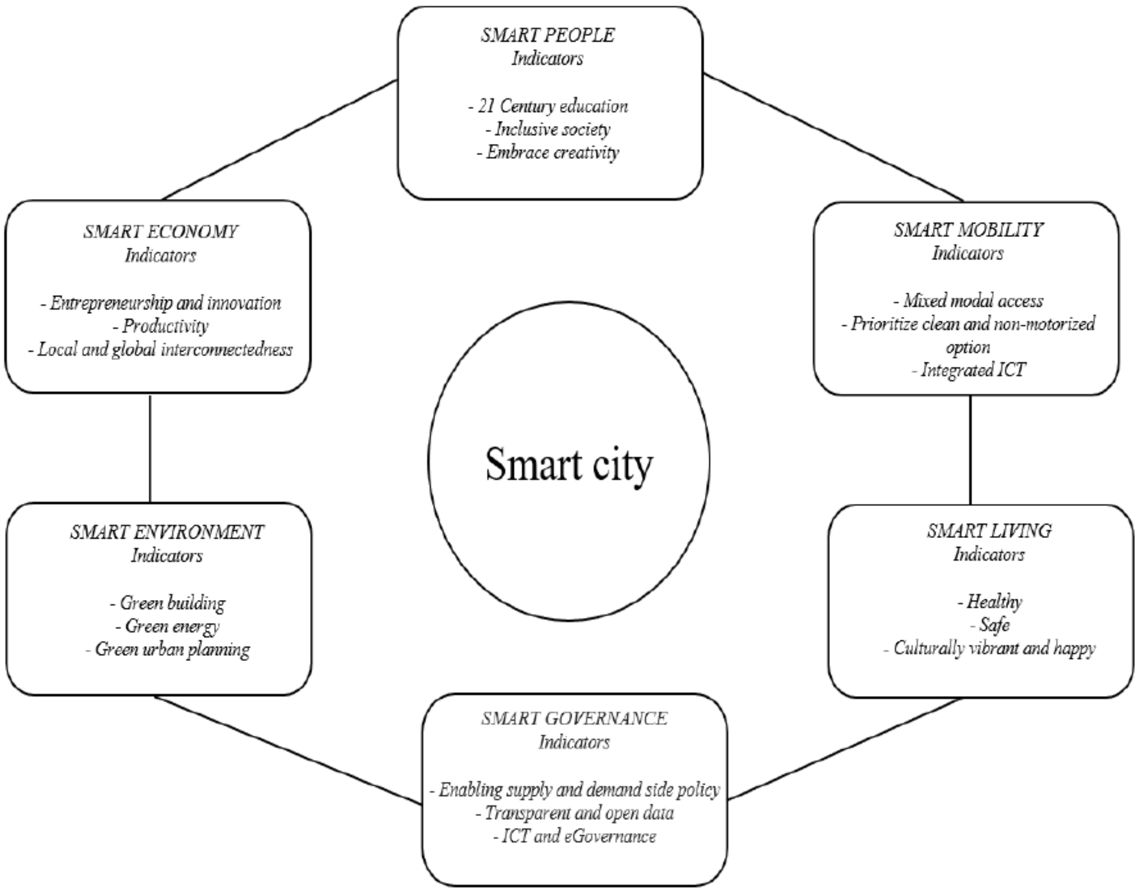


Figure 3: Smart city model (Chichernea, 2015: p. 2)

If a city needs to improve the quality of the lives of its citizens, it should ensure the implementation and sustainability of all six general dimensions (Çelikyay, 2017; Gobin-Rahimbux et al., 2020; Schiavone et al., 2019; Zait, 2017). Furthermore, Dameri et al. (2019) stress that cities must understand the importance of the social and cultural implications of each dimension because they affect people. The following segment critically discusses six dimensions of Chichernea's (2015) smart city model.

Smart people/citizens

'Smart people' comprises two groups: The first group is contributors, and the second group is consumers. Both these groups are classified as smart people. The following measurements are used for that classification: qualification levels, experience, an affinity for lifelong learning, ethnic plurality, creativity, flexibility, social ability, public life participation, open-mindedness and being cosmopolitan (Chauhan et al., 2016; Das, 2020; Kamil, 2018). Various scholars have indicated that smart people play a significant role in a smart city (Dadashpoor & Yousefi, 2018; Kamil, 2018; Pedro & Bolívar, 2018).

Most people living in a city can be contributors and consumers at the same time, although contributors participate in a smart city by contributing data through reporting issues or requesting services (Schuurman et al., 2012). Citizens must become contributors to a smart city (Dadashpoor & Yousefi, 2018; Schuurman et al., 2012) and have the basic knowledge of using different digital devices and technologies (Pedro & Bolívar, 2018). Nam and Pardo (2011) and Popescul and Radu (2016) suggest that if citizens are contributors and they do not know how to use these devices and technologies, the city should provide training. However, consumers are dependent on the data contributed by contributors and, as such, they use the contributed data to make decisions (Arief et al., 2019; Calderoni et al., 2012; Marrone & Hammerle, 2018).

Chaves-Diéguez et al. (2015) further state that a city must know how it plans to collect data from contributors and also know what it is going to use such data for because collecting data without a valid reason would be a waste of money, time and resources since it would not add any value (Megahed & Abdel-Kader, 2022; Tachizawa et al., 2015). Thus, smart people are crucial to the implementation of smart cities (Pedro & Bolívar, 2018).

In a smart city, citizens' data are vital to decision-making and allocating resources (Scholtz & Van Der Hoogen, 2022). South Africa has a data protection law that regulates the collection of personal information (Swales, 2021), known as the Protection of Personal Information Act (POPI Act) (Ngwenya & Ngoepe, 2020; Sutherland, 2017; Swales, 2021). This act stipulates that every entity seeking to collect, modify, save and utilise information must conform to the POPI Act (Republic of South Africa, 2013). An institution intending to collect personal information must receive explicit consent from people (Sutherland, 2017) and explain the purpose of collecting such personal information (Republic of South Africa, 2013; Sutherland, 2017). Accordingly, the POPI Act cannot be ignored when embarking on a smart city project in South Africa because all institutions engaged in the smart city project must comply with this Act, causing further complications (Scholtz & Van Der Hoogen, 2022). Furthermore, all institutions must ensure that citizens' data are secured.

Smart mobility

Smart mobility is the combination of transport and information and communication technology. It comprises all vehicle systems, intelligent transport infrastructures and autonomous intelligent vehicles (Tokody, Albini, Ady, Raynai & Pongrácz, 2018) that can offer collaborative transport for citizens and goods (Crivello, 2015; Turetken et al., 2019). Chauhan et al. (2016) and Silva et al. (2018a) hold that these transport digital innovations, systems and ICT infrastructures are capable of providing access to transport locally and internationally. It is used to address urban challenges, like traffic, gas emissions, etc. According to Crivello (2015) and Turetken et al. (2019), this may support the manufacturing and logistics industries (Turetken et al., 2019). Therefore, smart mobility is an essential component of smart city planning (Yigitcanlar & Kamruzzaman, 2019).

Smart living

Silva et al. (2018a) outline that smart living comprises buildings and waste and water management systems. It is based on health conditions, cultural facilities, individual safety, education facilities, housing quality, social cohesion and touristic attractiveness (Chauhan et al., 2016; Delponte & Ugolini, 2011) and aspires to satisfy citizens and improve their well-being (Canıtez & Deveci, 2018). This dimension is critical in assessing city readiness in general and also in a local context.

Smart governance

Smart governance focuses on the processes of decision-making, social services, perspectives and political strategies to ensure transparent governance (Dixon et al., 2014; Faisal et al., 2018). It also ensures unequivocal planning and development in running the affairs of the city efficiently and successfully (Canıtez & Deveci, 2018; Dixon et al., 2014; Faisal et al., 2018; Maye, 2019). By its nature, smart governance is employed for decision-making through the use of policies, regulations and political perspectives and strategies (Mazurek, 2018). While ensuring smart governance, a city would involve other institutions to define and implement policies within the city's jurisdiction (Gretzel, 2018). These policies are also implemented to detect any contravention of rules by the key role players in the smart city (Chatfield & Reddick, 2019).

In most cases, such policies refer to municipality initiatives that utilise ICT to improve the quality of the lives of their people while establishing sustainable development (Capdevila &

Zarlenga, 2015; Chourabi et al., 2012; Marsal-Llacuna & Segal, 2017; Yigitcanlar et al., 2018) and can be used as guidelines for addressing future problems in the city using ICT innovation (Cledou et al., 2018; Mayangsari & Novani, 2015; Pincetl & Newell, 2017). These policies can potentially make a considerable contribution to building sustainable cities since cities should not predominantly rely on only one enabling factor (Alawadhi et al., 2012; Martin et al., 2019; Yigitcanlar et al., 2019a).

A smart city also includes aspects such as social services and public and private participation (Chauhan et al., 2016; Nam & Pardo, 2011). Thus, for a smart city to be sustainable requires the appropriate smart governance to be in place. This governance is even more significant when connecting technologies to enforce decision-making and allowing knowledge transfer to improve performance and socioeconomic issues (Martin et al., 2019; Offenhuber & Schechtner, 2018; Ruhlandt, 2018).

Smart environment

Smart environment is the concept of establishing an environment with natural resources, installed sensors and computing and display devices (Bashynska & Kaplun, 2018). The smart environment is based on environmental protection, attractive natural conditions and pollution and environmental management (Canıtez & Deveci, 2018; Chauhan et al., 2016; Xia, Fong, Dai, & Li, 2019). Chauhan et al. (2016) submit that these devices enable users to understand and control the environment better and can be used to conserve natural resources and the environment by reducing the city's carbon footprint. Most smart cities achieve this by implementing carbon-reducing smart energy services to assure sustainable city operation while not utilising non-renewable energy (Silva et al., 2018a).

Smart economy

Smart economy comprises aspects of city competitiveness that include productivity, market, entrepreneurship, innovation spirit, the flexibility of labour markets, productivity, trademarks, labour market flexibility integration, linkages of international commerce and economic images (Chauhan et al., 2016; Neirotti et al., 2014). Chinese and Italian smart cities use their urban policies to address environmental impact by using technology (Dameri et al., 2019).

Overall, this framework theorises that for a city to be considered a smart city, it should have smart people, smart mobility, smart living, smart governance, a smart environment and a smart economy in place (Chichernea, 2015; Chourabi et al., 2012; Zawieska & Pieriegud, 2018).

Even though this framework is related to the smart city concept, its relevance for this particular research is limited because it only considers smart city dimensions and does not expose local context aspects that could influence small and rural municipalities' readiness. In contrast, the present research includes all these dimensions because, for a city to be considered a smart city, it should perform well in all six dimensions.

2.10.2 Fundamental concepts of a smart city

The previous subsection discussed the smart city model by investigating the six significant dimensions in the implementation of a smart city. This subsection critically discusses the fundamental concepts of a smart city model (see **Figure 4**) by Nam and Pardo (2011). This framework is different from the smart city model by Chichernea (2015) because Nam and Pardo indicate that for a city to be considered a smart city, it should be influenced by three factors: the technological, institutional and human factors (Farago, 2019; Nam & Pardo, 2011; Picatoste, Pérez-Ortiz, Ruesga-Benito, & Novo-Corti, 2018). The fundamental concepts of a smart city are suitable for guiding this study. This framework is used to explore core drivers for the successful implementation of a smart city project (Mazurek, 2018; Nam & Pardo, 2011).

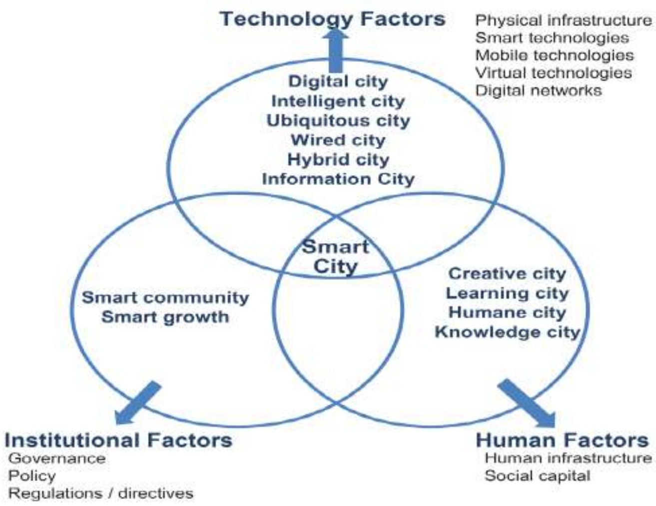


Figure 4: Fundamental concepts of a smart city (Nam & Pardo, 2011: p. 286)

Most academic scholars, such as Berst (2013) and Nam and Pardo (2011), concur that the technological factor is a prerequisite for a city becoming a smart city since it uses ICT to transform work and life within a city. Nevertheless, a city has to exceed basic technological requirements by integrating technologies, services, infrastructure and systems. The human factor includes social learning, creativity and education; the institutional factor includes external support for the initiative for new policies, regulation, governance and technology (Mazurek, 2018; Nam & Pardo, 2011; Neirotti et al., 2014).

In conclusion, human factors, institutional factors and technological factors are important when assessing small and rural municipalities' readiness for smart city implementation. Therefore, a framework that goes beyond the fundamental concepts of a smart city is needed because this framework ignores the environmental factors that could assist in exposing aspects that may be significant when assessing small and rural municipalities' readiness for smart city implementation. The next subsection discusses smart city maturity measurement components.

2.10.3 Smart city maturity measurement component

The previous subsection discussed the fundamental concepts of a smart city used to assess the smart city concept implementation. This subsection examines the smart city maturity measurement component (see **Figure 5**) framework by Supangkat, Arman, Nugraha and Fatimah (2018). The purpose of this framework is to evaluate city maturity measurement components to gauge their progress towards the implementation of smart city initiatives (Supangkat et al., 2018). The framework explores city services, city resources, the utilisation of resources and the citizen perception index element that could be useful when assessing small and rural municipalities' readiness for smart implementation.

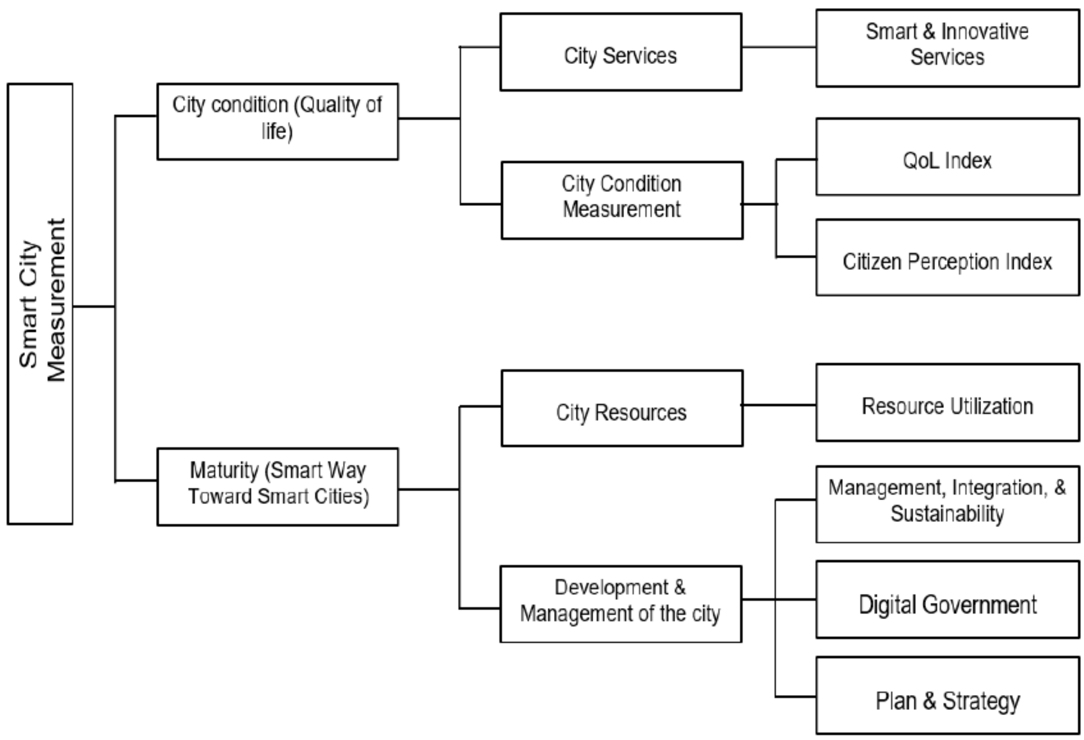


Figure 5: Smart city measurement components (Supangkat et al., 2018: p. 173)

There is a need for a framework that can evaluate and provide clear recommendations and support when developing a smart city. Again, this researcher agrees that the framework by Supangkat et al. (2018) can be used to understand human, organisational and environmental contexts. However, other scholars have pointed out that technological context is important in smart city implementation (Firmanyah, Supangkat, Arman & Adhitya, 2018).

To conclude, smart innovation and services are important in guiding this study towards the development of an integrated framework to assess small and rural municipalities' readiness for smart city implementation. The smart city measurement component framework alone cannot be used to assess small and rural municipalities' readiness for smart city implementation because it does not consider human and environmental factors holistically.

2.10.4 The smart city framework

The previous subsection discussed the smart city maturity measurement components model used to assess smart city concept maturity. The smart city framework (see **Figure 6**) by Berst (2013) serves as a guideline for understanding how cities can be transformed into smart cities.

This framework uses ICT as a measurement to assess city readiness for smart city implementation (González-Zamar et al., 2020).

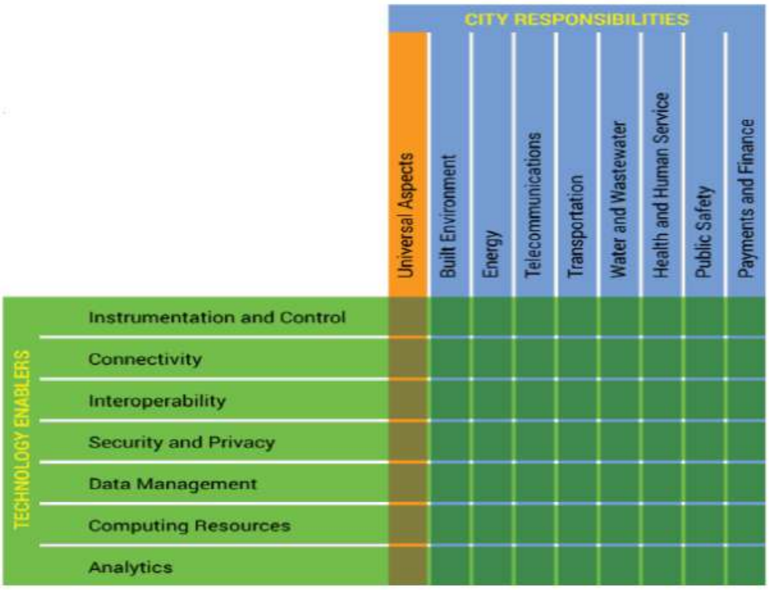


Figure 6: The smart city framework (Berst, 2013: p. 22)

The Berst (2013) framework deploys various types of technology to enable the city to meet its responsibilities. These responsibilities are represented on the vertical block of **Figure 6** above, while eight essential city responsibilities on the horizontal block represent technology as an enabler (Berst, 2013). A city seeking to implement the smart city concept must ensure it has smart buildings, sustainable energy and the interconnectivity of smart objects and transportation, to name a few. These responsibilities should be universal to all cities planning to develop a smart city (Berst, 2013; Desdemoustier et al., 2019b).

The framework employs common aspects to assess city readiness while ignoring distinctive aspects. However, Desdemoustier et al. (2019b) indicate that cities' aspects differ. A country could have several cities, of which aspects may vary depending on location and setting (Desdemoustier et al., 2019a). The drivers for a smart city are characterised by environmental issues, economic competitiveness, sufficient digital infrastructure, ICT prices and ICT upgrades (Desdemoustier et al., 2019b).

The framework by Berst (2013) applies to cities with identical features; however, the framework lacks clarification on how it could be used in small and rural municipalities, considering their uniqueness when being assessed for smart city readiness. Some elements of this framework, namely technology, security and privacy, data, connectivity and analytics play an important role when assessing small and rural municipalities' readiness for smart city implementation.

2.10.5 Smart city interoperability framework

The previous subsection discussed the smart city maturity measurement components framework that is used to assess smart city concept maturity. The design of the interoperability framework starts with information aggregation layers in each component, determining the relationships between those components while performing aggregation (Ahn, Lee, Kim & Hwang, 2016; Desdemoustier et al., 2019a). Most of these components correspond to an infrastructure that supports city responsibilities (see **Figure 7**).

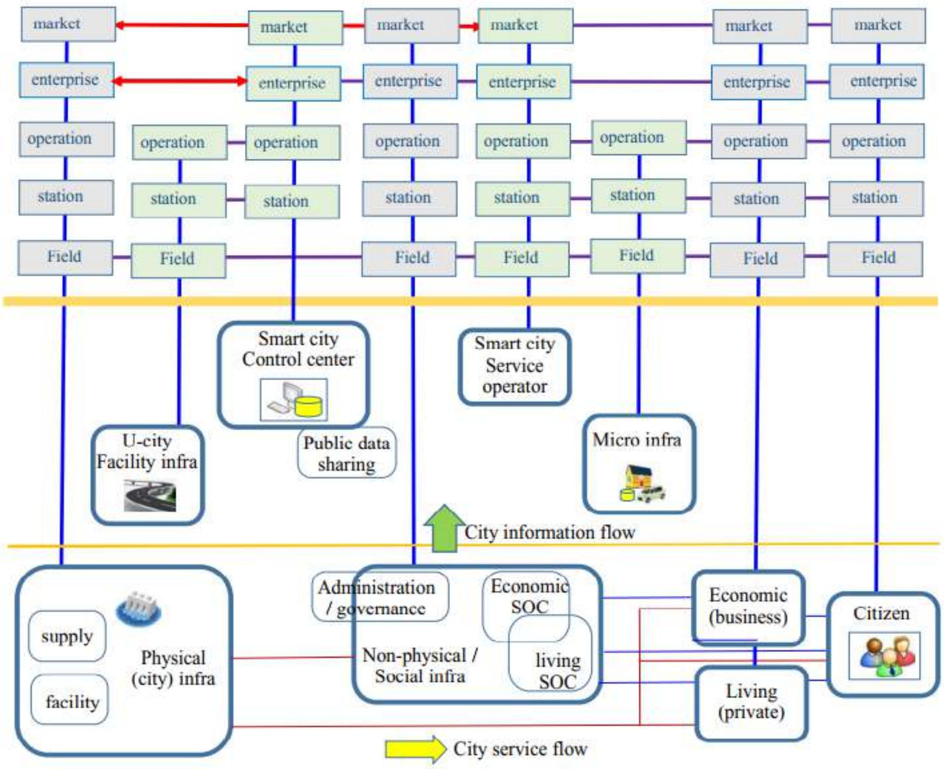


Figure 7: Smart city interoperability framework (Ahn et al., 2016: p. 341)

Accordingly, the information city flow layer permits public data sharing via various infrastructures (smart city control centre, smart city service operator, u-city facility infrastructure and micro infrastructure) (Ahn et al., 2016). This infrastructure connects all entities to ensure city information and service flow; these components are significant when transforming a city into a smart city.

The limitation of this framework is its focus which is limited to a small number of smart city services while not clarifying aspects of small and rural municipalities that could influence smart city implementation. Moreover, an information technology infrastructure used to connect different objects—to ensure a flow of information in the city—is vital for the framework that this study seeks to develop.

2.10.6 IoT technologies in a smart city

The previous subsection discussed a smart city interoperability framework that uses the infrastructure to enable public data sharing. IoT technologies are utilised in a smart city to radically improve the city's responsibilities or services because it could speed up transportation, make buildings more efficient and neighbourhoods safer and make water and electricity more affordable (Guo et al., 2018; Madakam & Ramaswamy, 2015). The IOT model proposed by Madakam and Ramaswamy (2015) agrees with Berst's (2013) framework regarding internet connectivity, security and privacy. Internet connectivity, security and privacy are fundamental to assessing a city's status regarding smart city concept implementation. **Figure 8** displays the components of IoT technologies in a smart city as proposed by Madakam and Ramaswamy (2015).

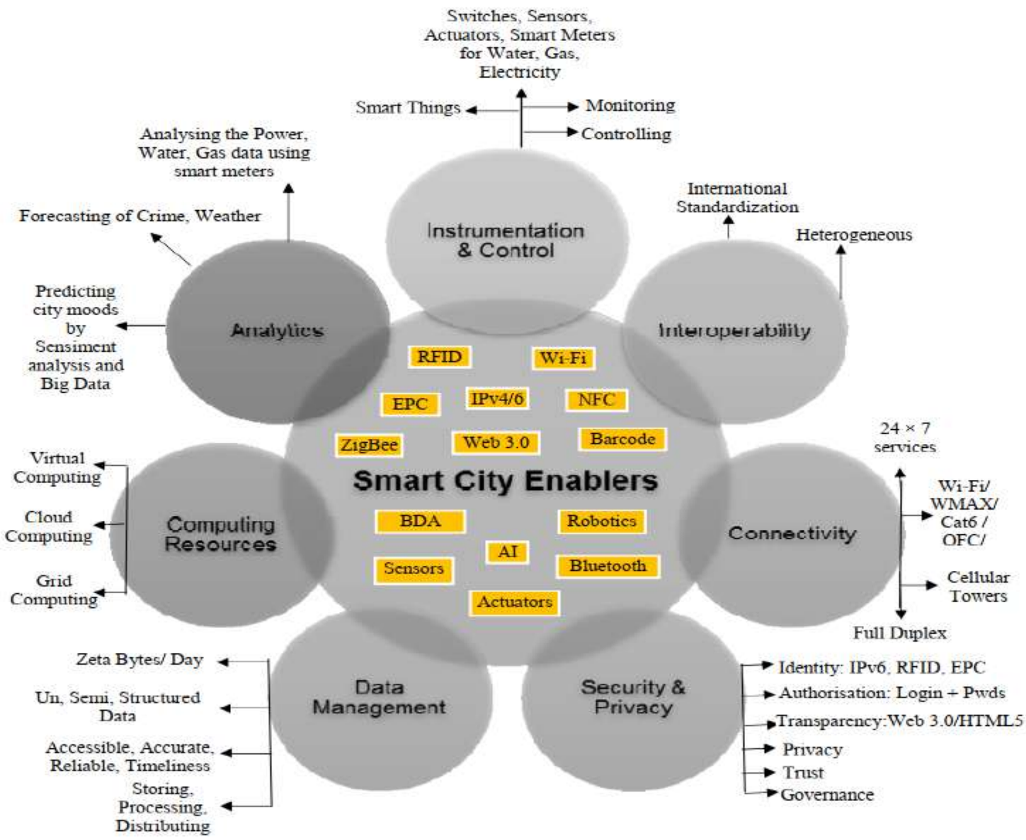


Figure 8: IoT technologies in a smart city (Madakam & Ramaswamy, 2015: p. 5)

The IoT uses technologies and electronic devices, which include sensors, radio frequency identification (RFID) smart cards, computers, laptops, actuators, CCTV and IP cameras embedded in buildings, municipal organisations, transportation and hospitals (among others) to monitor, manage and control a smart city (Madakam & Ramaswamy, 2015). However, the underpinning of this framework is smart city enablers using the IoT. IoT technologies are important in ensuring small and rural municipalities' readiness for smart city implementation. Hence, this model cannot be used to assess small and rural municipalities' readiness for smart city implementation because it does not consider human, environmental and institutional factors.

2.11 Conclusion

This chapter presented a literature review based on the concept-centric matrix using a systematic literature review approach. The primary goal of Chapter 2 was to establish a context for and review the smart city-related frameworks using relevant literature. To achieve this, the researcher analysed literature using the following concepts: smart city concept overview, smart city initiatives, aspects of small and rural municipalities, information systems drivers for smart city development, smart services and smart city-related frameworks for important research contributions.

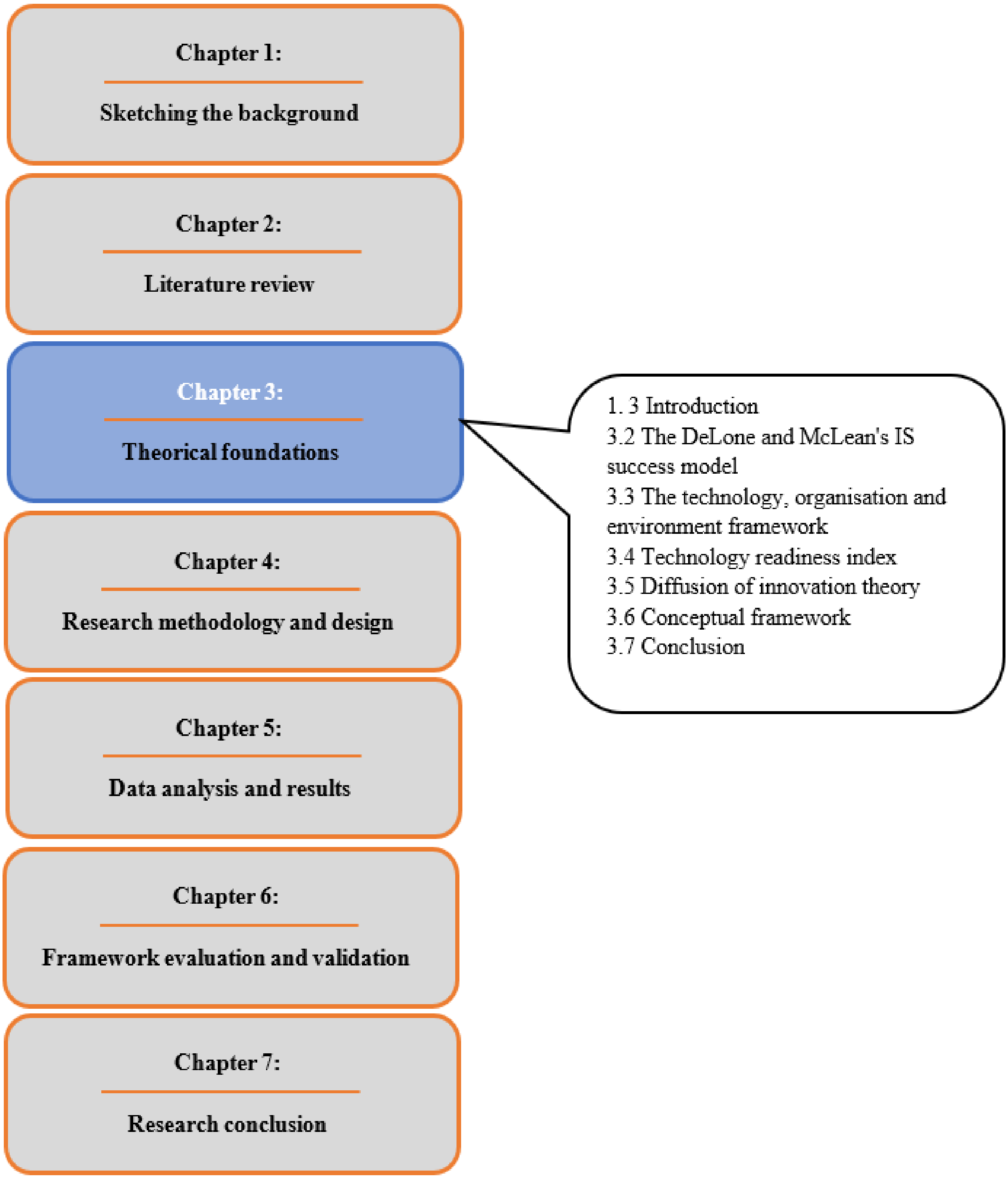
This chapter fulfilled its objectives by following a systematic literature review approach, as fully elaborated on in Sections 2.2 and 2.3. In Sections 2.4, 2.5, 2.6, 2.7, 2.8, 2.9 and 2.10, the researcher used a concept-centric literature matrix to analyse literature that supports the research problem and topic by exposing critical theories around the smart city concept. Furthermore, Chapter 2 achieved all the objectives for each identified concept or theme. This includes addressing the research questions and developing a proposed conceptual framework for this study.

This chapter provided credible evidence of the absence of consensus on the definition of a smart city concept by identifying different definitions, as shown in **Table 2**. Many scholars define this concept differently. The smart city concept is significant because smart cities utilise information effectively by employing communication tools and technologies to improve the lives of their citizens through service delivery. This study exposes different smart city initiatives in South Africa and other countries in Section 2.6. It also establishes that contextual aspects and IS drivers of small and rural municipalities are precursors to the implementation of a smart city concept and are also enablers of smart services. These are important when implementing a smart city concept, yet there is no framework specifically assessing small and rural municipalities' readiness for smart city implementation. For that reason, there exists an urgent need to develop an integrated framework to assess small and rural municipalities' readiness for smart city implementation in developing countries like South Africa.

The second chapter followed a systematic literature review approach to prevent bias by the researcher. The approach was also followed to extract, identify, evaluate and synthesise existing research. This process was executed through the use of keywords to extract literature for an extensive literature review to help the researcher understand and establish a firm theoretical foundation for the problem and topic. Chapter 3 considers the IS theories to underpin this study.

CHAPTER 3

THEORETICAL FOUNDATIONS



3.1 Introduction

The preceding chapter presented the review of substantive literature on the smart city concept and the limitations of the existing smart city frameworks. This chapter presents and examines some of the theories often used as a theoretical foundation in information systems studies investigating the adoption of a new idea or innovation. The theoretical foundation assisted in understanding the factors inherent in the assessment of a small and rural municipality's readiness for smart city implementation.

Thus, this study utilised the DeLone and McLean IS success model, the technology–organisation–environment framework (TOE), the technology readiness index (TRI) and the diffusion of innovation (DOI) theories to underpin the study. These theories are the lens through which to integrate the smart city frameworks discussed in Chapter 2 towards developing an integrated conceptual framework to assess small and rural municipalities' readiness for smart city implementation. This framework incorporated 27 components from the framework review in Section 2.10 and the above-mentioned theories as measures. The next section discusses DeLone and Mclean's IS success model.

3.2 The DeLone and McLean IS success model

The preceding section introduced this chapter. This section discusses the DeLone and McLean model, a significant concept in the successful implementation of IS from an organisational perspective. The DeLone and McLean model is regarded as an influential theory in information system studies and has been applied in most research. The model was initially developed in 1992 by DeLone and McLean and is used to evaluate IS success within organisations. It is constituted of six important elements: *system quality, information quality, use, user satisfaction, individual impact* and *organisational impact* (see **Figure 9**) (DeLone & McLean, 1992).

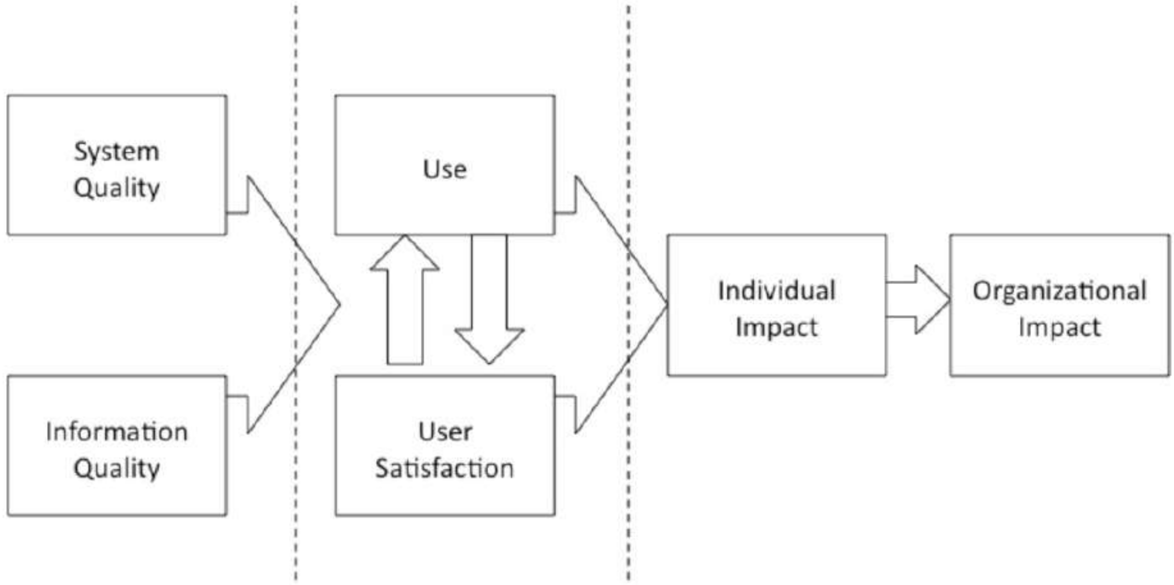


Figure 9: DeLone and McLean model (DeLone & McLean, 1992: p. 87)

This model was reformulated by the same authors after ten years by using feedback received from other researchers in the IS field. The revised framework consists of six elements: *system quality*, *service quality*, *information quality*, *intention to use or use, user satisfaction* and *net benefits* (see **Figure 10**) (DeLone & McLean, 2002).

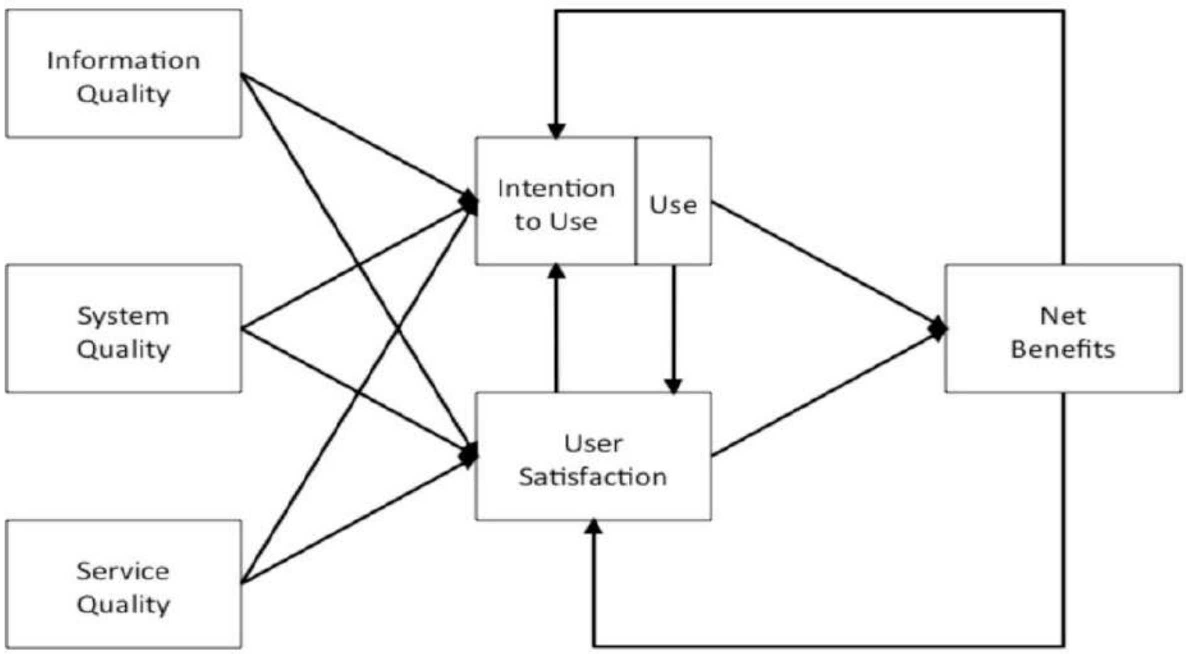


Figure 10: Reformulated DeLone and McLean model (DeLone & McLean, 2002: p. 9)

Initially, the DeLone and McLean model used *information quality* and *system quality* as independent elements (DeLone & McLean, 1992). Other scholars argued that when measuring IS success, it is important to include *service quality* as one of the measures (DeLone & McLean, 2002, 2003). *Service quality* was added to the revised model as one of the independent elements or constructs, even though it was seen as a subset of *system quality* (DeLone & McLean, 2002).

This model uses *system quality* to examine the actual information systems generating information for decision-makers, while *information quality* focuses on the quality of the information produced by the digital system (DeLone & McLean, 1992, 2002), which is the output of the processed data. This element appraises the meaning, timeliness and accuracy of the information produced by the digital system. *System quality* applies reliability, assurance, empathy, responsiveness and tangible aspects as indicators by which to measure IS success (DeLone & McLean, 1992). The quality of a system, its information and service quality influence the usage of the system and user satisfaction (DeLone & McLean, 2003).

This model has two dependent elements: *intention to use* and *user satisfaction*. The *intention to use* or *use* elements focus on the usage of the information or reports generated by the system (DeLone & McLean, 1992, 2002). When using this information or the reports, decision-makers or users should have clear intentions for why they need them. In contrast, *user satisfaction* examines whether users are satisfied with the system functions, information and services (DeLone & McLean, 2002, 2003). As a result, this dependent variable will impact individuals and organisations. These two elements were combined to produce net benefits (DeLone & McLean, 2002). Therefore, if *information quality, system quality, service quality, intention to use* and *user satisfaction* are measured, it will engender net benefits for the organisation (DeLone & McLean, 2002, 2003).

In Chapter 2, the literature suggests that *information quality, system quality, intention to use* and *user satisfaction* are significant in smart city implementation (Caporuscio & Ghezzi, 2015; Cretu & Cuza, 2012; Eremia et al., 2017). However, the frameworks presented in Chapter 2 to assess city readiness for smart implementation lack *information quality, system quality, intention to use* and *user satisfaction* as indicators. In conclusion, elements of DeLone and McLean's IS success model can be integrated with other theories to develop an integrated framework that can be used to comprehensively assess rural and small municipalities' readiness for smart city implementation.

3.3 The technology, organisation and environment framework

The preceding section presented a discussion of the DeLone and McLean IS success model. This section discusses the technology, organisation and environment (TOE) framework. The TOE framework was developed by DePietro, Wiarda and Fleischer (1990). This framework provides significant contextual elements that can be utilised to understand important components and processes involved in the implementation of technologies or innovation in various industries. According to DePietro et al. (1990), three contexts can be used to influence the decision to implement technological innovation: technological context, organisational context and environmental context (see **Figure 11**).

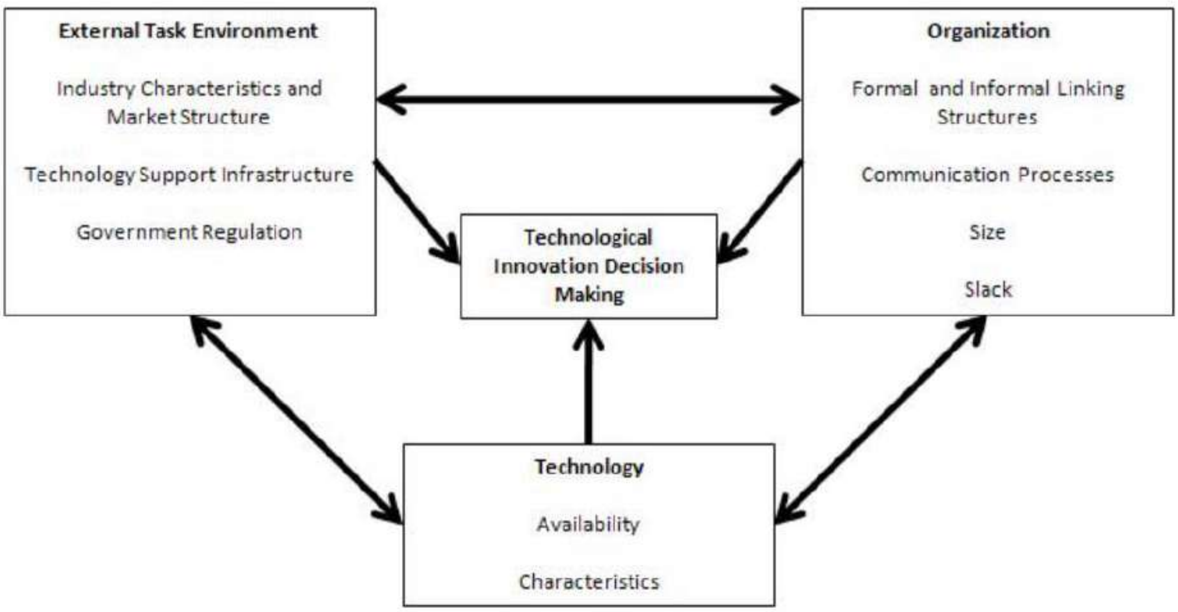


Figure 11: TOE Framework (DePietro et al., 1990: p. 153)

Organisational context: Organisational context is described using the following measures: the complexity of managerial structure, communication process, firm size, centralisation, the quality of human resources, formalisation and slack resources. Managerial structure is used to measure everyone involved in the management hierarchy. Most of their duties revolve around planning and communicating change and documenting policies and goals that will support organisation innovations (DePietro et al., 1990).

The communication process, as one of the measures in an organisational context, is a bridge to obtaining information about new technology in the industry before adopting it (Awa, Ukoha, & Igwe, 2017). Again, communication can impact the implementation and use of new technologies. However, Awa et al. (2017) and DePietro et al. (1990) indicate that organisational size has a bigger impact on a company in adopting technological innovation. Awa et al. (2017) report that big organisations are likely to adopt technologies quickly. Lastly, slack resources are also considered significant in the understanding and implementation of new technology because complex technologies end up not being implemented because of a lack of slack resources. Slack resources can include financial resources, human resources, etc. (DePietro et al., 1990).

Technological context: TOE uses technological context to examine technologies important and relevant to the organisation. This includes the features of existing and new technologies because they are important determinants in implementing and using technology. Some scholars report that the adoption and implementation of technologies depend on availability (DePietro et al., 1990). Technology should be compatible with the existing technological infrastructure for it to be adopted (Awa et al., 2017; DePietro et al., 1990).

Environmental context: An environmental context represents the place where an organisation conducts its business. According to DePietro et al. (1990), environmental context can be measured using technological support infrastructure, industry characteristics, government regulation and market structure to influence the implementation of technological innovation. However, the environmental context can pose either limitations or opportunities for implementing and using innovation. Such opportunities may arise from role players who could provide human resources, financial resources and important information on how to innovate (Awa et al., 2017; DePietro et al., 1990). These role players may include knowledge workers or producers, regulators, industry members, customers or citizens, suppliers, etc. The same role players could constrain an organisation through gatekeeping, lack of capital support, lack of information, and government regulations and policies (DePietro et al., 1990).

The TOE framework was later extended by Awa et al. (2017), as depicted in **Figure 12**. Awa et al. (2017) added an extra component, namely *individual context*. Individual context is an added strategic and tactical aspect that plays a significant role in the adoption of innovation. Individual context accommodates all users of the systems.

The *individual context* aspect has two measures: subjective norms and hedonistic drive. Subjective norms are used to explore users' social status, which plays an important role in individuals' adoption of new technology. The hedonistic drive dimension is not common in the IS domain, although it is critical to the adoption of innovation. This measure is used to describe and determine individuals' desire to adopt technology (Awa et al., 2017).

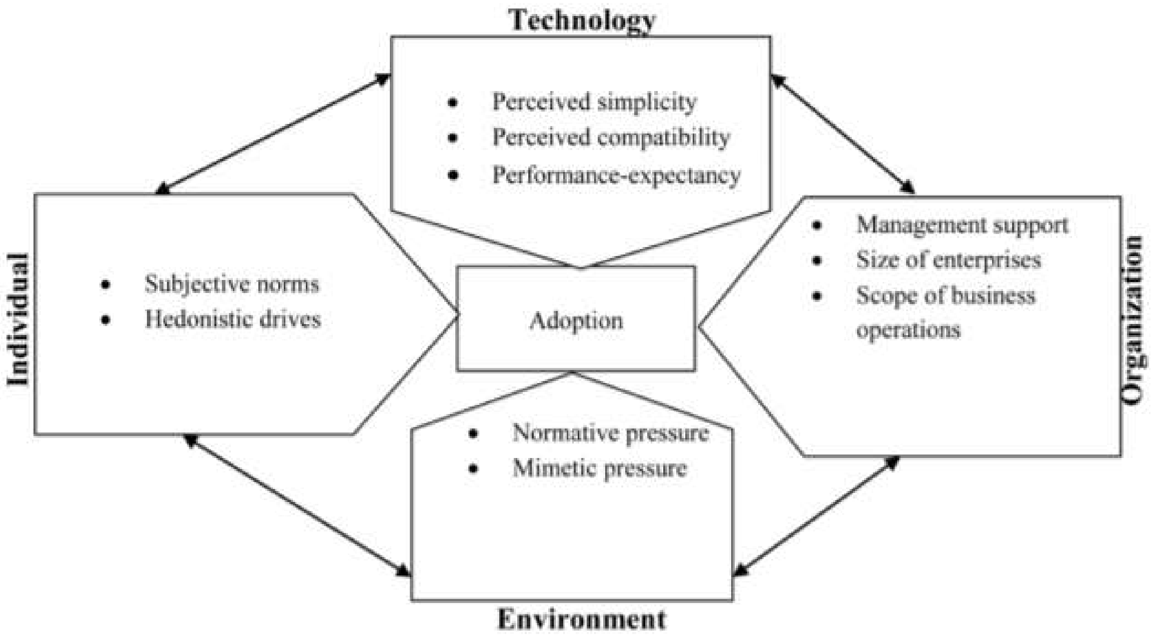


Figure 12: Revised TOE framework (Awa et al., 2017: p. 5)

3.4 Technology readiness index

The preceding section discussed the TOE framework. This section discusses the technology readiness index (TRI). The technology readiness index was developed in the year 2000 by Parasuraman (2000) to assess the willingness of users to adopt the technology within the organisation to achieve specific goals. This theory uses four components to measure the technology readiness index of a company, its employees and customers (Parasuraman, 2000), i.e., optimism, insecurities, discomfort and innovation.

- **Optimism:** The degree to which users have positive beliefs or views about a specific technology. In this regard, technology should enhance users' lives both at home and at work by giving them increased flexibility and control of their lives.

- **Innovativeness:** This component examines the level at which users take a leading role in experimenting with new technology to perform their duties. Here, users voluntarily experiment with new solutions to learn about such solutions.
- **Discomfort:** This component contrasts with the optimism construct. It examines the concern and fears around adopting new technology. The discomfort in this element is caused by a lack of control over the new solution.
- **Insecurity:** This component refers to users' doubts and uncertainties about new technology. Individual users become sceptical about the capability of the technology, and based on that, users develop the perception that a prospective technology would never help them to achieve their goals (Parasuraman, 2000; Parasuraman & Colby, 2015).

The TRI regards the optimism and innovativeness components as the main contributors to technology readiness (Parasuraman & Colby, 2015) while considering discomfort and insecurity components as hindrances to technology readiness (Parasuraman, 2000; Parasuraman & Colby, 2015).

The TRI is not fit to underpin this study by itself because it focuses on assessing technology readiness aspects. This study seeks to develop an integrated framework to assess small and rural municipalities' readiness by considering the most important aspects, such as the technological, environmental, organisational and human (for example, individual, employees and customers or citizens) contexts. Therefore, when as sessing the readiness of small and rural municipalities, TRI is only suitable because its components are used to measure technology adoption readiness. This theory is integrated with other theories to develop an integrated framework to assess the readiness of small and rural municipalities for the implementation of the smart city concept.

3.5 Diffusion of innovation theory

The preceding section discussed the technology readiness index. This section discusses the diffusion of innovation (DOI) theory. The DOI theory was developed in 1962 by Rogers (Rogers, 1962) and is also known as the innovation diffusion theory (IDT) (Rogers, 1983, 2003). This theory is popular in technology adoption studies. DOI theory is used in research projects to provide an understanding of the process of adopting innovation. Rogers (1983) regards innovation as an idea, object, solution, product or behaviour users recognise as new.

In DOI theory, adoption is defined as the way an organisation or people could use an innovation to change the way they act in performing their day-to-day operations (Rogers, 1983). The adoption of innovations does not occur concurrently in a social system. The social system is another aspect of the diffusion of innovation theory, consisting of interrelated components that are combined to solve a problem in order to achieve its main goal (Rogers, 1983, 2003).

The diffusion of innovation encompasses the innovation–decision process, as shown in **Figure 13** below. This process consists of five steps: knowledge, persuasion, decision, implementation and confirmation (Rogers, 2003). During the knowledge step, a group of users becomes cognisant of the innovation's existence (Rogers, 1983). Users tend to become aware of the innovation through several channels, including word of mouth, advertising or personal experience. At this stage, users are likely to have a limited understanding of the innovation. In the persuasion step, the user seeks more information and tests the innovation to identify its benefits and shortcomings (Rogers, 1983, 2003).

In Step 3, the decision step, users assess what they have discovered during the persuasion step to make informed decisions about whether to adopt or reject the innovation (Rogers, 2003). If the decision is to adopt the innovation, the users move on to the implementation step. This involves putting the innovation into practice. Thereafter, users move on to the confirmation step. During this step, adopters evaluate their decision and assess the outcomes. If the innovation meets or exceeds users' expectations, it can lead to further confirmation and adoption (Rogers, 1983, 2003).

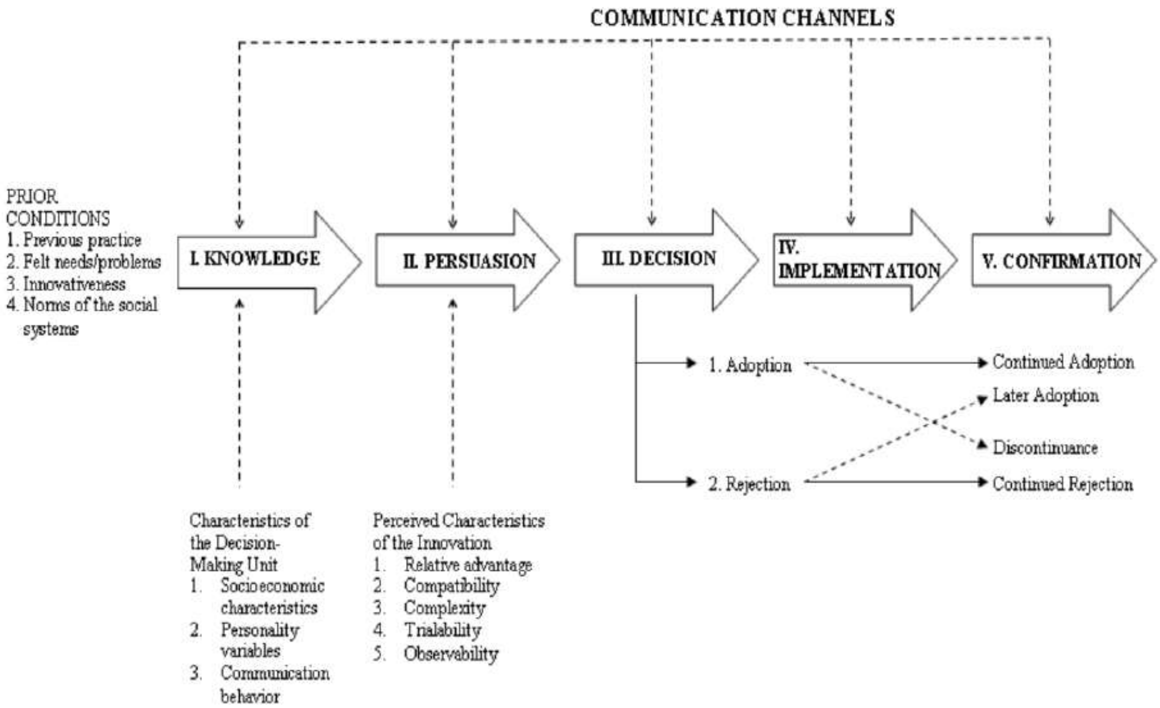


Figure 13: The innovation–decision process (Rogers, 1983: p. 165)

According to Rogers (1995, 2003), the adoption of innovation can be influenced by the following characteristics: relative advantage, compatibility, complexity, trialability and observability. Relative advantage refers to the degree to which an innovation is considered better than the innovation that preceded it (Rogers, 1983). This characteristic has been closely linked to individual perception of the use or the implementation of a new idea. An idea is likely to be implemented if users perceive an advantage over its predecessor (Rogers, 2003).

Relative advantage can be measured in terms of economic benefits, convenience, social prestige, satisfaction, productivity and other positive benefits. Sometimes, these benefits carry no weight; what matters is how individuals or users perceive the innovation. If users regard the innovation as advantageous, they are likely to adopt it. The more relative advantages of an innovation are perceived, the faster and more likely it will be adopted (Rogers, 1995, 2003).

Once more, it must be noted that innovations or new ideas should be compatible with the past experiences and needs of possible adopters. Compatibility is important in the adoption of a new idea or innovation because incompatibility may require many changes in the organisation and environment. If an innovation is compatible with the social system, norms, values and culture, it is likely to be adopted faster than other innovations (Rogers, 2003).

Complexity is a consequential characteristic that influences the adoption of innovation and refers to an innovation that is difficult to use and understand. An innovation that most users find simple to understand is adopted quickly (Rogers, 1983, 2003), whereas complicated innovations are adopted very slowly. Furthermore, all innovations should be tested before implementation to ascertain whether any relative advantages or compatibility and complexity issues exist, in which case trialability would uncover unknown aspects of the new idea. DOI theory indicates that an innovation upon which experimentation has been conducted is adopted faster than innovations that have not been tested (Rogers, 2003).

The last characteristic of the DOI theory is observability. Observability signifies that the results of a new idea or innovation are clear to potential adopters. Therefore, if potential adopters perceive observable results in such an innovation, they are likely to adopt the idea very quickly. Visible results eradicate the doubts of potential adopters who may be sceptical about adopting the new idea (Rogers, 1983, 2003).

Rogers (2003) indicates that the adoption of new ideas normally follows the process represented in the figure below as a bell curve (see **Figure 14**). It depicts five (5) types of adopters and a percentage allocation for each category. These types are *innovators, laggards, early majority, early adopters and late adopters.* Rogers (2003) posits that even though the advantages of a new idea or innovation are obvious, it will take time to become widely adopted.

Typically, the adoption process begins with around 2.5 per cent of innovators and visionaries. They spend much time and energy building new ideas and solutions. Once an idea is implemented, the first group are the ones who adopt the innovation early on, called *early adopters*. This group constitutes 13.5 per cent of the population and is good at identifying brilliant innovations that address their personal needs. They also serve as independent testers of the innovation (Rogers, 1983).

The third group in the bell curve is the *early majority*, followed by the *late majority*. Both groups share an equal proportion of 34 per cent. The early majority are comfortable with adopting a progressive idea, whereas the late majority are afraid to adopt new ideas. However, these two groups are cost-sensitive to taking the risk of adopting new ideas. The last group represents the *laggards*. Laggards inherently view adopting innovation as risky; they usually wait until the end of the adoption cycle before accepting the value of the new idea (Rogers, 1983, 2003).

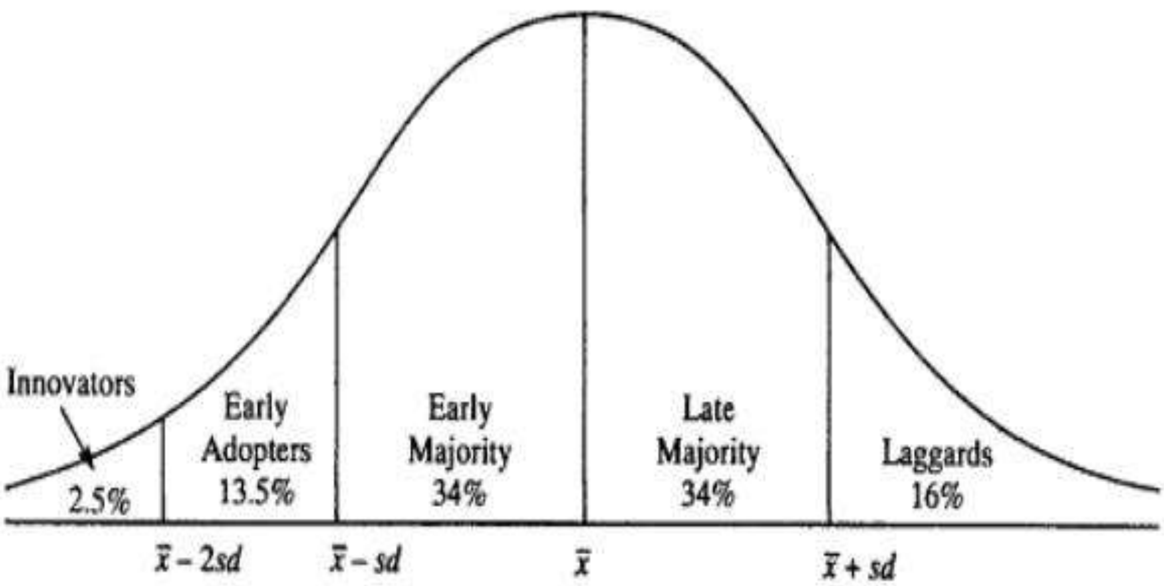


Figure 14: Adopters groups (Rogers, 1983: p. 247)

3.6 Conceptual Framework

The conceptual framework in this study was developed by combining 27 components from the TOE, TRI, DeLone and McLean model, DOI theories and the frameworks reviewed in Chapter 2. The 27 constructed components are compatibility, availability, complexity, relative advantage, information quality, system quality, security, executive support, partnership, skilled staff, size, resources, educational level, experience, innovation, optimism, government regulation, social norms, culture, economy, technology support infrastructure, user satisfaction, intention to use, human readiness, technology readiness, organisational readiness and environmental readiness (see **Figure 15**). All these components were selected from the literature review and IS theories because they had a substantial effect on assessing and implementing innovations. If an innovation is not compatible with users' devices or cultures, it would be difficult for users to adopt such innovation (Rogers, 2003). Furthermore, users are likely to adopt innovations that are easy to use and possess relative advantages (DeLone & McLean, 2002; Rogers, 2003).

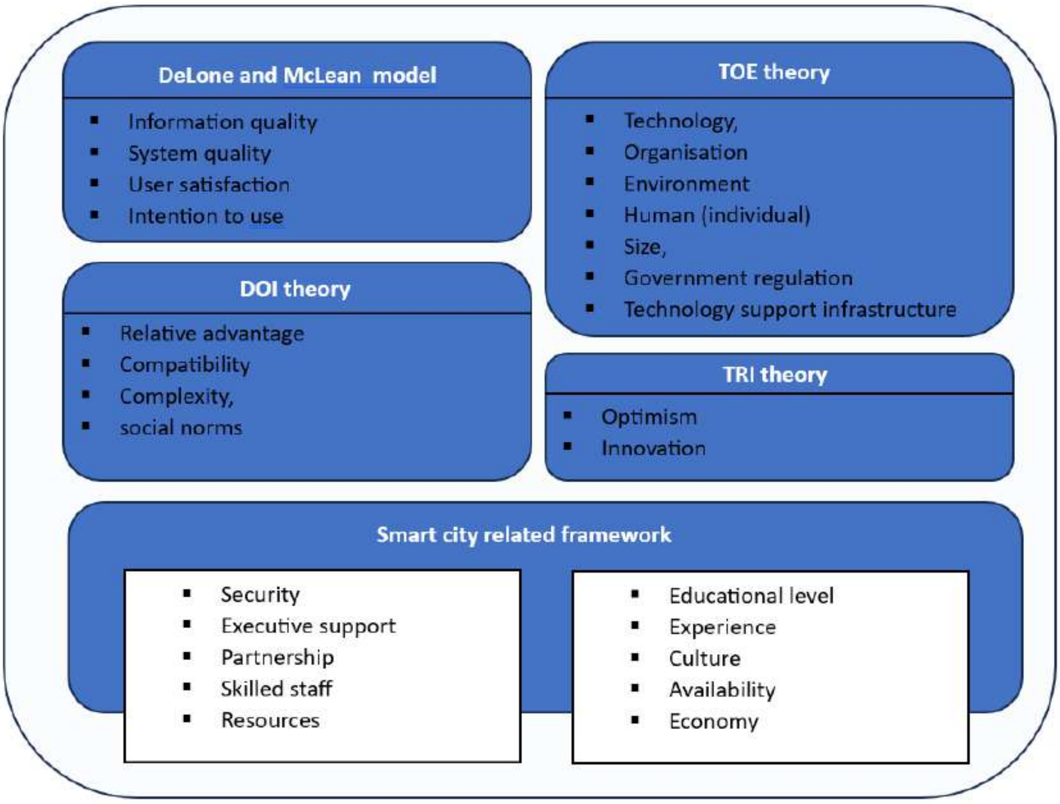


Figure 15: Integrated components

The main reason for the high failure rate of smart city projects (Almuraqab & Jasimuddin, 2017) is the lack of an appropriate assessment framework that assesses small and rural municipalities' readiness for smart city implementation. Several smart city frameworks have been developed for various reasons (see **Table 3**), yet no framework addressing the issue of small and rural municipalities' readiness for smart city implementation exists in South Africa or elsewhere. This framework (see **Figure 16**) provides cities with guidelines on how to assess the readiness of small and rural municipalities for smart city implementation.

Thus far, this study has applied components from various theories to a proposed conceptual framework for assessing small and rural municipalities' readiness for smart city implementation (see **Figure 16**); accordingly, there could be some overlap of components. To align such a framework by addressing any overlapping components, this framework was evaluated empirically and then improved as the final contribution of the thesis.

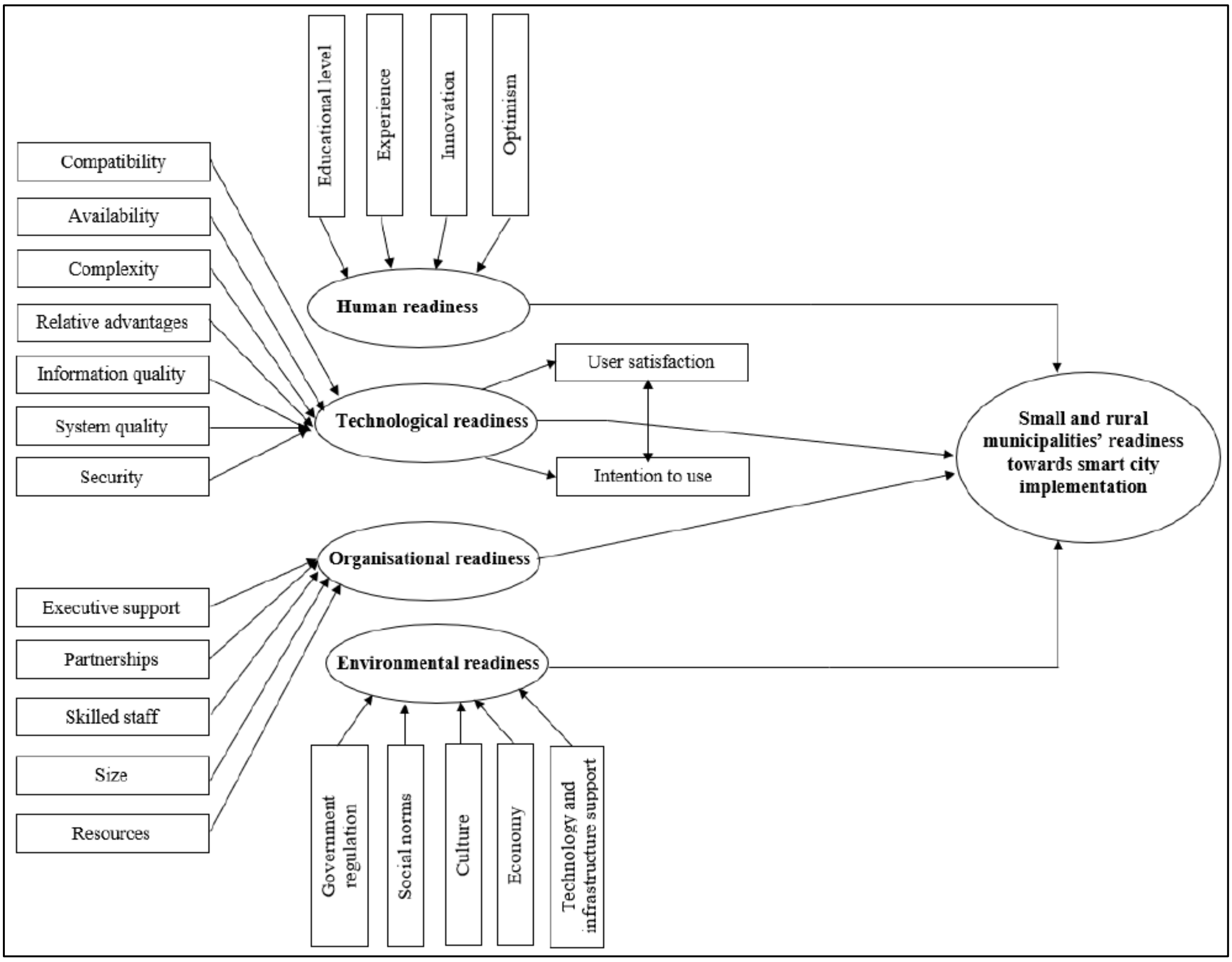


Figure 16: Proposed integrated framework to assess small and rural municipalities for smart city implementation.

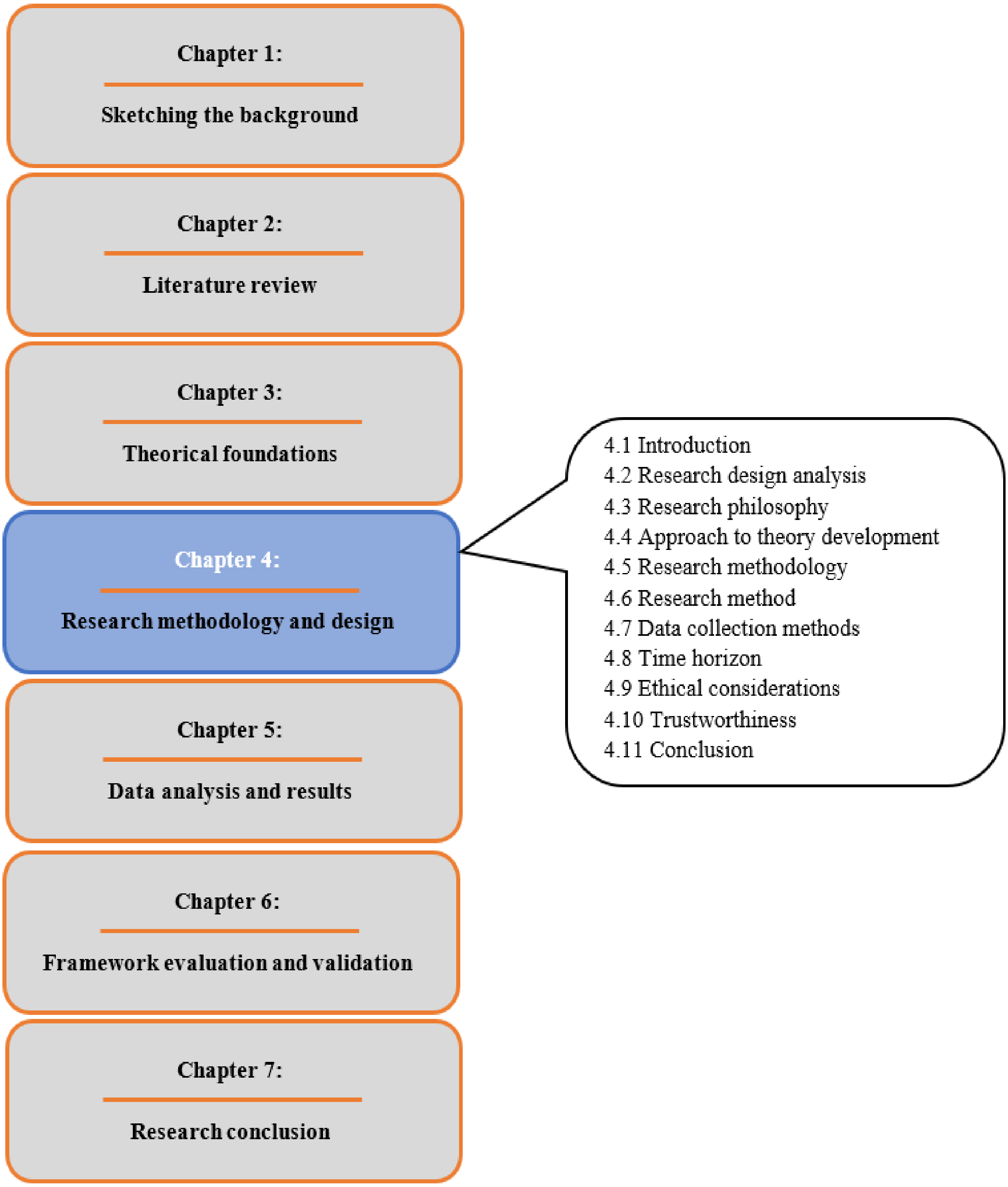
3.7 Conclusion

This chapter discussed the DeLone and McLean IS success model, the technology–organisation–environment framework, the technology readiness index and the diffusion of innovation theory since they are often used to guide information systems research. These theories were used to develop an integrated conceptual framework to assess small and rural municipalities' readiness for smart city implementation. This was achieved by identifying components that have a substantial impact on the adoption of new ideas in an organisation. The 27 concepts were identified and used to develop the conceptual framework in **Figure 16**.

Chapter 4 considers the research approach of this study and deals with epistemological beliefs, theoretical perspectives, a suggested methodology and methods. The methods used included case studies, interviews, document review, participatory design and expert reviews to achieve research objectives and to answer research questions.

CHAPTER 4

RESEARCH METHODOLOGY AND DESIGN



4.1 Introduction

The preceding chapter presented IS theories that have an impact on the implementation of new ideas or innovations. It proposed an integrated framework to assess small and rural municipalities' readiness for smart city implementation. This chapter presents the research methodology used to address the problem, answer research questions and, ultimately, achieve the research objectives.

This chapter predominantly aims to present and motivate the selection of the research methodology. This aim was achieved by following the so-called research onion developed by Saunders, Lewis and Thornhill (2019) and the research design by Crotty (1998). A discussion of the research approach, ontology and epistemology, theoretical perspective, research methodology, research method and data collection method in Chapter 4 contributes to the decision-making on a research methodology. Subsequently, sampling design, time horizon, trustworthiness and ethics are justified.

4.2 Research design analysis

When conducting an inquiry, a systematic approach is essential for collecting and analysing data to improve the understanding of interesting facts about the situation (Leedy & Omrod, 2011). Saunders et al. (2019) designed the research onion to present elements that should form part of the research methodology chapter of a thesis (see **Figure 17**). The outer layer depicts the choice of research philosophy, followed by the next layer, an approach to theory development; subsequently, the layer containing the choice of methodology, a layer of research strategies, the time horizon layer and finally, the data collection and analysis layer. According to Saunders et al. (2019), data collection is a crucial part of the research process, although other layers are also significant in influencing the direction of the research.

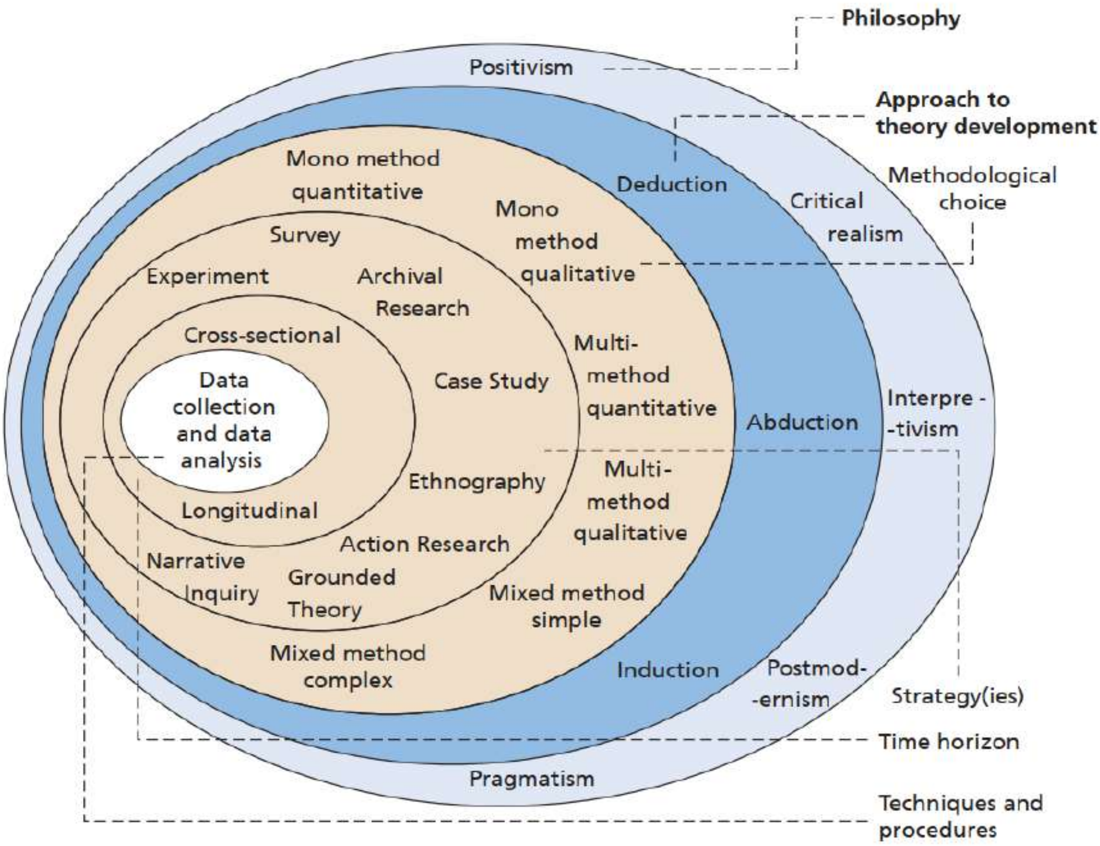


Figure 17: The research onion (Saunders et al., 2019: p. 130)

It is essential to outline the research design of the study from the outset. This research followed the design science research process (DSRP) developed by Peffers et al. (2007). **Table 4** below summarises the steps adapted from the process model by Peffers et al. (2007).

Table 4: Research design steps

Steps	**Activity**	**Outcome**
Step 1	Defining and justifying the research problem.	The research proposal (the problem statement forms part of Chapter 1 of this thesis).
Step 2	Defining research objectives.	The research proposal (the identification of the research objectives forms part of Chapter 1 of this thesis).

Step 3	Reviewing literature to develop a conceptual framework.	Presentation of the literature review appears in Chapters 2 and 3. One of the main outcomes is the conceptual framework in Chapter 3 (see **Figure 16**). In this step, two research outputs were produced.
Step 4	Case study section, data collection and presentation of the findings.	Nine case studies were selected in Chapter 4. Data were collected from five case studies; the findings generated from the interview data are presented in Chapter 5.
Step 5	Evaluating and validating the framework. For this step, the researcher adopted participatory design and expert review.	The final integrated framework is presented in Chapter 6 (see **Figure 32**).
Step 6	Communicating the findings.	A thesis, publications and presentations.

The figure below summarises the model by Peffers et al. (2007). As set out in **Figure 18** below, Step 1 of this study began with a preliminary literature review to identify the research problem. In Step 2, research objectives aligned with the problem statement were defined; in Step 3, the initial framework was developed based on the literature review. This was followed by Step 4, the identification of case studies and the data collection method. The study collected data from selected case studies. Section 4.6.1 discusses the selection of the case studies. After collecting the data, the researcher analysed the data; the findings are presented in Chapter 5.

In Step 5, an initial proposed conceptual framework was refined through interview findings and evaluation and validation processes. The initial proposed conceptual framework was refined by incorporating the interview findings into a revised framework. In this step, participatory design was used to confirm if participants' experiences had been addressed; thereafter, the researcher sent a revised framework to a group of experts to validate the revised framework towards producing the final framework. According to Kuechler and Vaishnavi

(2008), a framework is regarded as one of the outputs of design science research (DSR). In Step 6, the researcher documented and communicated the study’s findings through a thesis, publications and presentations. **Figure 18** presents the research process followed in this study.

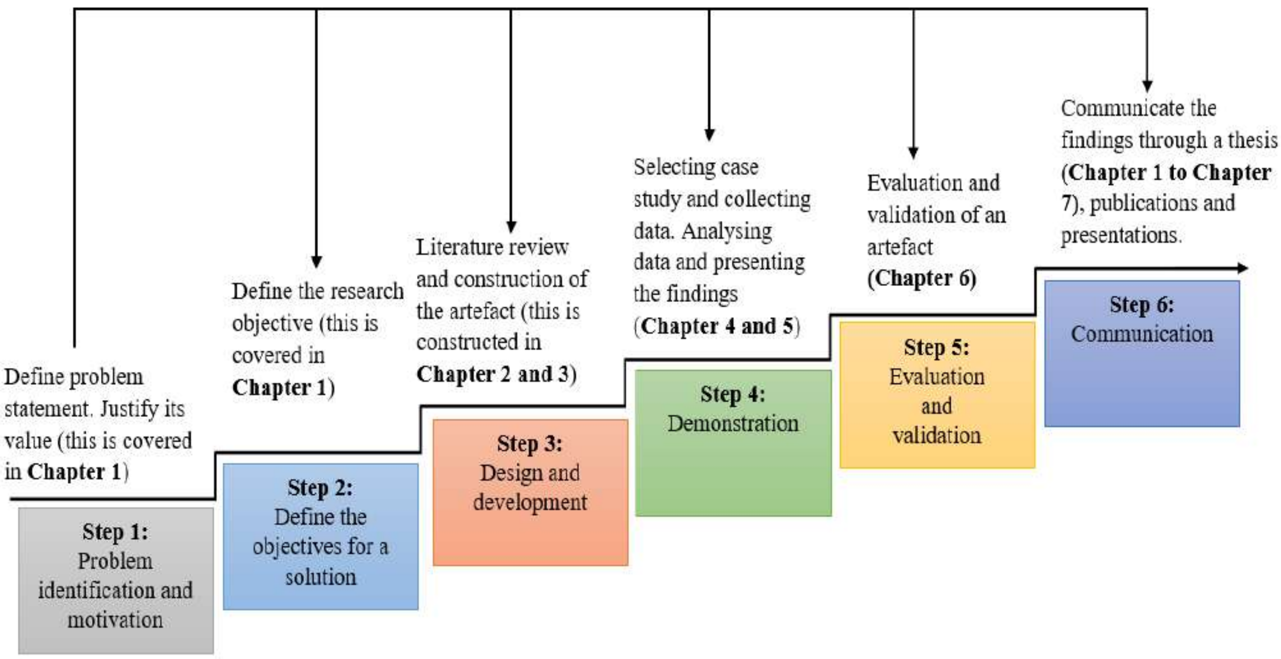


Figure 18: DSRM process model applied (Peffers et al., 2007: p. 54).

4.3 Research philosophy

When conducting research, it is important to identify the philosophical beliefs that would underpin the research since this promotes best practices (Cresswell & Clark, 2011). All research is grounded in philosophical beliefs about what reality is (ontology) and how reality can be known (epistemology) (Hay, 2002; Myers, 2013). Blanche and Durrheim (2006) specify that the philosophical grounding of research has three main parts: methodology, ontology and epistemology, whereas Kroeze (2012) details four main parts, namely methodology, epistemology, ontology and axiology (see **Table 5**). These philosophical beliefs are linked to the philosophical perspective underpinning the research project. Klein and Myers (1999) and Myers and Klein (2011) outline three philosophical perspectives: the positivist, critical and interpretivist research paradigms. These three philosophical perspectives are compared in Subsection 4.3.2 below to motivate the selection of the paradigm employed in this study.

Table 5: Description of philosophical assumptions

Features	**Description**
Ontology	Ontology deals with the nature of reality (Blaikie, 2010; Cantrell, 2001).
Epistemology	Epistemology deals with what can be known and how reality is known (Cantrell, 2001).
Philosophy	A philosophy refers to a philosophical framework or set of beliefs and practices that guide the process of conducting research (Myers, 2013).
Methodology	Methodology is a set of steps used to collect data to answer research questions (Cantrell, 2001).
Axiology	Axiology attempts to understand the characteristics of value and value judgement (Cantrell, 2001).

According to Hay (2002), ontology pertains to reality; epistemology is concerned with how reality is known (see **Figure 19**). The researcher further defines the paradigm as a belief, methodology as a procedure and methods for how to acquire knowledge (Hay, 2002).

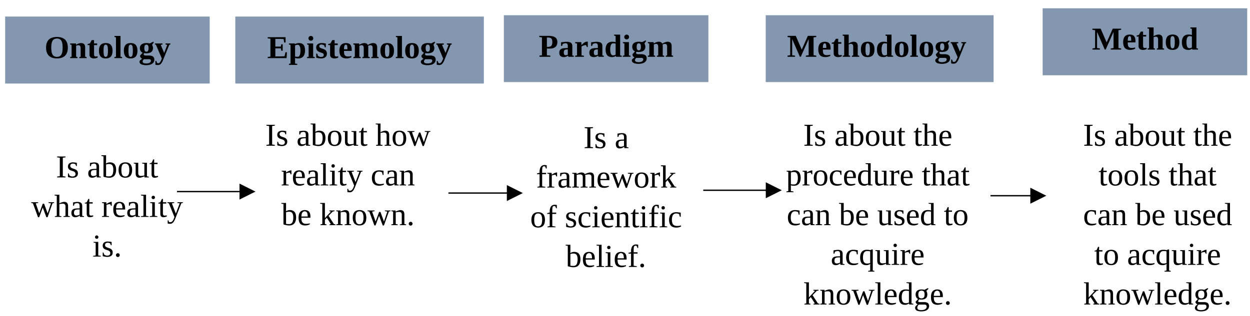


Figure 19: Modified from Hay (2002: p. 64) to show the difference between the terms.

According to Crotty (1998), it is necessary to detail the steps of the research by asking the following four questions:

i. What epistemology informs the proposed theoretical perspective?
ii. What philosophical stance supports the chosen methodology?
iii. What methodology governs the selection of research methods?
iv. What methods are suitable for this research?

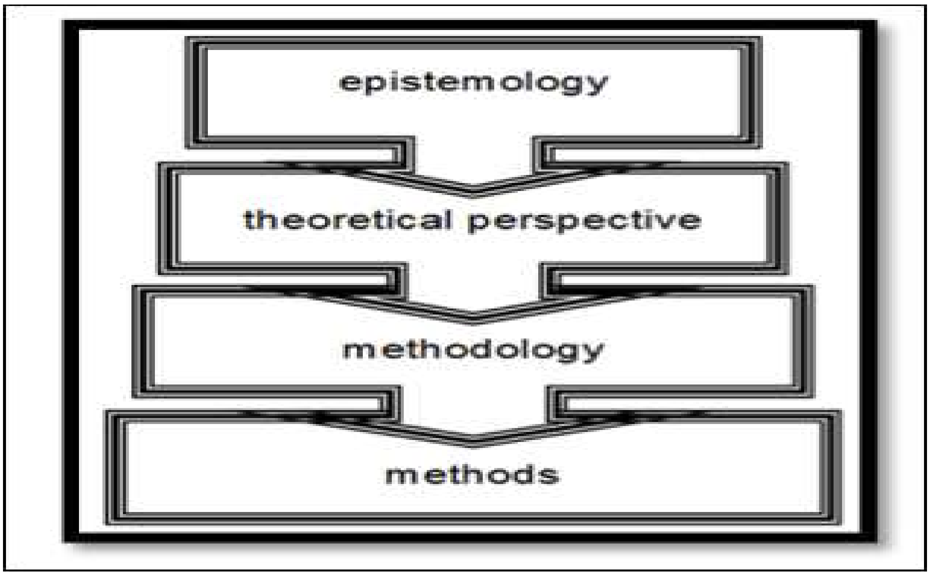


Figure 20: The research design as defined by Crotty (Crotty, 1998: p. 4)

The terms used in this thesis are based on the research onion of Saunders and Tosey as well as the Crotty definitions.

4.3.1 Ontology and epistemology

Ontology pertains to reality. Reality can be constructed and explored through meaningful activities and human interaction. Many social realities exist because of varying human experiences, including people's knowledge, interpretations, experiences and views (Cantrell, 2001). In contrast, epistemology refers to how reality is known; events are understood through a mental process of explanation that is influenced by interaction within a social context (Becker & Niehaves, 2007; Cantrell, 2001; Niehaves, 2005). Epistemology is important because it influences the way researchers frame their research projects in their quest to discover new knowledge (Moon & Blackman, 2014). The three commonly used epistemological stances in a research project are objectivist epistemology, constructionist epistemology and subjectivist epistemology (Crotty, 1998; Moon & Blackman, 2014).

Crotty (1998) argues that epistemology is associated with ontology because they complement each other. These philosophical beliefs are linked to theoretical perspectives. According to objectivist epistemology, reality exists independently of the individual mind (Moon & Blackman, 2014). This epistemology is underpinned by a positivist or post-positivist paradigm. Subjectivist epistemology assumes that knowledge exists in people and depends upon how they understand and perceive reality (Crotty, 1998; Moon & Blackman, 2014). This epistemology is underpinned by a postmodernist paradigm (Kroeze, 2012). Lastly, constructionist epistemology assumes that there is an interplay between the object and the subject (Moon & Blackman, 2014). Those who are active in the research process gain social knowledge by experiencing real-life or natural settings and discovering how people make logical sense of their social worlds in their usual settings through everyday conversations, routines and writing while interacting with others around them (Klein & Myers, 1999; Myers & Klein, 2011). These writings could be both visual (pictures) and text. The 'inquirer' and the 'inquired into' are interlocked in an interactive process of listening, talking, writing and reading. It provides a more personal, interactive mode of data collection (Cantrell, 2001).

4.3.2 Theoretical perspective

A theoretical perspective can be defined as being a way of doing things and is used to govern the investigation within a research project by providing processes and lenses through which inquiry will be undertaken (Weaver & Olson, 2006). However, Patton (1990) defines the theoretical perspective as a world vision, a common perception of the interpretation of the physical world (Patton, 1990). Myers (2013) submits that any research project depends on some theoretical perspectives on the nature of the world and how knowledge about the world can be acquired.

Research perspectives are important when conducting information technology and IS research. Klein and Myers (1999) and Myers and Klein (2011) discuss positivist, critical and interpretivist research paradigms. Although the authors acknowledge other research paradigms, these three paradigms explicated in the subsequent subsections are widely adopted in IS studies. The three theoretical perspectives are compared below.

The positivist paradigm is also known as the scientific method (Kamal, 2019). This paradigm is categorised as a way of understanding truth through objective testing to gain a one-way view of reality (Myers, 2013). In the social sciences, primary data within this paradigm are mostly collected through surveys that are analysed quantitatively (Makombe, 2017).

Critical research is a paradigm with a social perspective and aligns well with constructionism. Modern critical research has been influenced by the knowledge of said interests. Myers and Klein (2011) indicate three elementary areas of interest to society: technical knowledge interest, practical knowledge interest and emancipatory knowledge interest (Myers & Klein, 2011).

Researchers who conduct critical research are inspired by the ethical basis of this paradigm. Besides explaining and describing the research environment, researchers also investigate improving the power imbalances in social communities (Myers, 2013).

The interpretive paradigm contrasts with positivism inasmuch as it attempts to understand human reality subjectively. Where positivism alleges value-free observation, interpretivism considers observation but within the cultural and historical interpretations of social life (Crotty, 1998). Interpretive research intends to approach reality subjectively and to assist the researcher in the IS field in understanding human thinking and behaviour in an organisational and social setting (Klein & Myers, 1999; Thanh & Thanh, 2015). Interpretivist research endeavours to provide an understanding of the sense of noticeable facts (Glaser, 2001).

This paradigm attempts to understand phenomena through the explanation and exploration of human perception in a social context, shared values and language. The research process in interpretive research is not neutral (Gregor & Hevner, 2013; Myers, 2013; Oates, 2008). IS focuses on understanding the social setting of IS, where social processes are constructed and developed by people but influenced by the social context (Oates, 2006). Carr and Kemmis (1986) indicate that interpretivism is popular because of its essence of including stakeholders as participants and co-researchers throughout all research phases.

From the above discussion, the epistemological stance underpinning this research is subjectivism. Crotty (1998) describes this epistemology thus:

> *"There is no objective truth waiting for us to discover. Truth or meaning, comes into existence in and out of our engagement with the realities in our world."* (Crotty, 1998: p. 8)

Based on the epistemological stance and nature of the study, this research followed the interpretive theoretical perspective or paradigm per Eckert (1998), who details that interpretive research involves empirical data gathering and analysis from different sources, using various techniques such as interviews and document reviews. In addition, using interviews as a technique to elicit data assisted in exploring the meaning of activities and any uncertainties that might not be explored through a quantitative methodology (Dagada, 2014). Interpretive research commonly uses interviews and document reviews as methods of collecting data, as well as expert reviews to validate any proposed framework (Stake, 2010).

4.4 Approach to theory development

The approach to theory development is the second layer of the research onion. This layer entails three approaches: deduction, induction and abduction (Saunders et al., 2019). A deductive approach uses a top-down approach (Creswell, 2009; Saunders et al., 2019), whereas an inductive approach is a bottom-up approach using participants' opinions to generate broader themes and a theory interrelating these themes (Creswell, 2009). Inductive reasoning is linked to the interpretivist paradigm, while a deductive approach is linked to the positivist paradigm (Saunders et al., 2019).

The abductive approach is a combination of the inductive and deductive approaches (Saunders et al., 2019; Thompson, 2022). This approach is a way of reasoning that involves creating hypotheses for observed phenomena that do not fit into existing explanations (Awuzie & McDermott, 2017; Thompson, 2022; Van Hoek, Aronsson, Kovács, & Spens, 2005). The abductive approach further involves a process of iterative reasoning, where researchers develop various hypotheses and test them against existing evidence (Awuzie & McDermott, 2017; Janiszewski & Van Osselaer, 2022; Thompson, 2022). In most cases, the approach begins with observation, which leads researchers to follow the pragmatist paradigm (Creswell, 2009; Saunders et al., 2019).

Creswell (2009) emphasises that the inductive approach is appropriate for a design science research methodology. This study employed an inductive approach because a conceptual framework was developed using a literature review and was refined through a qualitative data collection and analysis method. The resultant refined conceptual framework was evaluated using participatory design and validated by expert review.

4.5 Research methodology

Crotty (1998) describes a research methodology as a strategy or plan of action that uses a particular method to achieve a desired outcome. Research methodology is the third layer of the research onion. This layer presents six methodological choices: mono-method qualitative, mono-method quantitative, multi-method qualitative, multi-method quantitative, mixed-method simple and mixed-method complex (Saunders et al., 2019). This study followed a qualitative approach using design science research methodology (DSRM).

The literature does not mention incorporating the research onion by Saunders into design science research; Saunders et al. (2019) also do not address design science research. However, they introduced another layer called *approach to theory development*. Therefore, there is no conclusion on how design science research should fit into the research onion. Venable (2011) nevertheless indicates that DSR should be part of the research onion but does not indicate on which layer of the research onion it should reside. In this study, DSR was added as a part of the approach to the theory development layer to assist the research in developing a framework as an artefact.

DSR methodology is considered suitable when a study aims to develop an artefact that addresses a real-world problem (Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, & Niehaves, 2018; Winter, 2008). This research employed the design science research methodology because it seeks to develop an artefact, namely an *integrated framework to assess small and rural municipalities' readiness for smart city implementation*. A specific design science research methodology process was employed to develop the artefact in this study.

Several DSR methodology process models have been developed for design science research, of which three are the most used. One of these models was developed by Kuechler and Vaishnavi (2008), the other one by Drechsler and Hevner (2016) and the last one by Peffers et al. (2007). These process models were developed for IS research (Peffers et al., 2007).

4.5.1 DSRM process model developed by Kuechler and Vaishnavi (2008)

The DSR methodology process model defined by Kuechler and Vaishnavi (2008) consists of five process steps, namely (see **Figure 21)** awareness of the problem, suggestion, development, evaluation and conclusion. Iterating through these process steps generates new knowledge (Kuechler & Vaishnavi, 2008). A brief overview of the process steps by Kuechler and Vaishnavi is provided below:

- *Process Step 1 – Awareness of the problem*: This step stipulates that the researcher should start by identifying the problem before the development of an artefact. The identification of the problem can be attained through a literature review, observation, etc. The output for this step is the research proposal.
- *Process Step 2 – Suggestion*: This step is an integral part of a research proposal. Here, the researcher creates a tentative design as a possible solution using existing knowledge. The output for this step is a tentative design.
- *Process Step 3 – Development*: Process Steps 3, 4 and 5 are performed iteratively in most cases. In this step, the tentative design is further developed using initial collected and analysed data. The output for this step is a draft artefact.
- *Process Step 4 – Evaluation*: The draft artefact developed in Step 3 is evaluated in this step. This is undertaken to verify the behaviour of the artefact to address its shortcomings. Performance measurements are the output of this step.
- *Process Step 5 – Conclusion*: The results obtained from Step 4 are consolidated and recorded in the last step, and subsequently used to improve the artefact. The output for this step is a final artefact.

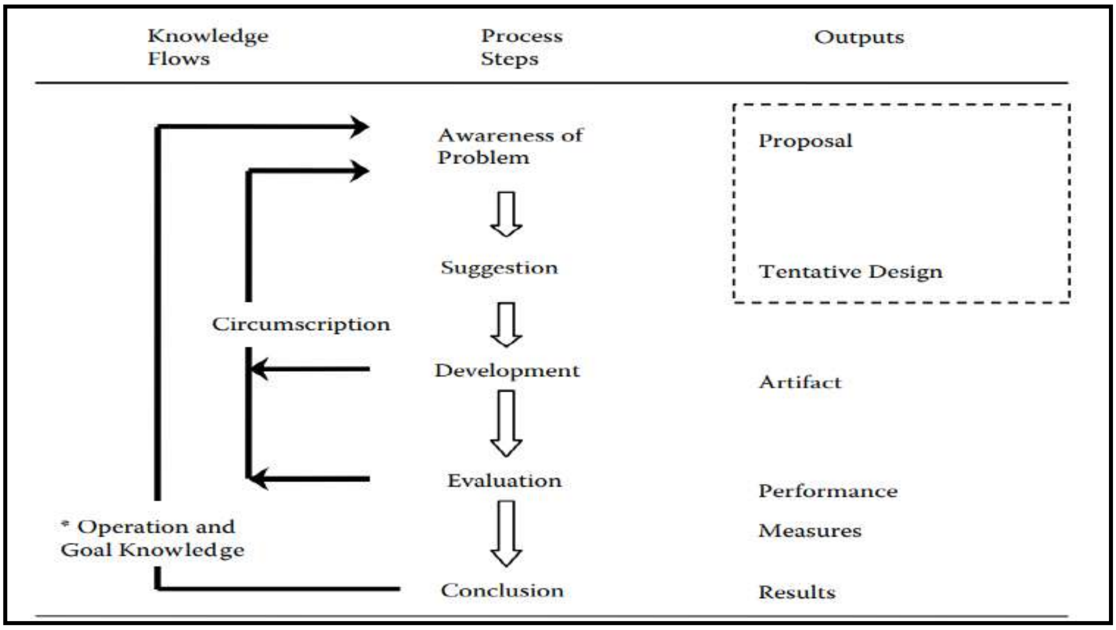


Figure 21: DSRM process model by Kuechler and Vaishnavi (2008: p. 20).

4.5.2 DSRM process model developed by Drechsler and Hevner (2016)

The process model developed by Drechsler and Hevner (2016) is known as the "four-cycle view of design science research" (Drechsler & Hevner, 2016: p. 5). This model evolved from the "three-cycle view of design science research" developed by Hevner (2007: p. 87), consisting of three cycles (see **Figure 22**): the relevance, design and rigour cycles.

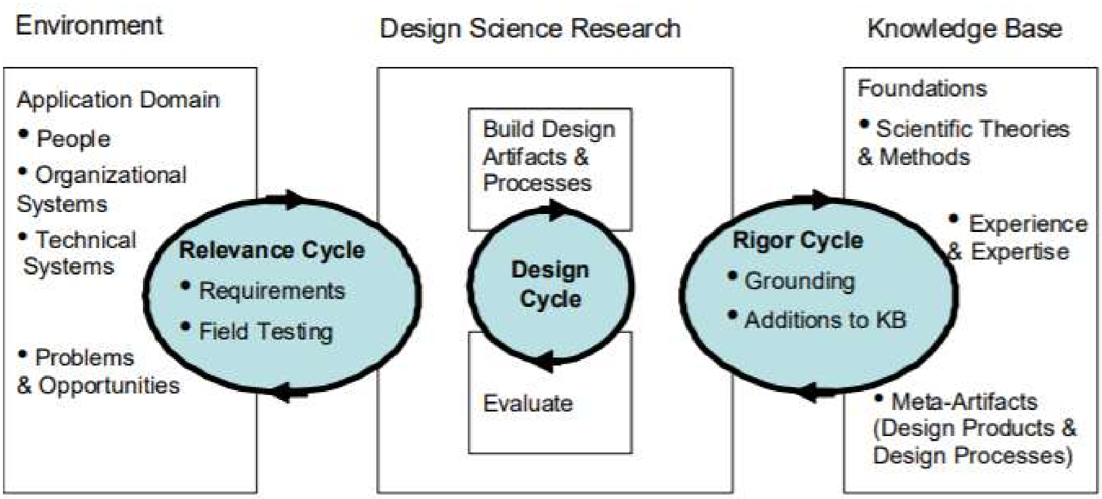


Figure 22: The three DSR cycle process model by Hevner (2007: p. 88).

Drechsler and Hevner (2016) indicate that their three-cycle DSR process model does not clearly show the starting point for identifying a research problem. The scholars also extended the three-cycle DSR process model by adding a fourth cycle. The fourth cycle is a **change and impact cycle,** as shown in **Figure 23** below. It is argued that this new cycle presents a starting point that triggers organisational dynamism through problem awareness. The cycle can capture the dynamic design of an IS artefact for an unstable environment (Drechsler & Hevner, 2016).

The **relevance cycle** initiates a design science research project by investigating internal environmental problems, opportunities, artefact requirements and fields within which to conduct testing. The next cycle is a **design cycle,** in which there is iteration between the development of an artefact and evaluation. The study constructs and tests an artefact, receives feedback, and the researcher modifies the artefact using such feedback. The last cycle is the **rigour cycle,** in which a study selects suitable theories and methods for developing and testing the artefact (Drechsler & Hevner, 2016; Hevner, 2007).

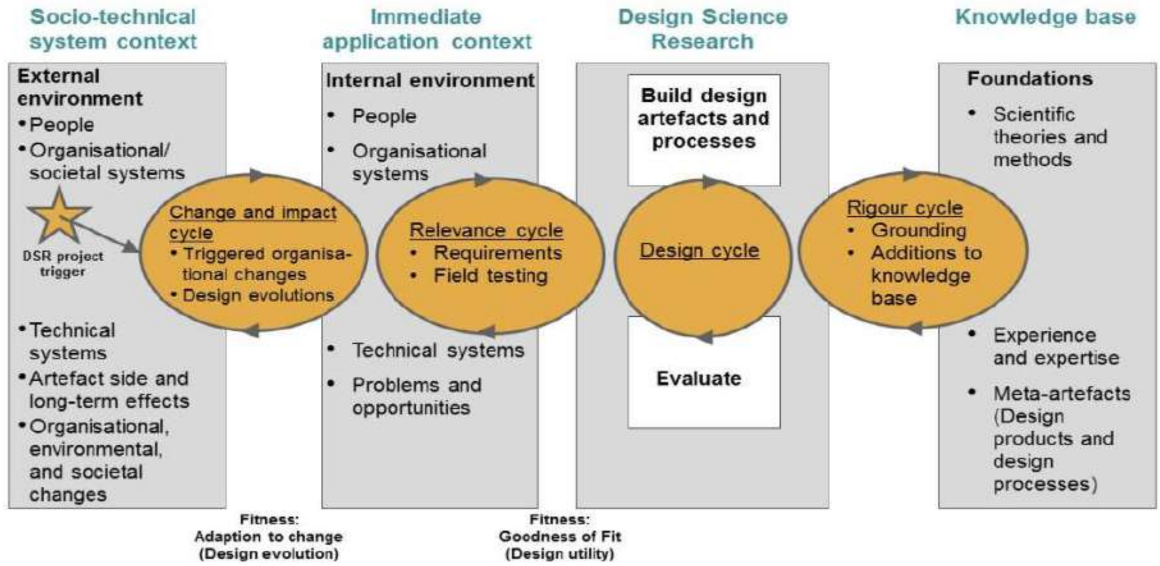


Figure 23: The four DSR cycle process model by Drechsler and Hevner (2016: p. 5).

4.5.3 DSRM process model developed by Peffers et al. (2007)

Peffers et al. (2007) developed a DSR methodology process model comprising the principles, procedures and practices that are required to conduct design science research. The model by Peffers et al. provides an iterative process model for solving a particular problem using six steps, as shown in **Figure 24** below.

- *Step 1 – Problem identification and motivation*: In this step, the researcher identifies a specific problem and motivates the importance of a solution. This informs the construction of an artefact, which is the solution for the study.
- *Step 2 – Define the objectives for a solution*: In this step, the researcher derives the objectives of the study from the problem statement as defined in Step 1.
- *Step 3 – Design and development*: This step involves the construction of the tentative artefact informed by the problem statement, objectives and literature.
- *Step 4 – Demonstration*: This step involves the demonstration of the artefact to verify if it solves the problem and then uses the findings to refine the initial artefact into a draft.
- *Step 5 – Evaluation*: In this step, the researcher tests if the draft artefact addresses the defined requirements.
- *Step 6 – Communication*: Here, the findings of the study are communicated in various forums. This can be done in the form of reports, journal articles, book chapters, etc.

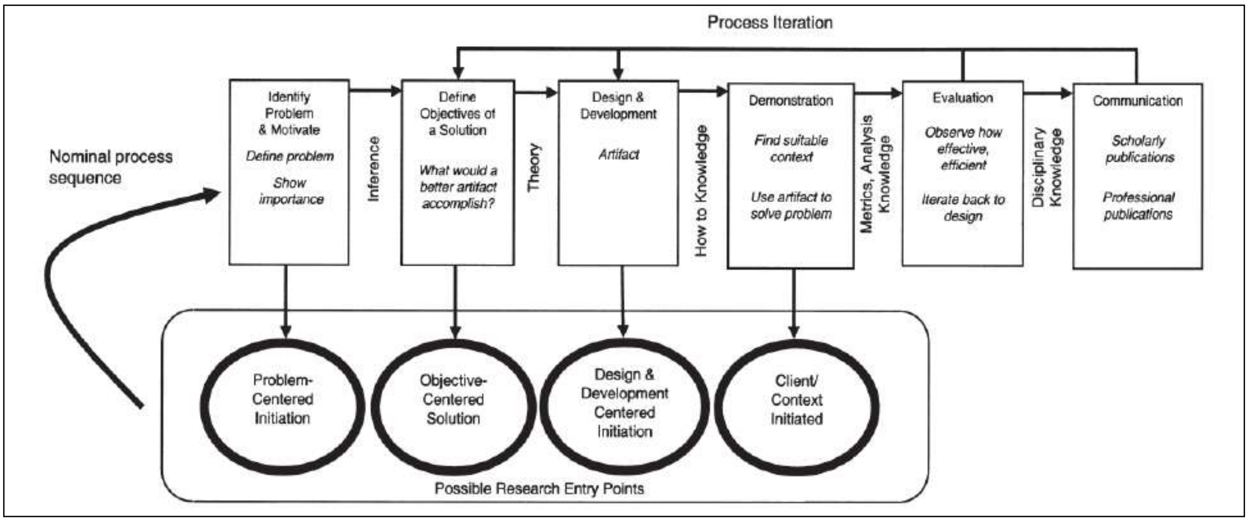


Figure 24: DSRM process model by Peffers et al. (2007: p. 54).

These three process models share common steps or activities. All of them commence with problem identification and justification; however, the models developed by Drechsler and Hevner (2016) and Kuechler and Vaishnavi (2008) are not explicit in terms of defining the objectives of a solution. This study employed the DSRM process model developed by Peffers et al. (2007) because it is clear in defining the objectives of a solution. The main objective of this study is to develop an integrated framework to assess small and rural municipalities' readiness for smart city implementation.

4.6 Research Method

A research method refers to procedures, strategies and tools that can be used to collect empirical data about reality as well as process and analyse it (Glasersfeld, 1996; Myers, 2013). It is formulated to address research questions and to achieve research objectives (Morehouse, 2012; Stake, 2010). According to Saunders et al. (2019), various research strategies include the use of a case study scenario (see **Figure 17**). A case study research strategy is capable of building theory (Saunders & Lewis, 2017). Therefore, this study is interpretivist research using the case study strategy to build a theory.

Various scholars consider a case study a comprehensive investigation into a subject that comprises a real-life problem (Saunders, Lewis, & Thornhill, 2015; Yin, 2016). Perry, Riege and Brown (1999) believe that a case study can be used as a method to address research questions within design science research. Creswell (2007) stipulates that case study research assesses an event within a real-life situation. A case study could be used to address 'how' and 'why' research questions where the emphasis is on a current situation (Yin, 2016).

The case study research strategy has gained acceptance in IS research because of its ability to develop a theoretical model (Ebneyamini & Moghadam, 2018). In design science research, a case study can be used as a research unit within which data can be collected and analysed by identifying themes to develop an artefact (Kuechler & Vaishnavi, 2008). A case study strategy is appropriate for this study because it seeks to identify themes and develop and evaluate a theoretical model (Gregor & Hevner, 2013; Hevner, Donnellan, & Anderson, 2013; Peffers et al., 2007; Wieringa, 2016).

Case study selection

Myers (2013) and Yin (2013) submit that case studies can be applied empirically to conduct an enquiry on understanding real-life situations in detail. This research used a case study research strategy to collect data to investigate the research problem in a real-life setting. This strategy indeed allowed the researcher to investigate the current research problem in a real-life environment, per Myers (2013).

4.7 Data collection methods

In Chapter 2, this study reviewed published literature to explore existing smart city frameworks and to present a robust theoretical foundation for the research problem and topic. The following main themes emerged from the existing literature: smart city concept overview, smart city initiatives, small and rural municipal aspects, information systems drivers for smart city development, smart services and smart city-related frameworks. The critical discussion supports the premise that a sufficient framework does not exist. The study accomplished the objectives for Chapter 2 by establishing the context and foundation for the development of an integrated conceptual framework using the relevant literature.

Thereafter, in Chapter 3, four theories, namely the technology, organisation and environment (TOE) framework, the DeLone and McLean model, the technology readiness index (TRI) and the diffusion of innovation (DOI) theory, were reviewed and adopted as guides for developing an integrated conceptual framework to assess small and rural municipalities' readiness for smart city implementation. The quality assurance of the conceptual framework was achieved by submitting a paper to the Innovative Technology and Learning (ICITL) conference in 2021. During the peer-review process, the study used the reviewers' feedback to improve the framework. This paper was accepted and presented virtually.

In Chapter 6, the study evaluates the proposed integrated conceptual framework empirically and improves it based on the results. Furthermore, the revised framework was validated and improved through expert review once more. The final, validated framework can be used to assess South African small and rural municipalities' readiness for smart city implementation. This study collected primary data and analysed it towards achieving such an assessment. Primary data refers to unpublished data gathered directly from respondents and institutions. The researcher also intended to collect secondary data; however, the participants refused to supply secondary data because it contained confidential information. Secondary data refers to data sourced from published material like policies, minutes, reports, books, journal articles and conference papers (Hofstee, 2008). The researcher therefore collected primary data through interviews (Chapter 5).

4.7.1 Sampling design

A sampling method is a mechanism through which to choose participants from a population to gather information regarding a particular situation (Brink, 1996). Case study research endeavours to explain and describe a phenomenon by ensuring a sufficient number of participants to assist in explaining the phenomenon (Ishak, Yazid, & Bakar, 2014).

Purposive sampling: Greenfield (2002) defines purposive sampling as the complete selection of a group of participants (using a subjective judgement technique) a researcher believes would form part of the research population. Babbie (1990) explains that purposive sampling is a selection of a sample based on a researcher’s understanding of the research, the population and its goals.

Purposive sampling can be employed in situations where the target population is too small to recruit a sufficient number of participants. This sampling technique is open to participant selection error and bias. However, in case study research, a researcher could use a snowball sampling technique to avoid being biased in the selection process. In this way, a study's raw data would be collected without the researcher influencing who would participate in the study to explain the study's phenomenon (Ishak et al., 2014).

Snowball sampling: Snowball sampling is also known as referral sampling (Babbie, 1990, 2005; MacNealy, 1999). Snowball sampling is utilised to obtain rich data by asking initial participants to help identify potential participants with the same knowledge quality. This method is effective because it uses referral networks (Cooper & Schindler, 2006; MacNealy, 1999). With this technique, the researcher does not know the participants in advance (Kothari, 2004).

Thus, this research used purposive sampling to select initial respondents from a municipality to collect data from such small and rural municipal officials charged with the implementation of smart city services or smart city concepts and integrated development planning (IDP). Other respondents from the same municipality were selected using the snowball sampling technique to avoid bias in the selection process. A sample unit from all the selected municipalities consisted of decision-makers, comprising mayors, deputy mayors, councillors, municipality managers, senior managers, middle managers, junior managers and information technology officials.

4.7.1.1 Sampling municipalities from each province

The study selected South African small and rural municipalities from the KwaZulu-Natal, Limpopo and Mpumalanga provinces as case studies for the collection of data for this study. In the figure below, it is apparent that these provinces have municipalities with a good mix of small (B3) and rural (B4) municipalities (see **Figure 25**). Three municipalities were selected from each of these provinces using purposive sampling.

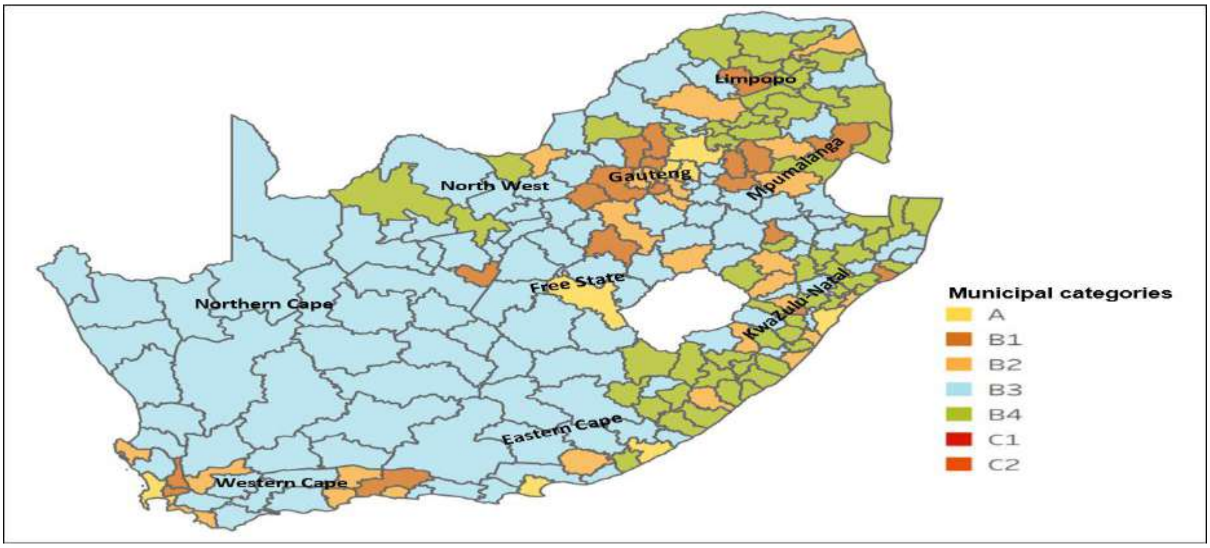


Figure 25: Municipal category distribution (Municipality Demarcation Board, 2018: p. 9).

4.7.1.2 Sampling participants for interviews

The research participants were chosen from municipality officials. First, participants per municipality were selected using purposive sampling. More participants were further selected using the snowball sampling method by asking the initial participants to help identify potential participants with similar knowledge quality. The literature indicates a lack of agreement on the fixed size of populations for semi-structured interviews. However, some studies suggest that a sample unit for semi-structured interviews should comprise a sample size of 5 to 25 respondents (Marshall, Cardon, Poddar, & Fontenot, 2013; Saunders, 2012). Some scholars suggest that a study employing semi-structured interviews is likely to reach its saturation point by the 12th respondent (Constantinou, Georgiou, & Perdikogianni, 2017). Hence, a total number of 18 respondents became the target sample size for the semi-structured interviews in this study.

4.7.1.3 Sampling documents for review

During the interviews, the researcher asked participants to recommend documents they believed could inform this research in identifying the relevant documents for the study. The researcher offered the following documents as examples: policies, minutes, reports, letters and newsletters. However, the participants did not recommend or share documents with the researcher because they contained confidential information; consequently, no documents were sampled for this study.

4.7.1.4 Sampling participants for participatory design

This study utilised snowball sampling to identify stakeholders who would typically be involved during the evaluation of a revised framework. Either the mayors or municipal managers were asked to nominate at least one person per municipality from the interviewees to become involved in the evaluation process of this framework to guarantee that their inputs were captured and also met their requirements.

4.7.1.5 Sampling participants for expert review

During the validation phase of the DSR model, the integrated framework to assess the readiness of small and rural municipalities for smart city implementation was made available to expert reviewers in the smart city domain. There is no agreement on the specific number of evaluators required to evaluate an artefact. However, Preece, Helen and Yvonne (2015) suggest three to five evaluators to identify approximately 75% of the usability problems of a design (see **Figure 26**), while Turner, Lewis and Nielsen (2006) indicate that four or five evaluators could discover around 80% of the usability problem.

Consequently, at least twelve experts were sampled to review the framework using a heuristic evaluation. This included scholars who have already designed frameworks within the smart city domain and managers from other South African metropolitan municipalities knowledgeable in the smart city domain. Those experts were identified using purposive sampling.

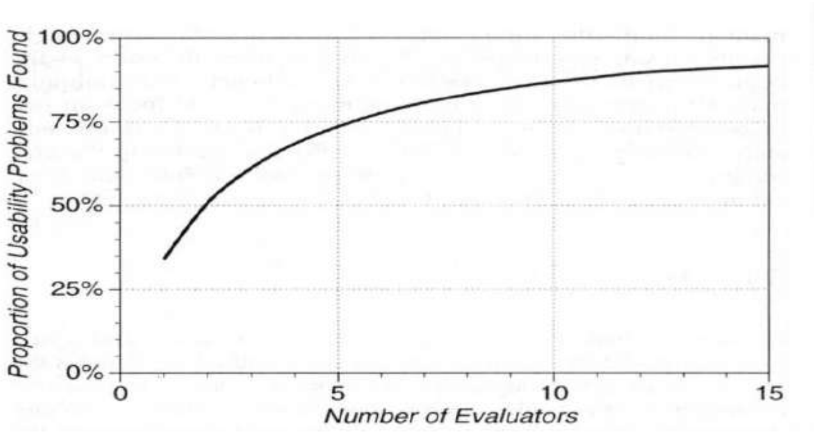


Figure 26: The curve depicts the ratio of problems within an interface identified by a heuristic evaluation using a range of numbers of evaluators (Preece et al., 2015: p. 409).

4.7.2 Data collection techniques

Figure 27 below displays the process flow followed to collect and analyse data to develop the final framework.

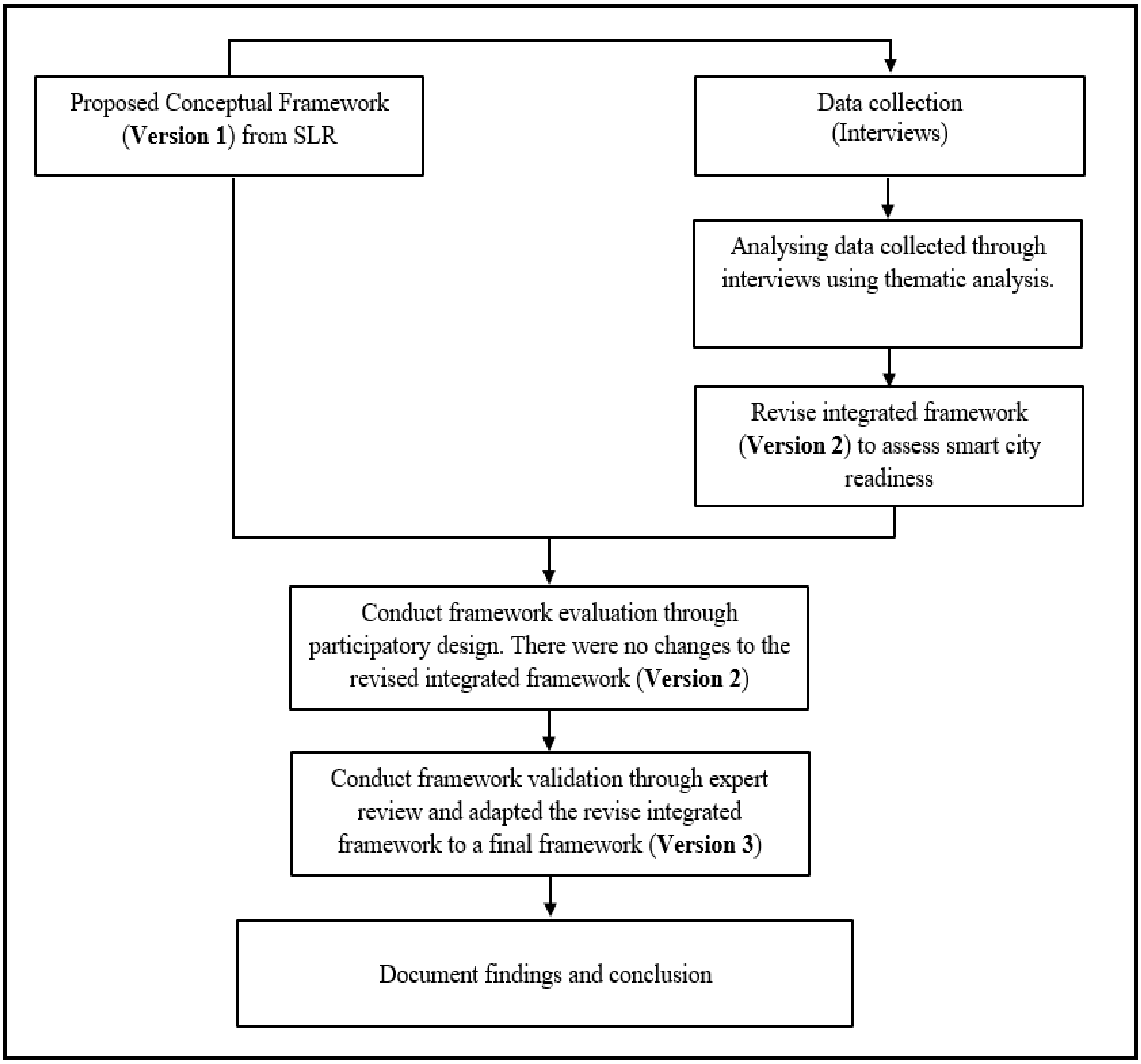


Figure 27: A process flow to guide the development of the final framework.

4.7.2.1 Data collection through interviews

According to Myers (2013), without discussion, it is difficult to understand why someone behaves in a certain way or why actions are executed in a certain way within organisations. Interpretivist research postulates that to understand why people do things in a certain way, one must usually ask specific questions (Kalof, Dan, & Dietz, 2008; Myers, 2013).

An interview is one of the most effective data collection techniques to collect data for interpretive studies (Myers, 2013; Yin, 2016). Myers (2013) summarises three basic kinds of interviews (see **Table 6**)

Table 6: Types of interviews (Myers, 2013: p. 121)

Structured interviews	Refer to the use of preformulated questions that are strictly governed regarding the instruction of the questions and are occasionally regulated as regards the available time.
Semi-structured interviews	Refer to the use of preformulated questions, albeit not strictly followed. New questions might arise throughout the discussion.
Unstructured interviews	List a few questions in case of any preformulated questions. In reality, respondents are free to respond in any way they wish. There is mostly no time limit.

Interviews were the primary source of data collection for this study. Myers (2013) explains that structured interviews comprise the use of preformulated questions, usually posed in a logical order and sometimes time-bound, whereas unstructured interviews are referred to as in-depth, open-ended interviews. Unstructured interviews involve the repetition of statements to confirm what has been said by other respondents (Qu & Dumay, 2011). Myers (2013) further points out that new questions may arise in the middle of the discussion in an unstructured interview. Semi-structured interviews embrace the elements of both structured and unstructured interviews.

This research used semi-structured interviews as its main data collection method for collecting data from small and rural municipalities for the reasons stated above. This type of interview uses preformulated questions, although the researcher is not obliged to follow them strictly. As stated by Myers (2013), new questions may arise during an interview. In this study, the researcher tried to adhere to the general structure of the preformulated questions as a guide during interviews to prevent the researcher from deviating. A semi-structured interview with preformulated questions allowed participants the freedom to express their views however they wanted. This method enabled the study to generate rich data.

4.7.2.2 Document review

Ruxwana (2010) declares that a document review is an evaluation of different documents to compare data collected by other data collection tools. Documents could provide written evidence to support or contradict data received through interviews (Clarke & Braun, 2013; Ruxwana, 2010; Uwe, Wendy, & Katie, 2014). Myers (2013) states that, in many ways, obtaining data from documents requires less effort than data procured from fieldwork or interviews. During the interviews, participants declined to share documents with the researcher because they contained confidential information. In this study, documents such as policies, minutes, reports, letters and newsletters could have been used to crosscheck the findings. Myers (2013) indicates that documents are extremely valuable for crosschecking research findings.

4.7.3 Data analysis and synthesis

The data collected through interviews were analysed for the construction and creation of knowledge towards fulfilling the purpose of this study. Therefore, the study utilised a thematic analysis approach to analyse the transcribed interviews. Creswell and Plano (2007) define inductive research as working from the bottom up, using the respondents' opinions to generate broader themes and a theory interrelating these themes.

Braun and Clarke (2006) and Clarke and Braun (2013) state that thematic analysis is used to identify, analyse and present patterns or themes from collected data. Oates (2006) suggests that a researcher should start by reading all the collected data to acquire a broad overview and thereafter search for prominent themes and patterns in the data.

The researcher followed the approach by Braun and Clarke (2006) to analyse data using thematic analysis. The researcher transcribed all the interviews, read and reread the transcripts and listened to the audio recordings again. During the reading process, the researcher identified the codes and later captured them on *ATLAS.ti* 8.1. Once all codes had been identified and captured on *ATLAS.ti* 8.1 they were organised into themes. Thereafter, the findings were interpreted and used to improve the proposed framework developed in Chapter 3. Chapter 5 presents the findings and interpretation of the analysed data.

4.7.4 Framework revision

The findings from the analysis of collected data through interviews and document reviews informed the improvement of the proposed framework (developed in Chapter 3) into the revised framework. In DSR, the word *evaluation* is used as a generic term for evaluating and validating both the artefact and processes (Abraham, Aier, & Winter, 2014). Evaluation is the most important phase in DSR to ensure the quality, completeness and usability of the artefact (Baskerville, Kaul, & Storey, 2018; Hevner et al., 2004). The revised framework was evaluated through the participatory design method to ensure quality and completeness and validated through an expert review method to ensure quality, completeness and usability.

The participatory design method is characterised by stakeholder involvement in the artefact development process to ensure the artefact fulfils the stakeholders' requirements (Muller, 2003; Spinuzzi, 2005). Spinuzzi (2005) explains that the participants' understanding is considered in this approach. Participatory design is a repetitive process consisting of three stages (see **Figure 28**):

- Exploration stage: During this stage, the researcher meets with the intended participants to elicit their requirements for the intended artefact.
- Discovery stage: Participants have to agree on the requirements for the final developed artefact.
- Prototyping stage: The artefact is developed.

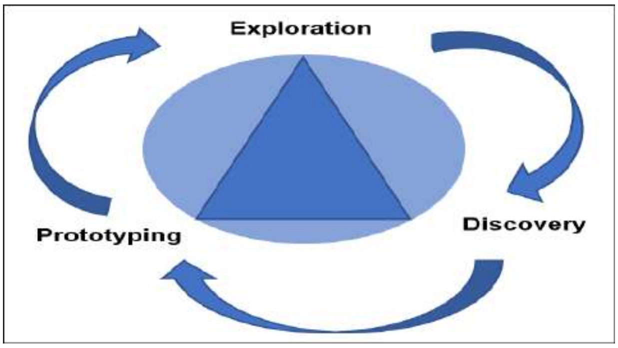


Figure 28: Participatory design process (Muller, 2003).

The term *expert review* is a broad phrase encompassing numerous approaches to inspection or validation. This approach is effective and cost-efficient for identifying usability issues (Korhonen, Paavilainen, & Saarenpää, 2009). In this study, an expert review was used by selecting experts in the smart city domain to evaluate the artefact, i.e., the revised framework. According to DuPont et al. (2009), an expert review is an inspection method to examine an artefact to detect usability issues (DuPont et al., 2009).

Table 7: Framework evaluation and validation stages

Stages	**Description**	**Outcome**
Stage 1	Data collection	Interview data
Stage 2	Data analysis and the development of a revised framework	Interview findings, revised framework and assessment tool
Stage 3	Framework evaluation: participatory design	Participatory design findings and development of an evaluated framework
Stage 4	Framework validation: expert review	Expert review and development of the final framework

4.7.4.1 Framework evaluation using participatory design

This study followed the participatory design stages mentioned above to ensure that all input by the participants was captured in the revised framework:

- During the exploration stage, the data collected from the interviews were used to elicit the basic requirements for a revised framework.
- In the discovery stage, a low-level revised integrated framework (**Version 2**) to assess small and rural municipalities' readiness for smart city implementation was developed using interview results and later communicated to the stakeholders.
- Lastly, in the prototyping stage, the researcher analysed the information received from the stakeholders to determine how the integrated framework (**Version 2**) could be improved or adapted to meet the needs of its intended users. Further, a high-level prototype of the evaluated framework (**Version 3**) was developed and again sent to the experts to validate whether it had captured aspects critical to assessing small and rural municipalities' readiness for smart city implementation.

4.7.4.2 Framework validation using expert review

During the framework evaluation stage, a final revised framework from the prototyping stage during participatory design was sent to the selected experts in the smart city domain to examine and identify any usability issues when assessing small and rural municipalities' readiness for smart city implementation. The information received from the experts was analysed to determine how the revised integrated framework could be improved or adapted even further to meet the needs of the intended users. A higher level of the final integrated framework **(Version 4)** was developed by improving the proposed revised framework. The final framework, assessment tool and implementation instructions are documented in Chapters 6 and 7 of the thesis.

4.8 Time horizon

According to Babbie (2005), the time horizon is significant in conducting research. Saunders et al. (2015) confirm that most academic projects are time constrained. Researchers are free to adopt one time horizon option of either a longitudinal or cross-sectional study (Babbie, 2005). Saunders et al. (2019) state that a longitudinal time horizon can be used to elicit data from multiple events, albeit with several interventions. Cross-sectional studies often use the survey technique. However, cross-sectional studies may also be used in qualitative research (Saunders et al., 2015). Saunders et al. (2015) declare that most case study research projects utilising interviews occur over a short period. This study employed a cross-sectional time horizon to collect data from different participants through interviews.

The cross-sectional time horizon was adopted to collect data from different participants through semi-structured interviews. It was also used to collect data from participants during multiple events.

4.9 Ethical considerations

Cooper and Schindler (2006) describe ethics as standards or norms of behaviour that guide moral choices about interpersonal relationships and personal behaviour with others. Research involving people as participants must be subjected to an ethics review committee to determine whether the research should be allowed to proceed (Olivier, 2004).

Therefore, before commencing data collection, the researcher obtained ethical clearance from the College of Science, Engineering and Technology (CSET) Ethics Review Committee. The researcher contacted municipalities to request clearance for collecting data. After obtaining clearance from the municipalities, the researcher began collecting data from the participants. The university would not have allowed this research to continue if any problematic ethical issues were involved. All participants were asked to sign a consent form before being interviewed. Zikmund (2003) states that anonymity refers to the protection of respondents' identities by not revealing their personal identifying information. All information provided by the participants was kept confidential by the researcher to protect the participants' privacy. Participants' information was stored in a digital folder with a password known only to the researcher. These records will be stored for a minimum of five years, starting on the day after the examination results of the study are released.

4.10 Trustworthiness

From an interpretivist point of view, trustworthiness refers to the trust researchers place in the study (Oates, 2006). In interpretivist research, trustworthiness can be assessed through credibility, transferability, dependability, confirmability and authenticity (Amin et al., 2020; Gunawan, 2015).

4.10.1 Credibility

Credibility strives to ensure that the results of qualitative research are authentic from the perspectives of the participants in the research (Moon, Brewer, Januchowski-Hartley, Adams, & Blackman, 2016; Shenton, 2004). In this research, credibility was ensured by employing the most suitable research method involving stakeholders in the development of an integrated framework to assess small and rural municipalities' readiness for smart city implementation, as well as experts in the smart city domain to review the framework.

4.10.2 Transferability

Transferability establishes whether research results can be generalised or applied to another situation (Moon et al., 2016; Shenton, 2004). This study considered local conditions and offered more elaboration for decision-makers to determine if the results could be applied to another situation. This was accomplished by using multiple case studies to increase the variety of the situations under study.

4.10.3 Dependability

Dependability refers to whether the research results are consistent and reliable (Moon et al., 2016; Shenton, 2004). All research processes should be documented in detail to ensure dependability, thereby enabling other researchers to trace the entire process (Oates, 2006; Shenton, 2004). This study thoroughly documented all processes and interviews to ensure dependability.

4.10.4 Confirmability

Attaining confirmability requires all necessary steps to be performed to ensure that a study's findings are supported by its participants' ideas and experiences (Shenton, 2004). This process is typically undertaken to moderate the impact of research bias. This study triangulated primary and secondary data to promote confirmability and avoid bias by the researcher. Shenton (2004) recommend that the detail of a study's methodology should be elaborated on to enable readers to determine whether the results are acceptable (Shenton, 2004). In this study, the design science research methodology was employed to support the development of a framework. Summary data and an analysis of the study will be provided for an auditor to judge if the results are sound and logically based on the data (Oates, 2006).

4.10.5 Authenticity

When addressing authenticity, the researcher must consider the impact of a context by considering sub criteria like fairness, educative authenticity, tactical authenticity, ontological authenticity and catalytic authenticity (Amin et al., 2020; Bryman & Bell, 2011). Fairness is the degree to which all underlying value structures and competing constructions of reality are deconstructed, exposed, assessed and considered in guiding the development of a framework or product (Amin et al., 2020). In this study, the researcher ensured fairness by collecting data from municipalities in different provinces and different personnel to appraise and guide the development of an integrated framework to assess small and rural municipalities' readiness for smart city implementation.

Amin et al. (2020) describes educative authenticity as the degree to which participants and a researcher improve their understanding and tolerate or appreciate the product developed by others outside their domain. This study ensured educative authenticity by allowing the participants and the researcher to appreciate a shared perspective on an integrated framework. The authors further explain that tactical authenticity is the degree to which participants are empowered to put the findings of a study into action (Amin et al., 2020). In this research, participants were provided (on request) with a final framework that would empower them to assess small and rural municipalities' readiness for smart city implementation.

Ontological authenticity is the improvement of an initial framework in providing all parties with a deeper understanding of the use of the improved framework (Amin et al., 2020). This study achieved ontological authenticity through a framework that would cause all parties to become sophisticated in the use of the framework by elaborating aspects that are influential in assessing small and rural municipalities' readiness for smart city implementation.

Lastly, catalytic authenticity is the degree to which action is taken to address issues raised by participants during the research (Amin et al., 2020). The researcher achieved this by sending the revised integrated framework to the participants for them to confirm that their inputs were implemented satisfactorily.

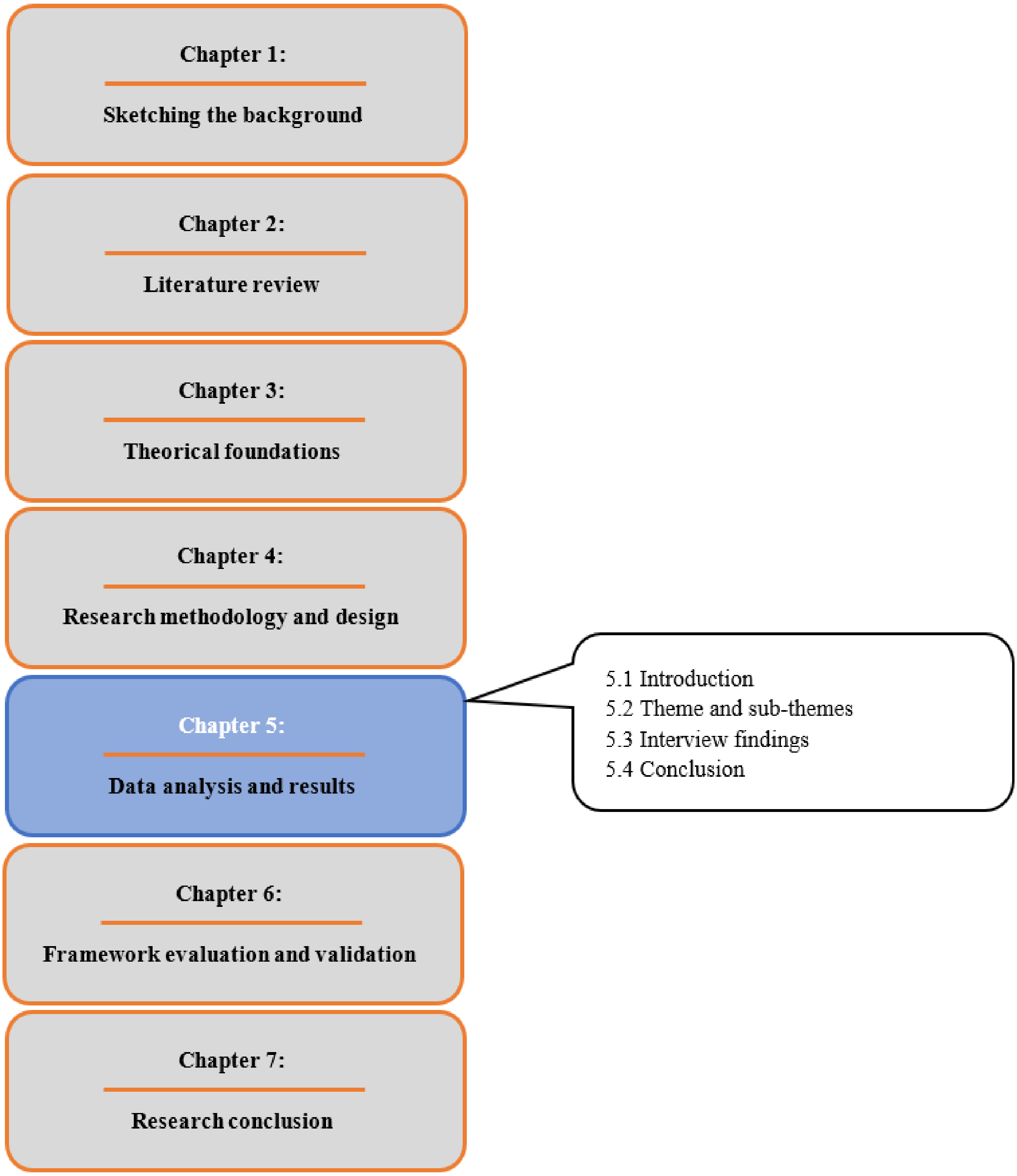
4.11 Conclusion

This chapter discussed and motivated the choice of design science research for this thesis. The researcher selected this methodology because it was suitable for the development of an integrated framework that could be used to assess South African small and rural municipalities' readiness for smart city implementation. This was achieved by using the multiple case studies research strategy to collect data from a combination of small and rural municipalities from three provinces in South Africa. The chosen methodological approaches are guided by the research onion by Saunders et al. (2019) and the research design by Crotty (1998).

Chapter 4 explored the applicable epistemological beliefs, theoretical perspective, and the suggested methodology and methods for the study. To conclude, the epistemological stance of this research is subjectivism, the theoretical perspective is interpretivism, and the methodology is design science research; the methods utilised include case studies, semi-structured interviews, document review, participatory design and expert review.

CHAPTER 5

DATA ANALYSIS AND RESULTS



5.1 Introduction

The preceding chapter addressed the research methodology, research design and data collection techniques followed in this study. This chapter presents the analysis, findings and interpretation of the interview data collected from small and rural municipalities' participants using the interview protocol in **Appendix E**. This study analysed the data using generative themes discussed individually in this chapter.

5.2 Themes and subthemes

To analyse interview transcripts, the researcher created codes on *ATLAS.ti* to identify participants' narratives that share the same meaning. The researcher commenced the data analysis by creating open codes to arrange participants' responses into groups through the identification of concepts. Open coding is the first stage in qualitative data analysis and includes the selection of data and its classification and comparison towards developing themes based on the expression and attributes of the data (Holton, 2010; Williams & Moser, 2019).

In addition, *list coding* was used to label the concepts using existing code. The researcher began by establishing a list of codes. When using *list coding*, an analyst or researcher highlights the quotation and assigns a code from a list of existing codes (Friese, 2017). For this study, the researcher highlighted a quote and linked it to a specific code to perform *list coding*.

Furthermore, the researcher grouped the related codes to create themes and subthemes; as such, three main themes pertinent to this study were created:

- Important factors for a readiness assessment for smart city implementation.
- Information system drivers for smart city development.
- The importance of assessing readiness for smart city implementation.

Subthemes were created from the main themes. Subthemes are more specific categories that fall under a larger theme (Williams & Moser, 2019). **Table 8** below presents a summary of the analysis and relationship between the main themes and subthemes. The subthemes under Theme 3 deal with the perception of the participants on what, why and how small and rural municipalities' readiness can be assessed for smart city implementation.

Table 8:Themes and subthemes relationship.

No	Themes	Subthemes
1	Important factors for a readiness assessment for smart city implementation	1.1. Human factors 1.2. Technological factors 1.3. Organisational factors 1.4. Environmental factors
2	Information system drivers for smart city development	2.1. Important information system drivers for smart city development 2.2. Available information systems drivers in small and rural municipalities for smart city development
3	Perceptions on assessing small and rural municipalities' readiness for smart city implementation	3.1. Perceptions on conducting a readiness assessment before smart city implementation 3.2. Perceptions on the importance of assessing readiness for smart city implementation 3.3. Perceptions on the conceptual framework to assess small and rural municipality readiness for smart city implementation (cf. Chapter 3)

5.3 Interview findings

Five small and rural municipalities participated in this study; fourteen participants were interviewed. All five municipalities and fourteen participants agreed to participate in this study. Each of these participants was working in one of the five municipalities. During transcription, the researcher quoted participants' words verbatim.

5.3.1 Important factors for a readiness assessment for smart city implementation

This theme comprises four subthemes: human factors, technological factors, organisational factors and environmental factors. These subthemes were used to discuss important factors that can be used to assess small and rural municipalities' readiness for smart city implementation.

- **Human factors**

The interview findings showed that human factors are important when assessing readiness for smart city implementation. Citizens and staff are regarded as people who play a significant role in smart city development. Human resource capacity is highlighted as one of the human factors. The findings confirmed that the municipalities have smart human resources. However, municipalities should still assess human readiness by establishing whether staff and citizens possess the requisite capabilities and technical skills. The findings indicate that if municipalities do not have the capabilities or skills required, they must equip their staff and citizens with the skills and knowledge needed to contribute to smart city development without experiencing skill limitations.

"You even went with the fourth one, which is your human readiness because it assesses the technical skills of both municipality staff and citizens." (Participant 5)

"When you have a project, people are involved and it's not just random people that are involved, it has to be capacitated people." (Participant 7)

"I think first you must assess human resource capacity. Determine if you have relevant or required capability or skills." (Participant 11)

The interview findings further revealed that people should be upskilled with information, communication and technology knowledge that would help them contribute to smart city development. In smart city development, technology is regarded as one of the important factors. Therefore, citizens and staff should be trained to capacitate them to use smart devices and technologies without struggling. Being literate in terms of using technologies and digital devices will enable citizens to access municipal services remotely.

“Another thing, if they are not ICT wise about using all the gadgets and other technological ICT related mechanisms that can be brought in because of that smart city concept, it cannot be maximally utilised because people won't understand the value of those particular gadgets or technologies. Yes, those will be hindrances or challenges in a journey of developing a smart city.” (Participant 1)

“That’s why we talked about upskilling people for the municipality to have smart people because if you don't have the knowledge it will not be an easy task to develop a smart city. And I believe as an institution we do have smart people but if we talk about citizens, I think they will need training in terms of using digital devices and technologies to access municipality services or to contact the municipality.” (Participant 5)

The interview findings also indicated that educating legislators who make decisions affecting smart city development is crucial. Everyone, including those in decision-making positions, should (at least) have passed matric or have formal education. The findings further postulate that if the legislators and decision-makers do not have formal education, it will be difficult for a municipality to develop a smart city.

“The other thing, is the level of education. The level of education counts a lot. As long as we are still taking people who do not have matric and say those people are going to be legislators, they make decisions for us the issue of smart cities will never work.” (Participant 1)

“Education is important, everything because without education people will not know how to participate and they won’t understand or see the value of a smart city. They won’t even see how the project is going to benefit them if they don’t have an education. Education is important, especially as a municipality we have this thing of enforcing some by-laws to the public. So, if the public or the community is not educated, if we don’t educate them, they will think that the municipality is not enabling but forcing them to comply.” (Participant 3)

The findings highlight that citizens must be supported by the municipality. They may have the requisite knowledge and be willing to participate in the development of a smart city, but without support, it would be difficult for them to reach their full potential. As discussed, upskilling citizens and staff is significant. Achieving this will entail funding, meaning the municipality should be able to support any upskilling programmes financially.

"If the people in power have the knowledge and willingness to implement a smart city but do not have the support from those above them or they do not have the funds to implement it, a smart city implementation would remain a dream or its implementation can be very slow." (Participant 6)

- **Technological factors**

The interview findings show that the technological factor is a core element in smart city development because a municipality must have digital infrastructures, such as applications or software, data, sensors, smart devices and network or internet connection. The participants' input demonstrates that social, physical, economic and technological infrastructure should be considered when implementing a smart city. The findings emphasised that a municipality should have all the necessary infrastructure because they play a critical role in data collection.

The interview findings further disclosed that to develop a smart city, a municipality must have modern technologies, infrastructure and access to the internet that would assist in the collection and analysis of data for decision-making. The findings also revealed a need for wireless internet connections to connect different digital devices, but that access to a wireless internet connection should be affordable or free of charge.

"To me, social infrastructure, physical infrastructure and economic infrastructure are important factors in the implementation of a smart city. We cannot have a smart city without having these factors in place because they are the pillars of a smart city. (Participant 4)

To develop or implement a smart city you need modern infrastructure, technology and free or cheaper wireless internet connectivity." (Participant 6)

"Remember I said a municipality should have suitable infrastructure and technology that can help the municipality to collect and analyse data. For you to collect the data we are talking about you need a network or internet connection." (Participant 10)

"Mmm, you should also look at four factors, social infrastructure, physical infrastructure, economic infrastructure and technological infrastructure." (Participant 12)

"Infrastructure development is key to me because you can have the technology, and relevant skills but if you don't have the infrastructure, it will be lousy. If you can have the infrastructure first, then after that you can have your technology, data, internet connection, skills and budget to implement a smart city." (Participant 13)

The findings further communicated that even citizens who live in rural areas or rural municipalities should have access to an internet connection. The findings indicated that this could be achieved through the provision of free Wi-Fi to citizens. Internet connectivity will enable citizens who live in rural areas to engage with their municipalities at any time.

"So, rural municipalities should have connectivity. You also want to connect the person who is in a village, must also have access to an internet connection and all of that. So, hence I am saying it's important because it connects people, whether rich or poor, they need to be connected." (Participant 2)

"I would say we have to look at network infrastructure and then in terms of the network infrastructure we have to have free Wi-Fi." (Participant 14)

In addition, digital infrastructure like sensors is required for a smart city to collect and analyse data and disseminate information. The interview findings revealed that sensors should be connected to other digital devices, infrastructures and software through a network or internet connection. However, such digital devices, sensors, software and technologies must have the processing ability to connect and collect data from other digital devices.

"In my view, as a municipality, we need applications, digital infrastructure, sensors, citizens and not forgetting traditional leaders and data. Yeah, these are the information system drivers because there is no way that you can have a smart city without applications—how will you collect data from the citizens? The very same application should run on the infrastructure such as servers." (Participant 4)

"I am saying you should have sensors, different devices, infrastructure, software and others interconnected through an internet connection to share, store and analyse data to assist in decision-making." (Participant 6)

"You need sensors because you can't run a smart city without (IoT) Internet of Things. So, sensors are crucial." (Participant 13)

- **Organisational factors**

The participants identified organisational factors as some of the important components of smart city development. When assessing readiness, the municipality itself must be regarded as an organisation. Further to the discussion on human factors, citizens and staff, the interview findings highlight that a municipality, as an organisation, should consider human resources and budget when assessing organisational readiness. The staff must ideally be eager to participate in the municipality promoting the development of a smart city.

In addition, the findings showed that a municipality on a journey to developing a smart city needs to have a sufficient budget to fund its smart city project. The interview findings also revealed that a municipality needs investors to raise money to fund its projects. Accordingly, municipal leaders should build partnerships with potential funders.

"Availability of willing human resources and the budget to implement a smart city. If the officials running the municipality and the decision-makers are slow to adopt new technologies or not open to new ideas that could hamper and affect service delivery. Or there is no budget

or plans within the budget to fund such initiatives, the chance of failing to implement a smart city is high." (Participant 6)

"A municipality should be a driving force from the mayor to different sections. You need money, you need funders and top management are in a good space to forge partnerships with private institutions." (Participant 8)

"If you talk about organisational readiness, it can even go as further as saying, you have skilled staff, technology, and the money to fund the project, you know." (Participant 9)

A municipality without funders or investors relies more on revenue and grants. However, the interview findings indicated that a municipality should collect revenue of at least 50 per cent for them to engage in a smart city project. The findings further showed that revenue collection is essential because it would provide the resources to fund the project.

"As a municipality, you should maximise the available revenue sources, not relying on grants and equitable share. Once the revenue collected by that municipality is above 50% of this budget, then you can start to initiate projects like a smart city project. A budget, and revenue collection is key for small municipality like us." (Participant 1)

Furthermore, the findings highlighted that in municipalities, politics play a huge role in the project's success since politics inherently create barriers and also because of the way municipalities are governed. In addition, a change of political leadership creates instability in the municipality and its projects because a new leader is accompanied by a new vision, objectives and strategies. The findings suggested that there had to be buy-in from political leaders to ensure the project's success, i.e., they must be interested in the transformation of the municipality into a smart city.

"There will be huge effects. But the issue of political will will play a major role. Because that's where in most cases, because South Africa is a wall-to-wall, has wall-to-wall municipalities[1]*. So, whether you like it or not the political will, will actually make it possible."* (Participant 1)

"The political element is also a key factor, you see these changes of politics, the politics, actually I can say is one of the factors that sometimes municipalities are not stable or sustainable because you have this mayor today you discuss or present his vision and all organisational structure support it, tomorrow while you are starting to get your grip, comes another mayor. This creates lots of holes because a new mayor will come with his vision. Instead of continuing with the predecessor's vision they will tell you that this is not important and focus on something else like giving the community grocery parcels. So, politics is the key and if you don't have buy-in from politicians, chances are the project won't see the light of day." (Participant 3)

Politicians form part of a high decision-making structure; when they are in the decision-making structure, they automatically have the power to vote for a project and budget to be approved. In municipalities, politicians are lawmakers, which is why it is paramount for them to be involved in the process of developing a smart city.

"There must be a political will because if politicians are not in support of the smart city concept, it will be difficult because they are the legislators who actually approve the projects and budgets." (Participant 1)

"If I can highlight the role players from the municipality side, the mayor, municipality manager and council they must play a leadership role in the quest for smart city implementation. Their active participation is very much important." (Participant 4)

[1] A wall-to-wall municipality refers to the demarcation of the municipality. In this statement, the participant is saying small and rural municipalities have boundaries within which they operate. They cannot operate beyond their boundaries unless there is a partnership of some sort with other municipalities.

"You need support from all political parties. You will also need private companies, IT companies to be part of these projects." (Participant 8)

"Okay, a council is formed by the mayor, the speaker, municipal manager and all the councillors. A council is the vision bearer to ensure that the municipality provides quality of life to the citizens." (Participant 14)

- **Environmental factors**

Environmental factors are the surroundings of the municipality, including the population, economy, energy generation, access to land and governance. A municipality must have access to land when developing a smart city. The findings revealed that most of the land in small and rural municipalities belongs to traditional leaders. Hence, the interview findings indicated that a municipality should involve traditional leaders in the smart city development process.

"As a municipality, we are very small and we are situated in the 'homelands' and we don't have that capacity." (Participant 1)

"Traditional leaders are some of the stakeholders. For example, in our municipality, most of the land belongs to the traditional leaders. So, in everything we want to do, we have to engage them." (Participant 4)

"In our municipality, most of the land is owned by traditional leaders, yes I would say traditional leaders are critical." (Participant 12)

In addition, the interview findings postulated that a municipality should consider population size when assessing environmental readiness because this would determine what resources are required to render services to the citizens. Furthermore, a municipality should have sustainable energy generation, serving the entire population with affordable electricity to enable the implementation of a smart city. The participants' input underlined that without electricity in small and rural municipalities, citizens couldn't connect to a network, meaning digital devices couldn't communicate. In addition, digital devices like sensors must always be active for them to collect data to be analysed for decision-making. The findings determined that without sustainable electricity, it would be difficult to implement a smart city.

"Once the electricity is gone you can't hotspot with your cellphone and everything cuts off. So those are the challenges that I think they make things impossible." (Participant 1)

"When looking at the load shedding and load reduction that we are experiencing lately we really need smart energy that will enable technology, sensors and infrastructure to operate 24 hours without failure. If there is no electricity some areas don't have network connectivity and citizens cannot access some of the applications. That is why I say we need smart infrastructure, smart technology and smart energy to implement a smart city. But at the moment we don't have any of these services." (Participant 3)

"Parastatals like ESKOM and NERSA should ensure that you have affordable and sustainable electricity. With the current load shedding, a smart city can be just a talk and talk." (Participant 8)

"Let's say two million people reside in the municipality, this means the infrastructure and resources required should correspond with the number of citizens." (Participant 12)

In addition, a municipality must have a sustainable economy because if the economy collapses, it will affect citizens and companies. Some citizens will lose their jobs, and some companies will collapse. This will, in turn, affect the revenue stream of the municipality. The findings show that employment contributes to the municipality's economy because it enables the collection of rates and taxes.

"You need a city where the economy doesn't die. You know, because once the economy dies, you know, the creation of jobs dies as well. There won't be people that are employed in that particular town. You know, but if the economy thrives, you know, it's sort of, you know, generate income to the municipality, because people will be paying rates and taxes." (Participant 5)

The interview findings indicate that municipalities must have policies that regulate both the municipality and the citizens. Municipalities should ensure that all existing policies are followed because if they are not, the municipality will receive a qualified audit. The existence of policies will promote good governance in the municipality, which would help it receive a 'clean' audit. The policies should support the development of the smart city.

"The regularity in terms of good governance because if there is no good governance, you cannot expect anything. If municipalities are getting declaimers qualified notice. It means then the processes are not followed to the latter and this result to poor governance. A smart city concept will require an institution that have policies in place. Not just that, they have to adhere to those policies to ensure that there is governance in the municipality." (Participant 1)

"We also need to look at your governance or the management and policies. How is our administration and in terms of our policies, are they flexible, our policies do they accommodate change, or do they accommodate this concept of smart city?" (Participant 13)

5.3.2 Information system drivers for smart city development

This theme comprises two subthemes, the first is related to the important IS drivers for smart city development, and the second is related to available information systems drivers in small and rural municipalities for smart city development.

- **Important information system drivers for smart city development**

The participants identified seven components they deemed important information systems drivers for smart city development, including network or internet connectivity, modern technologies, modern infrastructure, digital data, software, people and the automation of processes. The participants strongly believe that for the municipality to be effective, it should have network connectivity between different types of hardware and software.

In addition, the findings disclosed that the people within a municipality would be using different smart solutions or modern software to request services from the smart city. They would perform all this using smart devices, not having to turn up at any municipality office.

Hence, smart devices have to be connected to the network to link people or citizens with the municipality.

“I think, yeah, the most important is network connectivity; without network connectivity you do not have an environment in which you can develop a smart city. There is no use in having all these smart gadgets and stuff when you won’t be able to use them because of connectivity issues. I think it is one of the drivers in a smart city.” (Participant 1)

“We need to make sure people are important because they are the ones that will be using smart solutions and they will benefit from living in a smart city concept because most of the things they need will be at their fingertips. But hardware is where we store information, where we get information, and is where we actually get to take out that information and give it to those people who use it to make the decision. So, if hardware and software are broken, so we cannot work or assist people and to us it is like a dead day. We need to make sure that what things that are needed to help us to implement the smart city is 100% excellent.” (Participant 3)

“I think we need modern hardware, software and data or information. Or yeah, even internet connectivity is important because the software must communicate through some sort of network.” (Participants 10)

The findings revealed that an integrated platform would assist municipalities with storing citizens’ and smart cities’ data for decision-making. As indicated earlier, an integrated smart city would require a network connection to enable communication between hardware and software. In this study, the interview data confirmed network or internet connectivity as one of the key information system drivers in a smart city.

“An integrated platform where citizen and smart city information is stored, processed and analysed to help in decision-making. In other words here, I am saying you should have sensors, different devices, infrastructure, software and others interconnected through an internet connection to share, store and analyse data to assist in decision-making.” (Participant 6)

"I think the Internet of Things, internet connectivity and cloud computing are critical for smart city development. Because when you have the Internet of Things, you will be able to collect big data and to store this data, you need cloud storage. Later on, you can have processes and technologies to analyse the big data for decision-making." (Participant 11)

- **Available information systems drivers in small and rural municipalities for smart city development**

The interview findings revealed that some of the municipalities participating in this study had basic infrastructure, like hardware, software and network connection. The interviewees indicated they had the hardware infrastructure to capture information, approve applications, send emails and write reports. However, the findings pointed out that the existing infrastructure was old. The participants also indicated that the existing infrastructure was incompatible with modern technologies and that it would be difficult to implement a smart city using existing information system components. There was consensus among the participants that the existing information system components needed to be revitalised.

"I think we have the technology, infrastructure, data, even GIS systems. But most of these information system drivers are not 100%. For example, our computers and printers are very old." (Participant 4)

"Yes, as an institution we have infrastructure and technology but they are old." (Participant 6)

"Ah, our infrastructure is old, there is no way that we can implement a smart city using it. Technology, we don't have a budget to buy licenses for modern technology. So, infrastructure-wise and technology-wise we are not yet there." (Participant 8)

"Mmm, we have old infrastructure and software. I don't think with what we have you can develop or implement smart city." (Participant 10)

"For now, I can say we don't have any of this, if you can look at this municipality as a whole, the infrastructure here is old and is no longer compatible with the latest technology. We must

upgrade our infrastructure. In fact, every information system components need an upgrade." (Participant 12)

"We only have basic infrastructure as a municipality. Your hardware, software and internet connection. We use our computers to capture and approve applicant applications. To send and receive emails, write reports and nothing much." (Participant 13)

The interview findings revealed that most small and rural municipalities have existing network infrastructure, yet it has not reached the maturity stage. The findings confirmed that the existing internet connectivity was unstable and did not cover everyone in the city. However, the interview findings showed that there was an existing project to address these issues. Most municipalities are buying and installing fibre optic cables to connect the public.

"In terms of wireless internet connectivity, we are not yet there, even though there is something happening around this. As a municipality, we are busy with the rollout of fibre that is meant to be publicly available to the citizens." (Participant 6)

"I can say we have internet connectivity but it doesn't cover everyone and is not stable." (Participant 11)

5.3.3 Perceptions on assessing small and rural municipalities' readiness for smart city implementation

The interview responses revealed the participants' perceptions on assessing small and rural municipality readiness for smart city implementation. The findings on these perceptions are presented through the subthemes. The research used the following subthemes that emerged from interview data: 1. Reasons for assessing readiness for smart city implementation; 2. Starting point for assessing readiness for smart city implementation; 3. Fitness of the proposed conceptual framework for assessing small and rural municipality readiness for smart city implementation; and 4. Suggestions for the final framework for assessing small and rural municipality readiness for smart city implementation.

- **Perceptions on conducting a readiness assessment before smart city implementation**

The findings of this study revealed consensus on conducting assessment readiness before embarking on a smart city initiative. The participants agreed that when engaging in a smart city project, one should start by conducting readiness assessments. The findings affirmed that readiness assessments would assist in determining the existence of the required resources for smart city implementation. Furthermore, a readiness assessment was regarded as a proactive way to manage project costs and time. The extracts from the interviews established that failing to assess readiness might affect a smart city project negatively, making it prone to failure.

"Yes, obviously you cannot start without examining your ground if it is fit, you need to first plan and assess if you have all required resources." (Participant 1)

"So, conducting the assessment helps you to see where you are lacking, to see where you are as a municipality in terms of technology and infrastructure." (Participant 3)

"It helps in determining whether whatever project you are introducing will be sustainable. Because if you don't do the assessment before the implementation, whatever you're trying to implement is likely to fail." (Participant 7)

"This is like when you want to build a house, first you have to assess the soil, if it is suitable for the house that you want to build in order to avoid future problems. Without a thorough assessment, you might spend a lot of money in the long run because of cracks and other issues. I think this is important because it minimises the cost and time." (Participant 13)

- **Perceptions on the importance of assessing readiness for smart city implementation**

The findings on the perception of the importance of assessing small and rural municipalities' readiness for smart city implementation affirmed that assessment is important because it enables a municipality to identify areas that are lacking and need improvement. The municipality can revitalise all deficient areas to mitigate any problem that might emerge during the smart city development.

"So, doing the assessment helps you to see where you are lacking, to see where you are as a municipality in terms of technology and infrastructure." (Participant 3)

"Yes, assessment is important in order to avoid any issues that can arise in the future, you know." (Participant 5)

The participant interviews revealed that assessing readiness is an essential activity for examining the preparedness of municipalities to ensure that the foundation for smart city implementation is solid. The findings confirmed that before commencing with a smart city project, a readiness assessment is imperative because it would assist municipalities in ensuring that the budget to fund the project is sufficient.

"Assessing readiness will be an ideal move to examine your preparedness and this will help us as a municipality to lay the foundation for smart city implementation. I think yes, since we are in the planning phase of the smart city initiative we will examine our state in order to figure out what we must improve." (Participant 8)

"Yes, that should be a starting point for any project because in terms of readiness, as I indicated earlier, it will help you to determine if you have enough budget to execute the project. You check if you have any partnerships with the investors. So that is part of assessing readiness." (Participant 14)

- **Perceptions on the conceptual framework to assess small and rural municipality readiness for smart city implementation**

In this study, the candidate developed a conceptual framework, as seen in Chapter 3, the literature review. The framework was presented to the participants during the interviews. After the presentation, the participants were asked questions to obtain their perceptions regarding the proposed conceptual framework. The findings revealed consensus between the participants regarding the relevance of the proposed framework.

The findings from the interviews showed that the proposed framework had covered most aspects, from a South African perspective, that are significant in assessing small and rural municipalities' readiness for smart city implementation. In addition, the findings indicated that all aspects of the proposed framework are essential when developing or implementing a smart city. The findings asserted that each household should have at least one literate person.

In addition, the participants indicated that municipalities depend on government subsidies or grants. The findings also pointed out that the proposed framework would assist municipalities in attracting investors for their smart city initiatives. Furthermore, the participants indicated that this proposed framework would assist municipalities to realise their aspirations of implementing a smart city.

"I think it covers everything because it assesses the human element by looking at skills, knowledge and education. These things are important because in a smart city you need at least one person in a household who is able to read and write. I am happy because again it looks at the technology, infrastructure, information quality and things like policies and governance. This framework is long overdue. It will help the local municipality to head in the right direction." (Participant 3)

"Yes, the proposed framework is detailed and likely not to miss many aspects that are trivial to assessing small and rural municipalities' readiness to implement a smart city within the South African environment." (Participant 6)

"Okay, yes it does Mr Mashau, remember this framework will assist in terms of attracting investments because without investment it will be difficult for our municipality to implement a smart city. As a municipality, we do not make a lot of profit, we are dependent on the subsidy that we get from the government." (Participant 10)

"Because I think it covers the main key areas which should be involved in constructing and implementing the whole." (Participant 14)

The participants agreed that technological, organisational, environmental and human aspects are essential when assessing readiness for smart city implementation. The findings from the interviews further showed that it is difficult to separate these aspects when developing or implementing a smart city. They further indicated that human readiness is incorporated into the framework because it helps to establish the technical expertise of the municipality's citizens and staff.

"Yes, it does more, especially because you are talking about technology, organisation and evironment (TOE). To me, it does address and you even went with the fourth one, which is your human readiness because it assesses technical skills from both municipality staff and citizens. And it also assesses other elements, I think it does." (Participant 5)

"Yes, it covers the four most important aspects for smart city implementation, which are the readiness of human resources, technologies currently in use, the environment and organisation. These intertwined aspects are difficult to separate from each other as they complement each other very well." (Participant 6)

In further examining the perception of the proposed conceptual framework to assess small and rural municipality readiness for smart city implementation, there was consensus among the participants on the need for a framework in the form of a checklist with which the assessor could determine whether the municipality possesses the crucial aspects for smart city development. Such a checklist should contain all the aspects of the proposed framework as its measure.

"Yes, maybe you can have statements where whoever is assessing readiness they can tick. That is my suggestion." (Participant 4)

"Okay, all the factors that I identified earlier can be used as indicators in the form of a checklist to guide using Yes or No as assessment criteria. In this instance, you check if you have skilled staff, if you have, you tick Yes, if you don't have, you tick No, that will show that you don't have." (Participant 5)

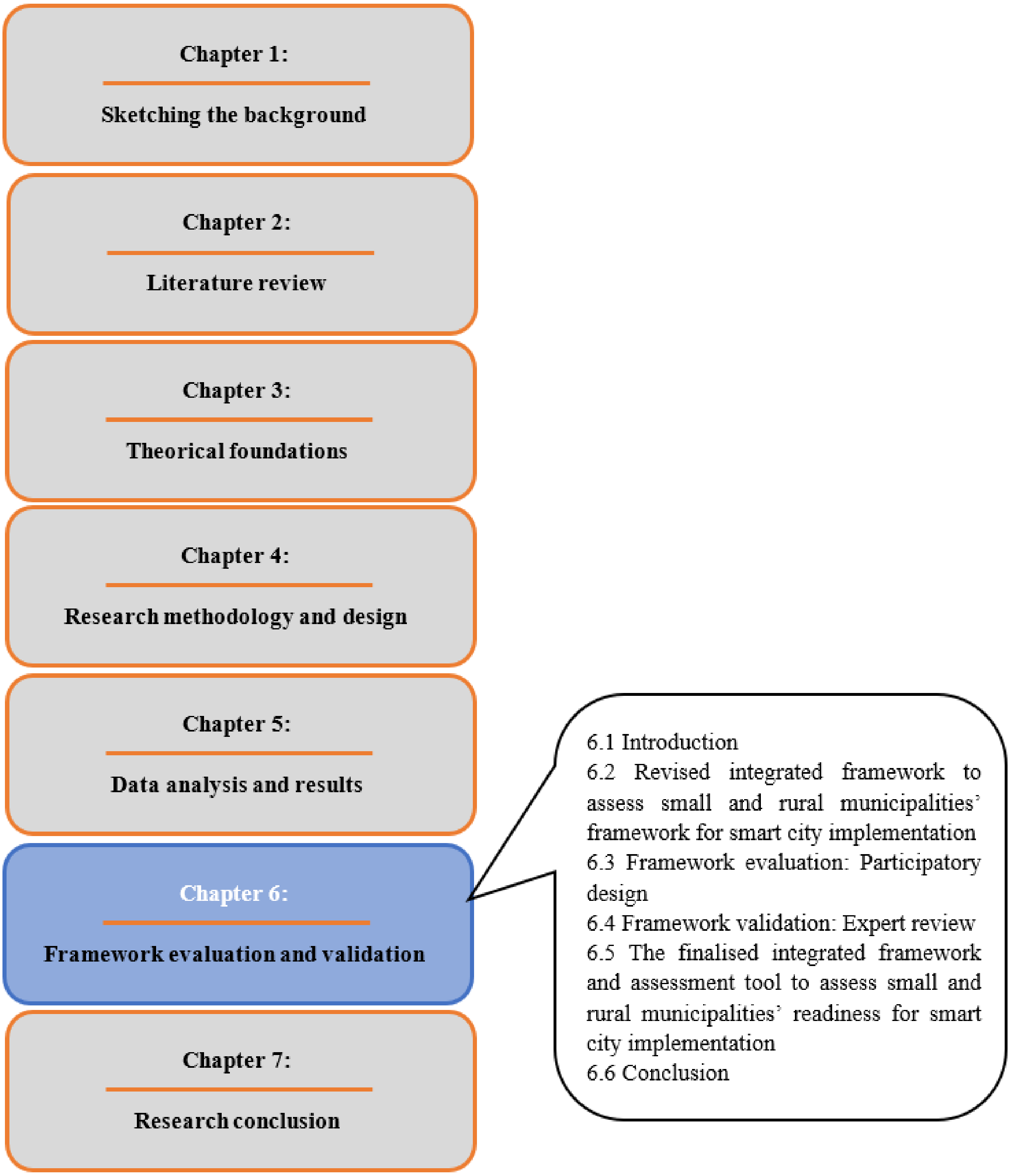
"Yes this framework is good, but I think you should have all these aspects in a table format where you will have tick boxes that the assessors will use to highlight the things they have as a municipality. For that, you can use Yes or No options. The assessor if the statement says do you have modern technologies if they have then, the assessor will tick Yes." (Participant 9)

5.4 Conclusion

This chapter presented the findings obtained from the interview data. This research analysed the data using themes. **Table 8** provides the thematic framework, which includes three themes relevant to this study and their subthemes. Those themes were used to discuss important factors critical to implementing a smart city. Additionally, the researcher utilised a second theme to discuss important information system components critical to smart city development. Lastly, the researcher used the third theme to discuss participants' perceptions regarding the assessment of small and rural municipality readiness for smart city implementation.

CHAPTER 6

FRAMEWORK EVALUATION AND VALIDATION



6.1 Introduction

The preceding chapter discussed the findings from the interview data through themes. This chapter discusses the evaluation and validation of the revised integrated framework to assess small and rural municipalities' readiness for smart city implementation in Chapter 3 (see **Figure 16**). This study utilised participatory design to evaluate the framework; thereafter, the study employed expert review to validate the framework towards producing the final integrated framework to assess small and rural municipalities' readiness for smart city implementation.

According to Peffers et al. (2018), the evaluation of an artefact or framework is important in design science research. Artefact evaluation comprises reviewing and inspecting the proposed solution to scrutinise if it addresses the research problem (Peffers et al., 2018). This study adopted a participatory design to evaluate the revised integrated framework using interview data to ensure that the participants' input had been addressed appropriately towards providing solutions to the research problem.

An expert review was used to validate the framework to identify and address usability issues. Chapter 3 provides a detailed justification for using participatory design and expert review.

Chapter 6 discusses participatory design and expert review and their data collection processes. In this chapter, the researcher also presents the findings, revised integrated frameworks and a final integrated framework to assess small and rural municipalities' readiness for smart city implementation, after which the chapter concludes.

6.2 Revised integrated framework to assess small and rural municipalities' readiness for smart city implementation

Before revising the integrated framework, the researcher undertook a further literature review using a systematic literature review approach. The literature was analysed using *ATLAS.ti* to identify key factors that can be used in assessing small and rural municipalities. Eighteen key factors were identified, including *smart city*, as depicted in the figure below (See **Figure 29**). This model was peer-reviewed and published in the *Smart Cities* journal (cf. https://www.mdpi.com/2624-6511/5/4/87).

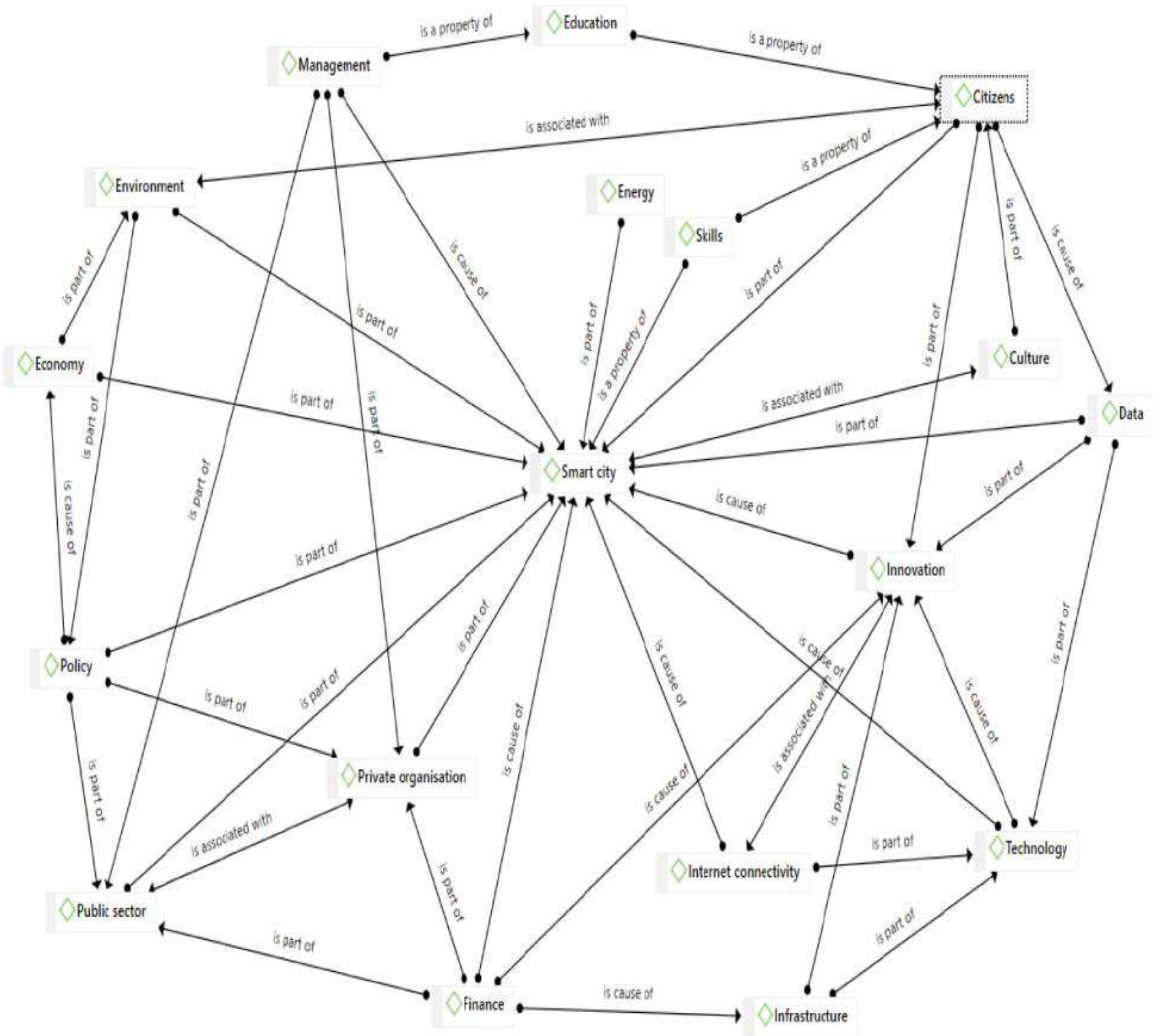


Figure 29: Smart city key factors model (Mashau et al., 2022: p. 1747).

The interview data were analysed to revise the proposed integrated framework (see **Figure 16**) developed in Chapter 3. The researcher factored in the interview findings while revising the proposed integrated framework. The revised framework (see **Figure 30**) contains 28 components compared to the 27 components that comprised the proposed conceptual framework (see **Figure 16**). During the interviews, most participants agreed that the proposed framework captured most of the essential components, such as the human, technological, organisational and environmental readiness factors. Therefore, all the factors identified as key components in **Figure 29** formed part of the revised integrated framework. Furthermore, all core components from the proposed framework in **Figure 16** remained in the revised integrated framework, while some of the secondary components that had been part of the proposed conceptual framework were removed, and new secondary components were added.

The revised integrated framework in **Figure 30** confirms that for a municipality to assess human readiness, it should ensure that its citizens have the relevant educational qualifications, skills and experience and act innovatively to assist in developing or implementing a smart city. Moreover, the interview data determined that from an organisational point of view, employees should also have the relevant educational qualifications, skills and experience. In addition, a municipality must have support for their smart city projects from management and politicians. The revised integrated framework indicates that a municipality should generate enough revenue to make provisions in the budget for funding its smart city project and acquire the required resources to ensure organisational readiness. The municipality should also forge partnerships with both the public and private sectors.

The interview data indicate that to assess technology readiness, the municipality should ensure the availability of affordable modern infrastructure and technologies, and such infrastructure must support internet connectivity. Furthermore, any modern technology must be compatible with the existing infrastructure. In addition, the available technology and infrastructure must be suitable for data collection and real-time analysis.

When assessing the readiness of South African small and rural municipalities, the interview data confirmed that a region must have reliable internet connectivity for citizens to connect with the municipality; and the municipality must have reliable or sustainable energy provision. Furthermore, municipal policies should support smart city development, with all citizens and staff adhering to such policies. Small and rural municipalities should elicit buy-in from traditional leaders. Lastly, the municipality must have a strong economy.

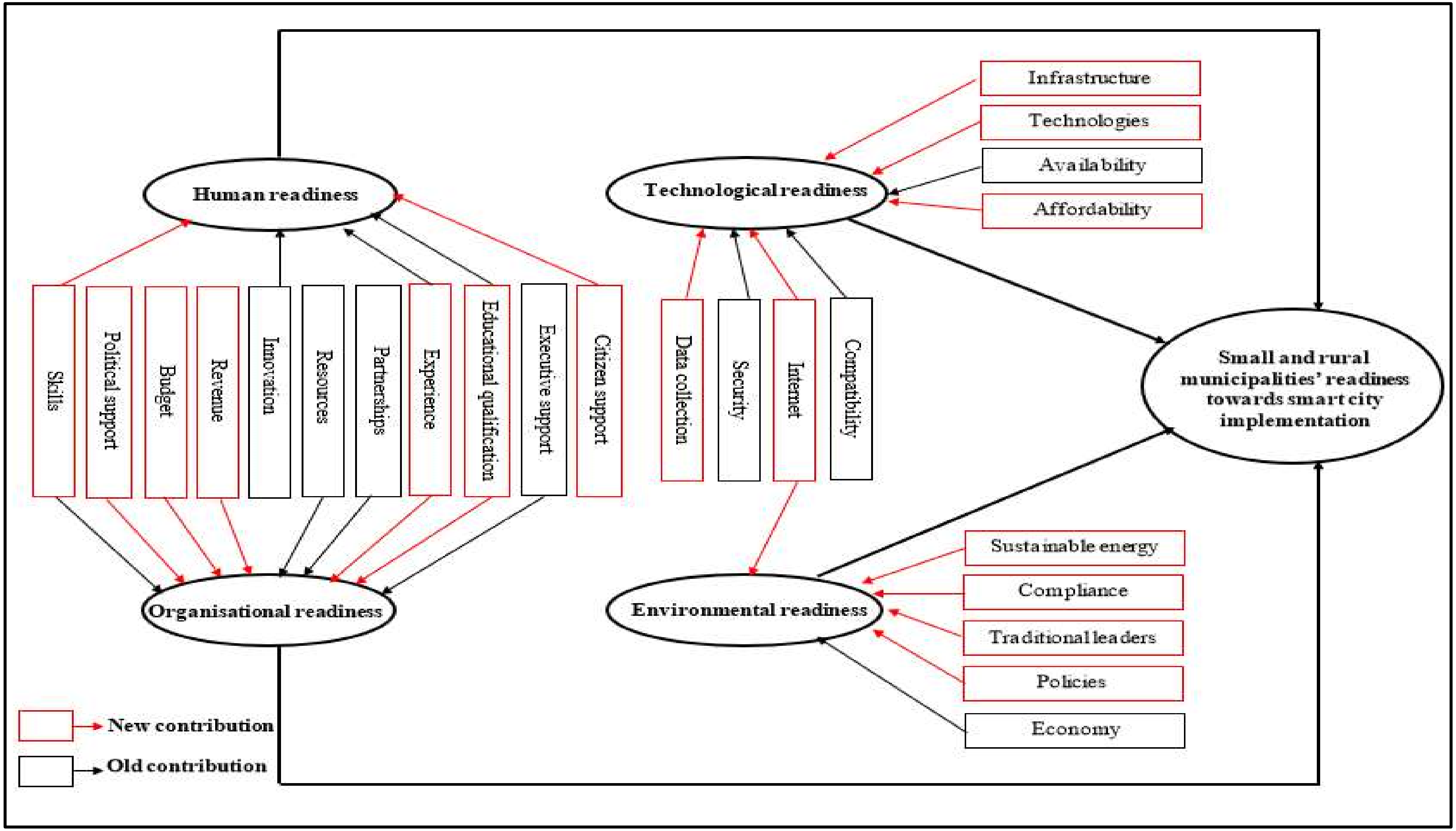


Figure 30: A revised integrated framework to assess small and rural municipalities' readiness for smart city implementation.

During the presentation of the proposed conceptual framework in **Figure 16** to the International Conference of Innovative Technologies and Learning (ICITL), the attendees indicated that there is indeed a need for assessment guidelines or tools because it is difficult to assess readiness levels using a framework alone. Furthermore, during the interviews during this research, the participants suggested that an assessment tool should be added to assist municipalities in gauging their readiness levels. Thus, a tool to assess small and rural municipalities' readiness for smart city implementation was developed, as shown below in **Table 9,** using 28 components from the revised integrated framework (see **Figure 30**).

AN ASSESSMENT TOOL TO ASSESS SMALL AND RURAL MUNICIPALITIES' READINESS FOR SMART CITY IMPLEMENTATION

For each question, select "Yes" or "No" in the third column. In the fourth column, enter the number that best represents your municipality's readiness. The scores are interpreted as follows: **0 = 0% Ready, 1 = 10% Ready, 2 = 20% Ready, 3 = 30% Ready, 4 = 40% Ready, 5 = 50% Ready, 6 = 60% Ready, 7 = 70% Ready, 8 = 80% Ready, 9 = 90% Ready, 10 = 100% Ready.**

Table 9: *An assessment tool to assess small and rural municipalities' readiness for smart city implementation.*

Number	Human readiness	Yes / No	Enter a score between 0 and 10	Comment
1	Some citizens in this municipality hold relevant educational qualifications for smart city implementation.			
2	Some citizens in this municipality have the relevant experience to develop a smart city.			
3	Some innovative citizens in this municipality can contribute to the development of smart city implementation.			
4	The citizens within this municipality possess the requisite skills to implement a smart city.			
5	The citizens residing in this municipality support smart city development.			
6	Enough people in this municipality possess the relevant technical skills to contribute to the implementation of a smart city.			
	Human readiness total score			

	Technological readiness		Enter a score between 0 and 10	Comment
7	The relevant social, physical and economic infrastructures exist within this municipality.			
8	The requisite modern technologies for smart city implementation are available within this municipality.			
9	The requisite modern infrastructure for smart city implementation is available within this municipality.			
10	The available modern technologies for smart city implementation are compatible with the municipality's existing infrastructure.			
11	Vendors of modern technologies and infrastructure are available and accessible within this municipality.			
12	Modern technologies and infrastructure are affordable.			
13	The available technology and infrastructure are suitable for collecting and analysing data in real time.			
14	The analysed data will provide the municipality with information for decision-making in real time.			
15	The existing infrastructure supports internet connectivity.			
16	The available technology and infrastructure are secured.			
	Technological readiness total score			

	Organisational readiness		Enter a score between 0 and 10	Comment
17	Municipal management supports the municipality in implementing a smart city project.			
18	Politicians support a smart city project in the municipality.			
19	The municipality has existing partnerships with the public and private sectors.			
20	Some employees hold relevant educational qualifications for smart city implementation.			
21	Some employees have the relevant experience to develop a smart city.			
22	Some employees possess the relevant technical skills to implement a smart city.			
23	The municipality has the requisite resources to implement a smart city.			
24	This municipality generates 50% of its revenue.			
25	A budget to fund smart city initiatives exists.			
	Organisational readiness total score			
	Environmental readiness		**Enter a score between 0 and 10**	**Comment**
26	There is a reliable internet connection within the municipality.			

27	The municipality has reliable and sustainable energy.			
28	Policies support smart city development in the municipality.			
29	The municipality’s personnel and citizens comply with policies to promote good governance.			
30	The entity has buy-in from traditional leaders.			
31	The municipality has a strong economy to ensure smart city development.			
	Environmental readiness total score			
Overall score for municipality readiness: **(To calculate the overall score, calculate the overall total of all the scores or total scores above.)**				

6.3 Framework evaluation: Participatory design

6.3.1 Sampling

As discussed in Chapter 4, participatory design is a method to ensure that participants' input or experiences are addressed satisfactorily (Muller, 2003; Spinuzzi, 2005). Participatory design involves sharing research findings with participants to review whether the findings have captured their experiences. Krefting (1991) states that ensuring that the participants' experiences are recognised in the findings proves that the study is credible and the participants' views were interpreted accurately. As discussed in Chapter 4, all participants for the participatory design iteration were selected from a pool of interviewees who had participated in the semi-structured interviews. A 'gatekeeper' from each municipality was asked to nominate one participant who had participated during the interview data collection process to evaluate the revised integrated framework to assess small and rural municipalities' readiness for smart city implementation.

For this iteration, the study collected data through an online survey using *Google Forms*. A *Google Forms* link was sent to all nominated participants via email. Participants' feedback was later extracted from *Google Forms* and entered into a Microsoft *Excel* spreadsheet and a portable document format (PDF) document for data analysis purposes. *ATLAS.ti* was used to analyse the data collected from the municipalities' representatives. The participatory design findings are presented below in **Subsection 6.3.2.**

6.3.2 Participatory design findings

In this subsection, data collected via *Google Forms* were analysed using thematic analysis. Four themes were identified: the relevancy of the revised framework, missing components on the revised framework, the effect of the revised framework and the suitability of the revised framework. All these themes were used to evaluate the revised framework to determine if the interviewees' inputs and experiences had been captured accurately in the framework.

- **Relevancy of the revised framework**

All the participants concurred on the revised integrated framework's relevancy regarding the assessment of small and rural municipalities' readiness for smart city implementation. Furthermore, the revised integrated framework evaluation findings emphasised that the revised framework was relevant because it had been designed to focus specifically on small and rural municipalities' perspectives and experiences. This finding makes the framework unique and focused on addressing small and rural municipalities' challenges when implementing smart cities. The findings further pointed out that the revised integrated framework has come at the right time, during which municipalities are in the early stages of implementing a smart city. The findings also affirmed that municipalities would be able to identify areas needing attention for smart city implementation.

"Our municipality is currently in the early stages of the smart city project, so this framework is timely. As a municipality, at least, we are able to determine where we are lacking. I like that we can use an assessment tool to rate ourselves in a variety of areas. Sincerely, something like this that specifically examines our municipalities is long overdue for a municipality of our nature." (Participant A)

"Very relevant." (Participant C)

"This framework is relevant because it was designed using information that affects local government. The issue of infrastructure, energy or electricity, internet connectivity, education qualification, skills, etc. If we can be ready in these aspects, I hope we can be able to implement smart city." (Participant D)

- **Missing components on the revised framework**

During the framework evaluation process, the researcher posed a question to the participants to identify any missing components or areas in the proposed revised integrated framework. The findings indicated that the participants were satisfied because their interview input had been properly reflected in the revised integrated framework.

The findings confirmed that the revised integrated framework was comprehensive because all components that were missing from the initial proposed framework were added to the revised framework. The findings noted that politicians, revenue generation, traditional leaders and the availability of internet connection were omitted from the initial framework. However, the participants indicated that it was difficult to point out any missing components. The findings verified that the participants had applied the revised integrated framework in conjunction with the assessment tool practically (see **Table 9**) and were able to measure their readiness levels.

"As far as I could tell, this covered everything we talked about in the interview. I like that this framework now has internet connectivity and traditional leaders. I appreciate that." (Participant A)

"This framework is comprehensive enough to identify areas that require further development. I'm glad you covered the important points we discussed in our conversation." (Participant B)

"Politicians run small and rural municipalities, if you have a look at the initial framework you presented, you didn't have this. The revenue generation and budget components were not factored into the initial framework. For a municipality to develop a smart city, they should be making enough profit otherwise, you won't be able to have a budget to finance your project. It is not a secret that we depend on grants and donations. Depending on this two, there is no way that we can develop a smart city. Assessing the availability of internet connectivity is a plus for me. How can you have a smart city that does not connect its citizens? I appreciate your effort; this is great." (Participant D)

"Honestly, there is nothing I can point out at the moment. I also used the assessment tool with my colleagues, I think we have an idea of where we are as a municipality." (Participant E)

- **Effect of the revised framework**

During the analysis of participatory design data, the study examined the effect of the revised integrated framework. The framework evaluation findings affirmed that the revised integrated framework would significantly affect small and rural municipalities in their journey towards implementing a smart city. The findings confirmed that the municipalities would conduct comprehensive readiness assessments for smart city implementation.

"This framework will be a game changer, particularly in small and rural municipalities because it provides guidelines on what to do before implementing a smart city. The assessment tool is my favorite because it lets you rate the level of readiness for each aspect and indicate whether the municipality is ready on each of them." (Participant B)

"I think as municipalities, we will be able to conduct 360-degree assessments. This will help us to be prepared before we start with the smart city project." (Participant C)

"But overall, this framework will make a huge difference in small and rural municipalities." (Participant D)

"It will have a great effect, more especially on the municipalities that want to implement smart city." (Participant E)

- **Suitability of the revised framework**

During framework evaluation, participants were asked to comment on the suitability of the revised integrated framework to assess small and rural municipalities' readiness for smart city implementation. The findings confirmed that the participants fully agreed that this framework is suitable for assessing small and rural municipalities' readiness for smart city implementation.

"Yes, 100 per cent. My colleagues and I are happy about the development of this framework and the assessment tool. This will alleviate the stress regarding smart city projects because there are no guidelines specific to our municipalities." (Participant A)

"Yes." (Participant D)

"Yes, I agree." (Participant E)

6.3.3 Results of the evaluation process

Overall, participants were satisfied that their experiences and input had indeed been considered when the study revised the proposed integrated framework to assess small and rural municipalities' readiness for smart city implementation. During this iteration, no additional items, components, perspectives, relationships and objectives were identified as missing from the revised integrated framework. Nevertheless, the study collected important data pertaining to both the revised integrated framework and the assessment tool. The feedback on the overall framework is summarised as follows:

- The participants indicated that the revised integrated framework was relevant and suitable for assessing small and rural municipalities' readiness since it provides a guideline on what actions to take for municipalities to become ready for implementing a smart city.
- The findings pointed out that the revised integrated framework was comprehensive enough to assist small and rural municipalities in identifying areas needing improvement before implementing a smart city.
- The findings revealed that municipalities beginning to engage in smart city projects would benefit from this framework because it is easy to follow and understand.
- The findings demonstrated that it was easy to use this framework to assess municipality readiness for smart city implementation.

6.4 Framework validation: Expert review

This section primarily aims to present the findings on the validation of the revised integrated framework. This iteration was conducted to identify any usability issues with the framework and to confirm whether the revised framework would be suitable for assessing small and rural municipalities' readiness for smart city implementation. The framework was validated through expert review. The researcher analysed the experts' feedback to improve the revised framework, as displayed in **Figure 30**.

6.4.1 Expert review participant sampling

In this study, twelve experts were requested to validate the revised integrated framework to identify any usability issues. The group of experts constituted scholars who have already designed frameworks within the smart city domain, as well as managers who are knowledgeable in the smart city domain from South African metropolitan municipalities. The experts in the smart city field were identified through purposive sampling. The researcher sent permission letters and participant information sheets to request permission for their participation in the study. Of the twelve participants, two indicated they could not participate because of their workloads. Three participants did not reply to the email.

During this iteration, the study collected data through an online survey using *Google Forms*. The researcher sent a *Google Forms* link to all the sampled participants via email. Seven experts reviewed the revised integrated framework and provided feedback. The experts' feedback was later extracted from *Google Forms* and entered into a Microsoft *Excel* spreadsheet and PDF document for data analysis. The findings for this iteration are presented below in **Subsection 6.4.2**.

6.4.2. Expert review findings

This subsection presents the data collected through *Google Forms* that were analysed to identify the missing components of the revised framework (see **Figure 30**). The *Google Forms* document contained a revised framework and questions. The experts were asked to review the framework and respond to the questions. Below are the participants' feedback based on the questions.

- **Relevance of revised integrated framework to assess small and rural municipalities**

The findings showed that the relevance of the revised integrated framework depended on the specific context and needs of a municipality. The participants' feedback took into account that this framework was developed focusing specifically on small and rural municipalities. Therefore, the participants' feedback confirmed that the revised integrated framework was relevant to small and rural municipalities because it would help them to assess their current readiness levels and identify areas needing improvement towards a smart city implementation.

"Highly relevant." (Participant A)

"The relevance of the revised framework to assess small and rural municipalities' readiness for smart city implementation depends on the specific context and needs of the municipality. The framework can be useful in helping municipalities to assess their current readiness and identify areas for improvement in their smart city implementation efforts." (Participant D)

"One advantage of the revised framework is that it is tailored specifically to small and rural municipalities, which may have unique challenges and opportunities when it comes to implementing smart city initiatives. The framework takes into account the specific needs and characteristics of these municipalities, which may differ from larger, more urban areas. The framework is relevant." (Participant E)

"Very relevant and easy to follow." (Participant G)

- **Missing components on the revised integrated framework**

Most participants agreed that the revised integrated framework was comprehensive. Some participants indicated that nothing was missing from the framework. However, the study gathered important feedback on the revised integrated framework. A few participants indicated a need to add buildings or homes under the environmental aspect of the revised framework. The literature supports this statement. According to Dewi et al. (2018) and Das (2020), the environment for a smart city should have smart buildings to collect data from households without any human intervention.

"I am not able to judge but I think the framework is comprehensive." (Participant A)

"Overall, the revised integrated framework and assessment tool are comprehensive tools to assess small and rural municipalities. The framework covers every area." (Participant E)

"I think there is a need to assess buildings/homes under an environment." (Participant F)

"None." (Participant G)

- **Complexity and usability of the revised integrated framework**

There was agreement between the participants regarding the complexity and usability of the revised integrated framework. The participants indicated that the framework was clear and covered all the key components. The way it is structured simplifies the assessment process when assessing readiness level; the assessor can interpret their results and gauge the municipality's readiness level for the implementation of a smart city.

"This framework is user-friendly and it includes guidance on how to use and interpret the assessment results. It provides a clear structure for assessing smart city readiness and the indicators are organised into different categories, which helps to simplify the assessment process." (Participant B)

"The revised framework is clear as it captures and diagrammatically shows all the elements key for smart city implementation." (Participant D)

"Yes, this framework is straightforward." (Participant F)

- **Suitability of the revised integrated framework to the context of South African small and rural municipalities**

To provide feedback on the suitability of the revised integrated framework, a few participants indicated they were unfamiliar with the South African context. In their responses, they explained that every country has different characteristics. Although Participant G was unfamiliar with South African small and rural municipalities, the participant still provided some perspective regarding the framework's suitability. The participant stated that this framework is fitting for the assessment of small and rural municipalities for smart city implementation.

Other participants familiar with South African small and rural municipalities agreed that the revised integrated framework was suitable for assessing small and rural municipalities' readiness. They further indicated that the framework contained the key measures necessary to assess small and rural municipalities' readiness for smart city implementation. Based on that, Participant F stated that this framework was highly suitable for South African small and rural municipalities.

"Yes." (Participant A)

"Actually, I have no idea about the South Africa environment. But each place has a different perspective and social-economy characteristic." (Participant C)

"It is suitable in the context of South Africa as some of the key components identified are in place already within municipalities across South Africa." (Participant D)

"Absolutely, it is highly suitable." (Participant F)

"As I have indicated early that I am not familiar with South African local government, but I consider this framework suitable." (Participant G)

- **Effect of the integrated framework on small and rural municipalities**

The participants' feedback postulated that the integrated framework would positively affect small and rural municipalities. The feedback affirmed that the framework would assist small and rural municipalities in identifying key aspects required for smart city implementation. This would also assist in capacity and capability improvement before a municipality commenced with a smart city project.

"The revised framework will help the local municipality focus on the most important needs of local communities for smart city implementation taking into account the resources available at a local level to implement smart city readiness." (Participant C)

"This framework can provide small and rural municipalities with a clear understanding of what it takes to become a smart city, including the necessary infrastructure, policies, and governance structures. This can help these municipalities to develop a roadmap for smart city implementation and identify areas where they need to improve." (Participant D)

"This framework can have several positive effects on these municipalities. It can help the municipalities to understand the requirements for smart city implementation, identify areas for improvement, build capacity, improve citizen engagement, and attract funding opportunities." (Participant E)

- **Suitability of the integrated framework and assessment tool to assess small and rural municipalities' readiness for smart city implementation**

The participants agreed that the revised integrated framework and assessment tool were suitable to assist small and rural municipalities in measuring or judging the readiness level for smart city implementation and identifying areas needing improvement. The participants' feedback confirms that the framework includes important components critical when assessing municipality readiness for smart city implementation.

"Yes." (Participant A)

"Yes." (Participant B)

"Yes, it is." (Participant C)

"The suggested assessment tool is of immense value as it encompasses all relevant components that constitute implementation of smart city readiness." (Participant D)

"Yes, the framework provides a comprehensive set of indicators and assessment criteria that cover different aspects of smart city readiness, such as infrastructure, governance, policies and citizen engagement. These indicators can help a municipality to assess its current level of readiness and identify areas where it needs to improve." (Participant E)

"Yes, the revised framework for assessing small and rural municipalities' readiness for smart city implementation can be a useful tool to enable a municipality to measure its readiness level for smart city implementation." (Participant F)

"If the researcher can add buildings, I will be happy." (Participant G)

6.4.3 Results of the framework validation process

In general, the group of experts were satisfied with the revised integrated framework to assess small and rural municipalities' readiness for smart city implementation. However, a few participants indicated the need to include a building component under the environment indicator. During validation, the researcher added a building component to the integrated framework and assessment tool to improve the rigour of the assessment of small and rural municipalities’ readiness for smart city implementation. **Figure 31** below details the improved framework with the new contribution.

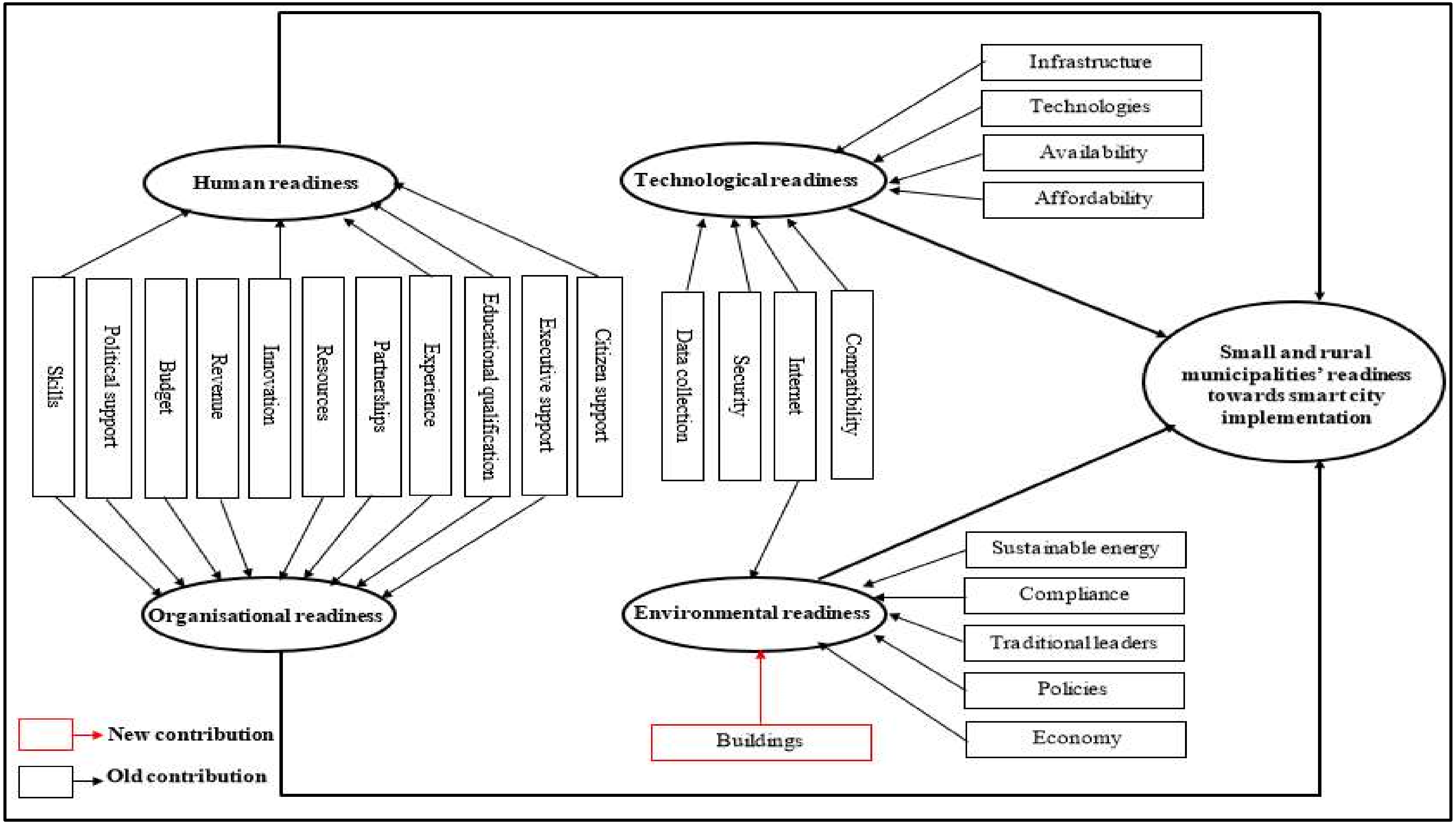


Figure 31: A validated integrated framework to assess small and rural municipalities' readiness for smart city implementation.

6.5 The finalised integrated framework and assessment tool to assess small and rural municipalities' readiness for smart city implementation

In devising the final integrated framework, the researcher started by developing a conceptual framework, as detailed in Chapter 3. The conceptual framework was revised using interview data, although the core part of the framework remained unchanged. However, some components were removed while others were added to the revised framework. During the ICITL conference and interviews, the participants indicated a need for an assessment tool to assist municipalities in measuring their readiness levels. Hence, the study developed an assessment tool to assess small and rural municipalities' readiness.

The revised integrated framework (see **Figure 30**) and assessment tool (see **Table 9**) were evaluated using participatory design. The framework and assessment tool were sent to a representative from each municipality. During this iteration, no alterations were made to either the revised integrated framework or the assessment tool. The revised integrated framework and assessment tool were validated through expert review. During this iteration, the main feedback was the need for a building component under the environment component. Consequently, the building component was added to the validated, integrated framework (see **Figure 31**) as a new contribution under the environment indicator. Thus, the integrated framework to assess small and rural municipalities' readiness for smart city implementation has been proven suitable, relevant, credible, evaluated, and validated or verified. **Figure 32** below presents the finalised integrated framework to assess small and rural municipalities' readiness for smart city implementation.

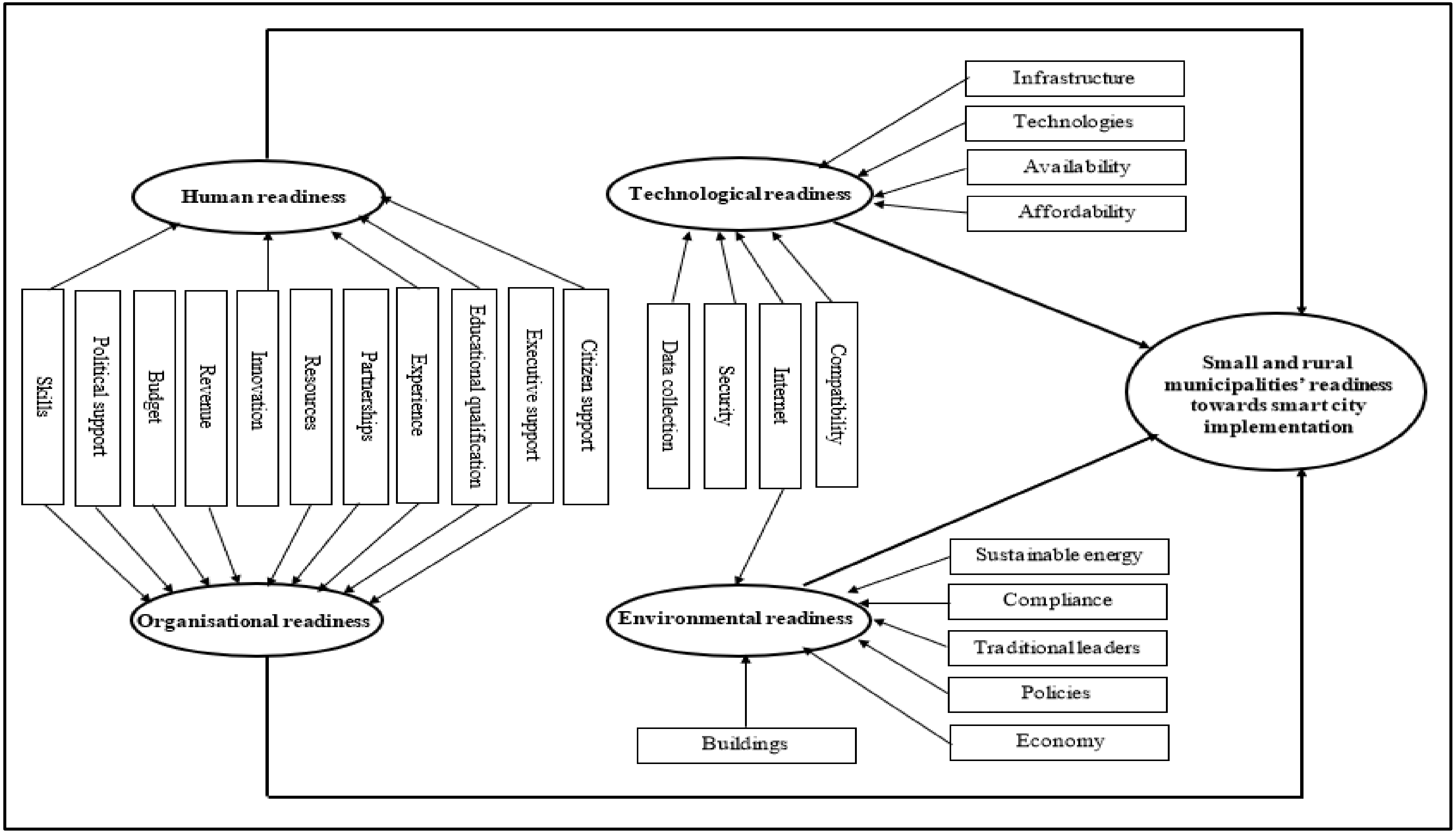


Figure 32: A finalised integrated framework to assess small and rural municipalities' readiness for smart city implementation.

6.5.1 Calculating readiness level using an assessment tool

Crucially, small and rural municipalities must know their readiness levels for smart city implementation. In this study, the researcher presented an assessment tool (see **Table 10**) that small and rural municipalities can use to assess their readiness levels. The assessment tool is divided into four parts: human readiness, technological readiness, organisational readiness and environmental readiness; all these parts have five columns. When assessing readiness, the assessor must complete Columns 3 and 4. Column 5 is optional; the assessor may complete this column when writing down a comment.

In the third column, the assessor must choose between "Yes" or "No". The assessor may choose "Yes" if something exists in that area and "No" if there is nothing at all in that area. In the fourth column, the assessor must grade the municipality readiness level using a score of 0 to 10. If the selected option in the third column is "No", the score must be zero "0"; but if the selected option is "Yes", the score should be between 1 and 10. These scores are interpreted as follows: 0 = 0% Ready, 1 = 10% Ready, 2 = 20% Ready, 3 = 30% Ready, 4 = 40% Ready, 5 = 50% Ready, 6 = 60% Ready, 7 = 70% Ready, 8 = 80% Ready, 9 = 90% Ready, 10 = 100% Ready.

The assessor should add up the scores for each part to obtain the total scores. After that, the assessor can use the total score to calculate the readiness level for each part. In addition, to calculate the overall score for the municipality, the assessor should add up all the scores to arrive at the total. Alternatively, the assessor could add up all the total scores to calculate the overall score for the municipality.

There are 32 components in the assessment tool, each counting out of 10. These components are classified into four indicators: human readiness, technological readiness, organisational readiness and environmental readiness. Human readiness consists of six components, technological readiness has ten components, organisational readiness has nine components, and environmental readiness has seven components.

Accordingly, human readiness has six components, each of which is scored out of 10; thus, the human readiness overall score is 60. To calculate a human readiness level, the total score would be divided by 60 and multiplied by 100. The same approach applies to calculating the technological readiness level. There are ten components for technological readiness on this level, and the technological overall score is 100. Correspondingly, the organisational readiness overall score would be 90. To determine the organisational readiness level, an overall score would be divided by 90 and multiplied by 100. To calculate the environmental readiness level, the same formula applies; the overall score for environmental readiness is 70; thus, the total score would be divided by 70 and multiplied by 100 to arrive at the environmental readiness level. Hence, the assessor would determine the readiness level for each part by using the formulas listed below:

- Formula to calculate human readiness level (HRL):

$$\boldsymbol{HRL} = (Human\ readines\ total\ score\ \div\ 60)\ \times 100$$

- Formula to calculate technological readiness level (TRL):

$$\boldsymbol{TRL} = (Technological\ readiness\ total\ score\ \div\ 100)\ \times 100$$

- Formula to calculate organisational readiness level (ORL):

$$\boldsymbol{ORL} = (Organisational\ readiness\ total\ score\ \div\ 90)\ \times 100$$

- Formula to calculate environmental readiness level (ERL):

$$\boldsymbol{ERL} = (Environmental\ readiness\ total\ score\ \div\ 70)\ \times 100$$

To calculate a municipality's readiness level, the assessor would add up the human, technological, organisational and environmental readiness levels' percentage scores and divide them by four (4). Alternatively, since the assessment tool has 32 components, each of which is scored out of 10, the total score of all the components could be divided by 320 and multiplied by 100 to arrive at a municipality's readiness level. To calculate the municipality readiness level (MRL) the assessor uses the following formulas:

$$\boldsymbol{MRL} = \frac{(HRL + TRL + ORL + ERL)}{4}$$

OR

$$\boldsymbol{MRL} = (Overall\ score\ \div\ 320)\ \times 100$$

If the municipality readiness level is between 0% and 50%, it would mean that the municipality is not yet ready and much work remains to be done. However, if the municipality readiness level is between 51% and 74%, it would mean that the municipality is not yet ready and some work remains to be done. If the municipality readiness level is at 75% or more, a municipality could be considered ready, yet requiring a few improvements. The municipality can start implementing a smart city while improving other areas that are not yet ready. Below is the finalised assessment tool (see **Table 10**). This assessment tool could be tested by future studies by practically applying the assessment tool in at least three small and rural municipalities and comparing the results to determine the accuracy of the assessment tool.

AN ASSESSMENT TOOL TO ASSESS SMALL AND RURAL MUNICIPALITIES' READINESS FOR SMART CITY IMPLEMENTATION

For each question, select "Yes" or "No" in the third column. In the fourth column, enter the number that best represents your municipality's readiness. The scores are interpreted as follows: **0 = 0% Ready, 1 = 10% Ready, 2 = 20% Ready, 3 = 30% Ready, 4 = 40% Ready, 5 = 50% Ready, 6 = 60% Ready, 7 = 70% Ready, 8 = 80% Ready, 9 = 90% Ready, 10 = 100% Ready.**

Table 10: The finalised assessment tool to assess small and rural municipalities' readiness for smart city implementation.

Number	**Human readiness**	**Yes / No**	**Enter a score between 0 and 10**	**Comment**
1	Some citizens in this municipality hold relevant educational qualifications for smart city implementation.			
2	Some citizens in this municipality have the relevant experience to develop a smart city.			
3	Some innovative citizens in this municipality can contribute to the development of smart city implementation.			
4	The citizens within this municipality possess the requisite skills to implement a smart city.			
5	The citizens residing in this municipality support smart city development.			
6	Enough people in this municipality possess the relevant technical skills to contribute to the implementation of a smart city.			
	Human readiness total score			

	Technological readiness		Enter a score between 0 and 10	Comment
7	The relevant social, physical and economic infrastructures exist within this municipality.			
8	The requisite modern technologies for smart city implementation are available within this municipality.			
9	The requisite modern infrastructure for smart city implementation is available within this municipality.			
10	The available modern technologies for smart city implementation are compatible with the municipality's existing infrastructure.			
11	Vendors of modern technologies and infrastructure are available and accessible within this municipality.			
12	Modern technologies and infrastructure are affordable.			
13	The available technology and infrastructure are suitable for collecting and analysing data in real time.			
14	The analysed data will provide the municipality with information for decision-making in real time.			
15	The existing infrastructure supports internet connectivity.			
16	The available technology and infrastructure are secured.			
	Technological readiness total score			

	Organisational readiness		**Enter a score between 0 and 10**	**Comment**
17	Municipal management supports the municipality in implementing a smart city project.			
18	Politicians support a smart city project in the municipality.			
19	The municipality has existing partnerships with the public and private sectors.			
20	Some employees hold relevant educational qualifications for smart city implementation.			
21	Some employees have the relevant experience to develop a smart city.			
22	Some employees possess the relevant technical skills to implement a smart city.			
23	The municipality has the requisite resources to implement a smart city.			
24	This municipality generates 50% of its revenue.			
25	A budget to fund smart city initiatives exists.			
	Organisational readiness total score			
	Environmental readiness		**Enter a score between 0 and 10**	**Comment**
26	There is a reliable internet connection within the municipality.			

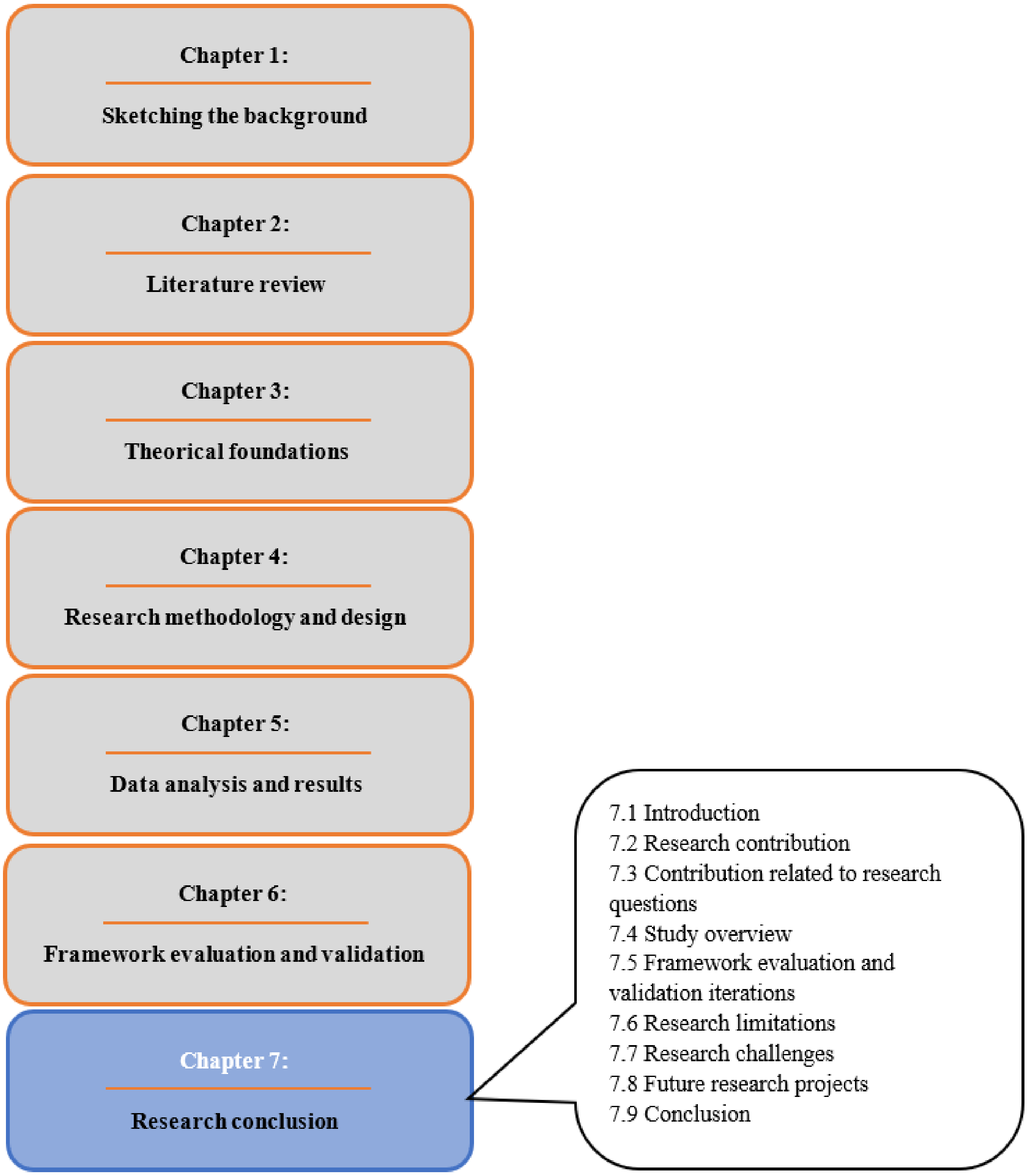
27	The municipality has reliable and sustainable energy.			
28	Policies support smart city development in the municipality.			
29	The municipality's personnel and citizens comply with policies to promote good governance.			
30	The entity has buy-in from traditional leaders.			
31	The municipality has a strong economy to ensure smart city development.			
32	Some buildings have the capability to collect data without human intervention.			
	Environmental readiness total score			
Overall score for municipality readiness: **(To calculate the overall score, calculate the overall total of all the scores or total scores above using any of these formulars:** MRL= ((HRL + TRL+ORL+ERL))/4 or MRL= (Overall score ÷ 320) ×100**)**				

6.6 Conclusion

This chapter primarily aimed to present, evaluate and validate the revised integrated framework to assess small and rural municipalities and to confirm the final framework and assessment tool. Chapter 6 further presented the framework evaluation findings, namely that the participants were satisfied that their experiences had been accurately captured on the revised integrated framework. A group of experts validated the revised integrated framework to identify any missing components and usability issues with the framework. The participants highlighted the need to add a building component to the framework; consequently, the framework was altered to include a building component. Furthermore, the researcher presented a final integrated framework and assessment tool to assess small and rural municipalities for smart city implementation. Lastly, the researcher presented the formulas that small and rural municipalities can use to determine their readiness levels for smart city implementation.

CHAPTER 7

RESEARCH CONCLUSION



7.1 Introduction

This study developed an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation. The previous chapter presented the revised integrated framework and discussed the evaluation and validation findings of the revised integrated framework. The study accomplished its goal by presenting a final integrated framework to assess small and rural municipalities' readiness for smart city implementation.

Chapter 7 is the last chapter of the study. This chapter presents the overall conclusion of the study and all the preceding chapters. The study achieves its aim in Chapter 7 by presenting the contribution of the study, the study overview, the framework evaluation and iteration phases, the limitations of the research, its challenges and possible future projects. Lastly, the study draws and presents its conclusions in the last section of the chapter.

7.2 Research contribution

The study primarily set out to address the research problem: The lack of an integrated framework to assess small and rural municipalities' readiness for smart city implementation. While addressing the research problem, various other research contributions were produced as a part of this study.

The smart city concept has gained more attention from various scholars within the smart city research domain. They have attempted to explore this concept as a way to address the challenges faced by most cities. Some scholars have indeed proposed various frameworks to assess cities' readiness for smart city implementation; however, most of these frameworks focus on big cities or metropolitan municipalities.

Even though vast numbers of publications exist in the information systems, smart city and rural studies fields, only limited literature exists on developing an integrated framework to assess small and rural municipalities' readiness for smart city implementation, especially in the South African context. This study focused on the development of an integrated framework to assess small and rural municipalities' readiness for smart city implementation.

This study has augmented the body of knowledge by contributing to the assessment of small and rural municipalities' readiness for smart city implementation. The study also advanced the field by exploring the key aspects critical to assessing small and rural municipalities' readiness levels for smart city implementation. Furthermore, the research produced contributions through a conference presentation and a publication in a peer-reviewed journal.

In addition, this study made a significant contribution by developing an integrated framework to help small and rural municipalities measure their readiness level for smart city implementation. The possible benefits of the integrated framework will assist the small and rural municipalities in reaching their readiness level for smart city implementation. Another practical contribution of this study is that the municipalities can use the assessment tool to determine their readiness level quantitatively.

7.3 Contribution corresponding to the research questions

This study intended to develop an integrated framework to assess small and rural municipalities' readiness for smart city implementation. The researcher formulated a main research question and four secondary research questions to assist in achieving the main objective of the study. Secondary Research Question 1 (SRQ1) asks: "*Why is the assessment of South African small and rural municipalities' readiness important for smart city implementation?*". This research question is addressed in Chapter 2 under Subsection 2.4.2, "Perception on smart city implementation" and in Subsection 2.4.3, "Ways to improve sustainability in a smart city".

In addition, SRQ1 is also addressed in Subsection 5.3.3. The findings revealed that the assessment of small and rural municipalities' readiness would assist municipalities in identifying the areas needing attention for smart city implementation. This will also aid small and rural municipalities in curtailing costs before and during a smart city project. The readiness assessment will reduce smart city project failure in small and rural municipalities.

Secondary Research Question 2 (SRQ2) asks: "*What are the South African factors that influence small and rural municipalities' readiness for smart city implementation?*". This question was addressed in Section 2.7, "Small and rural municipalities aspects", and in the publication produced from this study titled "Key factors for assessing small and rural municipalities' readiness for smart city implementation" (cf. https://www.mdpi.com/2624-6511/5/4/87). SRQ2 was also addressed in Subsection 5.3.1, "Important factors for readiness assessment for smart city implementation". The findings show that human, technological, organisational and environmental factors are fundamental when assessing small and rural municipalities' readiness for smart city implementation.

This study further addressed Secondary Research Question 3 (SRQ3), which asks: "*What are the information systems drivers for smart city development and why are they important?*". This research question was addressed in Section 2.8 and Subsection 5.3.2. The findings show that network or internet connectivity, modern technologies, modern infrastructure, digital data, software, people and the automation of processes are critical information drivers for smart city development.

Secondary Research Question 4 (SRQ4) asks: "*How could an integrated framework to assess small and rural municipalities' readiness for smart city implementation be developed and evaluated?*". This research question was addressed in Chapters 3, 4 and 6. A conceptual framework was proposed in Chapter 3. This framework was presented at the South African Institute of Computer Scientists and Information Technology (SAICSIT) Conference/ Symposium as a work in progress to seek more input. The revised conceptual framework was later presented at the Innovative Technologies and Learning (ICITL) conference and was published in *Lecture Notes in Computer Science*.

Furthermore, a revised conceptual framework was presented to the interview participants. All feedback was incorporated into the revised integrated framework. The revised integrated framework was evaluated by representatives of the interview participants to verify whether their experiences had been captured correctly. During this phase, there were no changes to the framework. Lastly, a group of experts validated the revised integrated framework to identify any usability issues with the framework. Their findings were captured on the framework.

The secondary research questions guided this study in addressing the main research question (MRQ): "*How can the South African small and rural municipalities' readiness be assessed towards smart city implementation from an IS perspective?*". Section 6.4 addressed the MRQ by presenting a finalised framework and assessment tool that can be used to assess small and rural municipalities' readiness for smart city implementation. Consequently, South African small and rural municipalities can use this assessment tool to measure their readiness levels.

7.4 Study overview

In this study, Chapter 1 laid the foundation for the entire study by presenting the problem statement, research questions and objectives, while Chapter 2 reviewed the literature, following a systematic literature review approach and a concept-centric literature matrix. Chapter 3 discussed different theories used to underpin the study and presented a conceptual integrated framework. Chapter 4 discussed the research methodology followed in this study, and Chapter 5 explored the interview findings. In Chapter 6, the study presented the revised integrated framework and assessment tool evaluation and validation findings. In addition, Chapter 6 delivered the final framework and assessment tool to assess small and rural municipalities' readiness for smart city implementation. In Chapter 7, the researcher presents their reflections and the conclusion of the study.

7.5 Framework evaluation and validation iterations

This study followed the design science research methodology process model developed by Peffers et al. (2007) to develop an integrated framework, presented in **Figure 32** as an artefact. The study executed four iterations of empirical data collection to evaluate and validate the framework for the improvement of the developed framework based on the literature review.

- **Iteration Ones:** In the first iteration, the researcher presented the initial conceptual framework (see **Figure 16**) to the SAICSIT and ICITL conferences. The paper was later published in the *Lecture Notes in Computer Science* (*LNCS*).
- **Iteration Two:** The researcher collected data using interviews and incorporated the interviewees' input into the revised framework. In addition, during this iteration, an assessment tool was developed, as suggested by the conference participants and interviewees.
- **Iteration Three:** In this iteration, the researcher circulated the revised framework and assessment tool among the municipal representatives selected from the interviewee pool to evaluate the framework for examining and confirming whether their experiences were accurately captured in the revised integrated framework.
- **Iteration Four:** This was the final iteration, during which the framework was sent to a group of experts to validate that the revised integrated framework did not have usability issues.

These iterations aided the researcher in improving the integrated framework and validating the artefact using a group of experts knowledgeable in the smart city domain from different institutions. The evaluation and validation contributed to the finalisation of the artefact to a great degree.

7.6 Research limitations

Even though this study contributed to the smart city body of knowledge, some limitations must be recognised. Since the study used a purely qualitative approach, there is room to complement the research with quantitative methods to statistically test hypotheses based on the results of the qualitative research. Qualitative research does not aim to generalise results but rather to provide a rich understanding of the context of some characteristics of human experience by studying a specific domain (Borgstede & Scholz, 2021; Myers, 2000; Polit & Beck, 2010). Another limitation is that the integrated framework was not tested using statistical data. Lastly, the proposed assessment tool lacks the prioritisation of different areas when assessing small and rural municipalities' readiness for smart city implementation. This limitation suggests future studies could test the framework using statistical data to allow for generalisation using quantitative data. The literature affirms that generalisation is the norm in quantitative research (Borgstede & Scholz, 2021; Polit & Beck, 2010).

7.7 Research challenges

In conducting this study, the researcher experienced some difficulties in obtaining permission to collect data from small and rural municipalities. The researcher requested permission from nine small and rural municipalities from three different provinces. Of nine municipalities, only five granted permissions for participation in the data collection. Two municipalities declined to participate in this study because they did not have a sufficient staff complement. The researcher continually followed up with two other municipalities, but they invariably replied that the request had been sent to the municipal manager.

The study encountered some resistance from municipalities to grant permission because of the use of an online platform to conduct the interviews. The researcher had to make adjustments to enable conducting the interviews face-to-face. Another obstacle was that, due to confidentiality concerns, the participants declined to provide certain documents that would have added value to this study.

Furthermore, the framework evaluation and validation posed some challenges. Although receiving feedback from the participants took some time, the evaluation phase proceeded well because all the nominated participants indeed provided feedback. During the validation phase, twelve participants were invited to review the framework. Of the twelve participants, two declined to participate because of their workloads; the other three participants did not reply to the invitation. Nonetheless, the data collection, framework validation and framework evaluation phases proceeded well, and the participants were cooperative during the data collection process.

7.8 Future research projects

The development of the integrated framework and assessment tool to assess small and rural municipalities has mapped out future research projects. Future research should investigate the impact of the integrated framework and assessment tool in small and rural municipalities. This study was based on multiple qualitative case studies, which posed a limitation that could be addressed by research based on a quantitative survey that would enable the collection of statistical data to allow for generalisation to a larger population (Polit & Beck, 2010). Future studies could explore security issues in small and rural municipalities regarding smart city implementation. In addition, future studies might consider prioritising various areas when assessing small and rural municipalities' readiness for smart city implementation. Lastly, another possible future project emanating from the current study would be the development of a *digital* assessment tool to assess small and rural municipalities' readiness for smart city implementation.

7.9 Conclusion

In the last chapter of the study, the researcher presented the overall conclusion of the study in the form of the contributions of the study, a study overview, the framework evaluation and iteration phases, and the limitations and challenges of the research. The researcher also suggested future research projects to be conducted. The last section of the chapter drew and presented the study's conclusions.

This study aimed to develop an artefact; consequently, the study developed an integrated framework as an artefact that could be used to assess small and rural municipalities' readiness for smart city implementation. The study required a methodology to guide the development, evaluation and validation of the framework. DSRM was appropriate for this research since the method seeks to solve problems by developing an artefact.

An integrated framework was initially developed in Chapter 3 using literature review data. This framework was later improved using feedback from a conference audience and interview data. The revised framework was evaluated by a group of representatives who had previously participated in the interviews. During this iteration, the researcher made no changes to the framework because the participants were satisfied that their input had been accurately reflected in the revised integrated framework. The revised integrated framework was also evaluated by a group of experts who suggested the need for a building component on the framework. This suggestion was implemented to improve the framework. The researcher presented the final integrated framework in Chapter 6.

This study further highlighted the limitations and challenges experienced during the research. In this study, obtaining permission from municipalities was one such challenge that affected the study. This study identified the use of a single research approach as a limitation, which demonstrates the need for a future study of this nature to adopt mixed methods.

The integrated framework and assessment tool developed in this study serves as a guideline to assess small and rural municipalities' readiness for smart city implementation. Before engaging in a smart city project, it is crucial to assess municipalities' readiness because it would assist in identifying areas needing improvement and also aid in curtailing costs. It is evident from the interview data that the integrated framework and assessment tool could be transformational for South African small and rural municipalities seeking to implement a smart city.

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Annexures:

Annexure A: Smart city concept centric literature matrix

No	References			Concepts					
	Author(s)	**Year**	**Publication**	**Smart city concept overview**	**Smart city initiatives**	**Small and rural municipalities aspects**	**Information systems drivers for a smart city development**	**Smart services**	**Smart city-related frameworks**
1	Ismagilova, Hughes, Dwivedi and Raman	2019	*International Journal of Information Management*	**X**	**X**	**X**	**X**	**X**	
2	Silva et al.	2018b	*Sustainable Cities and Society*	**X**		**X**			
3	Yigitcanlar et al.	2019b	*Sustainable Cities and Society*	**X**	**X**	**X**	**X**		
4	Ruhlandt	2018	*Cities*	**X**					**X**

5	Yigitcanlar et al.	2018	*Cities*	**X**			**X**	**X**	**X**
6	Dameri, Benevolo, Veglianti and Li	2019	*Technological Forecasting and Social Change*	**X**	**X**				**X**
7	Appio, Lima and Paroutis	2019	*Technological Forecasting and Social Change*				**X**	**X**	**X**
8	Lam and Ma	2018	*Cities*	**X**	**X**			**X**	
9	Ma, Lam and Leung	2018	*Telematics and Informatics*				**X**	**X**	
10	Lim, Kim and Maglio	2018	*Cities*	**X**			**X**		
11	Chourabi et al.	2012	*Annual Hawaii International Conference on System Sciences*			**X**	**X**		**X**
12	Bibri	2018a	*Sustainable Cities and Society*	**X**			**X**		
13	Mora, Deakin and Reid	2019	*Technological Forecasting and Social Change*	**X**		**X**	**X**		

14	Zhang et al.	2019	*Journal of Parallel and Distributed Computing*	**X**			**X**		
15	Heaton and Parlinkad	2019	*Cities*				**X**		
16	Corsini, Certomà, Dyer and Frey	2019	*Technological Forecasting and Social Change*			**X**	**X**		
17	Alavi and Buttlar	2019	*Future Generation Computer Systems*				**X**		
18	Antoniou et al.	2019	*Transportation Research*				**X**		
19	Chatfield and Reddick	2019	*Government Information Quarterly*				**X**		**X**
20	Camboim, Zawislak and Pufal	2019	*Technological Forecasting and Social Change*		**X**		**X**		
21	Hopkins and Mckay	2019	*Technological Forecasting and Social Change*				**X**	**X**	**X**
22	Huovila, Bosch and Airaksinen	2019	*Cities*			**X**	**X**		

23	Martin et al.	2019	*Sustainable Cities and Society*			**X**	**X**		**X**
24	Prendeville, Cherim and Bocken	2018	*Environmental Innovation and Societal Transitions*	**X**		**X**	**X**		**X**
25	Mayangsari and Novani	2015	*Procedia Manufacturing*	**X**		**X**		**X**	**X**
26	Pettit et al.	2018	*City, Culture and Society*	**X**			**X**		
27	Dacko	2016	*Technological Forecasting and Social Change*				**X**		**X**
28	Marine-Roig and Clavé	2015	*Journal of Destination Marketing and Management*			**X**	**X**		
29	Pincetl and Newell	2017	*Geoforum*			**X**	**X**		**X**
30	Lu, De Jong and Ten Heuvelhof	2018	*Journal of Cleaner Production*	**X**		**X**			
31	Delponte and Ugolini	2011	*Procedia Engineering*	**X**		**X**	**X**	**X**	**X**

32	Yigitcanlar and Lee	2014	*Technological Forecasting and Social Change*	**X**		**X**	**X**		
33	Dixon, Eames, Britnell, Watson and Hunt	2014	*Technological Forecasting and Social Change*	**X**		**X**	**X**		**X**
34	Steenbruggen, Nijkamp and Van Der Vlist	2014	*Technological Forecasting and Social Change*				**X**	**X**	
35	Galán-García, Aguilera-Venegas and Rodríguez-Cielos	2014	*Journal of Computational and Applied Mathematics*				**X**	**X**	
36	Lee, Lee and Woo	2014	*Computer Standards & Interfaces*				**X**		
37	Caporuscio and Ghezzi	2015	*The Journal of Systems and Software*	**X**			**X**	**X**	
38	Mišák, Stuchí, Platoš and Krömer	2015	*Energy and Buildings*				**X**	**X**	
39	De Jong, Joss, Schraven, Zhan and Weijnen	2015	*Journal of Cleaner Production*	**X**	**X**		**X**		

40	Offenhuber and Schechtner	2018	*Cities*		**X**				**X**
41	Marsal-Llacuna and Segal	2017	*Cities*				**X**	**X**	
42	Maria Lluïsa Marsal-Llacuna and Segal	2016	*Cities*				**X**		
43	Mosannenzadeh, Bisello, Diamantini, Stellin and Vettorato	2017	*Cities*	**X**		**X**			
44	Dadashpoor and Yousefi	2018	*Cities*			**X**	**X**		**X**
45	Vanolo	2016	*Futures*		**X**				
46	Botta, De Donato, Persico and Pescapé	2016	*Future Generation Computer Systems*				**X**		
47	Maye	2019	*City, Culture and Society*	**X**	**X**		**X**		**X**
48	Witanto, Lim and Atiquzzaman	2018	*Future Generation Computer Systems*				**X**		

49	Moustaka, Theodosiou, Vakali, Kounoudes and Anthopoulos	2019	*Technological Forecasting and Social Change*	**X**			**X**		
50	Sikora-Fernandez	2018	*Cities*	**X**			**X**	**X**	
51	Adapa	2018	*Journal of Cleaner Production*		**X**		**X**		**X**
52	Oomens and Sadowski	2018	*Tele-communications Policy*			**X**	**X**		
53	Marsal-Llacuna and Wood-Hill	2017	*Computer Standards and Interfaces*		**X**	**X**	**X**		
54	Aguilera, Peña, Belmonte and López-De-Ipiña	2017	*Future Generation Computer Systems*		**X**		**X**		
55	Shang, Wang, Li, Chen and Li	2018	*Technological Forecasting and Social Change*				**X**		
56	Suryotrisongko, Kusuma and Ginardi	2017	*Procedia Computer Science*	**X**	**X**				
57	Ma and Ren	2017	*Procedia Engineering*	**X**			**X**	**X**	

58	Farahani et al.	2018	*Future Generation Computer Systems*				**X**		
59	Cledou, Estevez and Soares Barbosa	2018	*Government Information Quarterly*			**X**	**X**		**X**
60	Lopez-Carreiro and Monzon	2018	*Sustainable Cities and Society*	**X**			**X**		
61	Lyons	2018	*Transportation Research Part A: Policy and Practice*				**X**		
62	Vitunskaite, He, Brandstetter and Janicke	2019	*Computers and Security*	**X**	**X**		**X**		
63	Zawieska and Pieriegud	2018	*Transport Policy*			**X**		**X**	**X**
64	Schiavone, Paolone and Mancini	2019	*Technological Forecasting and Social Change*			**X**	**X**		**X**
65	Wray, Olstad and Minaker	2018	*Cities*	**X**		**X**			
66	Kousiouris et al.	2018	*Future Generation Computer Systems*				**X**		

67	Matheus, Janssen and Maheshwari	2018	*Government Information Quarterly*	**X**		**X**			
68	Bibri	2018b	*Sustainable Cities and Society*				**X**		
69	O’Dwyer, Pan, Acha and Shah	2019	*Applied Energy*			**X**	**X**		
70	Tuballa and Abundo	2016	*Renewable and Sustainable Energy Reviews*					**X**	
71	Esmaeilian et al.	2018	*Waste Management*				**X**		
72	Bibri and Krogstie	2017	*Sustainable Cities and Society*				**X**		
73	Canıtez and Deveci	2018	*Economic and Social Development*				**X**		**X**
74	Almuraqab and Jasimuddin	2017	*The Electronic Journal Information Systems Evaluation*				**X**		
75	Bhide	2017	*Institute Transport Engineers Journal*	**X**	**X**	**X**			
76	Hajduk	2016	*Business, Management and Education*	**X**					

77	Perätalo and Ahokangas	2018	*Journal of Business Models*	**X**					
78	Farago	2019	*Economic and Social Development*	**X**					**X**
79	Grab and Ilie	2019	*Economic and Social Development*	**X**					
80	Iványi and Bíró-Szigeti	2019	*Periodica Polytechnica Social and Management Sciences*				**X**		
81	Mekhdiev, Prokhorova, Makar, Salikhov and Bondarenko	2018	*International Journal of Energy Economics and Policy*				**X**		
82	Csukás and Szabó	2018	*Journal of Economic Literature*	**X**		**X**	**X**		
83	Popescul and Radu	2016	*Informatica Economică*		**X**		**X**		**X**
84	Gretzel	2018	*Journal of Regional Research*				**X**		**X**
85	Hasbini, Eldabi and Aldallal	2018	*Journal of Entrepreneurship, Management and*			**X**	**X**		

			Sustainable Development						
86	Cretu and Cuza	2012	*Informatica Economică*	**X**	**X**		**X**		
87	Tachizawa, Alvarez-Gil and Montes-Sancho	2015	*Supply Chain Management: An International Journal*			**X**			**X**
88	Leong, Ping and Muthuveloo	2017	*Global Business and Management Research: An International Journal*	**X**		**X**	**X**	**X**	
89	Schuurman, Baccarne, De Marez and Mechant	2012	*Journal of Theoretical and Applied Electronic Commerce Research*	**X**	**X**	**X**	**X**		**X**
90	Sauer	2012	*Journal of Theoretical and Applied Electronic Commerce Research*			**X**	**X**		
91	Calderoni, Maio and Palmieri	2012	*Journal of Theoretical and Applied Electronic Commerce Research*	**X**	**X**		**X**	**X**	
92	Walravens	2012	*Journal of Theoretical and Applied Electronic Commerce Research*				**X**		

93	Schaffers, Ratti and Komninos	2012	*Journal of Theoretical and Applied Electronic Commerce Research*	**X**			**X**		
94	Bell et al.	2018	*Systemic Practice Action Research*		**X**		**X**		
95	Neagu	2018	*Studia Universitatis "Vasile Goldis" Arad*	**X**			**X**		
96	Faisal, Usman and Murtaza Zahid	2018	*International Journal of Education and Management Engineering*			**X**	**X**		**X**
97	Chichernea	2015	*Journal of Information Systems and Operations Management*		**X**		**X**	**X**	**X**
98	Lam and Givens	2018	*New Global Studies*	**X**					
99	Pau et al.	2018	*Future Internet*	**X**		**X**	**X**		
100	Nagy, Tóth and Szendi	2016	Club of Economics in Miskolc	**X**				**X**	
101	Gontar, Gontar and Pamula	2014	*Organizacijø Vadyba: Sisteminiai Tyrimai*	**X**		**X**		**X**	

102	Kitchin	2014	*GeoJournal*			**X**	**X**		
103	Bakici, Almirall and Wareham	2013	*Journal of the Knowledge Economy*		**X**	**X**	**X**		
104	Bilbil	2017	*Journal of the Knowledge Economy*			**X**			
105	Hielkema and Hongisto	2013	*Journal of the Knowledge Economy*	**X**			**X**		
106	Zygiaris and Sotiris	2012	*Journal of the Knowlegde Economy*		**X**				**X**
107	Liu, Heller and Nielsen	2017	*Knowledge and Information Systems*				**X**		
108	Popescu	2015	*Economics, Management and Financial Markets*	**X**		**X**	**X**		
109	Walravens, Breuer and Ballon	2014	*Digiworld Economic Journal*	**X**	**X**		**X**		
110	Komninos, Pallot and Schaffers	2013	*Journal of the Knowledge Economy*	**X**	**X**		**X**		
111	Kshetri, Alcantara and Park	2014	*Digiworld Economic Journal*	**X**					

112	Roche	2014	*Progress in Human Geography*			**X**	**X**		
113	Pedro and Bolívar	2018	*Academia Revista Latinoamericana de Administacion*	**X**	**X**	**X**	**X**		**X**
114	Keta	2015	*Romanian Economic and Business Review*			**X**			
115	Hamilton and Zhu	2017	*Journal of Government Financial Management*				**X**	**X**	
116	Peng et al.	2017	*Information Systems and e-Business Management*				**X**	**X**	
117	Pinochet, Romani, De Souza and Rodríguez-Abitia	2018	*Revista de Gestão*	**X**		**X**	**X**		
118	Pereira, Macadar, Luciano and Testa	2017	*Information Systems Frontiers*				**X**		
119	Smith	2017	*Institute Transport Engineers Journal*	**X**				**X**	
120	Dupont, Morel and Guidat	2015	*Journal of Strategy and Management*			**X**			

121	Cacho et al.	2016a	*International Journal of Tourism Cities*		**X**				
122	Bosha, Cilliers and Flowerday	2017	*South African Journal of Information Management*	**X**			**X**		
123	Chauhan, Agarwal and Kar	2016	*Emerald Group Publishing*	**X**	**X**	**X**	**X**		**X**
124	Khomsi	2016	*Technology Innovation Management Review*	**X**	**X**	**X**			
125	Artto et al.	2016	*Technology Innovation Management Review*			**X**	**X**		
126	Ojasalo and Tähtinen	2016	*Technology Innovation Management Review*				**X**		
127	Bifulco, Tregua, Amitrano and D'Auria	2016	*International Journal of Public Sector Management*			**X**	**X**		
128	Çelikyay	2017	*International Journal of Research in Business and Social Science*		**X**			**X**	**X**
129	Zait	2017	*Transforming Government:*		**X**				**X**

			People, Process and Policy						
130	Shichiyakh, Klyuchnikov, Balashova, Novoselov and Novosyolova	2016	*International Journal of Economics and Financial Issues*	**X**		**X**			
131	Öberg, Graham and Hennelly	2016	*IMP Journal*	**X**	**X**		**X**		
132	Capdevila and Zarlenga	2015	*Journal of Strategy and Management*	**X**	**X**	**X**	**X**		**X**
133	Scuotto, Ferraris and Bresciani	2016	*Business Process Management Journal*			**X**	**X**		
134	Jukka Ojasalo and Kauppinen	2016	*Technology Innovation Management Review*		**X**	**X**	**X**		
135	Dameri and Ricciardi	2015	*Journal of Intellectual Capital*	**X**	**X**	**X**	**X**		
136	Maier	2016	*Energy, Sustainability and Society*		**X**	**X**			

137	Du Plessis and Marnewick	2017	*South African Journal of Economic and Management Sciences*	**X**	**X**				**X**
138	Chichernea	2014	*Journal of Information Systems and Operations*					**X**	
139	Matos, Vairinhos, Dameri and Durst	2017	*Journal of Intellectual Capital*			**X**	**X**	**X**	
140	Strasser and Albayrak	2016	*International Journal of Supply and Operations Management*				**X**		
141	Nam and Pardo	2011	*12th Annual International Digital Government Research Conference*						**X**
142	Cilliers and Flowerday	2017	*South African Computer Journal*			**X**	**X**		
143	Alawadhi et al.	2012	*11th International Conference on Electronic Government (EGOV)*			**X**	**X**		**X**

144	Das and Emuze	2014	*Journal of Construction Project Management and Innovation*			**X**			
145	Hosseini, Frank, Fridgen and Heger	2018	*Business and Information Systems Engineering*	**X**	**X**		**X**		
146	Malhotra, Ross and Watson	2013	*MIS Quarterly*	**X**					
147	Mazurek	2018	*Journal of Global Business Insights*		**X**		**X**		**X**
148	Brandt, Ketter, Kolbe, Neumann and Watson	2016	*Business and Information Systems Engineering*	**X**	**X**				
149	Brandt, Ketter, Kolbe, Neumann and Watson	2018	*Business and Information Systems Engineering*	**X**	**X**				
150	Dittrich	2017	*Scandinavian Journal of Information Systems*			**X**	**X**		
151	Turetken, Grefen, Gilsing and Adali	2019	*Business and Information Systems Engineering*		**X**				**X**

152	Kandappu, Misra, Koh, Tandriansyah and Jaiman,	2018	*WWW '18 Companion Proceedings of the The Web Conference 2018*			**X**	**X**		
153	Santos	2018	*Focus*				**X**	**X**	
154	Menne	2019	*Morris Undergraduate Journal*				**X**	**X**	
156	Passe, Anderson, Brabanter, Dorneich and Krejc	2016	*Industrial and Manufacturing Systems Engineering Conference Proceedings and Posters. 21.*	**X**			**X**		
157	Kocs	2016	*Proceedings of the Fábos Conference on Landscape and Greenway Planning*					**X**	
158	Yavuz, Cavusoglu and Corbaci	2018	*Journal of Global Business Insights*			**X**		**X**	
159	Shafie	2017	*Journal of Smart Cities*				**X**	**X**	
160	Sun	2012	*SSRN Electronic Journal*			**X**			

161	Callaghan, Avery and Mulville	2017	*33rd. Annual ARCOM Conference*				**X**		
162	Valenzano, Mana, Borean and Servetti,	2016	*OSGeo Journal*				**X**		
163	Erraguntla, Delen, Agrawal, Madanagopal and Mayer	2017	*Suburban Sustainability*				**X**		
164	Angelidou	2017	*Journal of Urban Technology*	**X**		**X**		**X**	
165	Harold, Arata and Hale	2018	*The Cyber Defense Review*				**X**		
166	Peto	2019	*Interdisciplinary Description of Complex Systems*	**X**					
167	Marrone and Hammerle	2018	*Business & Information Systems Engineering*				**X**		**X**
168	Jayarajah et al.	2017	*SPIE: 8th Ground/Air Multisensor Interoperability, Integration and Networking for Persistent ISR*	**X**					

169	*Zaidi et al.*	2016	*UPEC16: 51st International Universities Power Engineering Conference*					**X**	
170	Veselitskaya, Karasev and Beloshitskiy	2019	*Theoretical and Empirical Researches in Urban Management*	**X**	**X**	**X**			
171	O’Grady and O’Hare	2012	*American Association for the Advancement of Science*	**X**	**X**				
172	Roy	2016	*Social Scientist*	**X**	**X**		**X**		
173	Quraishi and Siegert	211	*Journal of American Water Works Association*					**X**	
174	Komninos, Kakderi, Panori and Tsarchopoulos	2019	*Journal of Urban Technology*				**X**		
175	De Falco, Angelidou and Addie	2019	*European Urban and Regional Studies*	**X**			**X**		
176	Marrero, Macías, Suárez, Santana and Mena	2019	*Mobile Networks and Applications*				**X**	**X**	

177	Costa, Duran-Faundez, Andrade, Rocha-Junior and Peixoto	2018	*Sensor*				**X**		
178	Silva et al.	2018a	*Sensor*	**X**			**X**	**X**	
179	Hell and Varga	2018	*Interdisciplinary Description of Complex Systems*					**X**	
180	Mora, Deakin, Reid and Angelidou	2019	*Journal of Urban Technology*				**X**		
181	Van Winden and Van den Buuse	2017	*Journal of Urban Technology*		**X**			**X**	
182	Tokody, Albini, Ady, Raynai and Pongrácz	2018	*Interdisciplinary Description of Complex Systems*						**X**
183	Joss, Sengers, Schraven, Caprotti and Dayot	2019	*Journal of Urban Technology*				**X**		
184	Pasolini et al.	2018	*Sensors*	**X**			**X**		
185	Joss, Cook and Dayot	2017	*Journal of Urban Technology*	**X**					

186	Grossi and Pianezzi	2017	*Cities*			**X**			
187	Kummitha and Crutzen	2017	*Cities*		**X**	**X**	**X**		
188	Qiu, Liu, Pereira and Seo	2017	*Personal and Ubiquitous Computing*			**X**	**X**		
189	Calavia, Baladrón, Aguiar, Carro and Sánchez-Esguevillas	2012	*Sensors*					**X**	
190	Albino, Berardi and Dangelico	2015	*Journal of Urban Technology*	**X**					
191	Saleem, Shijie and Sharif	2019	*Mobile Networks and Applications*				**X**		
192	Gascó-Hernandez	2018	*Building a smart city: Lessons from Barcelona*				**X**		
193	Kamil	2018	*BRAIN: Broad Research in Artificial Intelligence and Neuroscience*	**X**			**X**		**X**
194	Bestepe and Yildirim	2019	*International Conference on Information Systems Post-Implementation*				**X**		

			and Change Management.						
195	Qingyun, Zhongliang, You and Lin	2018	*International Journal of Geoinformatics*	**X**					
196	Abella, Ortiz-de-Urbina-Criado and De-Pablos-Heredero	2017	*Cities*				**X**		
197	Angelidou	2014	*Cities*	**X**					
198	Asensio, Blanco, Blasco, Marco and Casas	2015	*Sensors*				**X**	**X**	
199	Camero and Alba	2019	*Cities*	**X**		**X**	**X**		
200	Bennati, Dusparic, Shinde and Jonker	2018	*Sensors*			**X**			
201	Garcia-Font, Garrigues and Rifà-Pous	2018	*Sensors*				**X**		
202	Kuk and Janssen	2011	*Journal of Urban Technology*				**X**		
203	Ahvenniemi, Huovila, Pinto-	2017	*Cities*	**X**	**X**				

	Seppä and Airaksinen								
204	Yamagata and Seya	2013	*Applied Energy*	**X**					
205	Zhang, Huang, Zhu and Qiu	2013	*International Journal of Distributed Sensor Networks*			**X**			
206	Tang et al.	2013	*International Journal of Communication Systems*				**X**		
207	Sánchez, Elicegui, Cuesta, Muñoz and Lanza	2013	*Sensors*				**X**		
208	Otero-Cerdeira, Rodríguez-Martínez and Gómez-Rodríguez	2014	*Sensors*				**X**		
209	Neirotti et al.	2014	*Cities*	**X**					**X**
210	Stratigea, Papadopoulou and Panagiotopoulou	2015	*Journal of Urban Technology*	**X**					
211	Coelho et al.	2017	*Applied Energy*					**X**	
212	Aina	2017	Cities				**X**		

213	Bashynska and Kaplun	2018	*Economics: Time Realities*						**X**
214	Marek, Campbell and Bui	2017	*Cities*			**X**			
215	Crivello	2015	*European Planning Studies*						**X**
216	Russo, Rindone and Panuccio	2016	*European Planning Studies*			**X**			
217	Soares, Borges, Fotouhi Ghazvini, Vale and De Moura Oliveira	2016	*Energy*					**X**	
218	Ma and Lam	2019	*Cities*	**X**					
219	Blanck, Ribeiro and Anzanello	2019	*Cities*	**X**					
220	Desdemoustier et al.	2019a	*Cities*		**X**				**X**
221	Alsaig, Alagar, Chammaa and Shiri	2019	*Sensors*	**X**	**X**				
222	Zhang et al.	2019	*Sensors*	**X**			**X**		
223	Akhter, Khadivizand,	2019	*Sensors*				**X**		

	Siddiquei, Alahi and Mukhopadhyay								
224	Ming and Wang	2019	*Sensors*					**X**	
225	Weber and Podnar Žarko	2019	*Sensors*	**X**					
226	Bhatti, Shah, Maple and Islam	2019	*Sensors*				**X**		
227	Chaturvedi and Kolbe	2019	*Sensors*				**X**	**X**	
228	Badii, Bellini, Difino and Nesi	2018	*Sensors*				**X**		
229	Malandra and Sansò	2018	*Mobile Networks and Applications*				**X**		
230	Hýllová and Slach	2018	*GeoScape*		**X**				
231	Granlund, Holmlund and Åhlund	2015	*Sensors*				**X**		
232	Sagl, Resch and Blaschke	2015	*Sensors*				**X**		
233	Zhao et al.	2018	*International Journal of Distributed Sensor Networks*				**X**		

234	De Maio, Fenza, Loia and Orciuoli	2017	*Journal of Parallel and Distributed Computing*				**X**		
235	Sodhro, Pirbhulal, Luo and De Albuquerque	2019	*Journal of Cleaner Production*				**X**		
236	Sánchez-Corcuera et al.	2019	*International Journal of Distributed Sensor Networks*				**X**		
237	Zang et al.	2017	*Personal and Ubiquitous Computing*				**X**		
238	Li et al.	2017	*Personal and Ubiquitous Computing*		**X**		**X**		
239	Calzada and Cobo	2015	*Journal of Urban Technology*				**X**		
240	Anthopoulos	2017	*Cities*	**X**					
241	Colmenar-Santos, Molina-Ibáñez, Rosales-Asensio and López-Rey	2018	*Energy*					**X**	
242	Calvillo, Sánchez-Miralles, Villar and Martín	2017	*Energy*				**X**		

243	Peng et al.	2018	*International Journal of Communication Systems*				**X**		
244	Michelucci, De Marco and Tanda	2016	*Journal of Urban Technology*	**X**					
245	Araujo, Mitra, Saguna and Åhlund	2019	*Journal of Parallel and Distributed Computing*				**X**		
246	Niu et al.	2015	*International Journal of Distributed Sensor Networks*					**X**	
247	Nižetić, Djilali, Papadopoulos and Rodrigues	2019	*Journal of Cleaner Production*				**X**	**X**	
248	Xia Li, Fong, Dai and Li	2019	*Journal of Cleaner Production*						**X**
249	Yigitcanlar and Kamruzzaman	2019	*Journal of Urban Technology*					**X**	**X**
250	Sun, Li, Zhang, Zhu and Gaire	2019	*Journal of Parallel and Distributed Computing*					**X**	

251	Iqbal and Khan	2018	*International Journal of Distributed Sensor Networks*					**X**	
252	Yigitcanlar et al.	2019a	*Journal of Urban Technology*				**X**		
253	Lakshmanaprabu et al.	2019	*Journal of Cleaner Production*		**X**	**X**			
254	Alkhatib, El Barachi and Shaalan	2019	*Journal of Cleaner Production*	**X**			**X**		
255	Chaves-Diéguez et al.	2019	*Sensors*				**X**		**X**
256	Gomez and Paradells	2015	*Sensors*			**X**			
257	Fernández-Güell, Collado-Lara, Guzmán-Araña and Fernández-Añez	2016	*Journal of Urban Technology*				**X**		
258	Colding and Barthel	2017	*Journal of Cleaner Production*	**X**					
259	Qi and Guo	2019	*International Journal of Distributed Sensor Networks*					**X**	

260	Sharifi	2019	*Journal of Cleaner Production*	**X**					
261	Baba, Gui, Cernazanu and Pescaru	2019	*Sensors*					**X**	
262	Yu and Zhang	2019	*Journal of Cleaner Production*	**X**					
263	Wu, Wang, Kumar and He	2017	*Personal and Ubiquitous Computing*				**X**		
264	Jabeur, Moh, Yasar and Barkia	2017	*Personal and Ubiquitous Computing*				**X**	**X**	
265	Poslad, Ma, Wang and Mei	2015	*Sensors*				**X**		
266	Guo, Lu, Gao and Cao	2018	*Sensor*				**X**		**X**
267	He, Weng, Mao and Yuan	2017	*Personal and Ubiquitous Computing*	**X**			**X**		
268	González-Zamar et al.	2020	*Electronics*						**X**
269	Ahn et al.	2016	*In International Conference on*						**X**

			Ubiquitous and Future Networks						
270	Berst	2013	*Smart City Council*						**X**
271	Brandt	2018	*Business and Information Systems Engineering*	**X**					
272	Desdemoustier et al.	2019b	*Technological Forecasting and Social Change*		**X**				**X**
273	Firmanyah, Supangkat, Arman and Adhitya	2018	*International Conference on ICT for Smart Society*						**X**
274	Giovannella	2014	*IEEE*			**X**			
275	Madakam and Ramaswamy	2015	*IEEE*						**X**
276	Picatoste et al.	2018	*Journal of Science and Technology Policy Management*						**X**
277	Supangkat et al.	2018	*Journal of Asia-Pacific Studies*						**X**
278	Szabo et al	2013	*IEEE*	**X**					**X**

279	SALGA	2015	*South African Local Government Association (SALGA)*		**X**				
280	Eremia, Toma and Sanduleac	2017	*Procedia Engineering*				**X**		
281	Musakwa and Mokoena	2018	*In Computers in Urban Planning and Urban Management*		**X**				
282	Aucamp, Pearton and Jansen Van Rensburg	2016	*In 35th Annual Southern African Transport Conference*		**X**				
283	Kamolov and Kandalintseva	2020	*Post-Industrial Society*		**X**		**X**	**X**	
284	Apostolopoulos et al.	2022	*Sustainable Cities and Society*		**X**		**X**	**X**	
285	Megahed and Abdel-Kader	2022	*Scientific African*	**X**			**X**		**X**
286	Lai and Cole	2022	*Urban Governance*	**X**			**X**		
287	Ushakov et al.	2022	*Transportation Research Procedia*				**X**		

288	Guenduez and Mergel	2022	*Cites*					**X**	
289	Galal and Elariane	2022	*HBRC Journal*	**X**	**X**			**X**	
290	Mashau, Kroeze and Howard	2020	*Smart Cities*	**X**		**X**	**X**		
291	Currin et al.	2022	*The Electronic Journal of Information Systems in Developing Countries*	**X**			**X**		
292	Scholtz and Van Der Hoogen	2022	*The 8th African Conference on Information Systems and Technology Proceedings*	**X**	**X**	**X**	**X**		
293	Bibri	2021	*Sustainable Futures*					**X**	**X**
294	Yigitcanlar et al.	2021	*Cities*	**X**			**X**		
295	Enwereji and Uwizeyimana	2022	*Journal of Business and Public Administration*	**X**	**X**	**X**	**X**		
296	Söderström, Blake and Odendaal	202	*Geoforum*	**X**					

297	Ji et al.	2021	*Sustainable Cities and Society*		**X**				
298	Mak and Lam	2021	*Sustainable Cities and Society*		**X**				
299	Bibri	2021	*European Journal of Futures Research*	**X**	**X**		**X**		
300	Kim and Kim	2021	*Journal of Open Innovation: Technology, Market, and Complexity*				**X**		
301	Ivars-Baidal et al.	2021	*Journal of Destination Marketing Management*		**X**			**X**	
302	Qayyum et al.	2021	*Sustainable Cities and Society*		**X**		**X**		
303	Ullah et al.	2021	*Technological Forecasting and Social Change*					**X**	
304	Mashau, Kroeze and Howard	2021	*Lecture Notes in Computer Science*	**X**		**X**	**X**		
305	Ramos et al.	2021	*Philippine Institute for Development Studies*		**X**				

306	Kumar et al.	2020	*Technological Forecasting and Social Change*		**X**	**X**			
307	Maccani et al.	2020	*Government Information Quarterly*	**X**	**X**				
308	Erastus, Jere and Shava	2020	3rd International Conference on Innovation Computing and Communication		**X**		**X**		
309	Antoni, Arpan and Supratman	2020	5th International Conference on Informatics and Computing	**X**				**X**	
310	Das	2020	*Construction Economics and Building*	**X**			**X**	**X**	**X**
311	Aghimien et al.	2020	*Smart and Sustainable Built Environment*					**X**	
312	Khan et al.	2020	*Sustainable Development*				**X**		
313	Hatuka and Zur	2020	*Telematics and Informatics*	**X**					

314	Sharifi	2020	*Sustainable Cities and Society*	**X**			**X**		
315	Marsal-Llacuna	2020	*Technological Forecasting and Social Change*				**X**		
316	Sharifi	2020	*Data in Brief*				**X**		
317	Noori, De Jong and Hoppe	2020	*Smart cities*	**X**					
318	Gobin-Rahimbux et al.	2020	*Information and Communication Technology for Sustainable Development*	**X**			**X**		
319	Arief at al.	2020	*Journal of Physics: Conference Series*						

Annexure B: Non-human ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

15 December 2020

Dear Mr Mashau

ERC Reference #: 2020/CSET/SOC/058
Name: Nkhangweni Lawrence Mashau
Student #: 47198028

Decision: Ethics Approval from 15 December 2020 to 14 December 2025 (No humans involved)

Researcher: Mr Nkhangweni Lawrence Mashau
47198028@mylife.unisa.ac.za, 015 962 9267, 076 200 8955

Supervisors: Prof. Jan Kroeze
Department of Information Systems, kroezjh@unisa.ac.za, 011 670 9117

Dr Grant Howard
Department of Information Systems, Howargr@unisa.ac.za, 011 471 2273

Working title of research:

An integrated conceptual framework to assess smart city readiness in small and rural municipalities: A systematic literature review

Qualification: PhD in Information Systems

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

The ***negligible risk application*** *was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 15 December 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics

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attached.

2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date 14 December 2025. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note

The reference number 2020/CSET/SOC/058 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

C Pilkington

Dr C Pilkington
Chair of School of Computing Ethics Review Subcommittee
College of Science, Engineering and Technology (CSET)
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Acting Executive Dean
Fulufhelo Nemavhola
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Annexure C: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

2022/03/01

Dear Mr Nkhangweni Lawrence Mashau

ERC Reference #: 2022/CSET/SOC/001
Name: Nkhangweni Lawrence Mashau
Student #:47198028
Staff #:

Decision: Ethics Approval from 2022/03/01 to 2027/03/01 Humans involved.

Researcher(s): Nkhangweni Lawrence Mashau
47198028@mylife.unisa.ac.za, 0762008955

Supervisor (s): Prof. Jan Hendrik Kroeze
kroezjh@unisa.ac.za, 0116709117

Working title of research:

Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation

Qualification: PhD in Information Systems

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2022/03/01 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

Open Rubric

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PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date *expiry date*. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

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Note

The reference number 2022/CSET/SOC/001 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

Dr D Bisschoff
Chair of School of Computing Ethics Review Subcommittee
College of Science, Engineering and Technology (CSET)
E-mail: dbischof@unisa.ac.za
Tel: (011) 471-2109

Prof. E Mnkandla
Director: School of Computing
College of Science Engineering and Technology (CSET)
E-mail: mnkane@unisa.ac.za
Tel: (011) 670 9104

Prof. B Mamba
Executive Dean
College of Science Engineering and Technology (CSET)
E-mail: mambabb@unisa.ac.za
Tel: (011) 670 9230

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Annexure D: Amended ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

2022/03/01

Dear Mr Nkhangweni Lawrence Mashau

ERC Reference #: 2022/CSET/SOC/001
Name: Nkhangweni Lawrence Mashau
Student #:47198028
Staff #:

Decision: Ethics Approval from 2022/04/22 to 2027/04/22 Humans involved.

Amendment to the certificate issued on 2022/03/01.

Researcher(s): Nkhangweni Lawrence Mashau
47198028@mylife.unisa.ac.za, 0762008955

Supervisor (s): Prof. Jan Hendrik Kroeze
kroezjh@unisa.ac.za, 0116709117

Working title of research:

Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation

Qualification: PhD in Information Systems

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2022/04/22 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

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The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date *expiry date*. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

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Note

The reference number 2022/CSET/SOC/001 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

Dr D Bisschoff
Chair of School of Computing Ethics Review Subcommittee
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Annexure E: Interview guide

INTERVIEW GUIDE

Researcher name: Mr Nkhangweni Lawrence Mashau

Research title: Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

Date: December 2021

Section A: Questions on smart city

1. What is your understanding of the smart city concept?
2. As a municipality, have you engaged in a smart city initiative(s)/project(s) or are you planning to? If yes, please indicate what were/are the initiatives all about.
3. Who is/are responsible for smart city initiatives?
4. What are the factors that you think are important for smart city implementation and why?
5. Who are the important stakeholders when implementing a smart city concept?
6. What are the challenges of implementing the smart city?
7. What are the important information systems drivers in the successful implementation of a smart city concept and why?
8. What are the information systems drivers that are currently available in this municipality?
9. If there are any information systems drivers, what do you use them for?
10. What are the important smart services in the successful implementation of a smart city concept?
11. What are the smart services that are currently available in this municipality?
12. If there are any smart services, what do you use them for?

Section B: Smart city readiness

13. When implementing a smart city, do you start by assessing municipality readiness?
    19.1. If yes, explain the framework you use to assess municipality readiness.

19.2. If no, explain how South African small and rural municipalities' readiness for smart implementation can be determined.

14. Why is small and rural municipality readiness important for smart city implementation?
15. What are the factors that you think are important for South African small and rural municipalities' readiness for smart city implementation and why?
16. Who are the responsible agents for South African small or rural municipalities' readiness for smart city implementation?
17. Why is South African small and rural municipalities' readiness important for smart city implementation?
18. When will the city under this municipality be smart?

Section C: A proposed conceptual framework based on the literature review

Please review the proposed integrated framework based on the literature review in **Figure 1** below and respond to the following question:

19. Does the proposed integrated framework to assess small and rural municipalities' readiness for smart city implementation address a real problem/need?
20. Would you consider this integrated framework suitable to assess small and rural municipalities' readiness for smart city implementation within the South African environment?
21. What effect(s) can the proposed integrated framework have in small and rural municipalities?
22. What is missing in the proposed integrated framework?

Proposed conceptual framework based on the literature review

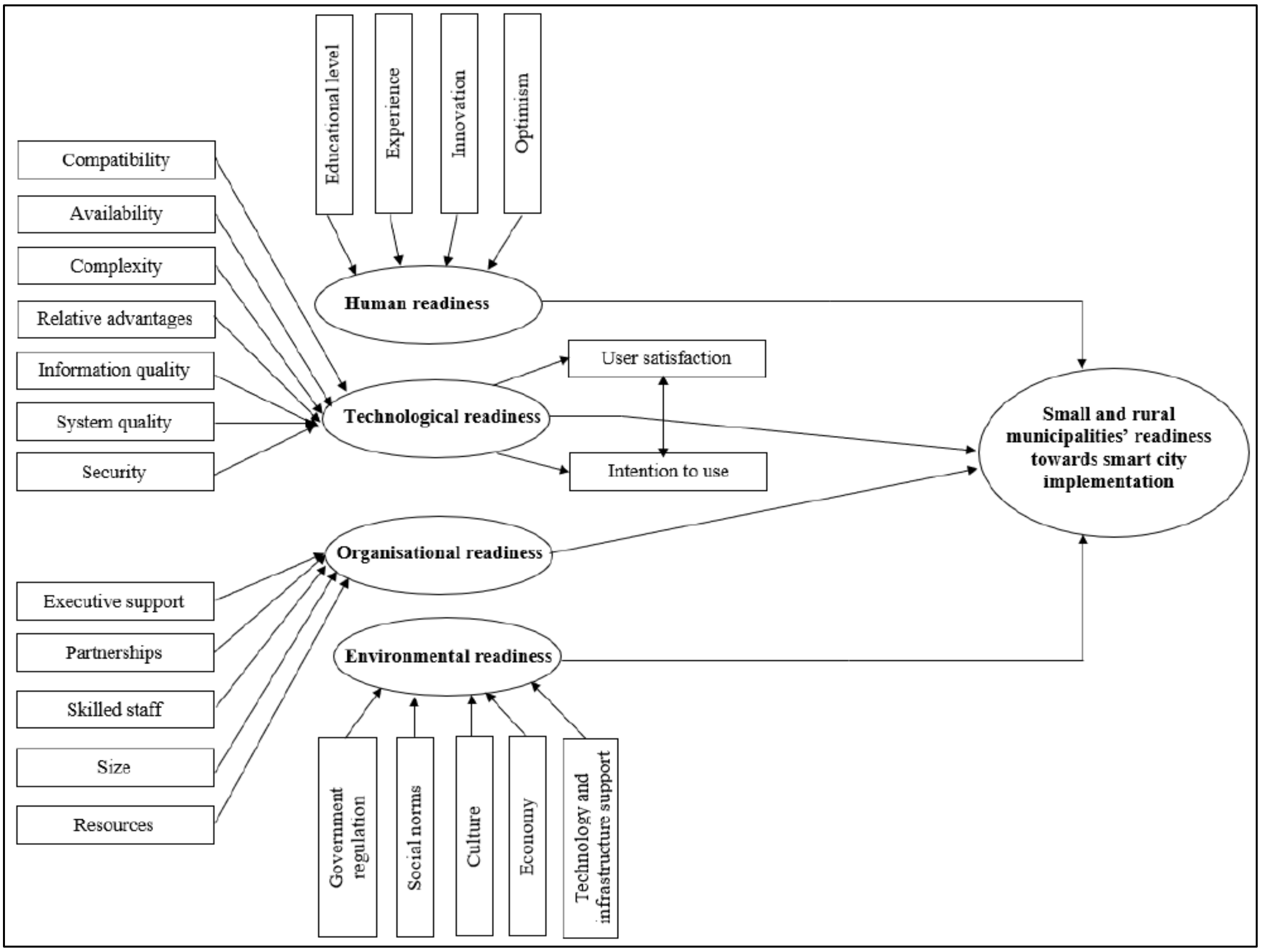

Figure 1: Proposed integrated framework

Annexure F: Protocol used to evaluate and validate the integrate framework

GUIDELINE TO EVALUATE AND VALIDATE AN INTEGRATED FRAMEWORK

Researcher name: Mr Nkhangweni Lawrence Mashau
Research title: Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation

Dear Participant,

I, Nkhangweni Lawrence Mashau (Student Number: 47198028), am doing research with Prof JH Kroeze who is a research professor. Prof JH Kroeze is an academic in the School of Computing at the University of South Africa (UNISA). We are inviting you to participate in a study titled "Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation". I am, therefore, inviting you to evaluate or review the revised framework and assessment tool per our agreement. The online evolution of the framework and assessment tool will take 15 to 45 minutes.

CONSENT TO PARTICIPATE IN THIS STUDY

I confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation. I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study. I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable). I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings but that my participation will be kept confidential unless otherwise specified.

I agree to participate in the research project under the condition described above *

Yes, I agree to participate

No, I do not wish to participate

*Required

Review the revised framework and assessment tool

To view/inspect the revised framework and assessment tool click this link: https://docs.google.com/document/d/1esGKHApl_lPJsArNFYlHcAMTo2q30q47/edit?usp=share_link&ouid=111659728629798321289&rtpof=true&sd=true

Based on your assessment of the revised conceptual framework and assessment tool, please answer the questions below.

1. How relevant is the revised integrated framework for assessing small and rural municipalities' readiness for smart city implementation?

*

Your answer

2. What is missing in the revised integrated framework?

*

Your answer

3. In your context, do you expect the application of the framework to yield any good results?

*

Your answer

4. Would it be simple to understand the revised integrated framework?

*

Your answer

5. Would it be easy to use the revised integrated framework to assess South African small and rural municipalities’ readiness for smart city implementation?

*

Your answer

6. What are the strengths and weaknesses of the revised integrated framework?

Your answer

7. Do you consider the revised integrated framework as a framework that can be used to assess South African small and rural municipalities' readiness comprehensively and rigorously for smart city implementation?

*

Your answer

8. Do you consider the revised integrated framework suitable to assess small and rural municipalities' readiness for smart city implementation looking at the South African environment?

*

Your answer

9. What effect(s) could the revised integrated framework have in small and rural municipalities?

*

Your answer

10. Is the revised framework suitable to assess small and rural municipalities' readiness for smart city implementation?

*

Your answer

11. Is the suggested assessment tool complete and suitable for use to enable a municipality to measure or judge its level of readiness for smart city implementation?

*

Your answer

Back

Submit

Clear form

Never submit passwords through *Google Forms*.

Never submit passwords through *Google Forms*.

Annexure G: Consent form

Researcher name: Mr. Nkhangweni Lawrence Mashau
Research title: Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

Date: December 2021

CONSENT TO PARTICIPATE IN THIS STUDY

I, ___________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the interview.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname………………………………………… (please print)

Participant Signature…………………………………………….Date…………………

Researcher's Name & Surname……………………………………… (please print)

Researcher's signature……………………………………………|Date…………………

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Annexure H: Permission letter

The details of the municipality are hidden in order to protect their anonymity, unless they grant permission to do so.

UNISA university of south africa

[redacted]

February 2022

Dear Sir/ Madam

Request for permission to conduct research at [redacted] local municipality

I, Nkhangweni Lawrence Mashau (Student Number: 47198028), am doing research with Prof JH Kroeze who is a research professor and Dr G Howard who is a senior lecturer. Prof JH Kroeze and Dr G Howard are academics in the School of Computing at the University of South Africa (UNISA). We are inviting you to participate in a study titled "Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation".

The aim of the study is to:

- establish the importance of assessing South African small and rural municipalities' readiness for smart city implementation
- identify influential aspects to determine South African small and rural municipalities' readiness for smart city implementation from an IS perspective
- explore required aspects for small and rural municipalities' readiness for smart city implementation
- identify information system drivers for smart city development and their significance
- determine responsible agents for South African small and rural municipalities' readiness for smart city implementation
- identify aspects that are important for South African small and rural municipalities' readiness for smart city implementation

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- develop an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation
- evaluate the developed integrated framework to assess South African small and rural municipalities' readiness for smart city implementation

In this study, nine (9) municipalities are purposively selected to identify interview participants that will be used for data collection. Another group of participants will be selected from the interviewee to assist in the development of a draft framework that will be used to assess small (B3) and rural (B4) municipalities for smart city readiness. Your municipality has been selected because it falls under the B3 or B4 category. The interest of this research caters for small and rural municipalities in South Africa. This municipality will assist us in gaining more understanding of the aspects that are of significance when assessing small and rural municipalities' readiness for smart city implementation.

This study will have three iterations. But your municipality will be involved in two iterations. In the first iteration, I will collect data using semi-structured interviews with the selected participants from your municipality. These interviews will be conducted via MS Teams or Face-to-Face and they will be recorded. Each interview session will take approximately 45 minutes. Furthermore, in the second iteration, data will be collected from selected participants from the interview group using an online questionnaire via Google Forms in order to check if user needs are addressed in the draft framework. This Iteration will take approximately 40 Minutes.

For the potential participants to qualify to participate in this study, they must be small or rural municipality officials who are entrusted with the responsibilities to implement smart city services or a smart city concept and integrated development planning (IDP). Potential participants may include decision-makers like mayors, deputy mayors, councilors, municipality managers, senior managers, middle managers, junior managers and information technology officials.

Following the gatekeeper's permission at each municipality, potential participants will be contacted as guided by the gatekeeper to ask if they wish to participate and their participation is completely voluntary. Once establishing the first contact person,

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participants will be selected using purposive sampling and more participants will then be selected using the snowball sampling method, thus, asking the participants to help identify further potential participants with similar experience and expertise.

The potential benefits of this study will be an integrated framework that may assist small and rural municipalities in assessing their readiness for smart city implementation. This framework will be developed specifically by looking at small and rural municipalities. It may serve as a foundation for any smart city implementation project. The proposed framework could be used by any officials who are entrusted with the responsibilities of implementing a smart city. This framework has the potential to help small and rural municipalities to identify significant components for smart city implementation. This may help rural and local municipalities to allocate and save resources in their smart city initiative.

There will be no compensation, reimbursement or incentives for participating in this study. There are no foreseeable negative risks involved in this research. The only foreseeable inconvenience will be the time requested by the researcher for the participants to participate in this study. Please be assured that the information collected or discussed during the data collection process will be used strictly for the purpose of this study and will be treated confidentially.

Once the research is completed, the findings will be available to the participants on request. The results will also be published in academic journals and conferences. The names of the municipalities and participants will not be included in any published records of the research. No one will be able to connect any findings to a specific municipality or participant. A pseudonym will be assigned to a municipality and participant to protect the participants' identity. The assigned pseudonym will be used in any publication or other research reporting methods. All data will be kept in secured files, in accordance with the standards of the University of South Africa. All information that can expose participants' identities will be removed immediately after the completion of each interview. Therefore, no one will be able to know your interview responses. Upon the completion of this study, all data will be stored in a protected digital folder that can be accessed by the researcher. The records will be kept for five years and after that they will be permanently destroyed.

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The results from this study will be used to assist small and rural municipalities in assessing their readiness before they implement a smart city concept. Assessment of small and rural municipalities' readiness for smart city implementation has not received much attention, especially in developing countries. This study will contribute to the body of knowledge in the smart city domain because it will provide small and rural municipalities with an integrated framework to assess their readiness for smart city implementation.

I therefore request your permission to conduct research at this municipality. I also request permission to use the following documents to cross-check research findings: **policies, meeting minutes, reports and newsletters**. Any sensitive information from these documents will be treated confidentially. Since these documents have sensitive information, please tick "**Yes**" if you are granting the permission and tick "**No**" if you are not granting the permission.

Table 1: Document permission.

NO	Document type	Yes	No
1	Municipality policies		
2	Meeting minutes		
3	Municipality reports		
4	Newsletters		

Should you require any further information or want to contact the researcher about any aspect of this study, please contact me, Nkhangweni Lawrence Mashau, on 076 200 8955 or mashau.lawrence@gmail.com. Should you have concerns about the way in which the research has been conducted, you may contact Prof JH Kroeze on 011 670 9117 or kroezjh@unisa.ac.za. Contact the research ethics chairperson of the Unisa School of Computing, Dr D. Bisschoff, on 011 471 2109 or dbischof@unisa.ac.za if you have any ethical concerns.

NL Mashau (**UNISA PhD Student**)

07/02/2021
Date

Permission to conduct this research at [redacted] Local Municipality is given by:

Name: ______________________________

Designation: ______________________________

Signature: ______________________________ Date: ______________________________

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Annexure I: Participant information sheet

The details of the municipality are hidden in order to protect their anonymity, unless they grant permission to do so.

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2022/CSET/SOC/001

Research permission reference number (delete if not applicable):

December 2021

Title: Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation

Dear Prospective Participant

My name is Nkhangweni Lawrence Mashau (Student Number: 47198028) and I am conducting research under the supervision of Prof JH Kroeze, who is a research professor and Dr G Howard, a senior lecturer in the Department of Information Systems, School of Computing at the University of South Africa. I hereby invite you to participate in a study entitled "Developing an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation".

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research in order to:

- establish the importance of assessing South African small and rural municipalities' readiness for smart city implementation
- identify influential aspects to determine South African small and rural municipalities' readiness for smart city implementation from an IS perspective
- explore required aspects for small and rural municipalities' readiness for smart city implementation
- identify information system drivers for smart city development and their significance.
- determine responsible agents for South African small and rural municipalities' readiness for smart city implementation
- identify aspects that are important for South African small and rural municipalities' readiness for smart city implementation
- develop an integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

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- evaluate the developed integrated framework to assess South African small and rural municipalities' readiness for smart city implementation.

WHY AM I BEING INVITED TO PARTICIPATE?

I obtained your contact details from your colleague during our conversation regarding this study. You are cordially invited to participate in this study because you either work for a small (B3) or rural (B4) municipality and you are entrusted with responsibilities to implement smart city services or smart city concept and integrated development planning (IDP). Another reason for you to be invited as a participant is that you participate in [redacted] local municipality decision-making process. You are either a mayor, deputy mayor, councilor, municipality manager, senior manager, middle manager, junior manager or information technology officials.

In this study, nine (9) municipalities were purposively selected to identify interview participants. We are targeting a minimum of 18 participants to be interviewed in this study. The information that you will provide will help us to develop an intergraded framework that will be used to assess small (B3) and rural (B4) municipalities' readiness for smart city implementation.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves the use of a semi-structured interview to collect data from the selected participants. The interviews will be recorded and kept safe in the password-protected folder. The interview questions will allow the participants to express their views on municipality readiness and smart city implementation. The duration for each interview session will not exceed forty-five (45) minutes.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participation in this study is voluntary and you are under no obligation to consent to participate. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw before any data collection session without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

By taking part in this study, you will help us to develop an integrated framework that will be used to assess small and rural municipalities' readiness for smart city implementation. The developed framework may serve as a foundation to municipalities that want to engage in a smart city project. This framework has the potential to assist small and rural municipalities in identifying significant components that will need attention before smart city implementation. The framework

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can be used by any municipality officials who are charged with the responsibilities to implement a smart city concept and it may save them time. In addition, the framework may save municipal resources towards the implementation of a smart city concept.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

The only foreseeable risk of harm is the potential for minor discomfort or inconvenience, thus research that would not pose a risk above the everyday norm. The inconvenience might include the time that will be spent during the interview. Please be assured that the information collected or discussed during the data collection process will be used strictly for the purpose of this study and will be treated confidentially.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to request the researcher not to record your name anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this study. If your name is recorded, it will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

Your anonymous data that will be collected through an interview may be used for other purposes, such as a research report, journal articles and/or conference proceedings. However, participant privacy will be protected in any publication of the information. In any publication, the individual participant won't be identified because the researcher will use pseudonyms to protect their identity.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of data will be stored by the researcher for a minimum period of five years in a locked cupboard/filing cabinet the work office of the doctoral student or as appropriate. All electronic files and folders will be password protected. These electronic data will be stored in a password protected doctoral candidate's computer. The backup of the electronic data will be saved in the external hard drive. The external hard drive will be locked in the cupboard/ filing cabinet in the doctoral student work office. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After the applicable period, hard copies will be shredded and electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There will be no payment or incentives, either in the form of money or gifts. Participants will not be compensated or reimbursed by the researcher for any cost that they may incur to participate in the data collection process.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the School of Computing, UNISA. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

Once the research has been completed, the findings will be available to the participants on request. If you would like to be informed of the final research findings, please contact Nkhangweni Lawrence Mashau on 0762008955 or alternatively send an email to: Mashau.lawrence@gmail.com.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact me, Nkhangweni Lawrence Mashau, on 076 200 8955 or mashau.lawrence@gmail.com. Should you have concerns about the way in which the research has been conducted, you may contact Prof. JH Kroeze on 011 670 9117 or kroezjh@unisa.ac.za. Contact the research ethics chairperson of the Unisa School of Computing Dr D. Bisschoff on 011 471 2109 or dbischof@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

Nkhangweni Lawrence Mashau (UNISA PhD Student)

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Annexure J: Gatekeeper permission letter

The details of the participating municipalities are hidden in order to protect their anonymity, unless they grant permission to do so.

[redacted]

[redacted] **LOCAL MUNICIPALITY**

Enq : [redacted]
Tel : [redacted] *851 0110*

DATE: 16 MARCH 2022

University of South Africa
Preller Street Muckleneuk Ridge. City of Tshwane
PO Box 392 UNISA
Pretoria
0003 South Africa

Dear Sir/ Madam

SUBJECT: LETTER OF PERMISSION TO CONDUCT RESEARCH FOR Mr NL MASHAU.

1. The above matter refers.
2. This serves to confirm that **Mr MASHAU NL,** PhD in Information Systems student at University of South Africa (UNISA) has been granted a permission to conduct research in [redacted] Local Municipality.
3. The research is based on "Developing an integrated framework to assess South African small and rural municipalities' readiness for smart implementation".
4. Hope you find this in order.

Regards

[redacted]

ACTING MUNICIPAL MANAGER

Vison: "A spatially integrated and sustainable local economy by 2030"

Mission: To ensure the provision of sustainable basic services and infrastructure to improve the quality of life of our people and to grow the local economy for benefit of all citizens

Annexure K: Language editing certificate

Certificate of Editing

PhD Thesis

DEVELOPING AN INTEGRATED FRAMEWORK TO ASSESS SOUTH AFRICAN SMALL AND RURAL MUNICIPALITIES' READINESS FOR SMART CITY IMPLEMENTATION

by

NKHANGWENI LAWRENCE MASHAU

Edited for English language usage

Lorinda Gerber
21st of June 2023

University of Cape Town · Universiteit van Kaapstad · iYunivesithi yaseKapa

Copy-Editing

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