

A coalescence of sustainable development goals and disaster risk reduction in the City of Tshwane

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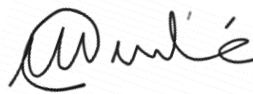
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Graduation October 2022

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.



Signature

Date: 1 June 2022

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First and foremost, I wish to convey my deepest gratitude to the Almighty God for giving me the vision, energy and courage to initiate and execute this study.

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SUMMARY

Currently, the rapid increase of urbanisation is slated to increase; it is estimated that by 2050, more than 2.5 billion people will be living in urban areas. As cities continue to grow, there is an urgent need to focus their efforts on development and the disasters that threaten the cities' sustainability and safety. Sustainable Development Goal (SDG) 11, namely *Make cities and human settlements inclusive, safe, resilient and sustainable*, brings sustainability and resilience to the fore. Cities should be facilitated to determine their resilience to disasters, as well as to be prepared to continue providing essential services should a disaster be imminent. In this context, improving cities' compliance with SDGs and resilience to expected and unexpected disasters is of utmost importance and requires a holistic approach.

City of Tshwane (CoT) has a long-term plan to address disaster resilience. The city developed the Vision 2055, which is regarded as critical in maintaining its resilience. However, insufficient evidence exists on how the city infuses disaster risk reduction (DRR) measures and the SDGs into its disaster resilience strategy. Thus, a need to promote a common integrated approach that will simultaneously address the city's disaster resilience and SDGs has emerged.

Therefore, this study sought to examine and establish how the coalescence of DRR and SDGs can form part of CoT's disaster resilience planning strategy, as well as how international disaster resilience frameworks are developed for cities. The study then set out to develop a disaster resilience framework with indicators to assist the CoT in incorporating DRR measures and SDGs in its disaster resilience planning strategy.

This qualitative research study is situated in an interpretivist research paradigm. The research assumed a case study design using qualitative methods in the form of a literature study, document analysis, and one-on-one interviews to identify the DRR measures and SDGs implemented in CoT and international frameworks. The latter provided a broad view of how CoT's DRR measures and SDGs are integrated into frameworks to determine its resilience to disasters. The study reviewed CoT's documents relevant to DRR and sustainable development, as well as four international disaster resilience frameworks developed for cities to identify commonalities as well as unique aspects underlying each framework. Data generation also entailed one-on-one interviews with purposively sampled officials from CoT Emergency Services,

Disaster Risk Management, and the City Sustainability department. Content analysis of the documents relevant to DRR and sustainable development, as well as the four disaster resilience frameworks developed for cities was followed by a comparative analysis of the four frameworks. Thematic analyses were applied to the data from the one-on-one interviews. Trustworthiness strategies and criteria were used to enhance the trustworthiness of this qualitative research study. Due consideration was given to ethical requirements.

The findings that emerged during data analysis include:

- That CoT, as a complex adaptive system, has a range of strategic documents and programs that address DRR measures and the SDGs but no consolidated disaster resilience strategy exists.
- That there is limited knowledge in CoT of the internationally adopted Sendai Frameworks priority DRR measures and the United Nations' (UN) 2030 SDGs.
- That clear themes for a disaster-resilient city emerged from known city resilience frameworks and CoT strategic documents and programmes.

This research study included the design and development of a comprehensive city disaster resilience framework for CoT. There were 10 indicators found to be essential in the city's endeavour to be a disaster-resilient and sustainable city. In conclusion, a framework was developed for integrating disaster resilience measures and SDGs in CoT's multi-sectoral disaster planning to augment its ability to reduce disaster risk and enhance the city's resilience to disasters.

Keywords: Disaster resilience, Disaster(s), Disaster Risk Reduction, Sustainable development, Sustainable Development Goals.

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LIST OF ABBREVIATIONS

CAP	Climate Action Plan
CityRAP	City Resilience Action Planning
CoT	City of Tshwane
CSIR	Council for Scientific and Industrial Research
DFID	Department for International Development
DRR	Disaster Risk Reduction
DR&VA	Disaster Risk and Vulnerability Assessment
DRMP	Disaster Risk Management Plan
ESD	Emergency Services Department
FNASREC	Faculty of Natural and Agricultural Sciences Ethics Committee
GDP	Gauteng's Gross Domestic Product
NDMC	National Disaster Management Centre
HDA	Housing Development Agency
KPA	Key Performance Areas
PAR	Pressure and Release Model
SDG	Sustainable Development Goal
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
UN-HABITAT	United Nations Human Settlements Programme
UNDRR	United Nations Office for Disaster Risk Reduction

UNISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
WCED	World Commission on Environment and Development

CHAPTER ONE: OVERVIEW OF THE STUDY

1.1 INTRODUCTION

This study researches a coalescence of Disaster Risk Reduction (DRR) measures and the Sustainable Development Goals (SDGs) in the City of Tshwane's (CoT) disaster resilience planning strategy. The research aims to develop a disaster resilience framework for CoT that will allow the city to determine its resilience to disasters and assist it in incorporating DRR measures and the SDGs into the strategy.

Chapter One begins with the motivation for the research study, leading to the problem statement explanation and a description of the research questions. The chapter further introduces the methods and strategies used in the study. Furthermore, ethical aspects related to the study are introduced, with the chapter breakdown following thereafter.

1.2 ORIENTATION AND PROBLEM STATEMENT

The year 2020 marked a turning point in the global quest for sustainable development, with cities home to a growing majority of the world's population (United Nations Human Settlements Programme [UN-Habitat], 2020:xv). Progress towards sustainable development proved slow, prompting the United Nations (UN) to announce a '2020 to 2030 Decade of Action', the ten-year period during which national and local governments, the private sector and civil society must accelerate their efforts to deliver on the SDGs (Van Tulder *et al.*, 2021:12). By 2030, countless local actions, the vast majority to be performed in cities or by city leaders, must collectively add up to a global shift toward a more sustainable future that reduces poverty, improves health outcomes, expands access to education and reduces carbon emissions, among other societal challenges (UN-Habitat, 2020:xv). Since 2015, the international community has adopted several key agreements to guide development. The **2030 Agenda for Sustainable Development** (UN, 2015), **Paris Agreement** (United Nations Framework Convention on Climate Change [UNFCCC], 2015), **New Urban Agenda** (UN-Habitat, 2016) and the **Sendai Framework for DRR** (UNDRR, 2015) amongst others, collectively form the backbone of international development policy, recommendations, goals, targets and indicators for member states. In each of these documents, local governments are recognised as important partners in the drive to a more sustainable future. The role of cities is woven throughout this tapestry of agreements, most

prominently in SDG 11, regarding sustainable cities and communities, and the urban dimension of the SDGs.

In their *World Cities Report*, the United Nations Human Settlement Programme (UN-Habitat) reported that cities are consuming land faster than they grow in population due to the increasingly common phenomenon of urban sprawl. Whether horizontal spreading, dispersed urbanisation or peri-urbanisation, the physical extent of urban areas is growing much faster than their population, thereby consuming more land for urban development (UN-Habitat, 2020:xvi). The unbridled expansion of urban areas has profound implications on energy consumption, greenhouse gas emissions, climate change and environmental degradation. The speed and scale of urbanisation also bring challenges, such as the provision of basic services and infrastructure (World Bank, 2020:1).

As cities continue to grow, there is an urgent need for cities to focus their efforts towards resilience to disasters and disturbances that threaten the cities' safety and sustainability (Prior & Roth, 2013:23; Weichselgartner & Kelman, 2015:249). Both nature-induced and human-made disasters can disrupt everyday life, causing economic loss and infrastructure damages, as well as the injury or loss of human life. Disasters not only create immediate humanitarian crises but also affect the development of a city in the long term (Asprone *et al.*, 2015:96; Wamsler, 2016:184).

To reduce the risk of and impact from disasters and increase the safety and well-being of citizens, cities must be more resilient and prepared to address and respond to disruptions. In this context, improving cities' level of resilience to expected and unexpected disasters is of the utmost importance and requires a holistic approach (Wilkinson, 2012:73; Collier *et al.*, 2013:21).

In South Africa, *city resilience* is commonly used as an approach for addressing a city's DRR measures. The City of Johannesburg, for instance, made urban resilience one of the key themes in its new Growth and Development Strategy known as *Jo'burg 2040*. It refers to social, environmental and economic resilience as part of its sustainable development measures (City of Johannesburg, 2011:11). eThekweni Municipal Council adopted the City Resilience Index following a successful bid to the Rockefeller Foundation Resilience Strategy. There were six levels identified for the resilience strategy, namely (i) strengthening local communities and building social cohesion, (ii)

improving the effectiveness of education and skills development, (iii) promoting economic growth, (iv) managing environmental assets more effectively, (v) creating a more inclusive and integrated spatial plan and (vi) improving municipal effectiveness (Roberts *et al.*, 2020:547). In 2019, the City of Cape Town was selected for a grant, pioneered by the Rockefeller Foundation, to support the development of a Cape Town Resilience Strategy. The strategy also adopted the City Resilience Index and identified five pillars as the core to a resilient Cape Town (namely a compassionate and holistically healthy, connected and climate-adaptive, capable and job-creating, collective and shock-ready, and collaborative and forward-looking city) (Croese *et al.*, 2020:6).

However, both CoT and the City of Ekurhuleni do not have resilient-specific strategies. They have incorporated resilience in their long-term planning strategies. CoT developed Vision 2055 (CoT, 2012) and the Vision 2030 Integrated Development Plan (IDP) (CoT, 2018), and Ekurhuleni developed its Growth and Development Strategy for 2025 (Ekurhuleni Metropolitan Municipality, 2005:35), respectively.

In 2015, UN members agreed on a specific resilience goal for urban areas, as part of the 2030 Agenda for Sustainable Development's 17 SDGs (UN, 2015:1). Emphasis is given to cities and human settlements adopting and implementing integrated policies and plans towards safety, inclusion, resource efficiency, mitigation and adaptation to climate change and resilience to disasters. SDG 11 brings sustainability and resilience to the foreground: "Make cities and human settlements inclusive, safe, resilient and sustainable" (UN, 2015:14).

Apart from SDG 11, resilience in cities is acknowledged both explicitly and implicitly in other SDG targets. SDG 1's Target 1.5 aims for instance, by 2030, to build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to extreme climate-related events and other economic, social and environmental shocks and disasters (UN, 2015:15). SDG 9's Target 9.1 emphasises building resilient infrastructure (UN, 2015:20) while SDG 13's Target 13.1 aims to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters (UN, 2015:23). Reducing disaster risk and building resilience is therefore an interrelated thrust of the 2030 Agenda for Sustainable Development; with cities being identified as one of the key stakeholders in the process of making cities resilient.

Though all levels of government are generally expected to become involved in sustainable development, the role and actions of a local government in making cities disaster-resilient is critical (Basu *et al.*, 2013:251). Malalgoda *et al.* (2011:8) agree that local government is best placed in the process of making cities disaster-resilient. As such, there is widespread agreement within the literature that local governments have a vital role in making cities resilient to disasters and also achieving the 2030 SDGs (Malalgoda *et al.*, 2013:ii; Schofield & Twigg, 2016:3; Gencer, 2017:9).

However, local government and its practitioners, who have the responsibility for building city resilience, need support and guidance to operationalise the resilience-building process (Weichselgartner & Kelman, 2015:249). Cities should be provided with means determining their resilience and be prepared to continue providing essential services should a disaster incident occur (Sharifi, 2016:629). Moreover, the SDGs and their targets stress the need for a framework of indicators to allow cities to determine their resilience and sustainability (Croese *et al.*, 2020:5). It is against this background that emerging demographics, urbanisation, climate trends, policy and assessment frameworks are needed to promote a common integrated approach that will simultaneously address city disaster resilience and its compliance to the SDGs. Strategic measures for monitoring and reporting progress made by cities in their endeavour to be disaster-resilient are therefore core elements of disaster risk management and sustainable development (Marzi *et al.*, 2019:3; Bello *et al.*, 2021:49).

Several frameworks and conceptual models have been developed to define the attributes and priority areas of monitoring cities' resilience. The Rockefeller Foundation and Arup developed a City Resilience Index that defines resilient systems and provides measurable indicators to guide cities in their resilience endeavour (Rockefeller & Arup, 2014:4). The UNDRR, formerly known as the United Nations International Strategy for DRR (UNISDR), developed the Ten Essentials Scorecard based on the Sendai Framework for DRR 2015-2030 priorities; it is hoped that this scorecard would assist cities in reducing disaster risks and losses and strengthen assets in cities (UNDRR, 2014). These frameworks demonstrate that building city resilience requires a holistic approach that includes understanding dependencies across city services, potential vulnerabilities and cascading effects, and cross-organisational resilience and collaborative efforts (Collier *et al.*, 2013:21; Jabareen, 2013:220; Aldunce *et al.*,

2016:58). The frameworks emphasise the key role of stakeholders in the resilience-building process and assist cities in developing disaster resilience strategies.

Specific to this research is the long-term strategy developed by CoT. Vision 2055 highlights four main principles which are believed to be critical in maintaining the city's resilience, namely (CoT, 2012:4):

- Building a resilient economy that can adapt to difficult circumstances, such as the impact of the recent global crisis (economic sustainability);
- Creating a resilient environmental system that can withstand environmental changes and disasters (environmental sustainability);
- Planning for a resilient social urban system that demonstrates high levels of inclusivity (social sustainability); and
- Ensuring a resilient governance system where there is capacity and capability to provide leadership, as well as institutions to support the developmental aspirations of the city's citizens and support an active citizenry (institutional sustainability).

Although CoT's approach is a long-term plan, which is distinctly different from medium- or short-term plans, insufficient evidence exists on how the city infuses DRR measures and the SDGs into its disaster resilience strategy. In April 2019, a CoT status quo report on a Disaster Risk and Vulnerability Assessment (DR&VA) was submitted by Disaster Risk Management Non-Profit Company (trading as DMS NPC). The report provided a current reality analysis of identified and prioritised risks based on previous risk and vulnerability assessments conducted in CoT. The assessment concluded that from a disaster risk management perspective, a large gap exists for adequate disaster risk management in CoT. In particular, the report indicated that:

“To fulfil the CoT's mission for disaster resilience, to achieve the SDGs and its related targets, and to ensure sustainable development, the CoT must adopt a more intentional integrated approach, specifically to ensure the mainstreaming of DRR and SDGs.”

(CoT, 2019:41)

One of the key findings of the DR&VA was the lack of a dynamic disaster risk profile for CoT. As a result, both proactive and reactive disaster resilience strategies and

subsequent developmental planning may not be accurately informed by a current disaster risk reality. Therefore, a tool with guiding indicators would allow CoT to develop a current disaster risk profile and disaster resilience strategy to consistently evaluate its progress towards the global targets of being a disaster-resilient city, through DRR and the achievement of the SDGs.

As such, CoT will be better positioned to achieve its mission of maximising disaster resilience of both Tshwane's municipality and economy through the coordination of all-hazard prevention, preparedness, mitigation, response and recovery activities within a framework of DRR measures and SDGs. Elmqvist *et al.* (2019:277) agree that cities need the means to determine whether their development trajectories will result in them becoming more (or less) resilient. Rockefeller and Arup (2014:3) added that "if governments, donors, investors, policymakers and the private sector are to foster more resilient cities, they need to understand the factors that contribute positively (or negatively) to resilience at a city scale". Cities need to identify where action and investment will be most effective. Cities also need to understand the dynamic networks of control and influence that reach beyond a city's administrative boundary and influence their ability to take appropriate action. Yet, at present, there is no tool available that guides CoT to incorporate DRR measures and SDGs towards a disaster-resilient strategy.

A framework for integrating DRR measures and SDGs in CoT's multi-sectoral disaster planning strategy will enhance its ability to reduce disaster risk and enhance the city's resilience to disasters (Bello *et al.*, 2021:4). Therefore, this study aims to synthesise the coalescence of SDGs and DRR into the CoT's disaster resilience planning strategy; to develop a disaster resilience framework with indicators and measures that will assist the city with its strategy development.

1.3 CLARIFICATION OF CONCEPTS

This study makes use of several key terms found in the literature. It is important that these terms be defined, to ensure clarity of concept and the application thereof.

1.3.1 Disaster

For this study, disaster is defined as a serious disruption of the functioning of a community or society involving widespread human, material, economic or

environmental losses and impacts. This would then exceed the ability of the affected community or society to cope using its resources (IFRC, 2021; UNDRR, 2021).

1.3.2 Disaster risk

Disaster risk refers to the potential disaster losses, in lives, health status, livelihoods, assets and services, that causes great harm, damage, or suffering which could occur to a community or a society over some specified future time period (UNDRR, 2021; Cambridge dictionary, 2021). In this research study, disaster risk refers to the likelihood (or probability) of loss of life, injury or destruction from damage from a disaster in each period (adopted from Twigg, 2015:6).

1.3.3 Disaster risk reduction and disaster risk reduction measures

The concept and practise of reducing disaster risks occur through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment and improved preparedness for adverse events (Rodolfo & Lapus, 2021:133; UNDRR, 2021). The National Disaster Management Framework (South Africa, 2005:3) refers to DRR as all the elements that are necessary to minimise vulnerabilities and disaster risks throughout society. In this research study, DRR refers to the aim to strengthen people and communities' resilience to natural hazards in order to prevent disasters and protect livelihoods, health, socio-economic assets and cultural heritage. DRR can therefore only be successful within the context of sustainable development because DRR forms part of social and economic development and is necessary, if development is to be sustainable, for the future. DRR measures in this research study refer to pre-event management activities designed to either directly enforce or empower the city to contain its vulnerability and hazards and enhance adaptive capacity and actions in the long and short term (Birkmann *et al.*, 2014:125; Clark-Ginsberg *et al.*, 2020:123; Yokomatsu & Hochrainer-Stigler, 2020:135).

1.3.4 Exposure

Exposure is defined as the presence and number of people, property, livelihoods, systems or other elements in hazard(ous) areas (and thus subject to potential losses) (Cardona *et al.*, 2012:65; UNDRR, 2021).

1.3.5 Disaster risk management

Disaster risk management is the application of DRR policies and strategies to prevent new disaster risk/exposure, reduce and manage existing disaster risk contributing to the strengthening of resilience and reduction of disaster losses through organisation, planning and application of measures preparing for, responding to and recovering from disasters (Shi, 2019:491; UNDDRR, 2021).

1.3.6 Disaster resilience

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNDRR, 2021). The International Panel on Climate Change defined disaster resilience as the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous events in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions (IPCC, 2012:34; Pal *et al.*, 2021:4).

1.3.7 Sustainable development

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development requires meeting the basic needs of all and extending to all the opportunity to satisfy their aspirations for a better life (WCED, 1987:43-44; Kakar *et al.*, 2021:14; Pohoată *et al.*, 2020:33).

1.4 KEY RESEARCH QUESTIONS AND SECONDARY QUESTIONS

The study was guided by the following key question: *How can the coalescence of the SDGs and DRR form part of the CoT's disaster resilience planning strategy?*

The secondary research questions are as follows:

- What DRR measures and SDGs form part of CoT's disaster resilience strategy?
- How are the DRR measures and the SDGs applied in CoT?
- How can a city disaster resilience framework complement the existing DRR measures and SDGs that are applied in CoT?

- What indicators of a city disaster resilience framework can be identified in CoT to determine its disaster resilience?
- What should CoT disaster resilience framework look like to assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy?

The research questions were addressed through the theoretical study of the literature, document analysis and empirical perspectives of CoT officials, who have extensive experience and knowledge in, both DRR and sustainability. In line with these research questions, the aims and objectives that support the study are stated below.

1.5 RESEARCH AIM AND OBJECTIVES

The research aims to synthesise how the coalescence of the SDGs and DRR can form part of the CoT's disaster resilience planning strategy. The aim considered three interconnected areas, SDG's, DRR and disaster resilience and to determine how the interrelations between the three areas are embedded within CoT's disaster resilience planning strategy, and the implications of this for sustainable development in the city.

Accordingly the following objectives of the study were set:

- Identify the existing DRR measures and SDGs that form part of the CoT's disaster resilience strategy;
- Determine how the DRR measures and SDGs are applied in CoT;
- Determine how a city disaster resilience framework can complement the existing DRR measures and SDGs applied in the CoT;
- Identify indicators of a city disaster resilience framework that will allow the CoT to determine its disaster resilience; and
- Develop a CoT disaster resilience framework that will be able to assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy.

The objectives are discussed in the following chapters:

- Chapter Five of the study presented CoT as the case study for this research. This chapter deals with objective 1 and identifies existing disaster risk reduction

measures and Sustainable Development Goals that form part of City of Tshwane's disaster resilience strategy.

- Chapters Five and Six of the study provided an extensive overview of how the city intends to apply DRR measures and achieve the SDGs. This chapter addresses objective 2 to determine how the disaster risk reduction measures and Sustainable Development Goals are applied in City of Tshwane.
- Chapter Six contextualised four international disaster resilience frameworks developed over the years to assist cities to measure their resilience to disasters. This chapter addresses objective 3 to determine how a city disaster resilience framework can complement the existing disaster risk reduction measures and Sustainable Development Goals applied in City of Tshwane.
- Chapters Six and Seven address objective 4 to identify indicators of a city disaster resilience framework that will allow City of Tshwane to determine its disaster resilience.
- A comprehensive city disaster resilience framework for CoT was presented in Chapter Seven which addresses objective 5 to develop a City of Tshwane disaster resilience framework that will be able to assist the city in incorporating disaster risk reduction measures and the Sustainable Development Goals in its disaster resilience planning strategy.

While the study cannot claim that the achievement of these objectives will result in the city being more resilient to disasters nor address the challenges of achieving the SDGs, achievement of these objectives holds great potential for CoT to acquire a disaster resilience planning strategy. The indicators will provide the city with guidelines of how the SDGs and DRR measures can be integrated into a disaster resilience planning strategy.

1.6 CENTRAL THEORETICAL STATEMENT

This study was grounded on systems theory (Kast & Rosenzweig, 1972:450; Von Bertalanffy, 1972:415; Meadows, 2008:11) and the complex adaptive systems theory (Railsback, 2001:47; Lansing, 2003:183; Coetzee, 2016:x) as its theoretical frame of reference. These theories were used because, whilst disaster resilience and sustainable development are a national and provincial government competency, their success depends on a city's systems and their interaction in the development of a

framework that guides DRR measures and the SDGs within the city's disaster resilience planning strategy. Systems theory explores the interactions between system components that would lead to the emergence of a city's disaster resilience planning strategy. Therefore, the complex adaptive systems theory could contribute significantly to the understanding of how departmental-level decision making impacts, positively or negatively, larger system dynamics in a city.

The following central theoretical statements underline the study:

- Achieving disaster resilience and the SDGs is a multi-sectoral process, hence mainstreaming it in planning strategies involves integration across all city departments. The prominence of SDGs to manage disaster risk must therefore form part of the local government's planning and execution framework (Jones *et al.*, 2014:78).
- DRR efforts are multi-sectoral efforts within a city and must be incorporated into ongoing development programs to ensure the city's resilience to disasters and sustainable development (Benson & Twigg, 2009:23).
- There is increasing recognition of the need to integrate DRR into development, not only for resilience but also for sustainability. This integration requires measures that analyse the progress of performance, programmes and strategies whilst monitoring implementation (Bendimerad, 2003:58).

1.7 RESEARCH METHODOLOGY

The study has applied a qualitative research approach that extensively reviews complexities, relationships and processes in a city; as well as identifies important indicators that are necessary for the effective integration of DRR measures and SDGs in the city's disaster resilience planning strategy. This study makes use of a single case study design and provides detailed documentation of CoT's DRR and sustainable development efforts in being a resilient city. Qualitative data generation methods in the form of document analysis and one-on-one interviews were applied (De Vos *et al.*, 2011:360; Kallio *et al.*, 2016:2954). A discussion on the elements of the research methodology follows in the next section.

1.7.1 Literature study

An effective and well conducted review as a research method creates a firm foundation for advancing knowledge and facilitating theory development (Webster & Watson, 2002:xiii). By integrating findings and perspectives from many empirical findings, a literature review can address research questions with a power that no single study has. A literature review is an excellent way of synthesizing research findings to show evidence on a meta-level and to uncover areas in which more research is needed, which is a critical component of creating theoretical frameworks and building conceptual models (Snyder, 2019:333).

To achieve its objectives, the study employs theoretical as well as empirical dimensions. Regarding its theoretical dimension, the study has conducted a literature review of articles, books, research reports and documents to ascertain the DRR measures, SDGs and city resilience patterns and trends, globally.

1.7.2 Single case study

The research assumes the format of a qualitative single case study (Yin, 2009:14). The research study is an empirical enquiry that investigates CoT's ability to infuse DRR measures and the SDGs in its disaster resilience strategy. A document analysis is undertaken on DRR and sustainable development policies, programs and practices. The qualitative approach involves one-on-one interviews with respondents from different departments in CoT Metropolitan Municipality. The study also carries out a comparative analysis of four disaster resilience frameworks developed and implemented in cities nationally and internationally. Various disaster and development related documents and previous research papers are analysed as part of CoT case study.

In line with the research, all relevant data are analysed and compared (cf. Chapter Six) to identify disaster resilience indicators. These indicators will assist CoT in the development of a disaster resilience planning strategy through the city disaster resilience framework as per the objectives of the study (cf. Chapter Seven).

1.7.3 Research paradigm

This research is approached from an interpretivist research philosophy to address the research objectives. According to Crotty (1998:54), the interpretivist research

philosophical position focuses on the exploration of how people interpret and make sense of their experiences in the world and how the context of events and situations, and the placement of these within wider social environments, have impacted constructed understanding. Studying this case through an interpretivist lens has enabled the researcher, who is a CoT employee, to determine how CoT and its departments interpret the need for the city to be disaster-resilient and how DRR measures and the SDGs are implemented in the city. This view is supported by Denzin and Lincoln (2001:43), who maintained that interpretive research philosophy is guided by the researchers' set of beliefs and feelings about the world and how it should be understood and studied.

1.7.4 Sampling strategy

The purposive sampling technique has been used because this research targeted a particular type of respondent according to what they already know about the field of DRR; this made it easier to include a range of perspectives (De Vos *et al.*, 2005:329; Terre Blanche *et al.*, 2006:304; Hall & Roussel, 2020:58). Patton (2002:43) described non-probability sampling as the deliberate choice of a respondent due to the qualities the respondent possesses (Etikan *et al.*, 2016:2; Sahu & Singh, 2021:117).

Policy and operational knowledge of DRR and the SDGs and the respondents' interest in city resilience has determined the choice of the respondents. The respondents constitute a mix of individuals from CoT Emergency Services Department (ESD), Disaster Risk Management section and the City Sustainability officials that participated in the one-on-one interviews using a semi-structured interview schedule.

With regard to the size of the sample, Marshall (1996:523) posits that an appropriate sample size for a qualitative study answers the research question adequately once saturation of data has been reached. In this case, 10 CoT officials involved in disaster management and sustainable development, have been selected and participated through one-on-one interviews held virtually on Microsoft Teams. In this research study, saturation of information was realized when no new views were noted during the one-on-one interviews with the CoT Emergency Services and the Sustainability Unit respondents who have first-hand experience in disaster risk management in CoT. A detailed discussion of the research methodology is presented later in Chapter 4.

1.8 METHODS OF DATA GENERATION

1.8.1 Document analysis

Document analysis is a systematic procedure for reviewing or evaluating documents when a researcher uses existing documents to gather data (Bowen, 2009:22; Bertram & Christiansen, 2015:2). The study reviewed CoT documents and programs relevant to DRR and sustainable development. The CoT Vision 2055 (CoT, 2012), CoT Vision 2030's IDP (CoT, 2019), CoT Climate Action Plan (CAP) (CoT, 2021), CoT DR&VA Report (CoT, 2019), and the CoT Disaster Risk Management Plan (DRMP) (CoT, 2007) were analysed.

The study also analysed and compared four different city disaster resilience frameworks to identify commonalities, as well as unique aspects underlying each framework. The following internationally recognised city disaster resilience frameworks were analysed for this study:

- i. United Nation's Disaster Resilience Scorecard (UNDRR, 2017);
- ii. Rockefeller Foundation's City Resilience Index (Rockefeller & Arup, 2014);
- iii. UN-Habitat's City Resilience Profiling Tool (UN-Habitat, 2017); and
- iv. UN-Habitat's City Resilience Action Planning Tool (UN-Habitat, 2018).

1.8.2 One-on-one interviews

For the one-on-one interviews, 10 CoT officials have been identified. The interviews aim to yield individual understanding and perspectives from the respondents on CoT's disaster resilience efforts, DRR and sustainable development measures known in the city. One-on-one interviews and not focus group discussion in this research study were ideal as to eliminate any exposure and judgement of possible inexperience from the 10 officials as would have been the case with focus group interviews (Cohen, Manion & Morrison, 2011:437). Even though the participants are all senior officials in CoT, were the researcher aware of the differentials between participants that may have caused some views to be silenced as some participants vary in status and in power in the city (Bloor *et al.*, 2001:20).

All data obtained from the document analysis and one-on-one interviews will be taken into consideration. Conclusions and recommendations will be drawn based on the findings (cf. Chapter Eight).

1.9 DATA ANALYSIS

Content analysis of the CoT's documents and programs relevant to DRR, resilience and sustainable development has been performed. The four international city resilience frameworks as well as the 17 SDGs and the Sendai Framework's priorities are all analysed through thematic analysis. Thematic analysis is also applied to the data from the one-on-one interviews. These approaches identify commonalities and differences in qualitative data, before focusing on relationships between different parts of the data, thereby seeking to draw descriptive and/or explanatory conclusions clustered around themes (Gale *et al.*, 2013:2). The study adopts Saldaña's coding stage method to manually code patterns (Saldaña, 2013:26). An inductive reasoning approach is used in the study. Some coding is based on concepts in the conceptual and theoretical framework of the study, as words and short phrases have emerged from the data as codes (inductive analysis) and are used during coding. In many cases, a combined approach is appropriate when the project has some specific issues to explore but also aims to leave space to discover other unexpected aspects of the respondents' experience or the way they assign meaning to phenomena (Gale *et al.*, 2013:3).

1.10 ETHICAL CONSIDERATIONS

The Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) at the Potchefstroom Campus of the North-West University granted ethics approval (NWU-01629-20-A9) for a research study with human respondents (cf. Addendum A). Written consent was obtained from CoT to research the city (cf. Addendum B). All respondents' participation was voluntary, suggesting that individuals were not compelled to participate in the research. Respondents were requested to confirm consent preceding the interview. A detailed description of the study and the purpose thereof was communicated to respondents (cf. Addendum C) before the study commenced, as suggested by Henn *et al.* (2009:71), and respondents had the option to withdraw from the study at any given stage.

1.11 QUALITY CRITERIA

Lincoln and Guba (1986:80) and Krefting (1991:217) highlighted four strategies; credibility, transferability, dependability and confirmability with which to establish the trustworthiness and rigour of a research study (cf. Chapter Four). The truth value has been ensured through the strategy of credibility by means of member checking. The neutrality of this research is ensured through the strategy of confirmability by means of reflexivity. Reflexivity was used in the study to question knowledge claims and enhance understanding by acknowledging the values and preconceptions the researcher brought to the study. Within the interpretative research philosophy, insight can be drawn from pre-understanding such as knowledge, insight and experience before engaging in the research programme, and understanding such as knowledge that develops during the programme (Haynes, 2017:284; Alvesson & Sandberg, 2021:2).

The researcher assumes a dual role in this research study as she is a researcher and employee of CoT. Due to this dual role, the researcher was fully aware of the potential conflicts of being the researcher and employee and therefore remained conscious of subjectivity. The researcher researched an aspect of her organisational life that she has experienced and observed. She therefore maintained a reflexive awareness of her shifting sense of self as both of belonging to the researcher and being outside it. The researcher remained objective by minimizing the potential for implicit coercion of the participants by allowing participants the opportunity to answer the open-ended questions based on their own experience and knowledge. The researcher acknowledges the desire for a positive outcome. Reflexivity enabled the research to be insightful, inter-objective and transparent. By incorporating legitimate reflexivity practices into the study, the researcher presented the research result with clarity and precision. Chapter 6 and 7 provide a comprehensive understanding of how the researcher arrived at the conclusion.

Finally, transferability will allow the reader to apply the findings to other cities that wish to integrate DRR and sustainable development in their disaster resilience strategy.

1.12 CONTRIBUTION OF THE STUDY

The contribution of this research study is the development of a city disaster resilience framework for CoT. The framework will assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy. The framework

acknowledges the complexities within CoT from a systems perspective. The framework presents a coalescence of DRR measures and SDGs for CoT. It highlights how resilience is an essential component of sustainable development and DRR in a city and how it can assist the city to determine its resilience to disasters.

This study called for the formulation of logically aligned and contextually synchronised chapters. To this end, the chapters of the research are outlined in the section below.

1.13 CHAPTERS OF THE THESIS

The research study is presented in eight chapters. These are briefly summarised below.

Chapter One: Overview of the study

The chapter orientates the reader into the study by introducing the problem statement and research questions that emphasise the study, by presenting the aims and objectives, the theoretical grounding, the methodology and the significance of the study. The chapter serves as the basis for the study to inform the subsequent chapters as outlined herein. This chapter has been useful to shape the execution of the study in pursuit of developing a conceptual framework with essential indicators for CoT's disaster resilience planning strategy.

Chapter Two: A systems approach to disaster management in cities

The chapter begins with an understanding of cities as they relate to systems theory. The focus then moves to complexity theory concerning the notion of cities as complex adaptive systems. The complexity of management of disasters in complex adaptive systems concludes the chapter.

Chapter Three: Disaster resilience: An imperative for disaster risk reduction and sustainable development

This chapter discusses the emergence of DRR and introduces disasters and the management thereof. The chapter explains how DRR enables disaster resilience with an extensive discussion on resilience. A discussion of the integrated link between resilience, sustainability and sustainable development is followed by a discussion on disaster resilience for sustainable cities.

Chapter Four: Research design and methodology

The chapter provides a detailed discussion on the methods of investigation used in the study. This includes the research design, sampling methods, data generation methods, data analysis and ethical consideration.

Chapter Five: City of Tshwane Metropolitan Municipality

This chapter provides an in-depth discussion of CoT Metropolitan Municipality by giving an overview of the geographical area, its demographics and vulnerabilities. The chapter elaborates on CoT's strategic documents and programs that address disaster risk management, resilience and sustainable development in the city.

Chapter Six: Results presentation, interpretation and discussion

A synthetic analysis presents the analysis of the data and an interpretation and discussion of the findings. This chapter is based on the research conducted on the preceding chapters.

Chapter Seven: A synthesis: Coalescence of Sustainable Development Goals and disaster resilience in City of Tshwane – a disaster resilience planning strategy framework

The chapter presents the CoT disaster resilience framework as a disaster resilience planning strategy. It introduces a coalescence of sustainable development and DRR for CoT.

Chapter Eight: Summary, contribution, recommendations, limitations and conclusion

The final chapter concludes the study. It provides a summary and the contribution to new knowledge as well as recommendations for further research. The limitations of the study and the conclusion reached are also presented in this chapter.

1.14 CONCLUSION

In this chapter, the purpose to undertake the research is well explained as the chapter outlined the problem statement, aim and objectives of the research study. CoT was introduced as the single case study for the research study. The methods used for the research, ethical aspects and chapter division were also presented in the chapter. The

next chapter introduces cities as complex adaptive systems and explains the complexities within cities from a systems perspective.

CHAPTER TWO: A SYSTEMS APPROACH TO DISASTER MANAGEMENT IN CITIES

2.1 INTRODUCTION

As more and more people are living in cities and the threat of disasters is ever growing, it is important to explore not only cities through the lens of complex adaptive systems but also disasters. While it is often noted that cities are often far from equilibrium, disasters are the inflection points at which cities and communities move from a steady state to one of instability, with the potential of significant loss and harm.

In cities, its physical, social and economic systems are increasingly interconnected, resulting in complex interactions which impact cities performance in the presence of disturbance. Cities are often dependent on complex infrastructure which are viewed as sub-systems, for example health systems, transport systems, emergency services systems, energy systems and so forth (Johnson, 2012:358; Friend & Moench, 2013:103). City systems are expected to be subject to multi-scalar relationships between the systems or sub-systems, where direct and indirect casual relationships, both physical and non-physical in nature, can result in impact to the overall system performance.

Chapter Two will conceptualise a city as a complex adaptive system and explain the types of economic, governance and social complexities within cities from a systems perspective. The fundamental principles of economic, governance and social complexities within cities as complex adaptive systems will be discussed in this chapter. First, the chapter will give a brief description of cities as systems and how cities are considered in systems theory. The focus of the chapter will be on the complexity theory regarding the idea of cities as complex adaptive systems. The complexity of management of disasters in complex adaptive systems concludes the chapter.

2.2 UNDERSTANDING CITIES AS SYSTEMS

Wirth (1938:4) proposed that a city is a permanent settlement of heterogeneous and interdependent individuals living and working at high population densities. Mumford (1961:29) added that “a city is a geographic plexus, an economic organisation, an institutional process, a theatre of social action, and an aesthetic symbol of collective unity”. A city, according to James *et al.* (2013:12) is “a large and permanent human

settlement generally consists of complex sub-systems for example sanitation, utilities, land usage, housing or transportation". Finally, O'Flaherty (2005:23) gives a minimalist definition of a city: "cities are circumscribed areas where concentrated individuals perform almost all the activities of their lives (sleeping, working, eating and playing)".

Key features associated with cities, also known as urban areas, include increased levels of contact and interaction, a concentration of power and culture, and opportunities for wealth creation, resource distribution and efficient use of natural resources (Mumford, 1961:29; Davis, 2002:34; Hillier, 2007:2). Cities are considered to be an adaptive system consisting of different elements that, when combined, have qualities that may not be present individually.

As per the above definitions and key features it is evident that cities consist of physical, social and economic systems that are considered adaptive and have elements that are interconnected, resulting in complex interactions. The interconnectedness and interactions between the elements impact the performance of the city and, in the event of a disturbance, impacts the interconnectedness and interaction (OECD, 2020:3). In non-scientific terms, such disturbances are commonly referred to as disasters (cf. 1.3.1). Typical examples of disturbances in South African cities include flooding due to increased levels of rain, electrical outages due to cable theft, storm surges, and so forth. These events often result in complex disruption of the interaction of three major components in the city: (i) the physical environment; (ii) the social and demographic characteristics of the communities that experience them; and (iii) the infrastructure components of the constructed environment (Simonovic, 2015:70).

Cities are expected to be exposed to disturbances that can impact the overall performance of a city and its elements as a system. The next section will conceptualise cities as a system within the systems theory.

2.2.1 Systems theory

In the 19th century, French physicist Nicolas Léonard Sadi Carnot, who studied thermodynamics, pioneered the development of the concept of a 'system' in natural sciences. In 1824, he studied the system which he called the *working substance* (typically a body of water vapour) in steam engines, in regards to the system's ability to do work when heat is applied to it (Salimi & Salimi, 2017:87). Systems theory only took off in the 1950s when von Bertalanffy, who became one of the pioneers of general

systems theory, published the article, *An outline of General Systems Theory* where he introduced models, principles, and laws that apply to generalised systems or their subclasses, irrespective of their particular kind, the nature of their component elements, and the relation or 'forces' between them (Von Bertalanffy, 1972). A few years later, Kenneth Boulding (Boulding, 2004) published *General Systems Theory: The skeleton of science* where he described the general approach and principles of systems. These publications would later help form many governmental policies, as well as urban planning theory and practice in the 1960s and 1970s (Mostafavi *et al.*, 2011:256).

Seeking to understand the nature of systems, Meadows (2008:2) argues that “a system comprises of a set of things - people, cells, molecules or whatever - interconnected in such a way that they produce their own pattern of behaviour over time”. Meadows’ description of a system suggests that through the active interaction between interconnected parts, systemic properties emerge that cause the systems to produce and maintain their own patterns of behaviour over time. Furthermore, the interlinked parts of systems produce effects that are different from those of the individual parts (Meadows, 2008:12).

Simonovic (2015:72) summarised a system as “a collection of various structural and non-structural elements that are connected and organised in such a way as to achieve some specific objective through the control and distribution of material, resources, energy and information”. It is, therefore, the connection between parts that makes it a system (Chadwick, 1913:36). A connection between agents must be achieved, otherwise, no interaction can take place (Larson, 2016:161). Therefore, the resulting interaction between the agents or elements produces something more than what the two agents or elements combined would be able to produce individually.

For this research, a system is described as multiple agents that interact with each other, over a network, to produce a particular outcome, pattern or behaviour, through feedback mechanisms which is more than the sum of any individual agents (Aritua *et al.*, 2009:72; Hunt *et al.*, 2009:509; Koopmans, 2017:17). The idea that cities are systems is not new and has been around for as long as systems-thinking has been with us, which emphasises the interactions of systems with one another in different contexts (Forrester, 1995:10). Systems-thinking distinguishes between the

interconnection within and between systems, and it investigates the interaction that the interconnections bring.

Many authors (De Roo, 2010:19; Ahern, 2011:341; De Roo *et al.*, 2012:1; Barthelemy *et al.*, 2013:4) have added that cities are complex systems that comprise a large and diverse number of different orders of systems. Barthelemy *et al.* (2013:1) agree, stating “cities comprise of a large and diverse number of different types of natural forming, interdependent hierarchies of systems whose interactions lead to behaviour that can be difficult to understand and predict”.

Applying a systems perspective to cities has also been used to understand the likely scenarios affecting the system resulting from disruptions in the city system and the implications of networked infrastructure failure in the city systems (Sims, 2010:42; Da Silva *et al.*, 2012:126).

The investigation of the impact of failures in a networked infrastructure revealed the complex interdependencies of networks in cities, highlighting the fragility of essential infrastructures and the importance of repair and maintenance to ensure urban resilience in restoring equilibrium in the network (Graham & Thrift 2007:18). However, Batty and Marshall (2012:22) disagree, claiming that the view that systems are in equilibrium is one of the major failings of systems theory in understanding cities. Johnson *et al.* (2017:13) agree with Batty and Marshall and state that “cities, to a large extent, are always in disequilibrium”. Batty (2017:81) further supports this view of cities in disequilibrium and says:

“The view of cities in equilibrium is borne of thinking about them physically but as soon as their dynamics are unpacked, is it realised that this is a superficial perception. Cities are always in disequilibrium. They are in fact far-from-equilibrium being maintained through a tension of many countervailing forces that break down and build up on many different spatial and temporal scales, thus all coalescing in strong volatility and heterogeneity in urban form and function.”

Systems thinking, therefore, provides a more holistic approach, in which cities are considered as complex systems exposed to be undergoing unexpected dynamic exchanges at any given time, constantly evolving and responding to internal interactions and the impact of external factors (Barnett & Bai 2007:143). Specifically,

the ultimate objective of the city as a system is to support the well-being of the urban population while generating wider socio-economic benefits. Well-being, as illustrated in Table 2.1 below, encompasses basic human needs (food, water and shelter), access to goods and livelihood opportunities, security, health, social relations and freedom to act (Maslow, 1943:370; Da Silva *et al.*, 2012:125; Friend & Moench, 2013:103).

Table 2.1: The purpose of the urban system - well-being (adopted Da Silva *et al.*, 2012:125)

Well-being	Example
Basic needs for survival	Biological and physiological needs. Adequate livelihoods, sufficient nutritious food, access to water, sanitation and shelter, access to goods.
Security	Safety needs. Personal safety, security from natural and man-made hazards, secure resource access, order, law and stability.
Health	Healthy body and mind. Feeling well, access to clean air and water, access to health care.
Good social relations and esteem	Belongingness, love needs. Social cohesion, mutual respect, ability to help others, family, personal relationships, achievements, status, responsibility and reputation.
Freedom of choice and action	Self-actualisation needs. Opportunity to achieve what an individual values doing and being, personal growth and fulfilment.

A system can also be divided into sub-systems that are separable and identifiable parts (components, elements) of that system (Sen *et al.*, 2016:2). All these systems and sub-systems are dynamic and involve constant interaction between and among sub-systems and systems. Thus, in a system, everything affects everything else, and therefore any given phenomenon cannot be studied without looking at the entire context in which the system is embedded (Phelan, 2001:132). A city (the system) does not function in isolation but is organised into areas (sub-systems) identified by

interdependencies, interconnections and interactions to ensure the operation of the system. Thus, Meadows (2008:12) states “a city system is an interconnected set of elements that is coherently organised in a way that achieves something and must consist of three kinds of things: elements, interconnections and a function or purpose”.

A city’s infrastructure network is a good example of an environment that consists of multiple systems. Networked infrastructure in cities, which are for example energy, water, sewerage, transport, waste and so forth, enable access to critical resources to provide basic services to the community (for example water, food and energy), provide education and health care facilities, buildings and services for government and businesses and access to markets and information (Graham & Marvin, 2001:87).

City infrastructure systems further consist of sub-systems as illustrated in Figure 2.1. The sub-system is where the operation of the system is processed; a single, predefined operating environment through which the system coordinates workflow and resource use (IBM, 2021). For example, energy networks or power plants are examples of sub-systems of the energy system, and vehicles or infrastructure are sub-systems of the transport system.

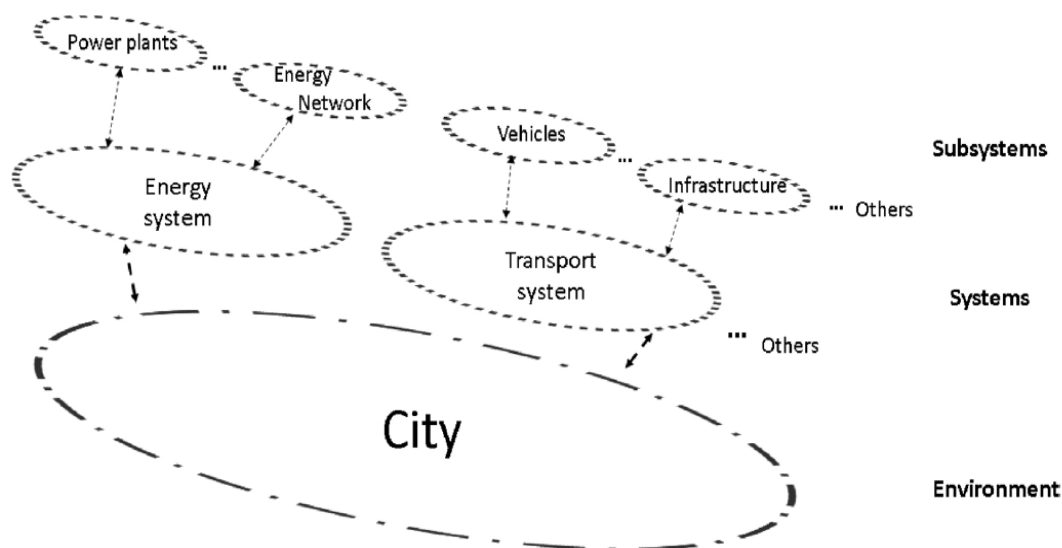


Figure 2.1: Example of city systems in systems theory (Lom & Pribyl, 2019:3)

In a city, one system depends on another system to enable the city to provide sustainable services, known as infrastructure inter-dependencies and interconnected services (Lewis & Petit, 2019:6). A highly simplified view of the infrastructure

interdependencies and interconnectedness in a system (as referred to by Meadows, 2008:12), is the network infrastructure that provides basic services to the community. Figure 2.2 illustrates a city infrastructure inter-dependency. The different coloured lines show how one system is dependent on another system. For example, providing water depends on the ability to use electricity to power the water pumps; however, for the city to provide electricity, it must purchase electricity, especially where there is no self-generation of electricity. Yet, for the city to be able to purchase more electricity, the community must pay for the electricity that is provided by the city. Therefore, society needs sustainable economic means to pay for electricity (and therefore water) as part of basic services and a safe environment. The concept of sustainability in this instance is made up of three pillars: the economy, society and the environment. Only through balancing economic, social and environmental sustainability factors in equal harmony can true sustainability be achieved. These principles are also usually used as profit, people and planet (Kuhlman, 2010:3436; Purvis *et al.*, 2019:682). This research study embraces a social-ecological interpretation that defines sustainability as the balanced management of profit, people and planet in a way that guarantees welfare and promotes equity of current and future generations.

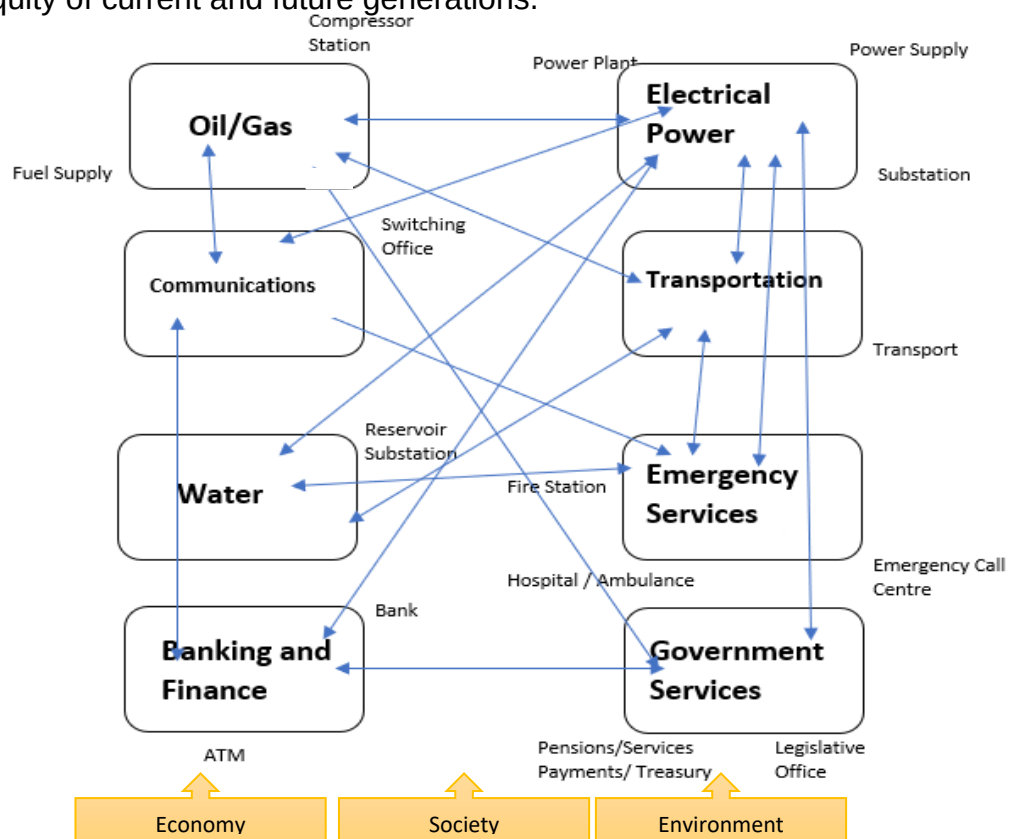


Figure 2.2: City infrastructure inter-dependencies showing interconnection, interaction and sustainability (adopted from Elvas *et al.*, 2021:821)

As illustrated in Figure 2.2, it is clear that infrastructure interdependencies in city systems are complex and dynamic. The increase in size and complexity of various systems and sub-systems is what causes increased susceptibility to disruptions and losses. Aritua *et al.* (2009:75) and Phelan (2001:132) agree - minor change in a system does not always have a minor cause-effect in a complex system, rather, it often results in complex non-linear interactions that disrupt the entire system. A disruption in one part of a system will result in a ripple effect and disrupt all other city systems, including the impact of sustainability on the economy, society and the environment. For example, a disruption in the electricity distribution system means that fuelling stations will not be able to dispense fuel, therefore, affecting the transport system; in addition, hospitals, shops, businesses, schools, universities and hotels will have difficulty in operating due to the lack of electricity. Traffic lights will not operate causing traffic flow disruptions and so forth. Figure 2.3 depicts how the disruption in the electricity provisioning would impact the city systems. The orange line indicates the break in connection due to a disruption resulting in no electrical power to the rest of the services.

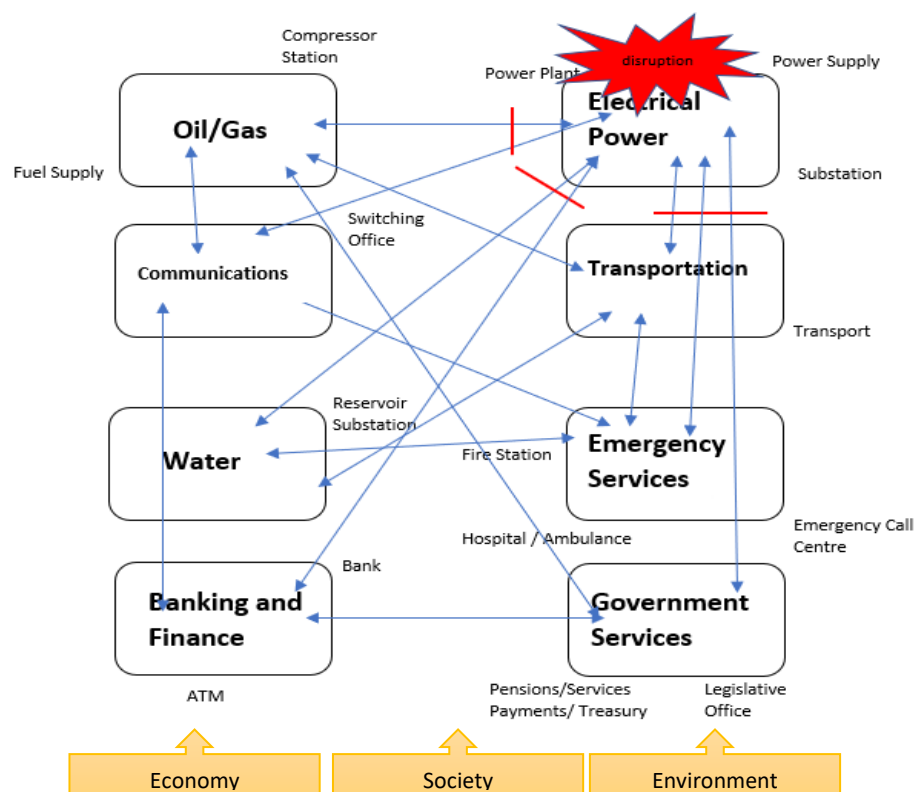


Figure 2.3: Disruption in city infrastructure inter-dependencies showing break in interconnection, interaction and sustainability (adopted from Elvas *et al.*, 2021:821)

The complexity of interdependencies and interconnectedness is what makes disruptions difficult to solve in a complex system. The increase in the size and complexity of the various systems causes an impact on sustainability and increased susceptibility to disaster losses in a city (Homer-Dixon, 2010:72). However, Cilliers (1998:ix) disagrees, stating that “it is not the size of the system that makes it complex but the nature of the interactions that determine the richness of a system”. Disaster risk management in a city is therefore intended to put measures in place to ensure the long-term survival of city systems and thus the city’s sustainability; this is because the impact of a disaster does not only cause physical destruction of the built environment, but it also disrupts and possibly destroys city systems.

2.2.1.1 Systems theory criticism

Although systems theory is a useful tool for understanding the world around us, it has also received some criticism, particularly within the urban environment. Among the critiques of the system theory was that it was deterministic in nature and was used to impose a top-down authoritarian way of thinking (Skyttner, 2005:498; OECD, 2019:20). Montuori (2011:414) supports Skyttner’s deterministic view and claims that “a system almost always produces the same output from a given starting condition or state”. Phelan (2001:132) adds that systems theory does not allow for the development of techniques to cope with emergent properties, interdependencies and environmental influences such as disasters and, therefore, limits itself through its bounded approach.

According to Ryan (2007:63), “systems analysts assembled mechanical solutions of recurring problems, rather than developing techniques that addressed emergent properties, interdependencies and environmental influences”. Edson (2008:5), however, disagrees; “systems thinking is both a world view and a process; it can be used for both the development and understanding of the system and for the approach used to solve a problem”. Friend and Moench (2013:110) write that systems theory does not address social value sets in a city and must therefore be supplemented with other relevant theories to account for human system readiness in cities. The Rockefeller Foundation and Arup, who developed the City Resilience Index, counter Friend and Moench based on collaborative research that recognises the city as a “system of systems” which include systems that determine human behaviour such as social, governance and economic systems (Da Silva & Morera, 2014:2).

A systems approach permits a wider variety of factors and interactions and represents an opportunity for hazards and disasters in cities and their overall management. Systems theory, therefore, provides an avenue for disaster scientists to explore the deeper interactions between system components that would lead to the emergence of disaster resilience (Harrison & Williams, 2016:12). Systems theory distinguishes between multiple and interrelated fundamental features of such a system, emphasises the dynamic character of processes of the system and allows it to adjust to changes (such as environmental changes) (Teece, 2018:362). A system's ability to adjust to the changing environment impacts the wider environment in the system and creates a constant cycle of change. The consequence of the constant change in a system leads to the complexity of systems as all elements must adapt to the changing environment.

2.2.2 Complex systems

Complex systems are a result of a variation of system theory that emerged in natural science fields aimed at explaining non-linear adaptation on micro- and macro scales in the natural environment (Hartvigsen *et al.*, 1998:427; Levin, 1998:432; Ahmed *et al.*, 2005:2; Page, 2011:32). The complexity theory, as found within the literature of general systems theory, includes ideas of emergence, self-organisation, non-linearity and adaptability (discussed later in the chapter). Rzevski and Skobel (2014:2014) also define complexity as:

“A property of an open system that consists of a large number of diverse, partially autonomous, richly interconnected components, often called agents; has no centralised control, and whose behaviour emerges from the intricate interaction of agents and is therefore uncertain without being random.”

Gershenson (2007:11) provides further interpretation of complexity by stating that “in order to have a complex system you need two or more distinct parts that are joined in such a way that it is difficult to separate them”. For this reason, complexity theory was developed as a tool to understand the complexity of the world by not only studying the individual parts but the connections between them.

Complexity, therefore, is the state of having many different parts connected or related to each other in complicated, often non-linear interactions, which are difficult to understand more completely. Complex disruptions are unpredictable and will present dire consequences for a system if not handled properly. Disruptions change over time,

are unique from moment to moment and often require immediate reaction time for decision-makers to resolve them (Johnson, 2012:65). Complex disruptions, resulting from numerous non-linear interactions, can devastate traditional systems that cannot adjust swiftly, cannot address several operations happening concurrently and cannot deal with information fast enough to make effective decision-making possible. As indicated earlier, a complex system interacts with and is open to its environment (Innes & Booher, 2010:45). This means that the environment in which the system finds itself has an impact on the system's behaviour. Sherman and Schultz (1998:17) and Holland (1992:24) therefore agree that complexity theory studies the rules that agents follow and how these basic rules can produce complex emergent behaviour in a system.

The notion that cities are complex systems can be traced to Jane Jacob's (1992:432) views of "problems of organised complexity", which to her meant "dealing simultaneously with a sizeable number of factors which are interrelated into an organic whole". When a complex system is divided into parts (such as people or locations in a city) the properties of each part are not only different, but they also depend on the size of the system of which they are a part of (Bettencourt *et al.*, 2013:76). These reflections suggest a city only makes sense as a complex system when all of its fundamental elements come together as an interacting whole when the entire city is the object of study. Complexity theory thus seeks to understand the interaction of agents, as well as the system as a whole, within the system's environment and how these interactions change over time.

The foundation of systems thinking is to contemplate the relationships in the system, the city departments in this instance and the integration of these relations between the various agents to perform as a system (in this instance the delivery of services in the city). It is through these relationships that a system is greater than the sum of the individual part which then makes a city a complex system (Innes & Booher, 2010:87; Page, 2011:32). Unlike systems theory, complexity theory does not seek to impose top-down control onto the system. Complexity theory wants to understand the rules that administer the system from the bottom-up. Complexity theory also includes an adaptive approach which co-evolves with the system as it changes (De Roo, 2010:19). Change is thus constant and should always be expected, and predicted where possible, however, the focus should be more on responsive adaptation rather than

predictive avoidance (Hartzog, 2005:22). Thus, the ability of a system to adapt to its changing environment is one of the defining features of a complex system.

2.2.3 Adaptive systems

The word adaptive provides an emphasis on conditions that allow systems and their ability to change over time in response to the interaction between systems, with their internal and external components that are part of a system which might influence the systems operation and its internal and external components that is parts of the system (Portugali, 2012:52). Adaptation within a system increases due to the adaptation of the individual elements that adjust to the environment around them (Page, 2011:25).

An adaptive system can effectively adjust from the current form in order to achieve required change to reduce disruption and increase benefit (Folke *et al.*, 2002:437). If the system adapts, then the system has a better ability to respond to changes in the environment (Confalonieri *et al.*, 2007:394). The adaptive ability, therefore, is the ability to prepare for and respond to disturbances and is dependent upon the availability and access to resources to adapt and continue with the system (Adger & Vincent, 2005:401; Turner, 2010:573; Engle, 2011:647). A stagnant system, on the other hand, is a system that is not able to adjust to the changing environment and will eventually collapse (Hjorth & Bagheri, 2006:84; Innes & Booher, 2010:206). Page (2011:25) agrees and adds that the adaption of agents' behaviour in a city system is the most important feature of a city. Holland (2006:7) however disagrees and states "the system itself does not adapt, it is rather the agents of the system that adapt by altering their behaviour". Nonetheless, it is not always best to adapt but rather consider changing to another state through transformation.

Transformation is defined as a response to a disturbance that differs from both coping and adaptation strategies in that the decisions made and actions taken change the identity of the system itself (Elmqvist *et al.*, 2013:723). Folke *et al.* (2010:87) define transformation as the capacity of a system to become a different kind of system, to create an essentially new system when ecological, economic or social structures make the existing system unsustainable.

Transformation approaches are applied when the frequency or intensity of a disturbance increase and the coping and adaptation strategies will be less likely to maintain the system in a required state (Tuvendal & Elmqvist, 2012:223). If it is

expected that more than one system objective will be disrupted and cannot be sufficiently recovered without intervention, the development of transformation strategies may be prioritised over adaptation strategies (O'Brien, 2012:667). City systems therefore either adapt themselves to improve their performance in response to new internal and external restrictions or transform if they cannot recover from the restriction. However, Tadi and Manesh (2012:515) disagree and state that transforming is far more challenging in a complex system. It requires cities to first consider the past to develop the future and it requires the change of components and the combination of its sub-systems over time. The entire complex system can, therefore, only transform by adaptive performances between the elements and sub-systems' change and combination over time. It is therefore evident that city systems are complex systems that are not stagnant as they continuously change, allowing the city to either adapt to change or transform to a new system should it not be able to adapt. This brings the discussion to complex adaptive systems.

2.2.4 Complex adaptive systems

It is now evident that cities are not only complex, dynamic, non-linear systems, but that they are responsive to internal and external changes and thus, as will be demonstrated in this section, have the attributes of a complex adaptive system. Cities are dissipative systems, demanding a constant inflow of resources to permit their functioning (Rees, 2012:247). These resources range from basics such as water and food to economic goods and information.

A complex adaptive system is a group of systems made of non-linear, interacting, multiple subsystems that depend on and cooperate with each other (Waddock *et al.*, 2015:993; Caws, 2015:514). Complex adaptive systems can change their structures and activities to align with their current environment (Turner & Baker, 2019:4). This adaptability results from the complex system's openness and ability to self-organise when there is a change in the environmental conditions such as social and economic changes inside and outside the city. The elements in a complex adaptive system are constantly responding to what other elements are doing to the environment and are thus continually changing through feedback and learning. Railsback (2001:48) adds that at the core of complex adaptive systems analysis is an attempt to show how simple

interaction between individual elements at a micro level, such as a community, lead to very complex behaviours at macro-level cities in this instance.

Complex system theory was formally proposed by Professor J. H. Holland (Holland, 1992:88; Holland, 2012:viii) at the 10th anniversary of the Santa Fe Institute in 1994, and it subsequently stimulated widespread attention in academia. The development of complex systems science reflects the constant development of people's knowledge of the world as the breadth and depth of scientific practice increase. It also reflects a revolution of dealing with complex problems in the field of knowledge (Von Bertalanffy, 1972:416; Waldrop, 1994:683). Complex adaptive system theory therefore provided people with new ways to identify, control and manage complex systems, and is extensively used in economic systems, ecosystems, and social systems. Compared with other theories, complex adaptive system theory sets the city system more in line with reality and can prevent the decline of the city system to a simple system, as well as the serious distortion caused by the different city systems. Complex adaptive systems are changing in response to both external disruptions and the impact of other elements on the system. A wide-ranging review of literature features certain key characteristics of complex adaptive systems theory (Innes & Booher, 1999:417; Boal & Schultz, 2007:411; Rammel *et al.*, 2007:11). Several properties of complex adaptive systems have been selected for this discussion as indicated below.

2.2.4.1 Self-organisation

Self-organisation is a property of a complex adaptive system that describes the process by means of which complex systems can instinctively organise and coordinate themselves from what can be seen as chaos, randomness or disorder into something that is ordered and structured without any direct internal or external influence (Richardson, 2005:619; Meadows, 2008:187; Helbing, 2009:425). Ashby (1960:413) understood a system to be self-organising, if the system changed its own organisation, rather than being changed by an external entity. De Wolf & Holvoet (2004:8) agree that self-organisation is a dynamic and adaptive process where systems develop and maintain their structure themselves, without external control.

2.2.4.2 Aggregation

According to Levin (1998:432), aggregation is the process whereby elements in a complex system organise themselves into sub-groups or hierarchal organisations that

have the same interests, needs and practices. As soon as sub-groups are formed, they do not remain separated. Instead, multiple interactions are established between different sub-groups that allows for active development and adaptation to the changing environment (Railsback, 2001:48; Boal & Schultz, 2007:414). The notion of aggregation, therefore, provides interesting ways of evaluation within cities, as it would help to focus attention on the role, relationship and contribution of coping mechanisms to the disturbance in a city.

2.2.4.3 Diversity

Diversity can be expressed as a variation between one type of element, or different types of elements as well as differences in the arrangement of the different types of elements (Patterson & Williams, 2005:361). Diversity is essential for any complex adaptive system as it assists to generate roles within the system, builds resilience and adaptability, creates competition and innovation and helps to create complexity (Page, 2011:16).

Diversity is made from progressive adaptations, changing conditions and imperfections and helps to improve the level of self-organisation within the city by allowing for a variety of possibilities (De Roo, 2010:19). It, therefore, allows for new changes and reduces the inflexibility within the system to create flexibility (Rotmans & Loorbach, 2009:184). A diverse system with several routes and redundancies is more stable and less vulnerable to external disruption than a uniform system. Cities are therefore diverse as they have many people, organisations, buildings and roads, amongst other things.

2.2.4.4 Redundancy

Redundancy means duplication or back-ups of a part or function of the system to ensure for the continuation of the system - if one part should collapse, there is another part or function that will take its place and perform the same function (Fleischhauer, 2008:277). Redundancy can take various forms, such as connectivity to other systems to substitute or replace the broken or missing links. Page (2011:32) agrees that redundancy means having several replicates of the same part or the extent to which different system elements can fulfil the same functional requirements for achieving the same goal. For city systems, for example, the redundancy of essential infrastructure,

from electricity and water networks to emergency services, is critical (Pelling, 2003:5; Newman *et al.*, 2009:61).

2.2.4.5 Emergence

Emergence refers to how system-level properties, characteristics and patterns emerge from the interaction between individual elements at a micro level, even though the individual elements bear no similarity to the final wider system characteristics (Hartvigsen *et al.*, 1998:428; Railsback, 2001:52). Lichtenstein (2014:2) adds that emergence is the process where local action has led to global patterns whose form cannot be predicted from a knowledge of the rule that governs the process of change. The restricted predictability is mainly due to the way a complex system emerges because of the large number of nonlinear interactions that lead to self-organisation in a complex systems performance.

The concept of emergence could be useful in the study of disruptions in a city. This is because it will allow the study to observe how an accumulation of lesser variables could lead to enhancing a city's ability to deal with disruption.

2.2.4.6 Feedback loops

The role of feedback loop in enhancing, stimulating, detracting, or inhabiting elements within the existing system is crucial for the development of complex adaptive systems (Holden, 2005:651; Walker *et al.*, 2012:31). Through these processes, feedback loops allow for the gathering of knowledge and adaptation of the dynamic environment thereby preventing the destruction of a system (Innes & Booher, 1999:412; Begun *et al.*, 2003:253; Rammel *et al.*, 2007:11). With its feedback, complex adaptive systems meet the need for constant testing, learning, and development of knowledge and understanding what is necessary to cope with change and uncertainty in the system (Carpenter & Gunderson, 2001:451). Feedback loops allow for a better understanding of how the city learns from previous incidents to improve its overall level of response to future disruptions.

The application and the implications of the complex adaptive system outside the essential analysis of feedback and system equilibrium, disequilibrium and the application of complexity science to disruptions have several implications for disaster research and more generally towards more sustainable and resilient cities. Theories of

self-organisation, emergence, feedback, redundancy and interacting processes are vital to both complexity and disaster, and these characteristics, as understood in complex adaptive systems, are applied in cities (Gunderson & Holling, 2002:43).

2.3 APPLICATION OF SYSTEMS APPROACH IN CITIES FOR DISASTER MANAGEMENT

As indicated in this chapter, cities are considered complex systems which consist of highly diverse and interconnected sub-systems and dependent entities connected by non-linear and multiple interactions. When the complex system is disrupted, it stops operating in normal conditions, due to disruption of the interconnections of the sub-systems. However, the impact of the disruption in a sub-system on the urban system cannot be foreseen in every detail before the disruption occurs (Atun, 2013:51). Managing hazards and disasters or disruptions in complex, self-organising, nonlinear feedback systems is therefore essential (Lorenz *et al.*, 2009:441).

Sustainable management of hazards and disasters or disruptions in cities requires extensive knowledge of three kinds of non-linear systems, namely (i) socio-economic systems (such as laws, regulations, policies); (ii) natural systems (such as land use, climatology, hydrology, geology) and (iii) constructed systems (such as transportation, water supply, drainage, electricity) (Mileti, 1999:107). Burger *et al.* (2021:1) added that disasters are caused by a combination of three interacting systems “(i) the physical system, consisting of geological, ecological and human-built systems; (ii) the social system, consisting of informal and formal human collective behaviour; and (iii) the individual sector system”. These systems and sub-systems are dynamic and involve constant interaction between and among the sub-systems and systems (Simonovic, 2010:49). The interactions and adaptations of these systems produce nonlinear relationships with properties of aggregation, feedback, self-organisation, emergence, diversity or heterogeneity, and flows of information, resources and energy. Typically studied in separate disciplines, the integration of these systems into a complex adaptive system may improve explanation of the phenomena and dynamics in disasters that interact and cut across systems (Burger *et al.*, 2021:3). Modern disaster management theories integrate these understandings of complex social, economic and political processes aggregated from the interactions between city systems in beneficial and destructive processes. These theories are used to measure the capacity of cities,

communities and businesses to survive and recover from disaster events (Cutter *et al.*, 2008:598). The theories also account for processes of adaptation, learning and decision making that are core properties of a complex adaptive system (Wisner *et al.*, 2012:171).

Salmon *et al.* (2012:353) argue that a disaster can be regarded as a system that cannot be broken down easily into parts and needs to be analysed as a whole. Thus, from a systems perspective, disaster management involves mutually dependent systems and processes to prepare, mitigate, prevent, respond and recover from the disaster or disturbance to reduce the negative impacts and consequences of such a disaster or disturbance on the community and the city (Fan & Mostafavi, 2018:1).

The understanding of dynamically linked systems has therefore led to, for instance, socio-ecological models in which disaster events occur within a complex adaptive system that learns and adapts in response to ongoing interactions. In this perspective the effects of individual and social system behaviour in groups and organisations are critical factors for explaining behavioural response and resilience to disasters (Joerin *et al.*, 2012:44). Scholars such as Mostafavi *et al.* (2011:256), Gorod *et al.* (2008:484) and Zhu and Mostafavi (2017:262) therefore emphasise the need for a systems perspective for the analyses of the disaster management phenomena and to integrate disaster management in a systems approach to assist cities in better dealing with the complications of interacting non-linear systems. Mileti (1999:26) and Simonovic (2010:30) agree and strongly support the incorporation of disaster management in a systems approach to managing disasters. In 2015, Simonovic (2015:73) published an article on the systems approach to the management of disasters where he said, in his explanation of what integrating disaster management is, that:

“Integrating disaster management in a system is an iterative process of decision-making regarding prevention of, response to, and recovery from a disaster. Integrated disaster management involves complex interactions within and between the natural environment, human population (actions, reactions, and perceptions), and built environment (type and location).”

This article resulted in different thinking to address the complexity of disaster management. Fan and Mostafavi (2018:1) agree that disaster management in a systems approach provides opportunities to explore interdependencies among various

systems and processes and that a systems approach to disaster management examines emergent properties of the system that could reinforce or aggravate the performance of such system and its processes.

The significance of disasters as an integrated system that contributes to losses of life was widely recognised by the 1990s, and studies on vulnerability accounted for social, cultural, economic and political processes as well as the ongoing geophysical and biological processes that trigger natural hazard events. One such example is the Pressure and Release Model and the Access Model proposed by Blaikie *et al.* (2003:49). In these models, the focus was on social vulnerabilities within a community rather than the hazard itself. These two models integrated top-down natural and social forces with bottom-up individual decision making of a population of actors, and they incorporated macro- and micro-mechanisms into the larger socio-ecological system. By studying the interconnections of natural and social systems, these researchers began to analyse the interrelated and interdependent elements in the ecological research fields with respect to human socio-cultural systems and ecological networks. The integration of ecological and social systems revealed interdependent relationships and adaptive strategies that evolved through selective forces to reduce vulnerability in disasters (Cannon, 1994:28). Cannon (1994:27) showed how the risks and opportunities in the environmental system are unevenly distributed throughout the population based on social power structures and can be analysed through vulnerability maps. Mileti (1999:6) used the socio-ecological systems approach to understand the complex interactions between the environment and human perceptions, actions and organisations to introduce the concept of sustainable hazard mitigation with the objective of using sustainable community planning to reduce disaster losses.

Other models, such as Blaikie *et al.*'s (2003:49) and Mileti's (1999:6) conceptualisations of "sustainability" reflected a shift in disaster issues from a paradigm of hazards and emergency to that of risk reduction and mitigation. Disaster events were no longer viewed as unusual and infrequent, but part of larger socio-ecological processes deeply rooted in local communities and embedded in complex adaptive systems (Olsson *et al.*, 2004:75). Such work also emphasised that when studying local- and regional-scale interactions, one should account for local memory and learning processes to address sustainability, risk reduction and the adaptive

capacity of these socio-ecological systems (Pelling, 2007:373). The work was subsequently extended to account for dynamically linked systems with structures, processes, feedback, nonlinearities, uncertainty, resilience and entropy that signal a complex adaptive system's ability to self-organise, to build capacity, to learn and adapt to recurrent disturbances and change (Adger *et al.*, 2005:75). Within disaster research, these effects have been explored as a community's adaptive capacity (Cutter *et al.*, 2008:598) and adaptive resilience (Zhou *et al.*, 2010:22). Work addressing complexity has spawned new areas for interdisciplinary theory such as relating critical infrastructure to society's feedback loops in cascading disasters (Pescaroli & Alexander, 2016:175). As a result, the application of system theory and the properties of complexity theory are therefore considered essential part for this research review.

However, the application of the systems approach in hazards and disasters is not an answer in dealing with the complications related to disaster management. Nevertheless, Simonovic's extensive research on the matter revealed that a systems approach for improving disaster management in cities offers at least six possibilities (2015:81):

- 1) The systems approach can assist all levels of government to organise disaster-related information to improve decision-making across sectors, departments and agencies.
- 2) The data essential to understanding resource gaps can be used to educate the public in understanding the relationships between their behaviour and environmental and economic consequences of natural disasters.
- 3) Systems approach in disaster management should assist in disaster planning and hazard forecasting. The use of models that clarify assumptions, identify feedback loops and monitor system behaviour can help decision-makers better anticipate change and to plan, budget and develop smarter disaster management policies.
- 4) The tools of systems analysis should be able to improve the quality of disaster-related decision-making. The systems analysis can assist the city to understand how the disaster can affect the city's operations as physical systems or the dynamics that govern the interactions between the social (people and economy), natural (water, land and air) and constructed systems (buildings, roads, bridges).

- 5) The systems approach can contribute to the enhancement of disaster behaviour by using systems thinking to build an organisational community around a common vision of DRR.
- 6) The systems approach can lead to effective pragmatism and preventative disaster risk management policies for the simple reason that most systems are nonlinear and therefore inherently unpredictable.

When studying the response to various risks and the impact of disruptions in a complex system such as a city, it is necessary to fully understand the structure and interaction of such a system and to consider the connection between different elements in the system and the dynamics of the entire system (Cutter *et al.*, 2008:32; Jabareen, 2013:220; Shi *et al.*, 2019:426). City systems, as established in this chapter, are therefore expected to be subject to integrated relationships between the systems or sub-systems where direct and indirect casual interactions, both physical and non-physical, can result in an impact on the performance of the entire system. The application of complex adaptive systems has led to new theoretical tools explaining sustainability and urban studies research such as adaptive capacity and adaptive governance in cities (Alessa & Kliskey, 2012:1; McPhearson *et al.*, 2016:566; Munene *et al.*, 2018:653).

To account for the complexities in disasters, Pelling (2007:380) developed a participatory framework of vulnerability and risk assessment that enables DRR and management in local government. This framework allows for adaptive learning using local knowledge that empowers the local community in times of disasters. This is also seen in adaptive governance (Folke *et al.*, 2005:441), in which key persons self-organise and develop common understandings and policies for ecosystem-based management, that can be applied to disaster resilience and risk reduction. In an analysis of DRR, Wisner *et al.* (2012:78) confirmed the importance of these disaster properties of multi-scale, top-down and bottom-up dynamics, outside specialist knowledge from many disciplines and local knowledge. These theories, models and frameworks integrate new conceptualisations of group behaviour, which all include social capital and resilience, networks and learning, open and adaptive systems, adaptive capacity and complexity.

The webs of connections, relationships and interactions within the systems lead to adaptations as system elements learn from and respond to new experiences. More significant, the system effects in the physical system affect both individuals and society - societal dynamics impact both the physical and individual systems and individual actors affect their physical and social systems.

Beyond the fundamental analysis of feedback and system equilibrium, the application of complexity science to disasters has a number of implications for disaster research and more generally towards more sustainable and resilient cities (Burger *et al.*, 2021:14). Theories of self-organisation, emergence and interacting processes are central to both complexity and disaster, and these properties, as understood in complex adaptive systems, are already being applied in some areas, such as with the model of the adaptive cycle in Panarchy (Gunderson & Holling, 2002:47). More important property connections, relationships, interactions and adaptations arising from individual actions, decisions and learning give rise to nonlinear dynamics and high levels of uncertainty. Understanding the dynamics of a complex adaptive system therefore requires the exploration of the latent capabilities and vulnerabilities in the particular system; in other words, those unobservable variables that are found to be significant in disaster outcomes as a result of bottom-up and feedback processes (Berke *et al.*, 1993:108).

A complex adaptive system operates within disequilibrium conditions resulting in continual adaptation and response to the constant flow of energy into the system. Uncertainty is inevitable in - and an integral part of - an evolving system. Consequently, top-down control is impossible. Spontaneous change occurs more readily where there is a range of different behaviour patterns. During change, it is crucial that the organisation, in this instance the city, adapts to the change in a relevant and responsible manner and continues to thrive. If it fails to adapt it might slowly become extinct (Rowe & Hogarth, 2005:97; Espinosa & Porter, 2011:54). A complex adaptive system does not simply change the system, it operates but also changes the environment in which the system operates. A complex adaptive system therefore requires constant adaptation to the environment and cannot achieve a 'correct' position as it is a dynamic and continuously changing situation. Systems and subsystems that have disruptions within their own operation and among neighbouring systems or

subsystems need to compromise and co-operate with each other to reach workable solutions rather than a 'correct' and superb solution. Therefore, it is essential for organisations or city systems to continuously monitor and evaluate each other in an infinitely complex process of co-evolution (McDaniel, 2007:36). Furthermore, it is of growing interest to develop innovative, creative and new ways to understand and approach sustainable development in a holistic and integrated manner (White & Lee, 2009:683).

Complex adaptive systems, which are characterised by ongoing change and development, feedback across all boundaries and levels and co-evolving bottom-up and top-down development, consist of a dynamic model that could address the key issues and solutions to enhance sustainable development (Espinosa & Porter, 2011:72) and disaster resilience. Sustainable development and DRR should be a co-evolutionary process of improving disaster resilience through improved understanding and knowledge of the city as a complex adaptive system. Co-evolution includes the dynamic interactions between two or more interdependent systems, which mutually affect each other's development. Therefore, co-evolution is regarded as an evolutionary process between two or more elements and/or sub/systems and is driven by reciprocal selective pressures and adaptations between these elements and/or sub/systems. In addition, co-evolution includes a range of nested hierarchies, inevitable uncertainties, multi-dimensional interactions and responses, and emergent properties. All this forms an essential part of a city's environment and the interactions between the departments where both sides modify each other continuously through mutual feedback which creates a dynamic process and is shaped by qualitative change, learning and adaptation (Rammel *et al.*, 2007:10). In an effort to capture the co-evolutionary dialogue, city management and planners need to invest in and design comprehensive systems of perception, evaluation and monitoring (Walker *et al.*, 2002:90; Rammel *et al.*, 2007:32). Management for sustainable development therefore needs to address the key notion of adaptive capacity (the ability to perceive information and to send responses for adaptive change) in order to deal with dynamic change in a socially, economically and ecologically sound way.

Subsequently, cities as complex adaptive systems can be said to be fundamentally characterised by the ability to be dynamically shaped or adapt to changes that occur within or from outside the system. Understanding that cities are complex adaptive

systems can assist city governance structures, not only through a better understanding of how to deal with growing complexities in cities but also by allowing them to develop improved strategies to manage disruptions in the complex adaptive system. Appropriate management in the face of a disaster or disruption in cities, therefore, requires a change of attitude towards the integration of economic, social and environmental concerns related to disasters, and of the actions necessary to deal with them in an integrated system (Simonovic, 2015:2).

2.4 CONCLUSION

In this chapter, cities were conceptualised as complex adaptive systems. The chapter began by defining a system as a collection of various structural and non-structural elements that are connected and organised in such a way as to achieve the specific objective of service delivery to the community. It was determined that the systems approach consists of systems and interrelationships among components that interact with each other to generate a particular behaviour. Complex systems interact in a non-linear manner, which creates the unique behaviour of each complex system.

This chapter specifically highlighted specific properties of complex adaptive systems: interconnections, relationships and interactions, and adaptations arising from individual actions, decisions and learning. Along with these properties, a complex adaptive system contains feedback loops, patterns of self-organisation, flows of information and resources, and system shifts between stability and instability (in and out of equilibrium). The chapter also discussed the impact of a disruption on the system that requires components and actors of the system to adapt and readjust in order to return to some form of equilibrium.

The lens of complex adaptive systems enables cities to integrate disaster science in the physical, social and individual systems that interact across scales. This integration accepts that disaster events are parts of ongoing interactions and processes of subsystems and not of an individual system. The recognition that disasters arise within complex adaptive systems offers a deeper understanding of the impact on systems and subsystems and how these systems should communicate and integrate to ensure the continuation of its operation as an agent and the system in its entity. The application of systems analysis in disaster management could therefore provide an improved

foundation for effective decision making in disaster prevention, preparedness, mitigation, response and recovery.

The insight into the city's capacity will most likely result in positive behaviour and improved disaster response and resilience within the city. Therefore, the next chapter introduces the disaster resilience theory as imperative for DRR and sustainable development in cities.

CHAPTER THREE: DISASTER RESILIENCE: AN IMPERATIVE FOR DISASTER RISK REDUCTION AND SUSTAINABLE DEVELOPMENT

3.1 INTRODUCTION

The previous chapter discussed the city as a complex adaptive system that must be able to adapt or transform over time in order to withstand extraordinary challenges or disruptions. The characteristics of interdependability among these systems highlight the importance of studying resilience through the theoretical lens of complex adaptive system theory, as processes in a city can be disrupted causing the entire system to be impacted. A disruption in any part of the system, therefore, requires the system to prove its capacity to adapt. The adaptive capacity of a complex adaptive system seeks to outline the immediate risk factors and the root causes of the disturbance in the system. By addressing these disruptions within the complex adaptive system, the importance of understanding how the disruption occurred, how to protect, prevent and mitigate against future disruptions and how to reduce the impact and recover should a disruption occur in the complex adaptive system are stressed. Resilience is the ability of communities and households living within complex systems to anticipate and adapt to risks, and to absorb, respond and recover from shocks and stresses in a timely and effective manner without compromising their long-term prospects, and adapt to new realities (Trump *et al.*, 2018:1; Hynes *et al.*, 2020:175). For this research, the city resilience concept described by Manyena *et al.* (2011:417) supported by the World Bank (2014:17) and Hollnagel (2017:247) is adopted. The latter references described city resilience as the ability to ensure the realisation of the SDGs through the capability to withstand disaster disturbance by means of prevention, mitigation, absorption, preparation for, response to and ability to recover and build back better after an incident. The UN defined sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987:24; Hassan & Lee, 2015:1265; Mensah, 2019:3). In this research study, sustainable development refers to meeting today’s needs without compromising the ability of future generations to meet their needs, achievable through the integration and acknowledgement of economic, environmental and social concerns throughout the decision-making process.

This chapter will begin by discussing the emergence of DRR by conceptualising a disaster and the management of disasters through disaster risk management. The chapter then explains how DRR enables disaster resilience with an extensive discussion on resilience. The chapter further deliberates on the integrated link between resilience, sustainability and sustainable development and concludes with a discussion on disaster resilience for sustainable cities. The chapter ends by introducing and contextualising four international disaster resilience frameworks developed for specifically cities.

3.2 EMERGENCE OF DISASTER RISK REDUCTION

Disasters may occur as a result of a hazard which is a naturally occurring or human-induced event with the potential to create a loss (Proag, 2014:369). Even though the origin and the cause of disasters are distinct, the effect on society is often similar, which includes loss of lives, economic losses, destruction of the built and natural environment and disruption of services and livelihoods (Haigh & Amaratunga, 2010:11). Researchers such as Blaikie *et al.* (2003:23) described disasters as ‘unnatural’ events that occur through the process of risk accumulation and are intensified by underlying dimensions, such as economic (poverty, financial stability), social (socio-spatial fragmentation, equity), political (limited democratisation and regionalisation), institutional (example limited institutional capacity) and fiscal (investments in buildings and infrastructure in hazard-prone areas). Disasters are seen to be caused by the complex interaction between risk, hazards and vulnerability with the potential of causing loss or damage to property (UNDRR, 2017). The potential loss of life, injury, destroyed or damaged assets that could occur in a system at a specific time is determined probabilistically where there is a hazard, vulnerability or lack of capacity. This probability is known as disaster risk. Therefore, a disaster is an event that has happened, but disaster risk is an event that has the potential to occur. Thus, the need to understand disaster risk in all its dimensions (exposure, vulnerability and hazard characteristics) is essential (Wahlström, 2017:336).

Risk is a function of hazard occurrence and projected losses. A common element is said to be ‘at risk’ when it is exposed to hazards and is likely to be unfavourably affected by the impact of those hazards when they occur, especially in situations of limited capacity (Von Kotze & Holloway, 1996:4). Disaster risk can be best explained as:

$$\text{Disaster Risk} = \text{Hazard} \times \text{Vulnerability} / \text{Capacity}$$

Some researchers have added the element of exposure to hazards as part of the equation (Cardona *et al.*, 2012:13). The relationship between these components indicates that each of the variables that define risk - the hazard, its vulnerability and the capacity - are of equal value. Reducing any one or more of the contributing variables will lessen the risk. When hazard and vulnerability are high, it will cause disaster but when capacity is present, it will decrease the impact. Disaster risk, therefore, arises when hazards interact with physical, social, economic, and environmental vulnerabilities (Kelman, 2018:283).

3.2.1 Hazard

A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (UNDRR, 2021). Hazards can be both natural and human-induced, such as floods and drought that can be caused by human activity (Gill & Malamud, 2017:247). Floods, for instance, can be caused by poor drainage systems whilst drought can be caused by over-irrigation or groundwater pollution.

The terms 'hazard' and 'risk' are often used interchangeably however, in terms of risk assessment, they are two very distinct terms. A hazard is any agent that can cause harm or damage to humans, property or the environment (Scheer *et al.*, 2014:1271; Basu & Debnath:2019:991; Havinga *et al.*, 2021:3) whilst risk is the probability that exposure to a hazard will lead to a negative consequence (Christensen *et al.*, 2003:192; Nguyen, 2021:19). There are the everyday risks in a city – for instance, risks related to unsafe and insufficient water, inadequate provision for sanitation and so forth. Another example is when wood stoves are used within a house that is poorly ventilated. The wood stove may pose a fire risk to the house as well as risks to occupants (burns or asphyxia – particularly high risk and problematic when there are high levels of overcrowding and children in the house) (Satterthwaite *et al.*, 1997:223). If there is no electricity, the use of candles and kerosene lights greatly increase the risks of accidental fires, with risks further compounded if houses are made of flammable materials. Various scholars such as Lopez-Calva and Ortiz-Juarez (2009:23) and Oliver-Smith (2009:12) agree that people's vulnerabilities (social,

economic, political, physical and environmental vulnerability) interact with hazards, posing a risk of injury, loss and damage to those people.

3.2.2 Vulnerability

Vulnerability refers to characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a hazard (Adger *et al.*, 2004:2; Keck & Sakdapolrak, 2013:9; Agrawal, 2018:147; Noy & Yonson, 2018:2). Turner (2010:570) defined vulnerability as “the extent to which a system is likely to experience losses from a hazard”. Adger (2006:269) added that vulnerability is “the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt”. Furthermore, the UNDRR (2021) defined social vulnerability as:

“The result of pre-disaster social factors that create a lack of capacity or capability to prepare for, respond to, and recover from emergencies. Social vulnerability includes people who are more likely to suffer disproportionately because of their existing social circumstances such as those associated with age, gender, race, medical illness, disability, literacy and social isolation.”

Researchers such as Oliver-Smith (2009:22) and Blaikie *et al.* (2003:76) agree that people’s vulnerability to hazards and lack of capacity to eliminate or attend to the identified vulnerabilities makes a society more prone to disaster. This often intensifies the actual damage and impact that such a disaster has on the community.

3.2.3 Capacity

Capacity refers to the strengths, attributes and resources available within a community, organisation or society to manage and reduce disaster risks and strengthen resilience (Pescaroli *et al.*, 2020:404, Schismenos *et al.*, 2021:1185; UNDRR, 2021). Like vulnerability, capacity depends on social, economic, political, psychological, environmental and physical assets available to identify, respond to, or eliminate a hazard. Understanding a city’s institutional background regarding risk reduction, building resilience and sustainable development can help to detect current gaps in the institutional capacity to coordinate and act towards prevention, mitigation, response and recovery in the case of disasters, as well as identifying the best and most-effective approaches to strengthen the institution's ability to achieve SDGs (Schofield & Twigg,

2016:5). Therefore, disaster risk can be reduced by either decreasing the hazard and/or vulnerability and or by increasing the capacities of the institution or society.

3.2.4 Disaster management

The South African National Disaster Management Act, Act 57 of 2002 adopted the International Sustainable Research Society's definition of a disaster as "a serious disruption of the functioning of a society, causing widespread human, material or environmental losses, which exceeds the ability of the affected society to cope using its own resources" (South Africa, 2002:43). The UNDRR summarised the definition of a disaster as an interdependent and systematic event that can trigger cascading effects, which is hard to predict, and where the disruption makes external help necessary (UNDRR, 2021). It is, therefore, essential for an institution or society to have measures and processes in place to prevent disasters from occurring at all costs.

Disaster management is defined as the organisation, planning and application of measures preparing for, responding to, and recovering from disasters (Etinay *et al.*, 2018:575; Moşteanu *et al.*, 2020:118; UNDRR, 2021). Disaster management thus comprehends all aspects of planning for and responding to emergencies and disasters, including both pre-and post-event activities. The traditional process of disaster management consists of two phases (i) pre-disaster risk-reduction and (ii) post-disaster recovery phase. The first phase consists of activities such as prevention, mitigation and preparedness while the second phase includes the activities of response, recovery and rehabilitation (Kelly, 1998:25; Asghar *et al.*, 2006:2; Yan & Pedraza-Martinez, 2019:2514). Figure 3.1 provides an illustration of the two-phased traditional model of disaster management as presented by Blaikie *et al.* (1994:25).

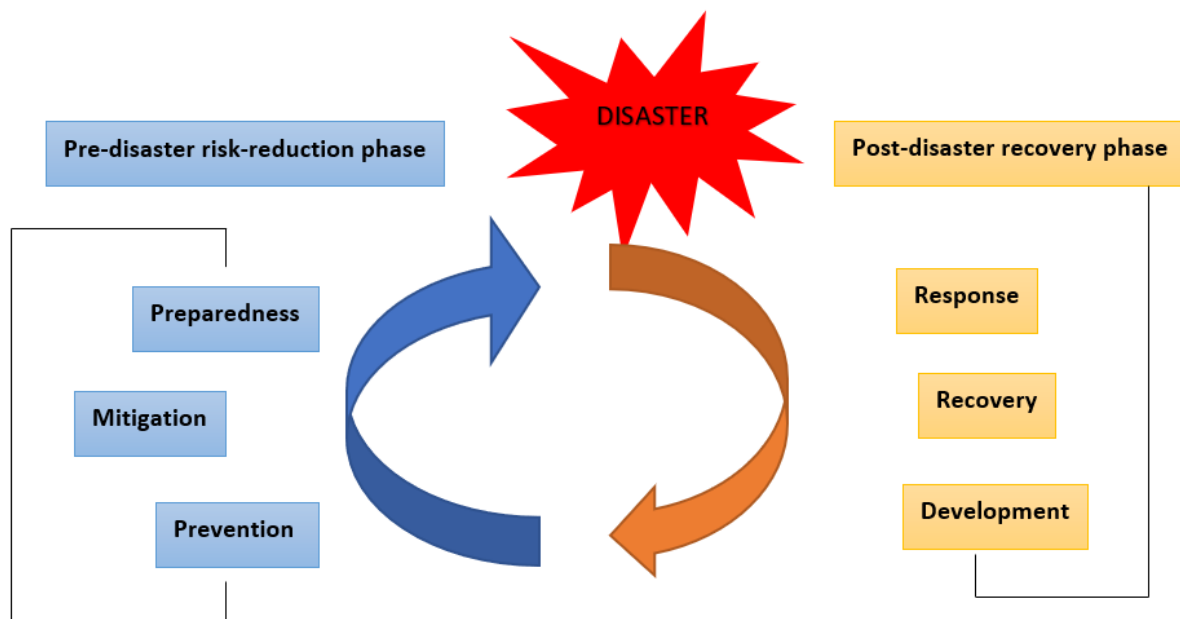


Figure 3.1: Two-phase traditional disaster management model (Blaikie *et al.*, 1994:25)

This traditional approach only started to change during the 1970s, which saw a dramatic increase in disaster events that caused increased deaths and greater economic losses than in previous decades (Blaikie *et al.*, 2003:10). With the repeated and snowballing effect on society and the economic impact of disaster came the realisation that there must be a more efficient way of dealing with disasters than only providing relief after the disaster.

To accommodate the shift in traditional thinking within the field of disaster management, ‘new mechanisms’ were needed to drive the management of disaster situations. As such, many disaster management theories, tools and policies emerged. Some of these theories and tools were the disaster management cycle (Baird *et al.*, 1975:20), the Pressure and Release Model (PAR) (Blaikie *et al.*, 2003:54), Kelly’s circular model (1998:25), and Manitoba’s model (2002:15). International policy measures, such as the UN (1994), the International Decade for Natural Disaster Reduction (1990-2000), International Strategy for Disaster Reduction (2001-2010), the Hyogo Framework for Action (2005-2015) and the most recent Sendai Framework for DRR (Action 2015-2030), all of which aim to contribute to the curbing of disaster losses, were also developed. Although not comprehensive (as there are many different disaster management models developed over the years), the following section will introduce some of these models.

3.2.4.1 Disaster management models

One of the models for disaster management proposed by Baird *et al.* (1975:41) was the disaster management cycle, which was designed to illustrate the constant process by which governments, businesses and civil society planned for and reduced the impact of disasters, planned for a response during and immediately following a disaster and took steps to recover after a disaster had occurred. However, the concept did not remain static. Various variations of this cycle have emerged over time, leading to much different interpretations in managing disasters by scholars and practitioners alike (Coetzee & Van Niekerk, 2012:2).

The earliest example of a disaster management cycle as proposed by Baird *et al.* (1975:42) comprised of six different phases in the process of disaster management, namely mitigation, prediction, warning, preparedness for relief, relief, reconstruction and rehabilitation. However, researchers such as Van Aalst *et al.* (2008:168), Crandall and Spillan (2010:18), Van Westen (2012:352) and Aubrecht *et al.* (2013:2), critiqued the cycle, indicating that its history has been influenced by disciplines such as sociology, geography, psychology, civil defence, public administration and development studies. Most recently, Etkin (2014:204) voiced his critique by saying that “the cycle does not explicitly emphasise the importance of capacity, resilience, informal networks and formal arrangements”. Thus, many adaptations and changes have occurred in the composition of the disaster management cycle, as well as its application. For example, in 1998, Kelly (1998:25) decomposed the cycle into eight phases. He proposed a circular model that reduces the complexity of disasters and also handles the non-linear nature of disaster events. Figure 3.2 is an illustration of Kelly’s circular model with the eight phases.



Figure 3.2: Kelly’s Disaster Management Cycle (Kelly, 1998:25)

Albtoush *et al.* (2011:56) critiqued Kelly's model and found that the model requires developing a comprehensive database of disaster impact with input and output information, which needs well-trained personnel to handle the information. It was also found that highly technical infrastructure is required to achieve reasonable results. The cyclic aspects of the disaster risk management that comprised of various phases, have in recent years been criticised for conceptualising and representing disasters in an overly simplistic way that typically starts with a disaster or disruption, then followed by relief, rehabilitation and reconstruction, hazard mitigation and emergency preparedness and subsequently leads onto yet another disaster (Bosher & Chmutina, 2017:35; Aubrecht *et al.*, 2013:7). Such recurring thinking has been proven to not be very useful for the complexities associated with understanding disasters and their risks as it implies actions which always involves a disaster and results in disasters.

Manitoba developed a model for the health sector in 2002, which also decomposed the disaster management cycle but into six phases:

1. Strategic plan that includes measures taken to provide a broad picture of what must be achieved and in which order, including how to organise a system capable of achieving the overall goals;
2. Hazard assessment that identify the threats and vulnerability;
3. Risk management to eliminate or reduce the threats as soon as possible and appropriately;
4. Mitigation to implement actions intended to eliminate or reduce the risk of hazards to the vulnerable;
5. Preparedness to develop response and recovery actions; and
6. Monitoring and evaluation to utilise quality improvement approaches to disaster management (Scott *et al.*, 2016:412).

Manitoba's model is considered one of the most famous integrated models (Nojavan *et al.*, 2018:5). Advantageously, the model provides a balance between preparedness and flexibility (resilience) with regard to disaster response. Each element observes its own boundaries and involves its own set of activities and processes. These elements are dependent on each other in terms of providing support and can be further broken down into layers of sub-components.

Bosher *et al.* (2021:526) considers the cyclic presentation of disaster management more a representation of how disasters are mis-managed and re-created and therefore recommend a new way of thinking about a non-cyclical presentation of disaster risk management that would be helpful to policy makers, practitioners, researchers and students alike. Bosher *et al.* (2021:526) propose, among others, to acknowledge the role of complex systems in disaster risk management (Coetzee & Van Niekerk, 2018:475) and to integrate DRR in disaster risk management (Contreras, 2016:277).

With the key principles in mind, Bosher *et al.* (2021:526) developed the helix shaped (corkscrew) conceptual diagram that encapsulate more important dimensions and factors to disaster risk management. Walshe *et al.* (2020:10) support the helix approach as they argue that “patterns of memory can be theoretically mapped as a helix”. The *disaster risk management helix*, as illustrated in Figure 3.3, starts with proactive attempts (blue arrows) to reduce the impact and occurrence of identified threats (a). The attempts include DRR efforts (explained later in the chapter), risk and vulnerability reduction measures that are developed, in line with community needs and capacities. Should a disruption occur (b) it is expected that the impact be reduced due to the earlier DRR activities. Post disaster recovery and rehabilitation follows the disruption (red arrow) that merge into DRR and preparedness activities (blue arrow). The ultimate result of the helix is to significantly reduce the impact (c) of the next disruption through continuous DRR efforts with possibly in some cases the elimination of disasters (d) and ultimately be a resilient and sustainable system.

The illustration also included Resources / Efforts with the understanding that if disaster risk management is addressed in a sustainable manner in a system, the less resources may be required for future disruptions (decrease the effect) and the period between the disruptions may be extended.

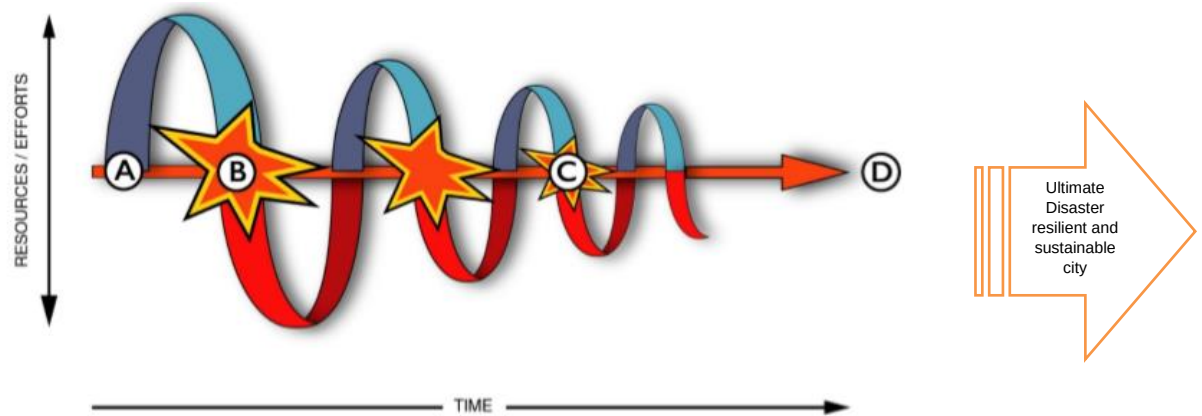


Figure 3.3: Helix diagram illustrating a reduction of risk over time (adopted from Boshier *et al.*, 2021:525)

The interactions, interdependencies, processes, feedback and knowledge of the physical system's elements have led to the conceptualisations of adaptive capacity and adaptive resilience (Burger *et al.*, 2020:5). The study, therefore, adopted a combination of the Manitoba model (2002:15) and the Boshier *et al.* (2021:525) helix model, illustrated in Figure 3.4, as it assumed the integrated disaster management framework approach that encourages the systems approach in cities. The blue and red arrows are adopted from Boshier *et al.*'s (2021:525) helix diagram where the blue arrow represents the DRR efforts and the red arrow the post-disaster response and recovery. The green and white box is adopted from Manitoba's model as DRR efforts with monitoring and evaluation to provide feedback included.

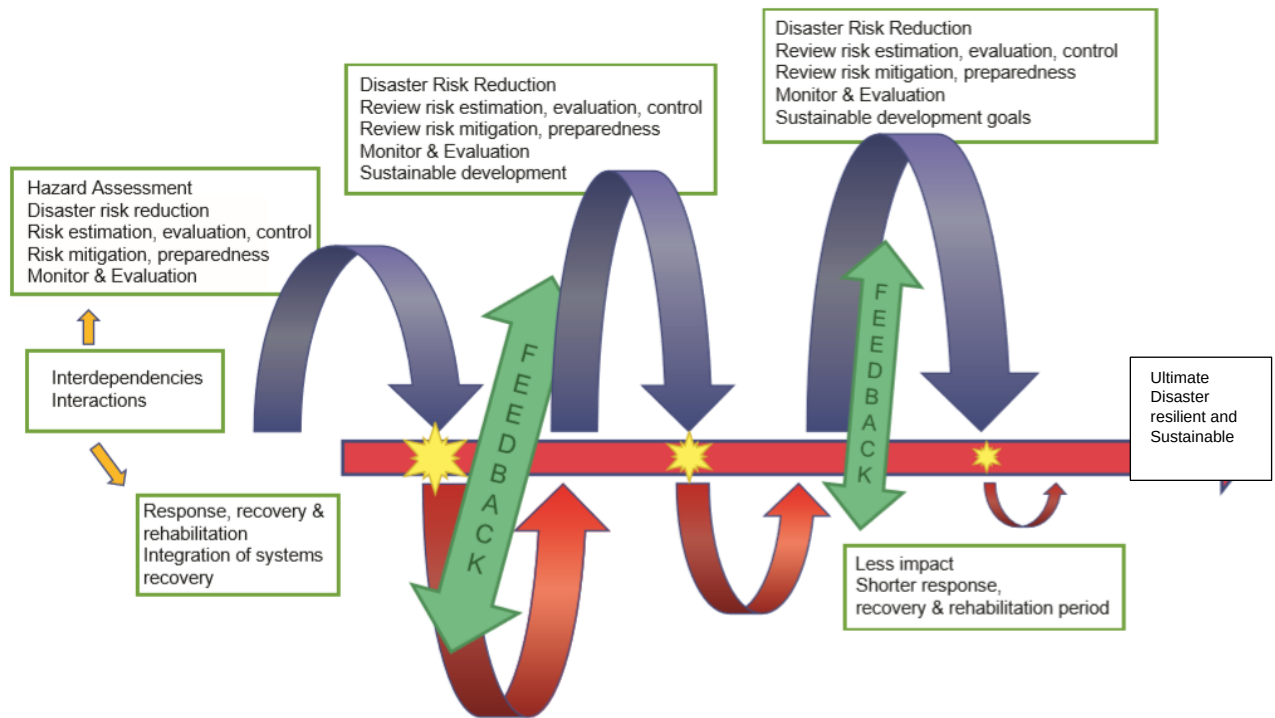


Figure 3.4: Integrated Disaster risk management model (adapted from Manitoba, 2002:34; Boshier *et al.*, 2021:525)

The scenario represented in Figure 3.4 is not an ideal scenario (where, in this case three ‘disasters’ occur before the threat is significantly reduced). An ideal scenario would require effective DRR that enables us to move from point ‘a’ on the diagram directly to point ‘d’ without experiencing (any) more disasters (Boshier *et al.*, 2021:525).

However, the process of developing different models for disaster management has been criticised throughout history. Alexander (1997:284) believed that no approach or model developed for disaster management had any significant progress on factors such as death tolls due to disasters, large-scale transfer of technology has not occurred, and disaster relief has not been adequately combined with mitigation and economic development. In 2016, Alexander (2016:2) reviewed the modern-day challenges facing researchers, scholars and practitioners who work in the field of DRR, whereafter he stated:

“There is a need for a major revision in the body of disaster theory so that it can consider dynamic changes in the modern world. On the other hand, disaster theory must adapt to new conditions if it is to remain the ‘road map’ that clarifies complex realities and enables disasters to be managed.”

The problem of finding linear solutions to disaster risk, as established in theory, has extended into global policy such as the Sendai Framework [for DRR]. The Sendai Framework (2015–2030) is an international document that was adopted by UN member states between the 14th and 18th of March 2015 at the World Conference on DRR held in Sendai, Japan (UNDRR, 2015).

3.2.4.2 Disaster risk reduction

The UNDRR (2021), which coordinates international DRR, defined DRR as “the concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters”. However, it also acknowledges that DRR involves every part of society, every part of the government and every part of the professional and private sectors. DRR is, therefore, described as the systematic development and application of policies, strategies and practices to understand, avoid or reduce the adverse effects of hazards and where the impact of such hazards is reduced or prevented (Van Niekerk, 2011:13; Kelman, 2018:281; Pescaroli & Alexander, 2018:2245). Specifically, the Sendai Framework sets four specific priorities for actions for DRR: (i) understand disaster risk, (ii) strengthen disaster risk governance, (iii) invest in DRR for resilience and (iv) enhance disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction (UNDRR, 2015:14). Each priority has its own DRR measures (referred to as key activities in the Framework). These should be implemented by governments and regions in their approach to DRR (UNDRR, 2015:14). A synopsis of the DRR key measures is further presented in Table 3.1.

Table 3.1: Measures to be implemented by local government

Sendai Framework priority	Key activities
Understand disaster risk	a. Assess disaster risks, vulnerability, capacity, exposure, hazard characteristics and the possible effect on a social and spatial scale on the ecosystem; b. Develop and disseminate disaster risk information; c. Evaluate, record, share and account for disaster losses; d. Communicate non-sensitive hazard-exposure, vulnerability, risk, disaster and loss-disaggregated information; e. Promote real-time access to reliable data; f. Build the knowledge on DRR; g. Improve dialogue and cooperation with relevant stakeholders, for effective decision-making in disaster risk management; h. Ensure the use of traditional, indigenous and local knowledge and practices, in disaster risk assessment; i. Strengthen technical and scientific capacity to assess disaster risks, vulnerabilities and exposure to all hazards; j. Promote investments in innovation and technology in disaster risk management; k. Promote the incorporation of disaster knowledge in formal and non-formal education; l. Promote strategies to strengthen public education and awareness in DRR; m. Apply risk information obtained to develop and implement DRR policies; and

	n. Disseminate disaster risk information through the involvement of community-based organisations and non-governmental organisations.
Strengthen disaster risk governance to manage disaster risk	a. Integrate DRR in local frameworks of laws, regulations and public policies; b. Implement DRR strategies and plans with targets, indicators and time frames, to prevent the creation of risk, reduce existing risk and the strengthen economic, social, health and environmental resilience; c. Determine technical, financial and administrative disaster risk management capacity to deal with the identified risks; d. Develop mechanisms to follow up, periodically assess and publicly report on progress on local plans; e. Assign clear roles and tasks to community representatives within disaster risk management institutions; comprehensive public and community consultations during the development of laws and regulations; f. Establish government coordination forums composed of relevant stakeholders at national and local levels to implement the Sendai Framework for DRR 2015–2030; g. Empower local authorities through regulatory and financial means to work and coordinate disaster risk management at the local level; and h. Formulate public policies aimed at addressing the issues of prevention or relocation of human settlements in disaster risk-prone zones, subject to national law and legal systems.
Invest in DRR for resilience	a. Allocate the necessary resources for the development and the implementation of DRR strategies, policies, plans, laws and regulations in all relevant sectors; b. Promote mechanisms for disaster risk transfer and insurance, risk-sharing and retention and financial protection; c. Strengthen disaster-resilient public and private investments;

	d. Protect or support the protection of cultural and collecting institutions and other sites of historical, cultural heritage and religious interest; e. Promote disaster risk resilience of workplaces through structural and non-structural measures; f. Promote the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning; g. Promote the mainstreaming of disaster risk assessment, mapping and management into rural development planning and management; h. Encourage the revision of existing or the development of new building codes/standards and rehabilitation and reconstruction practices to foster disaster-resistant structures; i. Enhance the resilience of national health systems, as well as in the implementation of the International Health Regulations of the World Health Organization; j. Strengthen the design and implementation of inclusive policies and social safety-net mechanisms; k. People with life-threatening and chronic diseases, due to their particular needs, should be included in the design of policies and plans to manage their risks before, during and after disasters, including having access to life-saving services; l. Encourage the adoption of policies and programmes addressing disaster-induced human mobility; m. Promote the integration of DRR considerations and measures in financial and fiscal instruments; n. Strengthen the sustainable use and management of ecosystems; o. Increase business resilience and protection of livelihoods and productive assets throughout the supply chains, ensure continuity of services and integrate disaster risk management into business models and practices;
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	p. Strengthen the protection of livelihoods and productive assets; and q. Promote and integrate disaster risk management approaches throughout the tourism industry.
Enhance disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction	a. Prepare, review and periodically update disaster preparedness and contingency policies, plans and programmes; b. Invest in, develop, maintain and strengthen people-centred multi-hazard, multi-sectoral forecasting and early warning systems, disaster risk and emergency communications mechanisms, social technologies and hazard-monitoring telecommunications systems; c. Promote the resilience of new and existing critical infrastructure; d. Establish community centres for the promotion of public awareness and the stockpiling of necessary materials to implement rescue and relief activities; e. Adopt public policies and actions that support the role of public service workers to establish or strengthen coordination and funding mechanisms and procedures for relief assistance and plan and prepare for post-disaster recovery and reconstruction; f. Train the existing workforce and voluntary workers in disaster response and strengthen technical and logistical capacities to ensure better responses in emergencies; g. Ensure the continuity of operations and planning, including social and economic recovery and the provision of basic services in the post-disaster phase; h. Promote regular disaster preparedness, response and recovery exercises; i. Promote the cooperation of diverse institutions, multiple authorities and related stakeholders at all levels; j. Promote the incorporation of disaster risk management into post-disaster recovery and rehabilitation processes;

	k. Develop guidance for preparedness for disaster reconstruction; l. Consider the relocation of public facilities and infrastructures to areas outside the risk range; m. Strengthen the capacity of local authorities to evacuate persons living in disaster-prone areas; n. Establish a mechanism of case registry and a database of mortality caused by the disaster in order to improve the prevention of morbidity and mortality; o. Enhance recovery schemes to provide psychosocial support and mental health services for all people in need; and p. Review and strengthen laws and procedures on international cooperation. The Sendai Framework shows the presence of linear thinking in the outcomes formulated.
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The Sendai framework identifies a multitude of complications in cities that contribute to the dramatic increase in disaster losses related to lives, livelihoods and infrastructure. The assumption is that there is a certain direct relationship between the lack of implementation of the Sendai framework's priority areas and the increase in disaster losses in all contexts. The logical argument made by Coetzee *et al.* (2017:785) is that:

“If progress is made in reducing or eliminating disaster losses, the primary focus should be on implementing the Sendai’s four-step global plan (linear reasoning). Therefore, once these priority areas have been implemented, at-risk communities will be rendered safer from disaster risk (or a possible state of equilibrium would have been achieved).”

However, Oxley (2015:17) criticised the Sendai Framework for not making provision for a system-wide perspective and holistic approach, as well as that it lacks appropriateness in contexts. Coetzee (2016:10) added that:

“From a systems perspective, the framework fails to consider the dynamic nature of disaster events by putting out desired targets to be achieved. This is problematic because it creates the impression that once these targets have been achieved, disasters will be reduced. Thus, through this linear reasoning of the framework, risk reduction becomes an ideal outcome for DRR interventions and not a constant process which makes it difficult for cities to implement the framework.”

A view to consider is how realistic should the pursuit of these goals, targets, and priorities be within the challenging developmental and governance context in South Africa. The current policy documents of the study case, as seen later in Chapter 5, do not always consider the Sendai framework goals, target and priorities of action when these policy documents are formulated. The Sendai Framework is not only unique to the study area, but considered an African state challenge as it relates to institutionalisation of DRR, political will, lack of funding, and shortage of human resources to carry out DRR activities (Van Niekerk *et al.*, 2020:180).

DRR contributes to strengthening resilience and therefore to the achievement of sustainable development. Existing efforts in DRR are complemented by new thinking concerning resilience, which seeks to unite a range of activities towards bouncing back

after a disaster. The concept of resilience is closely related to Manitoba's disaster management model, as it also applies a process-based framework that includes planning, preparation, prevention, monitoring and learning to respond to change in order to achieve desired long-term goals (Godschalk, 2003:136; Ahern, 2011:341). It has, therefore, been established that a disaster-resilient system is inherently an open system that can learn from the previous impact from feedback loops and make creative adaption possible (Lansing, 2003:183; Holden, 2005:651).

3.3 DISASTER RISK REDUCTION ENABLING DISASTER RESILIENCE

The concept of resilience remains one of the most contested in the field of disaster risk studies (Meerow *et al.*, 2016:38). Compared to other DRR terminology, is there conceptual disagreement largely from academics and practitioners on the concept of resilience (Manyena, 2006:433; Gaillard, 2010:220; Keating & Hanger-Kopp, 2020:1). Some of the disagreements around the concept of resilience and how it should be applied are based on three issues, namely (i) a confusion around how disaster resilience should be defined; (ii) how resilience can be measured and (iii) the subsequent practical orientation to how resilience should be augmented, as resilience is often viewed as an outcome to produce equilibrium or balance in a system, and not a continuous process of adaptation (Klein *et al.*, 2003:35; Zhou *et al.*, 2010:21; Alexander, 2013:2707; Harrist *et al.*, 2019:223). The latter researchers agree that, without a solid theoretical base, resilience almost becomes a redundant term that offers very little in terms of improving the efficiency of existing DRR intercessions. Therefore, as a starting point in understanding the complications of resilience and its application in the complex adaptive system, the emphasis should be on describing the origin and original use of the term resilience.

A general definition of resilience was published by the National Academies Press, as the ability to prepare and plan for, absorb, recover from and more successfully adapt to adverse events (Sharifi, 2016:629; Sharifi & Yagarnata, 2016:1654; Zemba *et al.*, 2019:603; Sharifi, 2021:285). Another definition was proposed by the UNDRR (UNDRR, 2021) as:

“The ability of a system, a community or society exposed to hazards to resist, absorb, accommodate to, and recover from the effect of a hazard in a timely

and efficient manner including through the preservation and restoration of its essential basic structures and functions.”

Resilience is considered a complex adaptive system due to several system processes and properties working together to allow the system to continue. Among these processes and properties are **diversity** (Reinmoeller & Van Baardwijk, 2005:61; Lade *et al.*, 2019:14), **redundancy** (Kharrazi *et al.*, 2020:1), **adaptive capacity** (Pahl-Wostl, 2009:354; Cafer *et al.*, 2019:201), **system structure** (Fiksel, 2006:15; Zhang *et al.*, 2021:116) and **feedback loops** (Eisenber *et al.*, 2019:1870; Rodriguez-Gonzalez *et al.*, 2020:109). Resilience is therefore essentially a system, as its properties are similar to the complex adaptive system properties (cf. 2.2.4). Hosseini *et al.*’s (2016:47) model, as illustrated in Figure 3.5, was adopted to show the resilience properties.

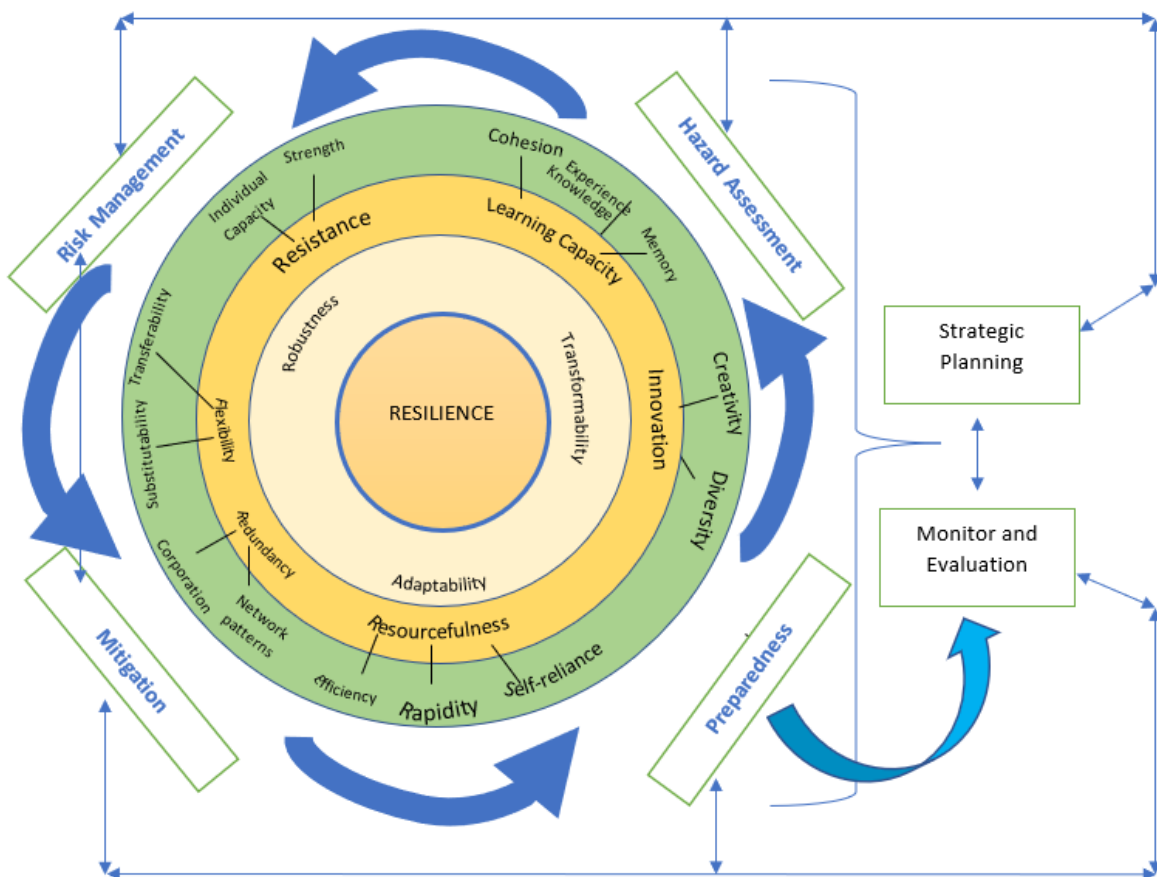


Figure 3.5: Key dimensions of resilience (adopted from Hosseini *et al.*, 2016:47)

The dimensions outside the circle are (as adopted from Manitoba’s model (2002:34) and Boshier *et al.*’s (2021:525) helix model) the main phases in relation to disaster risk management and DRR (cf. 3.2.4.1). The first circle represents the resilience properties

that need to be preserved and strengthened in order to enhance resilience whilst the concepts in the second circle are those that are amenable to policy change to enhance resilience. Hazard assessment, risk management, mitigation, preparedness, strategic planning, monitor and evaluation are elements added to Hosseini *et al.*'s (2016:47) model of resilience dimensions. The combination of Manitoba's and Boscher *et al.*'s models provide for the key dimensions of a complex adaptive system (cf. 2.2.4) and brings in the dimensions of disaster risk reduction (cf. 3.2.4.2).

Resilience is therefore not merely an endpoint or performance outcome; it is a process or a constant adaptive capability to adapt to change and prosper. Increasing adaptive capability is considered a means of both increasing resilience and decreasing vulnerability (Engle, 2011:647; Romero-Lankao *et al.*, 2016:342).

Resilience and vulnerability are regarded in a manner that indirectly links adaptive capacity to the availability and effective use of resources (Turner, 2010:570). Therefore, adaptive capacity essentially functions as a mediator in defining the levels of vulnerability and the system resilience through the accessibility of capital that is needed to realise change.

Duit (2016:364) challenge the importance of resilience in disasters and believe that resilience only focuses on the nature of the disaster, therefore, reducing the risk and severity of it. However, he does not contemplate the properties of what it is or what it is subject to. Hart *et al.* (2016:7) further argue that the return to a normal state does not necessarily determine resilience. Systems exposed to any form of disturbance that is notably different later can still be considered resilient.

Even though resilience emerged rapidly to dominate disaster management thinking in the context of emergency management (Cutter *et al.*, 2008:598; Zhou *et al.*, 2010:22; Aldunce *et al.*, 2014:252; Parker, 2020:1; Sakurai & Chughtai, 2020:585), this research will only focus on disaster resilience within the city realm.

3.3.1 Disaster resilience

According to the Hyogo Framework for Action (UNISDR, 2002), disaster resilience is determined by the degree to which individuals, communities, the public and private organisations are capable of organising themselves to learn from past disturbances and reduce their risks to future ones, at international, regional, national and local levels.

In this research, disaster resilience is the ability of individuals, communities and states and their institutions to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term changes and uncertainty (Linkov *et al.*, 2018:128; Manyena *et al.*, 2019:104; Hynes *et al.*, 2020:178). In practice, the Department for International Development (DFID) developed a framework, depicted in Figure 3.6, of the **core elements of disaster resilience** (DFID, 2011:7; Keating & Hanger-Kopp, 2020:103):

- **Context:** Whose resilience is being built? It should be the resilience of, for instance, a social group, socio-economic or political system, environmental context or institution.
- **Disturbance:** What shocks (sudden events like conflict or disasters) and/or stresses (long-term trends like resource degradation, urbanisation, or climate change) the system aims to be resilient to.
- **Capacity to respond:** The ability of the system or process to deal with a shock or stress depends on exposure (the scale of the shock or stress), sensitivity (the degree to which a system will be affected by, or will respond to, a given shock or stress) and adaptive capacity (how well it can adjust to a disturbance or moderate damage, take advantage of opportunities and cope with the consequences of a transformation).
- **Reaction:** How will the system respond? A range of responses are possible, including (i) bounce back better; are enhanced, exposures are reduced, and the system is better able to deal with future shocks and stresses; (ii) bounce back, where pre-existing conditions prevail; or (iii) recover but worse than before, meaning capacities are reduced. In the worst-case scenario, the system collapses, leading to a disastrous reduction in capacity to cope in the future.

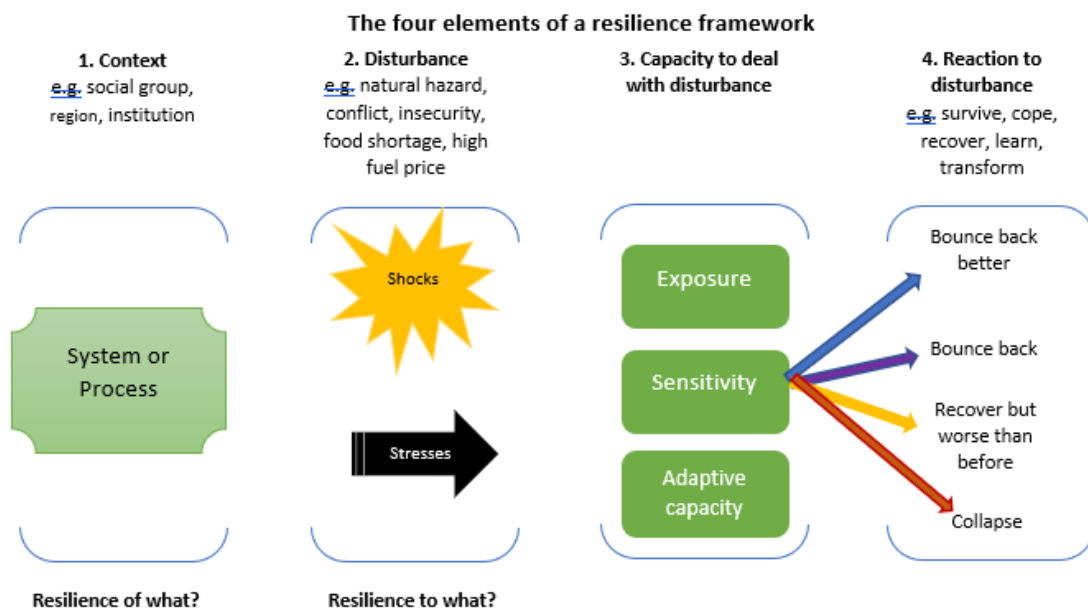


Figure 3.6: Elements of resilience framework (DFID, 2011:7)

The lens of resilience can help to enhance responses to disaster risk, as it calls for a complete deliberation of hazards, exposure, risk, vulnerability and capacity (Manyena, 2006:436; DFID, 2011:8; Sandifer & Walker, 2018:3). Disaster resilience, therefore, aims to save lives whilst protecting infrastructure, livelihoods, social systems and the environment to recover from a disturbance (Walker & Salt, 2012:xiii; Falk, 2013:3).

The World Bank (2013:54) developed five core areas of disaster resilience as a response to the growing demand for building disaster resilience. It is expected that the implementation of these five core areas be monitored and evaluated and they are, therefore, linked with Manitoba's model that also included monitoring and evaluation:

- **Risk identification:** Understanding disaster risks and anticipating the probable impacts of natural hazards, disaster and climate risk assessments can help governments, communities, businesses and individuals make informed decisions to manage that risk.
- **Risk reduction:** Disaster risk information can assist with different development strategies, plans and projects that can, in turn, reduce risks. This can either be done by avoiding the creation of new risks or by addressing existing risks.
- **Preparedness:** Adequate preparedness measures are essential because disaster risk can never be completely eliminated. Preparedness through early

warning systems, for example, saves lives and protects livelihoods and is one of the most cost-effective ways to reduce the impact of disasters.

- **Financial protection:** Financial protection strategies protect governments, businesses, and households from the economic burden of disasters. These strategies can include programs to increase the financial capacity of the state to respond to an emergency, whilst protecting the fiscal balance.
- **Resilient reconstruction:** The challenge of reconstruction also presents an opportunity to promote disaster risk management through integrated resilient recovery and reconstruction planning that will drive longer-term resilient development.

Whilst disaster resilience has featured prominently in international policies, it has also been subjected to criticism. Some authors believe that disaster resilience does not add anything particularly new to the substance of humanitarian or development assistance (Manyena, 2006:434; Levine *et al.*, 2012:2; Korostelina, 2021:24). Others oppose the re-labelling of long-standing approaches as resilience-building, as this has no meaningful effect on how humanitarian or poverty reduction programmes are implemented (Manyena, 2006:435; Maxwell *et al.*, 2009:31; Levine *et al.*, 2012:4).

There is also concern that, as a concept, disaster resilience has been depoliticised placing too much responsibility on the individual and wider society rather than on state actors who have the political power to address the underlying causes of vulnerability to disasters (Manyena, 2006:436; Norris *et al.*, 2008:146; Béné *et al.*, 2012:10; Levine *et al.*, 2012:4; Amery, 2019:365).

Addressing disaster resilience as a complex adaptive system emphasises understanding individual capacities and how these interact to generate resilience (Hartvigsen *et al.*, 1998:427; Gillespie-Marthaler *et al.*, 2019:67). Every city's approach to building resilience looks different, but common among them is a need for resilience monitoring and measurement all along the journey (Flax *et al.*, 2016:2). Importantly, basing the analysis of resilience and the formulation of subsequent models for understanding and measuring the resilience of complex adaptive systems means that there is an inherent understanding that resilience is not the end-point for a society to achieve, but rather a journey that will lead to constant adaptive change (Rose, 2007:387; Norris, 2008:130).

Resilience is associated with the ability to adapt to shocks and reorganise without suffering major changes in structure (Walker *et al.*, 2004:54; Cainelli, *et al.*, 2019:657; Bowen *et al.*, 2020:54). However, an important feature of resilience which brings sustainability and the capacity to transform to play, is that systems may be resilient but in an unwanted state which also applies to complex adaptive systems, such as cities (Olazabal *et al.*, 2012:11; Bristow & Healy, 2020:89). This explains the two-sided nature of urban resilience, or the non-equilibrium view of resilience as stated by Romero-Lankao *et al.* (2016:13), and requires societies to adopt the resilience futures they want - which may relate to different methods of sustainability.

3.4 RESILIENCE AND SUSTAINABILITY

Sustainability aims to manage different units, represented by people and society, on the one hand, and by the environment and natural resources, on the other, that are linked by complex relationships and disturbances (Kates *et al.*, 2001:641; Gunderson & Holling, 2002:14).

The change to sustainable cities depends on social, cultural, economic and environmental factors. In the rapidly-growing cities of developing economies, basic needs such as energy, water and mobility must be met sustainably, while resources are managed effectively. De Jong *et al.* (2015:25) add that the future depends on the sustainability of social, economic and environmental dimensions in cities. Ghisellini *et al.* (2016:11) agree that sustainability in cities will be achieved when the three dimensions (social, environmental and economic) are balanced in equal harmony.

City sustainability should therefore be followed by evaluating and managing the impact of the changes in the city in terms of its economic, cultural, social and environmental impacts. In other words, city sustainability must signify optimum stability between the satisfaction of the economic, environmental and social requirements of different players that frequently conflict with one another.

A sustainable transformation in a city environment needs to be adequately reliable, dependable, and robust to fulfil social and economic needs, and appropriately maintainable and energy-efficient to satisfy environmental and economic requirements. Hence, a sustainable city is equitable, for example, it satisfies social and economic requirements and is viable - it meets environmental and economic requirements (Kibert *et al.*, 2011:78; 136).

The connection between sustainability and resilience is evident and has been debated by several authors using different approaches (Tobin, 1999:13). Through Tobin's approach, it can be said that resilience is part of sustainability (see Figure 3.7). The complexity of sustainability can be summarised in the following rules (WCED, 1987:43):

1. The sustainability of a system includes a dynamic equilibrium among various factors relating to economic activities, society and the environment, which are often governed by contrasting or opposing influences;
2. The sustainability of transformations and processes must be dynamic, for example, it must be guaranteed for the entire duration in which their effects are felt; and
3. Sustainability must be provided in terms of all the actors involved; both those directly contributing to the processes and those affected by the secondary effects. Furthermore, sustainability must be guaranteed for both present and future generations.

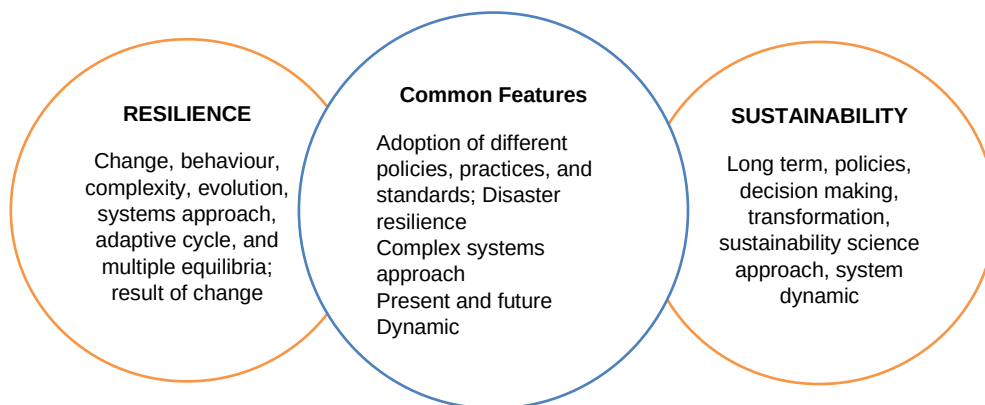


Figure 3.7: Common features between resilience and sustainability

The link between resilience and sustainability can thus be defined as a structure or an infrastructure that will be sustainable if it can reduce the negative effects of potential disasters, both during and after such events, in terms of the social, environmental and economic responsibility they require from all actors involved (Zhou *et al.*, 2010:21). Sustainability represents the end goal that cities must chase to secure a decent quality of life for all people, today and in the future, through robust and successful resilient cities.

It is consequently vital for a city to be resilient by having the ability to return to the previous stage or reach a different stage of equilibrium. It is also essential to determine that the system of transformations that occurs during and after the event are sustainable, irrespective of the original pre-event or the final post-event stability stages. This notion is supported by Redman (2014:2), who indicated that the sustainability and resilience approaches should both be recurrently applied because they share many objectives and elements in their effort to understand the dynamics of the system, to improve strategic capabilities and include diverse perceptions.

The sustainability approach provides a focus on how to model the future from the past and fit planning requirements to those predictions to achieve specific and sustainable outcomes for the system (Coaffee & Lee, 2016:248). The resilience approach focuses on building a system's adaptive capacity to positively respond to shocks and stresses without predetermining the specific outcome of the actions (Redman, 2014:4). Therefore, sustainability prioritises outcomes; resilience prioritises process. Capabilities of a city's systems resilience will thus contribute to achieving the city's economic, social and environmental targets of a sustainable city but needs the city to maintain its systems functions at a satisfactory functional level.

While there is still considerable vagueness around what resilience thinking is and how it can be applied in city systems, there is general agreement that resilience is an appreciated way of engaging with the complications of city developments and informing interventions/sustainable development strategies for cities (Cartalis, 2014:259). It is against this view that city resilience has become a policy concern for international agencies, reflected in the inclusion of a specific SDG for making cities and human settlements inclusive, safe, resilient and sustainable (SDG 11).

3.5 RESILIENCE AND SUSTAINABLE DEVELOPMENT

Sustainable development is defined by the World Commission on Environment and Development (WCED), in the Brundland report as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987:14). Sustainable development is a form of development that adopts adaptive and transformative capabilities and generates opportunities to maintain reasonable long-term prosperity in complex inter-linked social, economic and ecological systems.

Sustainable development seeks to combine two goals, namely (i) meeting the needs of the present, (ii) without compromising the ability of future generations to meet their needs. Matoso and Jobbins (2016:1) add that “the delivery of basic health, education, clean water and sanitation services and social protection (social safety nets to livelihood enhancing programs) is a critical component of strengthening resilience”.

Similar to resilience, sustainable development can also be seen as a process, in addition to a normative state, and can require iterative steps of assessment, planning, monitoring and re-assessment to achieve desired long-term goals. These goals are linked to system integrity, livelihood sufficiency, opportunity, resource maintenance and adaptation (Adger *et al.*, 2005:399).

In September 2015, the United Nations Sustainable Development Summit adopted a new framework to guide development efforts between 2015 and 2030, entitled *Transforming our world: The 2030 Agenda for sustainable development*. The 17 SDGs, as depicted in Figure 3.7, were intended to be universal and refocused priority development areas. It was hoped that these goals would be action-orientated, brief and easy to understand and communicate, as they are limited in number, aspiring, global in nature and universally applicable to all countries. This vision was intended whilst taking different realities and challenges, levels of development and specific policies and priorities of different countries into account (Osborn *et al.*, 2015:3). The UN's Department of Economic and Social Affairs (UNDESA) continuously publishes the progress of countries, including South Africa, in their efforts to achieve the SDGs. UNDESA recognised the significant progress South Africa made on the country's developmental journey since the advent of democracy in 1994. South Africa is therefore considered well placed towards meeting the SDGs (UNDESA, 2021:71).



Figure 3.8: UN 17 Sustainable Development Goals (UN, 2015)

The 2030 Agenda includes a dedicated goal that sets out to make cities inclusive, safe, resilient and sustainable (UN, 2015). This specifically relates to Target SDG 11b, which states that:

“By 2030 the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for DRR 2015-2030, holistic disaster management at all levels.”

SDG 11 took the opportunity to make resilience the core purpose of sustainable development specifically for cities. Folke *et al.* (2010:7) agree and state that:

“Resilience provides a missing link of sustainable development. It is not a substitute for sustainable development, but a necessary component. Resilience is therefore considered a pre-request for achieving sustainable development because it guides policies towards sustainability.”

Although the idea of resilience capacity in city systems becomes slightly ambiguous when taken into account their sustainable development, defining and assessing resilience at the city level is an attempt to overcome these limitations (Constantinescu & Frone, 2018:169). Therefore, resilience, the capacity to persist, adapt and transform in the face of change, is an essential precondition for sustainable development and to

achieve the SDGs. Resilience provides opportunities for positive, environmentally sustainable and long-lasting transformation in this new reality.

Among the various resilience definitions discussed, there are a few common characteristics of resilience. Most definitions of resilience refer to the ability of a system to absorb and adapt to disruptive events and to recover from disturbance are considered critical components. Some definitions require a return to a steady or pre-disturbance state while others allow for system degradation or the possibility of an improved or changed state. Many descriptions include an emphasis on preparedness and recovery activities. The achievement of resilience is often linked to achieving the desired level of system performance. Therefore, enhanced resilience may be the way to restore the balance between the three pillars of sustainable development when disruptions impact social, economic and environmental operations in a city as a complex adaptive system.

As seen in this chapter, city disaster resilience is a strategic arrangement comprising of interactions between DRR, sustainability and sustainable development. If resilience provides a means for sustainable development, then it should be accepted that city disaster resilience constitutes, by itself, an indicator for sustainable development that can turn from means into purpose to ensure sustainable development.

3.6 DISASTER RESILIENCE FOR SUSTAINABLE CITIES

City resilience has conventionally been defined as the measurable ability of any urban system to maintain continuity through all shocks and stresses, while positively adapting and transforming towards sustainability (UN-Habitat, 2020). Therefore, a resilient city assesses, plans and acts to prepare for and respond to hazards - natural and human-made, sudden and slow-onset, expected and unexpected.

A resilient city is better positioned to protect and enhance people's lives, secure development gains, foster an investible environment and drive positive change (UN-Habitat, 2018:19). The Rockefeller Foundation and Arup's research on developing the Cities Resilience Index, as supported by UN-Habitat (2017:42), UNDRR (2014:34), Bello *et al.* (2021:23), the World Bank (2014:67), Bahadur *et al.* (2015:1), Sachs *et al.* (2019:805), ISO (2016:3), Van Zeijl-Rozema *et al.* (2008:410), Gupta and Vijayalakshmi (2020:4) and Eisenbeiss (2016:1) agree that a disaster-resilient city that achieves the SDGs is a system that provides for the well-being of its community (cf.

2.1.1). A city has elements of vulnerability, diverse livelihoods, basic services and community support; a disaster-resilient city, therefore, provides for the following fundamentals:

1. Minimal **human vulnerability** indicated by the extent to which everyone's basic needs are met.
2. **Diverse livelihoods** and employment facilitated by access to finance, ability to accrue savings, skills training, business support and social welfare. Principles of equity, equality and fulfilment of human rights that allow for assessing the population's access to their basic developmental rights translated into access to basic social protection and social services such as education, health, food and social care, and anticipate potential shocks and stresses in order to build their social resilience (UN-Habitat, 2017:42).
3. Effective **safeguards to human health** and life, relying on integrated health facilities and services and responsive emergency services. The delivery of **basic services** such as health, education, clean water and sanitation services and social protection (social safety nets to livelihood enhancing programs) is a critical component of strengthening resilience (Matoso & Jobbins, 2016:1).
4. Collective identity and **community support** are observed as active community engagement, strong social networks and social integration. Cultivating an environment for social connectedness which promotes a culture of mutual help through recognition of the role of cultural heritage and education is essential (UNDRR, 2014:34).
5. **Comprehensive security** and rule of law including law enforcement, crime prevention, justice and emergency management. Bello *et al's* (2021:23) planning for DRR of the 2030 Agenda for Sustainable Development study identified law enforcement as an essential measure to be included in a governance framework for resilience.
6. **Sustainable economy** observed as sound financial management, diverse revenue streams, the ability to attract business investment, adequate investment and emergency funds (World Bank, 2014:67; Bahadur *et al.*, 2015:1).
7. **Reduced exposure** and fragility indicated by environmental stewardship, appropriate infrastructure, effective land-use planning and enforcement of planning

regulations. Sachs *et al.* (2019:805) focus on planning for disaster resilience and claim “governments need a strategy to design and implement key intervention”.

8. **Effective provision of critical services** indicated by diverse provision and active management; maintenance of ecosystems and infrastructure, and contingency planning. The International Organisation for Standardisation (ISO) 37101 categorially states that progress towards sustainable development through maintaining and improving city services is a core component of a resilience city (ISO, 2016:3).

9. **Reliable communications** and mobility indicated by diverse and affordable multimodal transport systems, information and communication technology (ICT) networks and contingency planning.

10. **Effective leadership and management** involving government, business and civil society, and indicated by trusted individuals, multi-stakeholder consultation and evidence-based decision-making. Van Zeijl-Rozema *et al.* (2008:410) added that in the context of sustainable development that governance is regarded as an essential and indispensable steering tool in a city. Gupta and Vijayalakshmi (2020:4) state “building the adequate governance, coordination and financing mechanisms to guard against disasters is not easy and requires strong and committed leadership”.

11. **Empowered stakeholders** indicated by education for all, and access to up-to-date information and knowledge to enable people and organisations to take appropriate action. Johnson and Blackburn’s (2014:35) research study, which was conducted with 50 cities participating in the UNDRR Making Cities Resilient Program, found that cities have reported that the institutionalisation of DRR and disaster management is most effective where specific people or departments within local government are made legally responsible for implementation and coordination among all relevant departments or sectors.

12. **Integrated development planning** is indicated by the presence of a city vision, an integrated development strategy and plans that are regularly reviewed and updated by cross-departmental working groups. Eisenbeiss (2016:1) added that “coordinated territorial planning and cross-section cooperation are significant for effective implementation of 2030 Agenda”.

As seen above, from a sustainable city perspective, resilience is not only a differentiating factor at the regional and sectoral level, but also one able to serve its

purpose - to create and maintain social, economic and ecological prosperity of all systems affected by human activity (Constantinescu & Frone, 2018:169). Increasing disaster risks present a massive challenge to the success of the SDGs and their target actions. Therefore, the application of the DRR measures and the building of resilience in the city offers a strategic opportunity to ensure the success of the SDGs and ensure that development gains are secure and sustainable. Unless disaster risks are effectively managed, increasing disaster loss and impacts will continue to undermine efforts to reduce poverty and achieve sustainable development (UNDRR, 2015:4). Hence, CoT's objective should be to work towards sustainability and ensure positive long-term impacts, whilst being truly sustainable, which entails incorporating resilience to drive and protect development goals.

Over the past few years, there has been an increase in the number of frameworks and tools developed for measuring a city's resilience to disasters. As climate change advances, measuring resilience becomes an even more significant topic in science and policy circles that influence future urban development (Sharifi & Yamagata, 2016:255). Resilience indicators, in particular, are essential in helping planners and decision-makers understand where the city stands in terms of resilience to disasters and develop strategies and action plans for creating more resilient cities. The next section of the chapter introduces four different frameworks developed through the lens of cities' resilience and DRR and draws attention to measures that may contribute to the implementation and achievement of SDGs.

3.7 CONTEXTUALISATION OF FOUR INTERNATIONAL DISASTER RESILIENCE FRAMEWORKS

A contextualisation of each of the four internationally recognised disaster resilience frameworks is presented.

3.7.1 United Nation's Disaster Resilience Scorecard

The Disaster Resilience Scorecard for Cities developed by UNDRR applied 10 essentials to enable cities in establishing a baseline measurement of their current level of disaster resilience. Each essential identifies priorities for investment and actions to track progress in improving a city's disaster resilience over time (UNDRR, 2015:67). It intends to guide cities towards optimal resilience and challenge complacency, as well as remind authorities and stakeholders that there is always more to be done to ensure

lasting resilience (Johnson & Blackburn, 2014:29). Table 3.2 shows the key functions and the focus of each of the 10 essentials.

Table 3.2: Ten essentials and key focus areas (UNDRR, 2015:10-90)

Essentials	Key focus
1. Organise for disaster resilience	Put in place an organisational structure and identify the necessary processes to understand and act on reducing disaster risks.
2. Identify, understand and use current and future risk scenarios	Local governments should identify and understand their risk scenarios and use this knowledge to inform decision making.
3. Strengthen financial capacity for resilience	Understand the economic impact of disasters and the need for investment in resilience. Identify and develop financial mechanisms that can support resilience activities.
4. Pursue resilient urban development	The built environment needs to be assessed and made resilient, as applicable.
5. Safeguard natural buffers to enhance the protective functions offered by natural ecosystems	Identify, protect and monitor critical ecosystem services that confer a disaster resilience benefit.
6. Strengthen institutional capacity for resilience	It is important to ensure that all institutions relevant to a city's resilience have the capabilities they need to discharge their roles.
7. Understand and strengthen societal capacity for resilience	Ensure understanding and strengthening of societal capacity for resilience. Cultivate an environment for social connectedness which promotes a culture of mutual help through recognition of the role of cultural heritage and education in DRR.

8. Increase infrastructure resilience	Assess the capacity and adequacy of, as well as linkages between, critical infrastructure systems and upgrade these as necessary according to risks identified in Essential 2.
9. Ensure effective disaster response	Building on the scenarios in Essential 2, ensure effective disaster response.
10. Expedite recovery and Build Back Better	Ensure sufficient pre-disaster plans according to risks identified, and that after any disaster, the needs of the affected are at the centre of recovery and reconstruction, with their support to design and implement rebuilding.

As shown in Figure 3.9, the 10 essentials offer broad coverage of the many issues cities need to address to become more disaster-resilient. Essentials 1-3 cover governance and financial capacity; Essentials 4-8 cover the many dimensions of planning and disaster preparation; and Essentials 9-10 cover the disaster response itself alongside post-event recovery.

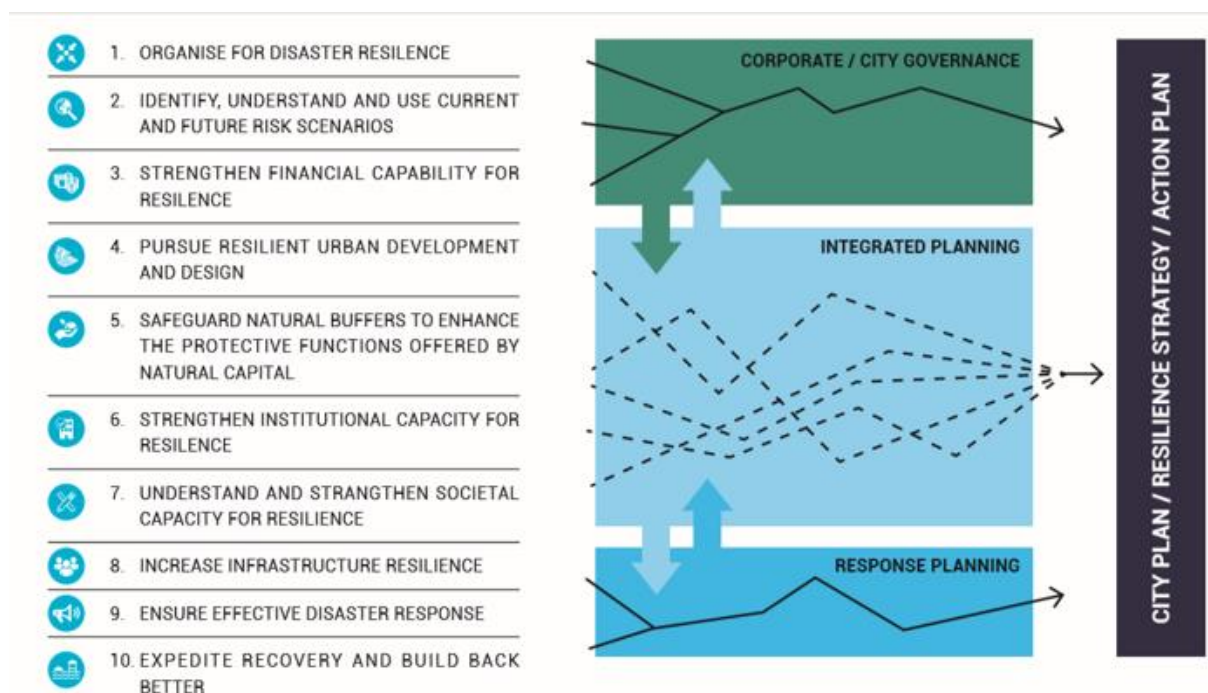


Figure 3.9: Ten essentials for making cities resilient (UNDDR, 2015:3)

The Disaster Resilience Scorecard for cities has various advantages, such as increased awareness and education, understanding resilience challenges, enabling dialogue between key city stakeholders and ultimately leading to actions and implementable projects that will deliver increased resilience for the city over time.

3.7.2 Rockefeller Foundation's City Resilience Index

The purpose of the City Resilience Index developed by the Rockefeller Foundation and Arup is to provide cities with a robust, holistic and accessible basis for assessment so that they are better placed to make investment decisions and engage in urban planning practices that ensure cities survive and thrive no matter the shock or stresses they encounter (Rockefeller & Arup, 2014:21). The City Resilience Index provides a lens to understand the complexity of cities and the drivers that contribute to their resilience, as well as a common language that enables cities to share knowledge and experiences (Da Silva & Morera, 2014:3; Rockefeller & Arup, 2014:5). The City Resilience Index was developed to enable cities to carry out an objective assessment of their resilience and measure progress against an initial baseline (Rockefeller & Arup, 2014:8). The City Resilience Index is measured by gathering data and analysing the resilience competence of a city, by assessing eight key functions of an urban system. Table 3.3 shows the key functions and the focus of each key function.

Table 3.3: City Resilience Index Key Functions (Rockefeller & Arup, 2014:10)

Key function	Focus
Deliver basic needs	Providing an adequate and dependable supply of essential services and basic needs to a city's whole population.
Safeguard human life	Integrated health facilities and services, and responsive emergency services.
Support human relationships and identity	Active community engagement, strong social networks and social integration.

Promote knowledge, education, and innovation	Education for all relies on access to up-to-date information and knowledge, to enable people and organisations to take appropriate action.
Enforce the rule of law, justice, and equity	Includes law enforcement, crime prevention, justice and emergency management.
To protect and maintain assets	Diversity of provision, redundancy, active management and maintenance of ecosystems and infrastructure and contingency planning.
To support livelihoods	Access to finance, ability to accrue savings, skills training, business support and social welfare.
To stimulate economic prosperity	Sound management of city finances, diverse revenue streams, and the ability to attract business investment, allocate capital and build emergency funds.

The City Resilience Index is built on four essential dimensions of urban resilience. These include leadership and strategy, health and wellbeing, economy and society, infrastructure and environment - as depicted in Figure 3.10.



Figure 3.10: City Resilience Index (Rockefeller & Arup, 2014:9)

The City Resilience Index model is currently being implemented in more than 100 cities across the globe to help municipal governments cope and deal with complex problems resulting from climate change but also as a result from social, economic and political problems. The Rockefeller Foundation funds the appointment of so-called resilience officers in cities that are members of the 100 resilient cities network. In South Africa, eThekweni and the City of Cape Town are members of this network and have resilience officers appointed by the foundation. The City Resilience Index presents an opportunity for change in the way in which governance occurs at the municipal scale, by using dimensions and drivers of resilience to inform planners and policymakers on future resilience-building efforts.

3.7.3 UN-Habitat's City Resilience Profiling Tool

The City Resilience Profiling Tool focuses on making cities resilient through local governments, by providing the tools and knowledge required to build their capacity to prepare, respond and recover from all shocks and stresses, leading them towards sustainability (UN-Habitat, 2017:14). As tabulated in Table 3.4, the City Resilience Profiling Tool has an urban system approach that considers five critical and interdependent principles common to cities.

Table 3.4: City Resilience Profiling Tool Principles (UN-Habitat, 2017:30)

Principle	Focus
City identification	This principle explores the city's development narrative through its historical background and its spatial context, specifically in the aspects of climate, ecosystems, urban areas and physical assets. It introduces the city's administrative structure, characteristics and strategies, highlighting those related to resilience and describes the city's inhabitants through their composition, characteristics and dynamics and outlines basic information on the economy and livelihoods.
Local governments and stakeholders	With an emphasis on decision making and decision implementation, on financial governance and strategic planning, Principle 2 considers the key functions of the local government in developing and consolidating the resilience at a city level, all by considering the broader frameworks of administrative and fiscal decentralisation, and the fulfilment of international quality standards in the area of good governance.
Shocks, stresses and challenges	This principle assesses the city's proneness to stresses, shocks and future challenges, as well as the existence and performance of risk reduction measures and strategies aimed at decreasing the possible impacts of those threats on the urban scale.
Urban elements	The fourth principle includes all the elements that frame the urban area, from a close-up in the built environment to the broader scale of the ecology, the supply chain and logistics, basic infrastructure and mobility, all the elements at the service of inhabitants, or enabling life in the urban system.

The tool provides cities with the necessary framework and approach to evaluate urban resilience and develop actions for resilience tailored to their city. By outlining the general context of the city, including all relevant stakeholders and plausible shocks and stresses, and providing a framework for data gathering, the City Resilience Profiling Tool allows a preliminary identification of gaps and opportunities over a series of different aspects regarding the city's structure and functionality, thereby providing a baseline for future actions (UN-Habitat, 2017:12). The City Resilience Profiling Tool is built on four essential principles that collectively provide an in-depth picture of the city and its stakeholders. The integration of the four dimensions - city identification, local government and stakeholders, shocks, stresses and challenges, and urban elements - are illustrated in Figure 3.11.

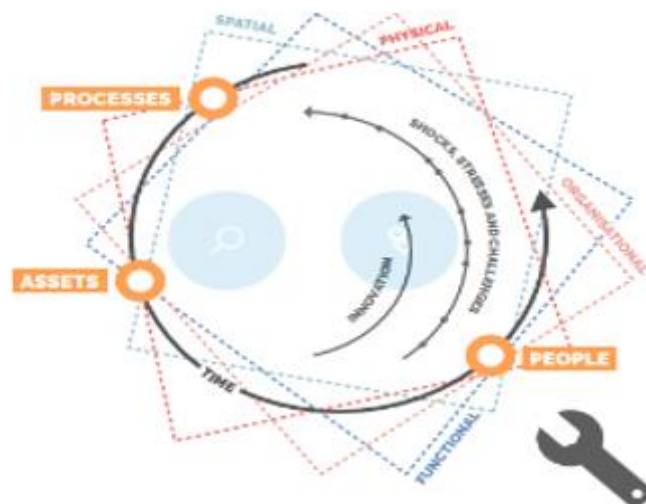


Figure 3.11: City Resilience Profiling Tool (UN-Habitat, 2017:12)

The City Resilience Profiling Tool follows a holistic and integrated approach, which not only aims at increasing the resilience of a given city but also generates a learning value on data gathering and organisation beyond the scope of resilience. The tool also diagnoses the level of resiliency through various indicators within a city and proposes a plan on how to increase it through action.

3.7.4 UN-Habitat's City Resilience Action Planning Tool

The overall purpose of the City Resilience Action Planning tool (CityRAP) is to assist cities in reducing (both environmental and socio-economic) risks, enhancing adaptation and promoting sustainable development (UN-Habitat, 2018:1). The

CityRAP tool aims to support, facilitate, complement, and deepen existing development processes and capacities to ensure that a city can reinforce its resiliency as an endogenous process (Spaliviero *et al.*, 2019:2).

The tool is built on participatory methods and consensus-building techniques to involve all those concerned to identify the entry points, in order to start progressively building the city's resilience with minimal external support. A key principle of the tool is bottom-up planning. Relevant stakeholders, communities and urban dwellers are engaged in the process through participatory risk mapping exercises, focus group discussions and cross-sectorial action planning (UN-Habitat, 2018:6).

The CityRAP tool is structured around five pillars to determine the status of the city's resilience (Table 3.5); urban governance, urban planning and environment, resilient infrastructure and basic services, urban economy and society and urban disaster risk management. The integration of the five pillars is illustrated in Figure 3.12 hereafter.

Table 3.5: An overview of the five pillars and objectives (UN-Habitat, 2018:9)

Pillar	Focus
Urban governance	This pillar focuses on the relationship between citizens and the local government and requires adequate and efficient legal, policy, administrative and operational frameworks.
Resilient infrastructure and basic services	Ensuring equal access to infrastructure and basic services is crucial to meet the vital needs of the urban population and to allow a city to function and develop properly. It is essential that the design and management of infrastructure and basic services fully integrate the concept of resilience.
Urban economy and society	This pillar refers to the processes, mechanisms and activities that allow cities to become drivers of socio-economic development in a country or region, by creating jobs, increasing households' income, generating investments, reducing social tensions and crime, increasing equality and inclusion, promoting

	social mix and enhancing security and safety, among other aspects.
Urban planning and environment	This pillar includes all aspects related to planning and design of the urban space, the quality of the natural environment (air, water, soil), public/green spaces and climate change.
Urban disaster risk management	This pillar refers to the ability of the local government and communities, in terms of capacity, knowledge, processes and systems in place, to prevent, anticipate, respond to and recover rapidly from the impacts of natural or manmade threats in the city.

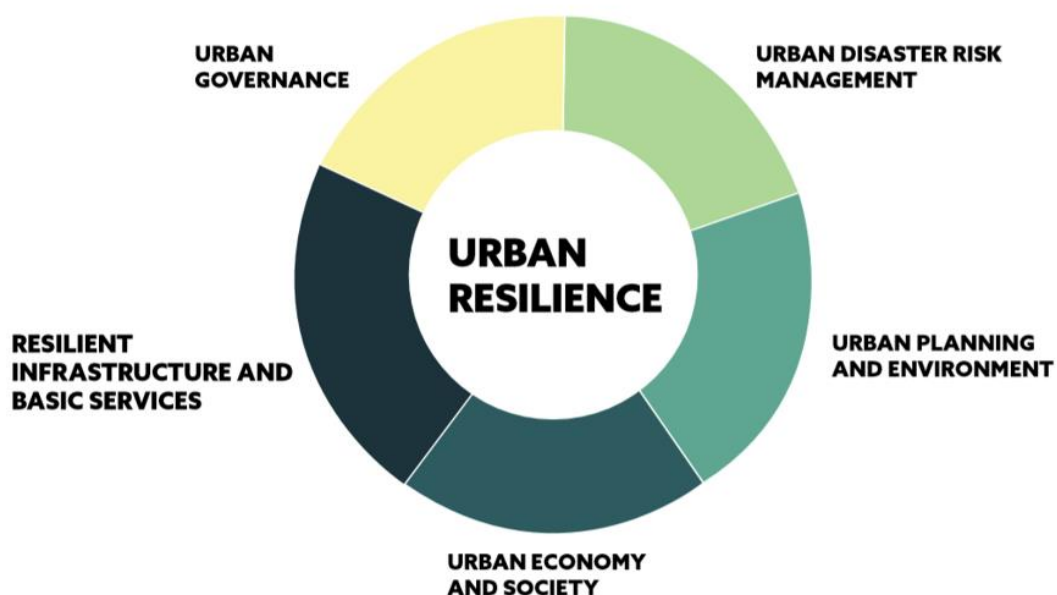


Figure 3.12: City Resilience Action Planning tool pillars (UN-Habitat, 2018:8)

The CityRAP tool has met with high demand from several African countries. The tool is currently being implemented in Comoros, Ethiopia, Malawi, Mozambique, South Africa, Zambia and Zimbabwe, allowing scope for further rounds of learning. Learning and innovation, driven by a desire to hold planning as close as possible to those at risk means the CityRAP tool can support city managers in engaging with populations at

risk, leveraging local knowledge and enabling a process that allows the timely undertaking of decisions for building endogenous resilience.

3.8 CONCLUSION

This chapter introduced the emergence of DRR and explained how DRR enables disaster resilience in a city. The chapter presented different disaster management models and introduced the helix disaster risk management model as a new, improved way to deal with disasters. The helix model places a lot of emphasis on DRR efforts with the aim of reducing the impact of disruptions should they occur. Disasters are events that cause great damage, loss of life and overwhelm the capacity of people to cope. What makes things worse is the element of surprise. This research does not call for completely abandoning the traditional disaster management cycle but rather it challenges it. This research promotes a value-based approach for disaster management which incorporates contemporary aspects of management, including innovation, entrepreneurship, leadership, situation awareness, resilience and learning - which are likely to enable people to deal with the elements of surprise and uniqueness of disasters.

Among the various resilience definitions discussed in the chapter, there are a number of common attributes of resilience. Most definitions of resilience refer to the ability of a system to absorb and adapt to disruptive events. Recovering from disturbance is considered a critical component; some require a return to a steady or pre-disturbance state while others allow for system degradation or the possibility of an enhanced or transformed state; many include emphasis on preparedness and recovery activities and the attainment of resilience is often linked to achieving a desired level of system performance. Common features of resilience and sustainability were introduced where it was clear that the link between resilience and sustainability is defined as a structure that will be sustainable if it can reduce the effect of a disruption. It is therefore concluded that improved resilience may be the way to restore balance between the three pillars of sustainable development when disruptions question social, economic and environmental operation, especially in a city as a complex adaptive system.

The chapter conceptualised complex adaptive systems, with a city as the system that is adaptive by nature to the city's dynamics and must be able to respond and react to disturbance or change and maintain the delivery of essential services. The city should

therefore be a resilient city that has a measurable ability to maintain continuity through all shocks and stresses, while positively adapting (or transforming) towards sustainability. Both sustainability and resilience recognise the need for preventive measures for the use of resources and in relation to emerging risks, aiming to promote the integrity of future well-being. The chapter concluded with a contextualisation of four international disaster resilience frameworks developed specifically for cities.

The next chapter presents the research design and methodology used for this study. The discussion includes the research technique, sampling technique, sample (research respondents), data generation methods, data analysis and the research design process used for the study.

CHAPTER FOUR: RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

This chapter details the methodological choices made for the study, including the research technique, sampling technique, sample (research respondents), data generation methods, data analysis and the research design process of the study, to answer the research questions. The chapter presents the philosophical orientation of this research and explains why a qualitative research approach was considered appropriate. The strategies implemented to establish the trustworthiness (credibility, transferability, dependability and confirmability) of the study are also discussed.

4.2 RESEARCH DESIGN

The study assumed the format of a single case study using a qualitative approach to take a deeper look into complexities, relationships and processes; as well as to identify important indicators that are necessary for a city's disaster-resilience framework. A framework can assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy (Marshall & Rossman, 2011:69).

Ultimately, qualitative research aims to understand and interpret. Qualitative research is characterised by describing the process of meaning-making and describing how individuals interpret what they experience. This research study is also descriptive in nature as it provides a detailed documentation of phenomena of interest (Bhattacharjee, 2012:6). The qualitative method (in the form of document analysis and one-on-one interviews) were applied in this single case study, wherein the CoT is the case.

A single case study is considered the most appropriate design for this research study as it enables the researcher to obtain an in-depth understanding of the context of DRR and sustainable development in the CoT. Different aspects such as geographical area, population, vulnerability to disaster, current and future risk and hazards were also considered during the case study.

According to Yin (2009:2), case study research is best applied when the research addresses descriptive or explanatory questions such as what, how and why. Leedy and Ormond (2005:135) describe case studies as the collection of data on the subject being investigated. Thomas (2011:513) defines the case study method as research

that concentrates on one thing - looking at it in detail without trying to generalise from it. This single case study was undertaken to develop a framework that will assist CoT in including DRR measures and SDGs in its disaster resilience strategy.

One of the advantages of a case study is that case studies are real – they offer a chance to get a snapshot of real-life as well as the opportunity for a holistic approach without the distraction of too many variables (Gummesson, 2007:229). Merriam (2009:51) agrees and states that the rich and holistic account produced by a case study offers insight and expands the readers' experiences, thereby playing an important role in advancing any study field. According to Neale *et al.* (2006:4), another advantage of a case study is that it provides more detailed information when compared to other methods, since the data gathered from multiple methods (for example, interviews and document reviews) are presented and provide a complete story. Furthermore, a case study can investigate a phenomenon in its context and are therefore considered a valuable way of looking at the world around us (Yin, 1994:283).

Neuman (2014:42) describes six strengths of a case study design. *Conceptual validity* refers to how the case study has helped identify indicators pertaining to a city disaster-resilience framework. The *heuristic impact* refers to how the case study has helped to learn about and discover how a city can incorporate DRR measures and the SDGs in its disaster resilience planning strategy. *Casual mechanisms identification* refers to how factors are interrelated and affect one another. The case study can *capture complexity and trace processes* over time regarding how complex a city disaster-resilience framework is. The case study aided the researcher to draw from the existing disaster resilience planning efforts in CoT. Additionally, the case study has the ability to *elaborate holistically* on the entire situation of the CoT by including multiple viewpoints from the respondents. These strengths cause the case study to be an appealing design for the research study and aided the researcher in obtaining insight into how, as a local government, CoT experiences and applies DRR measures and the SDGs in their strategic approach to disaster risk management.

Unfortunately, a case study limitation is generalisability; it focuses on a single unit. Whilst a lot can be learned from one particular case Merriam (2009:51) and Yin (2009:14, 15) discuss a limitation to case study research as being a lack of rigour. Yin states that the researcher might allow biased views to influence the conclusions. In this research study, the latter has been overcome through confirmability.

4.2.1 Role of the researcher

The researcher's role in qualitative research is critical, as they gather data and implement analysis (Creswell, 2007:16). Therefore, the researcher's role in this study was that of an observer, as she was the primary instrument of data generation and data analysis; she coded and analysed the data to uncover emerging themes.

The researcher is an employee of CoT. As an employee of CoT, she is responsible for managing the Disaster Risk Management section in CoT and is therefore directly interested, involved and committed, not only as a researcher but as an employee of CoT. Central to the interpretivist research paradigm is the assumption that realities are multiple, fluid, and co-constructed, and knowledge is taken to be negotiated between the researcher and respondents. From the latter framework emerges evaluative criteria valuing research that illuminates subjective meanings and understands and articulates multiple ways of seeing a phenomenon. Rich substance and content, clear delineation of the research process, evidence of immersion and self-reflection, and demonstration of the researcher's way of knowing, particularly with regard to tacit knowledge, are essential features of high-quality research (Cohen & Crabtree, 2008:335). Bearing this in mind, the researcher endeavoured throughout this study to be mindful of being unbiased and subjective throughout the study. She aspired to acknowledge and consider opinions shared by individuals who participated in the study, as the respondents were considered to have extensive experience in the subject matter. The researcher was mindful in ensuring that she passed on the respondents' meanings when she interpreted them.

4.2.2 Literature study

According to Creswell (2009:25), a literature review provides a framework for establishing the importance of the study and provides a benchmark for comparing the results with other findings. Majam and Theron (2006:604) maintain that a literature review should explain to the reader the theoretical context of the problem being examined. The wide-ranging critical and integrative literature review (Mouton, 2001:179) was undertaken on themes focusing on disaster resilience and sustainable development in cities, as well as the implementation, use and working models of city disaster-resilience frameworks within the theoretical frame of this study. As such, academic books, peer-reviewed journal articles, research reports, dissertations,

government publications and international models were all consulted to understand disaster resilience and sustainable development in cities. Empirical findings, national and international policy and legislative frameworks within the field of disaster resilience and sustainable development were also consulted.

The literature review helped the researcher gain in-depth knowledge on the broader area of cities' resilience to disasters. The initial review of the literature helped the researcher to narrow down the area of study to the local government context. Consequently, the researcher was able to identify initial gaps in the selected subject domain. The initial review helped the researcher to understand that there is a need to assist cities in the process of being disaster-resilient, following which local governments are required to play an essential role as they are the main governing body in every city. Therefore, the critical review of the literature helped to refine the initial research ideas and to gain thorough knowledge in the research.

4.3 PHILOSOPHICAL ORIENTATION

In recognising the importance of research philosophy, Easterby-Smith *et al.* (2008:76) claim that it is central to the notion of the research design and that failure to think through philosophical issues can seriously affect the quality of the research. Griggs (2000:11) agrees and adds that:

"Philosophy is fundamental to the development and presentation of logical argument, the capacity to identify, analyse, and interpret published research results and the ability to discuss methods and theory in the context of the philosophical schools in which they originate."

Under interpretivism, the ontological thought is relativist, seeking to understand the meanings attributed by and experiences of different populations, against the background of competing perspectives on life and the world within the setting being investigated (Reeves & Hedberg, 2003:32). Interpretivist positions are founded on the theoretical belief that reality is socially constructed and fluid. Interpretivism assumes that there is no objective knowledge independent of thinking (Grbich, 2012:65). Thus, findings or knowledge claims are created as the investigation proceeds. Findings, therefore, emerge through dialogue in which conflicting interpretations are negotiated among members of the community.

A dialogue between researchers and respondents is therefore critical. According to Creswell (2007:43), it is through this dialectical process that a more informed and sophisticated understanding of the social world can be created. According to Fryer (1991:15), the researchers operating within the framework of the interpretivist research paradigm are focused on investigating the complexity, authenticity, contextualisation, shared subjectivity of the researcher and the subject(s), as well as the minimisation of illusion. Using the interpretivism perspective, this research provided a detailed analysis of how CoT employees experience and perceive disaster resilience and sustainable development in CoT. These perceptions shaped how disasters, resilience and sustainable development are interpreted and understood within city structures and the city's knowledge systems.

Qualitative research can be naturalistic, holistic or inductive (Terre Blanche *et al.*, 2006:43). This research used the inductive research approach to gain an understanding of DRR and sustainable development frameworks relating to cities' resilience. Inductive research involves the search for patterns from the responses of the respondents and the development of explanations for those patterns. In the final stage of this research, the researcher added to the theory by using data and the identified indicators.

The interpretivist research paradigm, which is an inductive process, was chosen because it provides an in-depth understanding and interpretation of certain contexts to deep insight and conclusions that may differ from others (Saunders *et al.*, 2012:43). The interpretive paradigm enabled the researcher to consider different factors based on the respondents' personal experiences, which helped describe the reality of the interpretivist research.

According to Ueltzhoffer and Ascheber (1999:47), interpretivism elucidates the individual's subjective patterns, personal experiences, viewpoints and motives and thus the researcher's creative potential. The respondents in this research have different experiences in DRR, disaster resilience and sustainable development due to their diverse backgrounds. Due to the latter, their viewpoints and motives towards a disaster-resilient and sustainable development framework differ and thus provided the researcher with the opportunity to develop a framework that considers the different views. This paradigm also supported the research to be more focused on the specific topic (Moustakas, 1994:12). The interpretivist research paradigm enabled the

researcher to treat the context of the research and its situation as unique, considering the given circumstances associated, as well as the respondents involved.

4.4 SITE SELECTION, SAMPLING TECHNIQUE AND SELECTION OF SAMPLE

This section of the chapter provides the site selection, sampling techniques and the selection of respondents pertaining to this study. The respondents in this study are CoT employees who have experience in emergency services, disaster risk management and sustainability.

4.4.1 Site selection

The site for data gathering was the CoT Metropolitan Municipality. As the researcher is an employee of CoT Emergency Services and has first-hand experience in disaster risk management, it was convenient to have CoT as the study site. This allowed the researcher access to various strategic documents and senior officials who participated in the research study.

4.4.2 Sampling techniques

The sampling technique applied for this research study was purposive sampling because the researcher selected respondents who have extensive experience in disaster risk management and sustainable development (Marshall, 1996:523; De Vos *et al.*, 2005:238). The researcher had the opportunity to select the respondents who could best provide feedback to assist the researcher in achieving the objectives of the study (Marshall, 1996:523).

Lunenber and Irby (2008:177) maintain that for qualitative research, one should purposively select respondents who meet criteria that will provide a sample that is likely to yield the type of information that is needed to achieve the purpose of the research. In this study, 10 officials involved in various areas of disaster risk management and sustainable development were selected and participated by way of one-on-one interviews. This small sample size resonates with the argument of Lunenburg and Irby (2008:176), who postulate that qualitative research summarises sampling techniques that produce samples that are predominantly small and non-random.

4.4.3 Selection of sample

In this study, preference was given to key respondents who, due to their employment in CoT, positions, operational knowledge and experiences, have adequate information about all aspects of disaster risk management, disaster resilience, sustainability and sustainable development.

Identified respondents who met the aforementioned criteria were invited via email to participate in the research study. Each respondent is an employee of CoT, with representative of senior and junior managers, who availed themselves for the interview. The research questions and aim of the study formed part of the invitation letter (cf. Addendum C) to the identified respondents, who provided consent subject to anonymity. Table 4.1 captures the respondents who accepted the invitation and who formed part of the research study. The code *P_n* designates the different respondents.

Table 4.1: Respondents participating in the study

Respondent	Department in CoT	Role in the City
P1	Emergency Medical Operations	Responsible for emergency medical response in CoT.
P2	Disaster risk Management Section	Responsible for disaster risk management (prevention, mitigation, response and recovery) in CoT.
P3	Fire and Rescue Operations	Responsible for fire and rescue operations in CoT.
P4	Office of Public Information and Liaison Officer	Responsible for emergency service communication and public information on disasters and other crises.
P5	Office of the Chief of Emergency Services	Responsible for overseeing the management of the Office of the Chief of Emergency Services.

P6	Disaster Risk Management Section	Responsible for disaster management policies and strategies in CoT.
P7	Disaster Risk Management Section	Responsible for strategy formulation in disaster risk management.
P8	Office of Economic Response	Conduct research on sustainable economic-related matters on a global and national scale that impact the city's economy.
P9	Office of City Sustainability	Coordinate and drive climate change response in CoT.
P10	Disaster Risk Management Section	Coordinate the prevention, mitigation, response and recovery of disaster risk management in CoT.

The data generation method provides a foundation for the research study (Leedy & Ormrod, 2005:48). The course of the data gathering process is captured in Table 4.2.

Table 4.2: Course of the data gathering process

Dates	Activity	Data generation method	Aim
April 2017	Research Proposal Committee approves research study		
September 2017 – January 2019	Literature review and shift in the research topic	Not applicable	To answer the research question referred to in section 1.4 (cf. Chapter One).

February 2019 – December 2019	Identify and compare the four frameworks and identify and study CoT strategic documents	Document analysis as referred to in Table 4.3	To answer research questions referred to in Section 1.4 (cf. Chapter One). To achieve objectives 1, 2 and 3.
December 2019	Identify and liaise with respondents to form part of the study	Not applicable	Ethics compliance requirement.
February 2020	FNASREC grants ethics approval for study and CoT grants permission to conduct research	Not applicable	Ethics compliance requirement
May 2020	Engagement with all 10 respondents	One-on-one interviews	To answer research questions referred to in Section 1.4. To achieve objectives 1, 2 and 4.
August 2020	Shared interview content with all 10 respondents to confirm the correctness	Member checking	Credibility
September 2017 to 2021		Researcher reflection on dual role	Reflexivity

4.5 DATA GENERATION METHODS

Despite Merriam (2009:42) stating that a case study does not claim any particular method of data generation or data analysis, elements of data generation applicable to a case study include the sources of data (respondents and documents), methods of data generation (document analysis and interviews) and the organisation of data (Yin, 2009:120; Rule & John, 2011:59). Data generation techniques applied in this research study aimed to obtain sufficient data to answer the research questions of the study.

The research study adopted a multi-method approach for the generation of data. Many authors, such as Saunders *et al.* (2009:87), Yin (2009:120) and Collis and Hussey (2009:76), support and encourage the use of multi-methods for data generation. The multi-method data-generating tools strengthened the credibility of the research as the researcher reviewed and analysed all the data that cut across different data sources (Korstjens & Moser, 2018:121). The case study research used document analysis and one-on-one interviews to gain an understanding of DRR and sustainable development in CoT.

4.5.1 Document analysis

Document analysis is a form of qualitative research in which documents are interpreted by the researcher to give voice and meaning around an assessment topic (Bowen, 2009:28). A document analysis was undertaken on the components of DRR and sustainable development in CoT's disaster resilience strategy. CoT's documents and institutional publications such as policies, procedures and reports were accessed and studied and included in the case study. These documents were accessed on the CoT web page and are in the public domain.

An analysis of the documents was supplemented by the literature review that was undertaken before conducting the one-on-one interviews. The documents provided in-depth knowledge about DRR, sustainable development and the SDGs and disaster resilience. Document analysis was also conducted on four international frameworks that provided the researcher with a broad view of how DRR and SDGs are integrated into cities' methodology to disaster resilience. The frameworks also confirm that cities' resilience is measurable and can allow cities to determine their level of resilience.

4.5.1.1 Documents analysed in the study

CoT documents addressing DRR, disaster resilience and the SDGs in some way or another were identified to form part of the analysis. Table 4.3 provides the list of documents identified to be included in the analysis that were deemed important and relevant for a city disaster-resilience and sustainable development framework. Each document referred to was analysed to determine the extent to which it describes, addresses or considers disaster resilience and sustainable development in CoT.

Table 4.3: Documents analysed in the study

Document	Description
CoT Vision 2055 (CoT, 2012)	This document described the CoT's long-term strategy.
CoT Vision 2030: IDP (CoT, 2018)	The IDP provides for the spatial development plan and service delivery commitment to the community of CoT.
CoT CAP (CoT, 2021)	Climate Action Plan, which combines climate actions and climate adaptation plans.
CoT DR&VA Report (CoT, 2019)	A comprehensive report on the findings of the 2019 Disaster Risk and Vulnerability Assessment conducted in the city.
CoT DRMP (CoT, 2007)	Disaster risk management plan articulating compliance to the Disaster Management Act in terms of key performance indicators and key performance areas.

The researcher was able to find appropriate documents online, except for the Disaster Risk and Vulnerability report. The latter document was made available within the Disaster Risk Management section and was included in the document analysis.

The second set of documents that were gathered as part of document analysis were four international city disaster-resilience frameworks. Although many different

frameworks exist, the following were identified due to their reference to city resilience as the main focus. Table 4.4 lists the four international city disaster resilience and sustainable development frameworks analysed in this study.

Table 4.4: City disaster-resilience frameworks analysed in the study

Framework	Description of framework
United Nation's Disaster Resilience Scorecard (UNDRR, 2017)	This framework provides a set of assessments that will allow local government to monitor and review progress and challenges in the implementation of the Sendai Framework for DRR; and assess their disaster resilience. The framework is structured around UNDRR's Ten Essentials for Making Cities Disaster-resilient.
Rockefeller Foundation's City Resilience Index (Rockefeller & Arup, 2014)	The framework forms the basis of a tool that should enable all interested in city resilience to convene around a common understanding of that idea and begin to 'baseline' what matters most for making cities more resilient.
UN-Habitat's City Resilience Profiling Tool (UN-Habitat, 2017)	Aim to support local governments and relevant stakeholders to transform urban areas into safer and better places to live and improve their capacity to absorb and rebound quickly from all potential shocks or stresses, leading them towards sustainability.
UN-Habitat's City Resilience Action Planning Tool (UN-Habitat, 2018)	Aim to enable local governments of small to intermediate-sized cities, or neighbourhoods/districts of bigger cities or metropolitan areas to plan and undertake practical actions to strengthen the resilience of the cities.

4.5.2 One-on-one interviews

One-on-one interviews with semi-structured interview questions using an interview schedule with open-ended questions were applied in the study (cf. Addendum C). One-on-one interviews were ideal to eliminate any possible exposure and judgement of inexperience of senior officials that participated in the study (Cohen, Manion & Morrison, 2011:437). Through one-on-one interviews the respondents had the opportunity to fully participate and shared their views on the research topic and did not have to be hesitant to answer questions (Bloor *et al.* 2001:20, Greenbaum, 1998:199).

An interview timetable was prepared indicating the date and time of the interviews with the respondents. The interview invitation letter (cf. Addendum D) was sent to respondents through email. All respondents provided written consent to participate in the research study. The respondents were made aware of their voluntary participation and that no respondent would be prevented from discontinuing the interview at any given time. All interviews were conducted on Microsoft Teams due to the COVID-19 pandemic that prohibits face-to-face engagement. Respondents 6 and 10 did not have access to Microsoft Teams and was requested to respond to the questions in writing. Verbal and written consent was provided by the respondents that allowed the researcher to record and use the content for this research study.

The interview questions aimed at providing an understanding of DRR and sustainable development in CoT were posed to each respondent systematically and consistently (Behr, 1998:152). The same set of questions, known as the interview schedule, was used for all the respondents since it was intended as such for summarising, comparability and uniformity (Rule & John, 2011:65). The researcher kept to the interview questions as per the schedule so as not to be biased. The interviews lasted between 30 minutes to an hour; this was deemed sufficient as most of the respondents responded to all questions within the hour. Each interview was transcribed after the interview was concluded. The interview schedule contained interview questions that were constructed in an open-ended manner so that the respondents could answer the questions with ease (Addendum D). The questions were formulated without being double-barrelled. The questions were worded clearly and were posed one at a time. The questions were listed in the order they were posed ensuring that the interviewing process strengthened the trustworthiness of the data generated.

Open-ended questions probed yielding in-depth responses about the respondent's knowledge in the research area. The reason for using open-ended questions was to allow respondents to answer comprehensively and not to restrict respondents' answers because of the complexity of city disaster resilience and sustainable development (Myers & Newman, 2007:17). The open-ended questions were designed to capture and probe respondent's responses to their knowledge on their respective understanding of disaster resilience and sustainable development in CoT. The use of probing respondent's response during open-ended interview questions are supported by Weller *et al.*, (2018:1) who emphasise probing to increase the amount of information collected per respondent to increase sample efficiency. And who stated that "Rather than attempting to reach complete saturation with an incremental sampling plan, a more productive focus might be on gaining more depth with probing and seeking the most salient ideas" (Weller *et al.*, 2018:12). The interviews were used to help answer the research questions.

4.6 DATA ANALYSIS

This study applied qualitative data analysis methods intending to develop a CoT disaster resilience framework to assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy. These are further discussed below.

4.6.1 Document analysis

Content analysis was used to analyse CoT documents. The documents appear in Table 4.3. The content analysis of the documents assisted the researcher to understand and interpret the raw data. Content analysis, as a technique, allowed the researcher to analyse the expressive content of the data to give it meaning in relation to the objectives of the research study (Krippendorff, 2013:49).

The analysis of the documents enabled the researcher to compare disaster resilience, DRR measures and the SDGs. The content analysis enabled the researcher to make comparisons, deductions and interpretations.

The researcher applied the provisional coding method for the content analysis (Saldaña, 2013:144). Provisional coding establishes a predetermined 'start list' set of codes (Miles & Huberman, 1994:58). The provisional list was generated from the literature review related to the study's conceptual framework. The pattern of pre-

defined codes in the document analysis of CoT strategic documents was identified through content analysis (Merriam, 2009:178). The motivation for the relevant keywords used in the document analysis is found in Addendum F. Reference to each code was highlighted and coded using manual coding. Content analysis was used to identify the number of times such reference is made to the pre-defined code.

The second set of documents, the four identified international city resilience frameworks listed in Table 4.4, as well as the 17 SDGs (cf. Chapter 3) and the Sendai Framework's priorities (cf. 3.2.4.2), were analysed through thematic analysis. The four frameworks with their own unique pillars, essentials, categories and sets were regarded as codes for the thematic analysis as described in Addendum G. Furthermore, the thematic analysis of all the documents in the second set was undertaken against each code. The codes produced themes that gave rise to indicators, with key factors being identified.

As indicated by UN-Habitat (2015:6), the SDGs are ultimately the key to the success of sustainable development in local spaces. Implementing the Sendai Framework's priorities is considered progress towards meeting the SDGs (UNDRR, 2014:1) and achieving a substantial reduction in disaster risk and loss of life (UN, 2015:3). The intention of analysing the four frameworks, SDGs and the Sendai Framework was to identify the emerging themes within and across the four internationally renowned city disaster-resilience frameworks, the SDGs and the Sendai Framework priorities. By systematically comparing the four frameworks with the SDGs and the Sendai Framework's priorities, the researcher searched for prevalent patterns between each and through each code (Berg-Schlosser *et al.*, 2009:3; Verweij & Gerrits, 2013:46).

The coding process required persistent checking for overlaps and consistencies until each segment was assigned to a category. An important aspect of this process was to remain open to the discovery of new categories and then themes as the process continued (Smith, 2003:53). Different categories related to wider disaster concepts, as well as issues of different elements of a disaster resilience framework, were identified from the four international frameworks. Where possible, the categories identified from the provisional coding were compared and contrasted later with the findings of the interviews and the case study. It was hoped that involving all these categories in the analysis process would draw together information pertaining to the context, setting and the individual respondents, providing a fuller picture of the complex and multi-faceted

disaster resilience reality in the CoT as well as establishing the trustworthiness of the data.

4.6.2 One-on-one interviews

Specifically, data were analysed using thematic analysis. Braun and Clarke (2012:59) defined thematic analysis as a method for identifying, analysing and reporting patterns and themes within data. Franzosi (2004:550) built on this by defining thematic analysis as a method where the coding scheme is based on categories designed to capture the dominant themes present in a text. Coding is an integral part of data analysis and refers to labels that highlight different themes within the data (Rule & John, 2011:77). However, more than that, Saldaña (2013:3) explains that code is a word or short phrase that “symbolically assigns a summative, salient, essence capturing and/or evocative attribute to text”. Coding is thus a method that enabled the researcher to organise and group similarly coded data into categories or “families” because they share some characteristics – the beginning of a pattern. The researcher used classification reasoning and own tacit and intuitive senses to determine which data “look alike” and “feel alike” when categories were formed (Lincoln & Guba, 1986:73).

Manual coding was applied for this research study. The researcher read through each transcribed interview and manually identified codes through an inductive approach. The codes emerged from the data. Later, in the data analysis process, categories and themes emerged from respondents’ responses to the interview questions (Braun & Clarke, 2012:87). The major categories were compared with each other and consolidated towards themes. Figure 4.1 illustrates Saldaña’s coding model for qualitative inquiry that was used in this study (Saldaña, 2013:13).

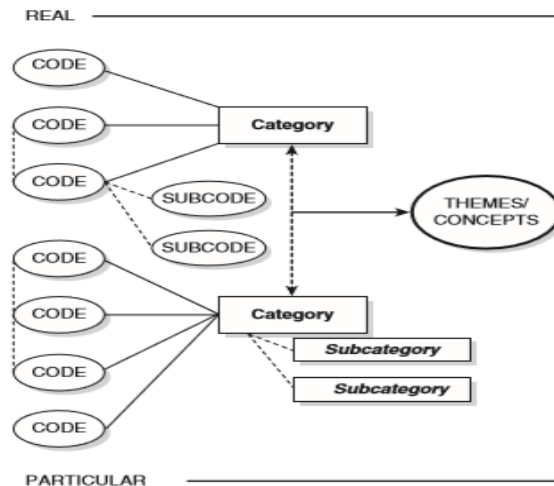


Figure 4.1: Saldaña's model for qualitative inquiry used in the study (Saldaña, 2013:13)

The analysis took place in several phases, as described by Braun and Clarke (2012:57). These are described below.

- *Phase One - Familiarising with data:* The researcher familiarised herself with the data. The researcher was the interviewer of the one-on-one interviews and she transcribed the data herself. The researcher therefore read and re-read the data several times, noting initial ideas.
- *Phase Two - Generating initial codes:* In this phase, the researcher generated initial codes by coding interesting features of the respondents' responses.
- *Phase Three - Searching for themes:* The researcher then used the different codes and grouped them so that categories and themes could begin to emerge.
- *Phase Four - Reviewing themes:* After a few weeks' break, the researcher reviewed the categories and themes to ensure that the themes were, in fact, themes.
- *Phase Five - Defining and naming themes:* In this phase, the researcher refined the themes to identify the core of what each theme was about and ensure that its name captured what it was meant to.
- *Phase Six - Producing the report:* The researcher then began to write up the data with supporting verbatim quotations from the transcriptions.

Despite there not being an independent coder, the data that was analysed was discussed with the promoters and they both looked and agreed to the data in its

transcribed form and as it was analysed. Addendum E provides for an excerpt of a one-on-one interview with a Participant.

4.7 QUALITY CRITERIA

This qualitative research study followed procedures to establish and contribute to the trustworthiness of this research study. These procedures are discussed below.

4.7.1 Trustworthiness

The term “trustworthiness” refers to how the inquirer can persuade the audience that the findings of the study are worth paying attention to and that the research is of high quality (Johnson & Turner, 2003:297). The researcher achieved the trustworthiness of this research through the strategies of credibility, transferability, dependability and confirmability (Krefting, 1991:217).

4.7.1.1 Credibility

The credibility of the study, or the confidence in the truth of the study and therefore the findings, is important (Connelly, 2016:435). After recording the interviews, member checking took place. Feedback was provided to respondents to ensure that the researcher had a grasp of the content and a thorough understanding of their responses. Member checking was done whereby participants were requested to confirm and agree to content of the interviews. Harper and Cole (2012:1) agree that member checking continues to be an important quality control process in qualitative research as during the course of conducting a study, participants receive the opportunity to review their statements for accuracy. In conclusion of the analysis, the interpretations made were provided back to the respondents to verify accuracy and understanding. Nolan and Behi (1995:589) agree and maintain that all criteria developed for use in qualitative studies rely heavily on presenting the results to those who were studied and asking them to verify whether they agree. A useful indicator of the credibility of the findings produced is when the respondents themselves and the readers of the study view the study findings and regard them as meaningful and applicable in terms of their experience. The researcher aimed to eliminate bias that might have been brought to the study by constantly reflecting on the research process and the researcher’s own dual role in the research.

4.7.1.2 Transferability

A rich and thick description was given of the research context and setting to allow other researchers to assess how transferable their findings are (Krefting, 1991:220). Other researchers may decide, upon reading this research study, whether the findings of this study can apply to their situation meaning that transferability is determined in terms of the reader of the study (Merriam & Tisdell, 2015:256). The researcher did not aim at generalising any findings. The researcher provided detailed contextual information of the case, and a description of the research design and methods so that readers can determine whether transferability to other situations is possible (Krefting, 1991:220). Transferability was also ensured by presenting (i) the metropolitan municipality involved within a South African context, (ii) data generation methods where data was gathered systematically through document analysis and one-on-one interviews, (iii) the respondent selection, and (iv) data that was analysed and interpreted (Moretti *et al.*, 2011:12). In this way, the researcher provided information in the research study to the reader, to make it possible for readers to transfer it to a different context.

4.7.1.3 Dependability

Dependability is important to trustworthiness because it establishes the research study's findings as consistent and repeatable (Streubert-Speziale & Carpenter, 2007:33). Researchers aim to verify that their findings are consistent with the raw data they gathered. They want to make sure that if some other researchers were to look over the data, they would arrive at similar findings, interpretations and conclusions about the data (Statistic Solutions, 2017:76). This is important to make sure that there was not anything missed in the research study, or that the researcher was not sloppy or misguided in their final report. The researcher ensured consistency in the data generation process by ensuring that all the one-on-one interview questions were consistently conducted. Data was analysed in six phases after being collected through document analysis and one-on-one interviews (cf. 4.6.2). The first phase of data collection was for the researcher to transcribe the interview recordings and identify initial codes. The different codes were grouped to identify possible categories and themes. After three weeks, the researcher reviewed the categories and themes to ensure that the themes were indeed themes. According to Krefting (1991:221), a code-

recode procedure on data during the analysis phase of the study can increase the dependability of the study.

4.7.1.4 Confirmability

Confirmability is the last strategy of trustworthiness that a qualitative researcher must establish (Forero *et al.*, 2018:54). This strategy regards the level of confidence that the research study's findings are based on the respondents' narratives and words rather than potential researcher biases (Statistic Solutions, 2017:77). Firstly, the researcher used direct verbatim quotations from the transcripts of respondents, to validate and confirm the interpretations. Secondly, the researcher followed a reflexive analysis. Reflexive analysis proved useful to ensure that the researcher was aware of her influence on the data. Reflexivity is an attitude that a qualitative researcher adopts when collecting and analyzing the data (Palaganas *et al.*, 2017:438). A qualitative researcher must look at his or her own background and position to see how this influence the research process (i.e., selecting the topic, choosing the methodology, analyzing the data, interpreting the results, and presenting the conclusions) (Haynes, 2012:1).

As the categories and themes emerged during coding, the researcher reflected on the analysis and constantly reminded herself to keep her focus on what emerged from the data analysis (Krefting, 1991:218-221). The researcher was aware of her subjectivity due to her dual role in the research study and she was wary of setting aside any presuppositions and biases.

4.8 ETHICAL ISSUES

Babbie (2001:470) believes that anyone involved in research needs to be aware of general agreements about what is proper and improper in scientific research. According to Merriam (2009:231), when interviewing the respondents, they may feel their privacy has been invaded, however, they may also be keen to share their knowledge.

The research was carried out with the consent of the relevant parties such as North-West University, CoT and the respondents. Information obtained during the research process was treated as confidential and this assurance was given to respondents. During the interview process, the researcher explained the purpose of the research

and this was confirmed with each respondent when conducting and recording the interview. During the encoding of data, the respondents' anonymity was protected by using pseudonyms.

4.8.1 North-West University ethics approval

Ethical considerations are principles and regulations guiding the handling of research in specific contexts (Sarantakos, 2012:21). To conduct any data generation, all researchers are required by the North-West University to apply for the mandatory ethical clearance approval. The researcher followed all the procedures and submitted the required documentation to get approval from the ethics committee before starting the data generation.

The FNASREC at the Potchefstroom Campus of the NWU granted ethics approval (NWU-01629-20-A9) for a research study with human Respondents (cf. Addendum A). This process involved a detailed description of the research study process and its ethical aspects.

4.8.2 Permission

Authorisation to conduct data gathering was secured from the CoT research department - a designated department within CoT which is responsible for managing and granting approval to research the municipality (cf. Addendum B). This was after receiving ethics approval from the North-West University research and ethics committee. All the necessary documentation was submitted, and after a waiting period of two months, permission was granted. Written consent was obtained from the CoT to research the city.

4.8.3 Informed consent and confidentiality

For the entire duration of this study, adherence to ethical requirements, responsibilities and agreements relating to the nature and context of this study were strictly enforced. Given the organisational setting and research context, several important ethical issues were taken into consideration. The role of respondents in the research is important because of issues related to their willingness to participate and/or not participate, the protection of their identities, confidentiality and anonymity and informed consent. All respondents' participation was voluntary, suggesting that individuals were not compelled to participate in the research. Respondents were requested to confirm

consent preceding the interview. A detailed description of the study and the purpose thereof was communicated to respondents (cf. Addendum C) before the study commenced as suggested by Henn *et al.* (2009:71) and respondents had the option to withdraw from the study at any given stage.

4.10 CONCLUSION

Chapter Four focused on the research approach, method of research, data generation, data analysis, quality criteria and ethical issues in this research study. The chapter explained the actual data generation procedures. Specific focus was placed on the single case study wherein the CoT is the case. The role of the researcher and her subjectivity as an employee at CoT were covered in the chapter. A section was dedicated in the chapter to discuss the CoT as the selected site, purposive sampling as the sampling technique and the respondents that participated in the study. The chapter provided a discussion on data generation methods through document analysis and one-on-one interview. The process of applying qualitative data analysis by means of document analysis and one-on-one interviews and the phases of data analysis were discussed in the chapter. Credibility, transferability, dependability and confirmability are discussed to establish and contribute to the trustworthiness of the study.

The next chapter thus presents the case of CoT to illustrate the current risk and vulnerabilities in the city and present the different ways the city attempts to approach disaster resilience.

CHAPTER FIVE: CITY OF TSHWANE METROPOLITAN MUNICIPALITY

5.1 INTRODUCTION

The CoT is characterised by continued growth of the urban population, as well as significant growth in the construction, trade and transport sectors. Urban growth in CoT places enormous pressure on the environment, resulting in potential environmental impacts, including increased water run-off leading to higher flood risks and pollution of groundwater, increased water consumption due to higher standards of services, increased concentrations of air and water pollutants and the degradation or complete loss of arable land and biodiversity (Chakwizira *et al.*, 2020:84)

CoT faces the challenge of providing for the needs of a growing population and economic sector while attempting to alleviate poverty and reduce inequality, particularly in the face of increasing climate change and other social, political and economic forces. To add to the complexity, CoT is required to address the needs of several diverse regions (seven administrative regions), which include urban, peri-urban and rural areas (John *et al.*, 2015:4).

The vulnerability assessment to climate change conducted for CoT in 2021 highlighted that large areas within the city are exposed to the impact of future climate change. Much of the vulnerability identified comes from the fact that large portions of the city's population are not equipped with enough adaptive capacity to face the projected changes and anticipated impacts of future climates. Climate change in CoT is predicted to impact main sectors in the city, including biodiversity, infrastructure, water, human settlements, energy and human health, giving rise to several priority climate-related risk factors (CoT, 2021:12).

The CoT's vision is to create a liveable, resilient and inclusive city that will balance the competing needs of social, spatial and environmental issues brought about by the city's ever-changing population dynamics (Clarke & Kuipers, 2015:13). The city developed and implemented many strategic documents with the intention (amongst others), to assist the city in its sustainability and resilience path.

The CoT highlights four main principles which are believed to be critical in maintaining resilience; i) building a resilient economy that can adapt to difficult circumstances, such as the impact of the recent global crisis (economic sustainability); ii) creating a resilient

environment system that can withstand environmental changes and disasters (environmental sustainability); iii) planning for a resilient social urban system that demonstrates high levels of inclusivity (social sustainability), and iv) ensuring a resilient governance system where there is a capacity and capability to provide leadership, as well as institutions to support the developmental aspirations of the city's citizens and support an active citizenry (institutional sustainability) (CoT, 2012:12).

This chapter introduces CoT Metropolitan Municipality by giving an overview of the geographical area, its demographics and vulnerabilities. The chapter presents an overview of the CoT strategic documents considered relevant to this study. The documents are the CoT Vision 2055, CoT Integrated Development Plan (informed by Vision 2030), CoT Climate Adaptation Plan, and the outcome of the Disaster Risk and Vulnerability Assessment report. The chapter ends by addressing the CoT's Disaster Risk Management Plan.

5.2 OVERVIEW OF CITY OF TSHWANE METROPOLITAN MUNICIPALITY

CoT was established on 5 December 2000 through the integration of various municipalities such as the Municipality of Pretoria, Akasia and Centurion that had previously served the greater Pretoria expanse and surrounding areas. The boundary of the city was further amended on 28 May 2008 through a proclamation in the Government Gazette which incorporated the former Metsweding District Municipality, including Nokeng tsa Taemane (Cullinan) and Kungwini (Bronkhorstspuit), into the borders of the CoT. The incorporation, which gave birth to the new CoT in May 2011 after the local government elections, was in line with the Gauteng Global City Region Strategy to reduce the number of municipalities in Gauteng by the year 2016 (CoT, 2019:10).

The incorporation of the above-mentioned areas enlarged CoT to an extent of 6 345 km². Figure 5.1 illustrates the size of the city as it stretches almost 121 km from east to west and 108 km from north to south, making it the third-largest city in the world in terms of land area, after New York and Tokyo/Yokohama (as at 2019). It also makes up more than 30% of Gauteng Province, which is 19 055 km² in extent (CoT, 2019:20).

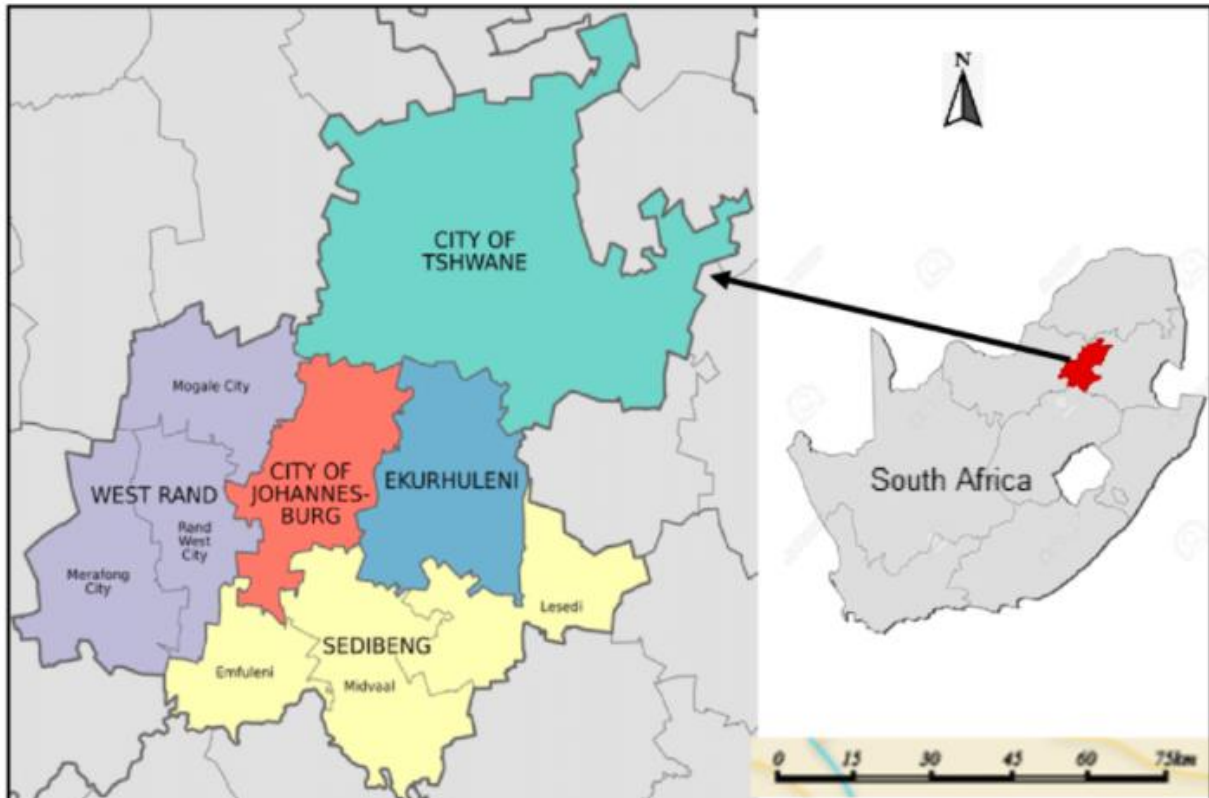


Figure 5.1: CoT in context with Gauteng Province (Nhamo *et al.*, 2021:3)

CoT consists of 107 geographically demarcated wards and has just over 3,3 million residents. For administrative purposes and to enhance service delivery, the CoT is divided into seven regions as illustrated in Figure 5.2.

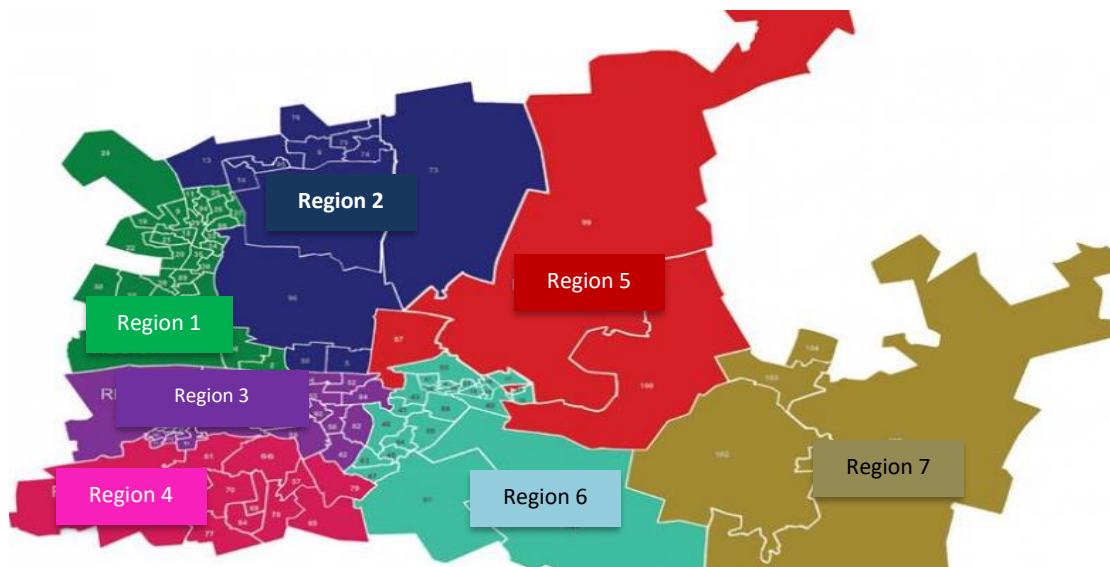


Figure 5.2: CoT regional map (CoT, 2020:12)

As a principal means of collecting basic population and housing statistics required for social and economic development, policy interventions and their implementation and evaluation, South Africa has conducted three censuses (1996, 2001 and 2011). Census 2011 was the third census to be conducted since the democratic elections in 1994. Several populations and household attributes were measured, and a variety of indicators were generated. The following section will provide Tshwane-specific profile results on census topics of demographics, service delivery and risk assessments conducted from 2011 in CoT.

5.3 CITY OF TSHWANE DEMOGRAPHIC AND RISK PROFILE

Understanding the demographic profile of CoT is important from a DRR perspective, as it strongly influences the conditions of the social and economic vulnerability of communities exposed to hazards identified in the city. The following section provides an overview of the city's population and socio-economic information expressed statistically, including the delivery of basic services in the city.

5.3.1 Population

In 2011, the national population for South Africa was estimated to be 51,500,000 of which the population in the Gauteng Province was 11,900 000. The population estimate in the same year in the CoT was 2,830,000 which is 5,5% of the national population and 23,8% of the province. From 2011 up to 2019, CoT's population increased to 6,0% of the national population with an estimate of 3,560,000 people residing in CoT. Figure 5.3 depicts the population growth in CoT from 2011 to 2019.

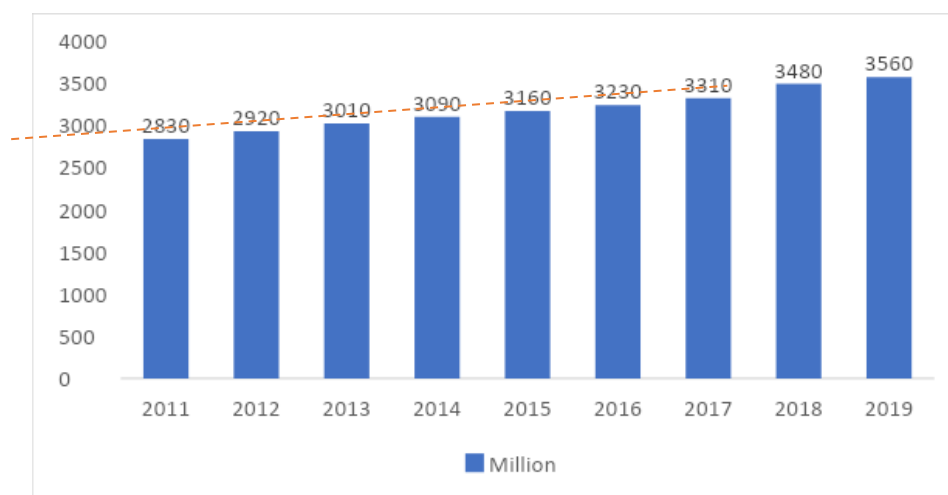


Figure 5.3: CoT population growth 2011 to 2019 (CoT, 2019:13)

Over the past nine years, CoT's population increased by 730 000 people with an average of 81 000 people per year. Should the increased average in CoT remain, the estimated number of people residing in the city will be at around 4 451 000 in 2030 and 6 962 000 in 2050.

5.3.2 Education and employment

As CoT is considered the education hub of South Africa, the city has experienced a steady decline in the number of people without any schooling over the period 2009 to 2019, while the number of people with a grade 12 or matric certificate and tertiary qualification increased by an annual rate of 4,35% (CoT, 2019:23).

In 2019, 86,43% of total employment in CoT was recorded as formal employment, while 13,57% were informally employed, the bulk of which took place in the trade sector. In the same year, the community services sector recorded the highest employment figures for CoT, followed by the finance and trade sectors, respectively. The growing informal sector is indicative of the barriers in entering the trade sector (such as capital and skills), as well as the fact that the economy is not growing fast enough to generate adequate jobs for the unemployed, thus the informal sector is used as a survival mechanism. In 2019, the unemployment rate in CoT was recorded at 22,6%, which is significant, although it is lower than both the Gauteng Province and the country's unemployment rates (CoT, 2019:24).

5.3.3 Economic profile

Understanding the economic profile of CoT is important from a disaster risk and sustainable city perspective, as it strongly influences the conditions of the economic vulnerability of the city and determines the sectors that could potentially be impacted by a major incident or disaster occurrence. CoT has a diverse and vital economy, with five main sectors, including community services, finance, trade, manufacturing and transport. Other significant dynamic growth sectors include construction, the green economy and research, innovation and development.

CoT contributes approximately 28% to Gauteng's Gross Domestic Product (GDP) and 10% to the national GDP, which indicates the significant role the city plays in the countries' economy. Priority industrial estates within the city include Rosslyn, Babelegi, Ekandustria and Sunderland Ridge. CoT is also home to several corporate

headquarters and accommodates more than 30 Johannesburg Stock Exchange listed companies (CoT, 2019:34). In terms of economic growth, in 2019 CoT achieved an annual growth rate of 1,19%, which was slightly higher than the Gauteng Province (0,97%), however lower than that of South Africa (1,32%) (CoT, 2019:35).

5.3.4 Basic service delivery profile

According to UN-Habitat (2020:12), CoT has a critical shortage of affordable housing stock to address the needs of its growing population. Associated infrastructure services are also lagging, as CoT does not have adequate financial resources to maintain a big proportion of its existing infrastructure, let alone provide all its much-needed new infrastructure. Figure 5.4 below summarises the backlog in providing access to basic service delivery in CoT concerning refuse disposal, electricity, housing, water and sanitation. The city's service delivery backlog in sanitation (14,9%), water (1,3%), electricity (7,4%), and refuse removal (14,4%) is indicated below.

Household services diamond: 2018

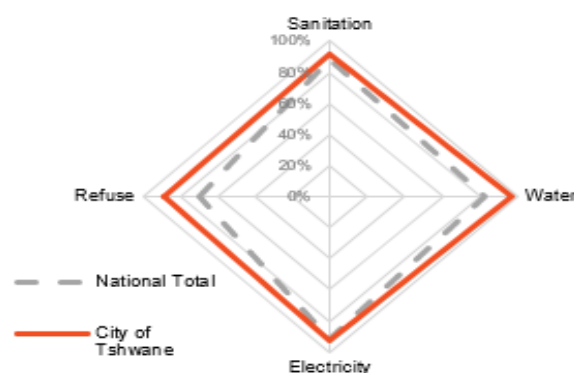


Figure 5.4: CoT service delivery backlog (CoT, 2019:48)

5.3.5 Environmental profile

Urban growth in CoT places enormous pressure on the environment, particularly on the Open Space system. Understanding the environmental profile of CoT, including natural resource systems, is important from a DRR and city sustainability perspective as it strongly influences the conditions of environmental vulnerability. It is important to determine environmentally sensitive areas, influenced by urbanisation and other dynamic pressures, which could potentially be impacted by the occurrence of a major incident or disaster.

5.3.5.1 Water resources

CoT has approximately 6 000 kilometres of natural watercourses, which include 19 river types. Water resources for CoT consist of a series of dams, rivers, wetlands and groundwater resources. CoT contains 35 unique wetland types which provide a variety of ecosystem services such as groundwater recharge, flood attenuation, pollution abatement, habitat for biodiversity, recreation opportunities and provision for the livelihood of some communities through the harvesting of resources.

Unfortunately, due to CoT's high portion of South Africa's urban, industrial and mining activity, as well as significant areas of arable agriculture, the condition of hydrological systems and water quality have been negatively impacted. Water quality has been affected by numerous issues, such as acid mine drainage, wastewater from treatment plants, fertilizer and pesticide runoff and water flows regimes (for example catchment hardening and increased stormwater flows) (CoT, 2019:84).

5.3.5.2 Climate profile

Annual average temperatures for CoT are 20°C in the northern regions, 18°C in the central and eastern regions, and 16°C in the far southern regions. Summers are warm, with an average temperature of approximately 22°C, and winters are mild with an average temperature of about 12°C (CoT, 2019:87).

The city sporadically experiences drought conditions, including dry spells and heatwaves, particularly during El Niño years. Rainfall peaks during summer (December to February), while the winters are very dry. Most of the rainfall in summer in CoT occurs from thunderstorms embedded in tropical-temperate cloud bands. In addition, isolated heat thunderstorms, often associated with hail, damaging winds and flash floods, can also frequently occur in CoT during the warmer months. Potential increases in the number of extreme rainfall events per year (and related thunderstorms, hail, lightning and flooding) are expected to exceed the capacity of infrastructure to deal with the runoff, leading to flash flooding or general flooding of low-lying areas (CoT, 2019:88).

5.3.5.3 Urban profile

As an economic urban hub, CoT experiences ongoing urbanisation due to the migration of people to the administrative capital for better living conditions, education

and employment opportunities. According to Magidi and Ahmed (2015:32), the proportion of urban areas in CoT increased from 12,77% in 1984 to 26,70% in 2015. Figure 5.5 below illustrates the land cover of CoT in 2019 in terms of the spatial distribution of both urban and non-urban areas. Approximately 8% of CoT's urban area is open space areas, 7% is vacant state-owned land and the remaining land is mostly agricultural land.

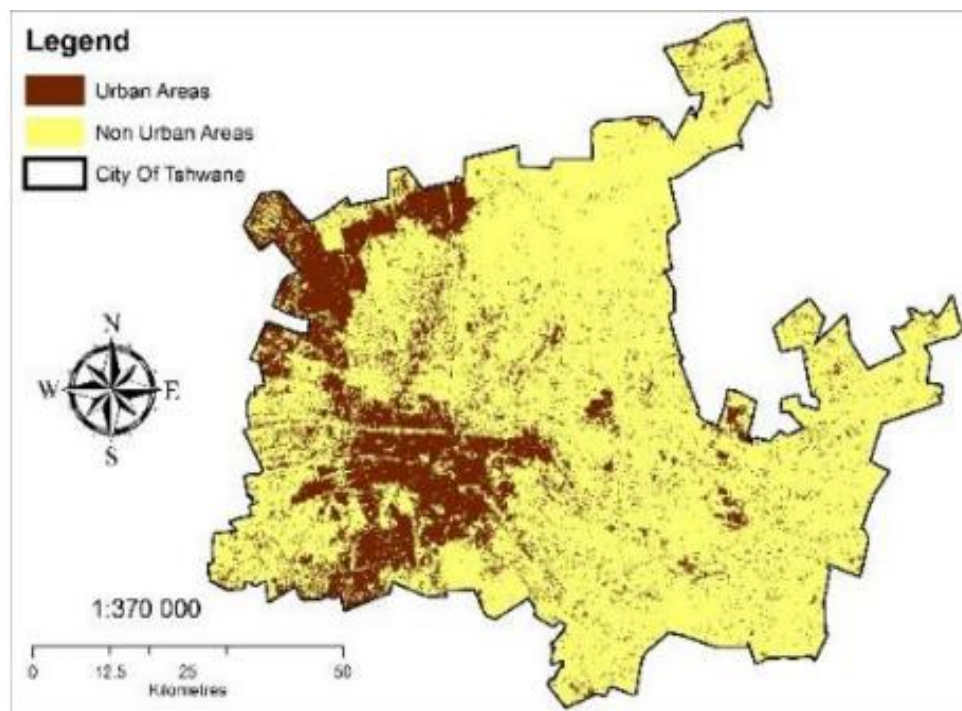


Figure 5.5: CoT urban profile (Magidi & Ahmed, 2015:43)

5.3.6 Urban growth

According to the CoT Regional Spatial Development Framework (CoT, 2018:29), CoT's urban growth is not the result of planned growth but of the extension of its boundaries to incorporate new areas over time, resulting in a vast and complex sprawled city form. A large contributing factor to urban growth is the major universities (such as the University of Pretoria, University of South Africa and the Tshwane University of Technology amongst others) in CoT attracting students from all over South Africa and neighbouring countries. As a result, the city struggles to cope with the demand for housing and additional infrastructure and services required to meet the basic needs of a growing population, leading to the emergence of new informal settlements, growth of existing informal settlements and an increase in the number of backyard dwellings (CoT, 2019:90).

5.3.6.1 Informal settlements

According to CoT Housing and Human Settlements Department, there are a total of 227 informal settlements in the city (CoT, 2019:92). According to the Housing Development Agency (HDA), CoT has the highest rate of growth of households living in shacks (informal dwellings) at a municipal level (HDA, 2012:12). Notwithstanding the urbanisation/migration to urban areas, a lack of access to land and housing through formal means has resulted in the urban poor resorting to informal processes to address their land and housing needs on their own. This has resulted in many poor people dwelling in informal settlements, erected mainly on illegally occupied land.

According to the CoT Regional Spatial Development Framework (2018:32), residents in many informal settlements still only have access to rudimentary water and sanitation services, and infrequent refuse removal and area cleaning. Figure 5.6 illustrates the number of informal houses recorded in informal settlements located in each of the seven regions of CoT. Region 1 has the highest number of informal structures (82 790), which is to be expected considering it hosts the most informal settlements in the city. This is followed by Region 3 with 65 263 informal structures, and Region 2, with 62 973 informal structures.

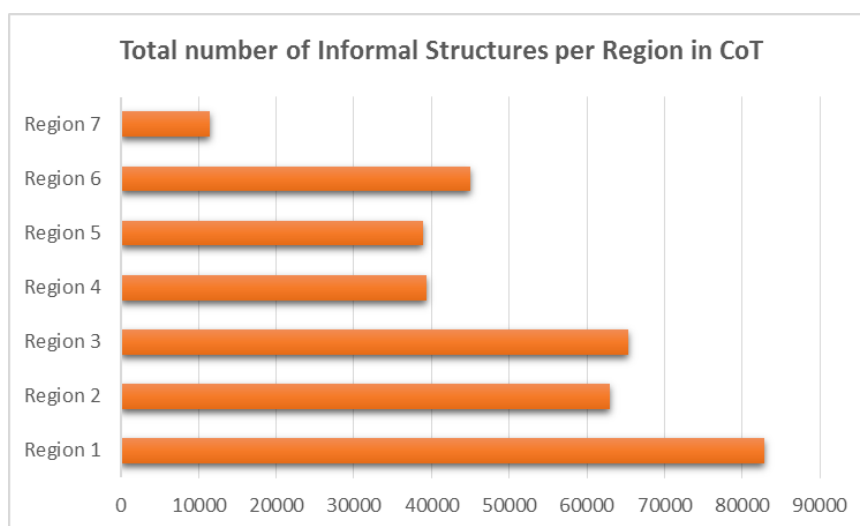


Figure 5.6: CoT informal settlements (CoT, 2019:93)

5.3.7 Vulnerability profile

Factors that influence conditions of socio-economic, economic, environmental and physical vulnerability in cities such as CoT include geographic location, urban design, land-use management, disaster management, changing demographic structures,

economic and institutional stability and maintenance of public infrastructure. Figure 5.7 briefly describes the conditions of vulnerability in CoT, following the research study conducted by the Council for Scientific and Industrial Research (CSIR) in 2019. For each vulnerability indicator depicted below, a vulnerability score out of 10 is provided, including CoT's ranking in Gauteng out of nine municipalities. A high vulnerability score depicts an undesirable state (high socio-economic vulnerabilities, environmental and economic pressures and so forth), while a lower score depicts a more desirable state that reflects a more resilient community and environment.

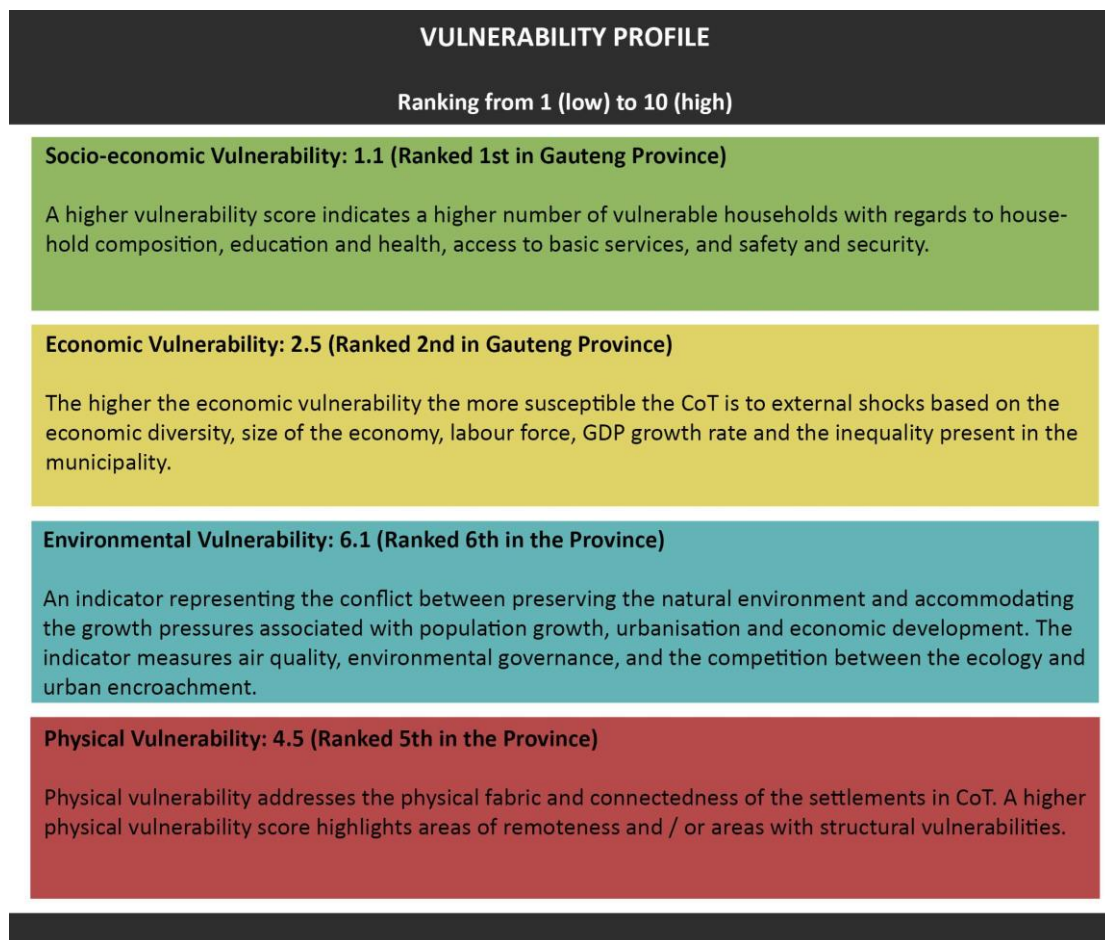


Figure 5.7: CoT vulnerability profile (CoT, 2019:102)

5.3.8 Disaster risk profile

A DR&VA was conducted in the CoT during the 2019/2020 financial year. The assessment was a comparative assessment of the 2007 and 2018 risk assessments. Recurring hazards identified in all disaster risk assessments include veld fires, flooding, sinkholes, hazardous material incidents, transport incidents, mission-critical failure and special event incidents (CoT, 2019:31). These hazards are still present in

the city with new additional hazards identified in the 2019/2020 risk assessment that include radiological hazards, crime, epidemics, illegal dumping, civil unrest and water pollution.

5.3.9 Climate change

The CoT climate change vulnerability assessment (CoT, 2021:32), consolidated risks identified in the regional and sectoral assessment, and prioritised risks that are relevant to CoT, given the expected significant changes in temperature and rainfall. The following risks were prioritised according to the magnitude and likelihood of their negative impacts and will be used to inform adaptation actions for the city:

- i. Loss of ecosystem goods and services;
- ii. Increased energy demand;
- iii. Increase in diseases affecting human and animal health;
- iv. Damage to infrastructure (storm-water systems, roads, bridges);
- v. Water insecurity;
- vi. Flooding and damage to human settlements and private property; and
- vii. Increase in sinkholes.

In response to climate change projects for the city, the CoT has adopted several mitigation and adaptation policies. DRR does not, however, feature in policies ii, iii, v and vi:

- i. The city's long-term sustainability vision, Vision 2055, considers the city's transition towards a low carbon, resource-efficient and climate-resilient city (CoT, 2012:9).
- ii. To bring this vision into reality, the Green Economy Strategic Framework, supports CoT Vision 2055 and provides a strategic guide towards a low-carbon, climate-resilient and resource-efficient growth trajectory that creates a maximum number of jobs and stimulates economic activity while ensuring sustainable development (CoT, 2013:7).
- iii. The Sustainable Energy and Climate Change Strategy aimed to encourage the integration of sustainable energy and environmental concerns into urban development in South Africa (CoT, 2005:2).

- iv. The Climate Change Response Strategy aims to set the context for climate response, based on the city's current emissions profile, climate hazards/risks as well as determining the emissions that need to be reduced (CoT, 2015:3).
- v. A Food Security Policy that highlights the objective to encourage the building of communities and civic responsibility in order to promote a safe and healthy environment; this will be achieved by promoting environmentally responsible urban agriculture in the pursuit of food security (CoT, 2005:13).

In addition to the above policies, the following section describes strategies implemented by the city in addressing disaster resilience and sustainable development.

5.4 CITY OF TSHWANE STRATEGIC INTENT TO DISASTER RESILIENCE AND SUSTAINABLE DEVELOPMENT

CoT adopted various long-, medium- and short-term strategies that intentionally or unintentionally address issues of DRR and sustainable development. The next section of the chapter will provide an overview of the strategic documents that relates to DRR and sustainable development in CoT. The documents selected for this review includes Vision 2055: Remaking South Africa's Capital City and the CoT Climate Action Plan as the long-term strategies. Vision 2030 The integrated development plan provides for medium to short term strategic planning in the CoT. The CoT Disaster Risk and Vulnerability Assessment outcome report that is included in this section provides for a comprehensive view on the current priority risks in the CoT. The last document included is the CoT Disaster Risk Management Plan that provides for the arrangements for disaster risk management within CoT.

5.4.1 Vision 2055: Remaking South Africa's Capital City

In 2012, the then-Executive Mayor Kgosietsi Ramakgopa announced the CoT's Vision 2055. This long-term vision adopted by the city is to have a city that is liveable, resilient and inclusive; whose citizens enjoy a high quality of life, have access to social, economic and enhanced political freedoms and where citizens are partners in the development of the African Capital City of excellence, all by 2055. This vision builds

on strategic plans developed by the National Development Plan (NDP) for 2030 and formulates how the Capital City should tackle climate change, migration, population growth and economic and social activity, and reverse the spatial effects of apartheid. Tshwane's Vision 2055 is meant to serve the following objectives (CoT, 2012:3):

- i. To develop a framework to help the city do a better job, to focus its energy, to ensure that all stakeholders and role players are working toward the same goals;
- ii. To assess and adjust the organisation's strategic direction in response to a changing environment;
- iii. To open up public discourse on the key challenges confronting the city and how to develop appropriate solutions; and
- iv. To capture the imagination of CoT's residents and stakeholders around the city's vision and hold each other accountable in the journey towards 2055.

The vision is made up of six broad outcomes that represent the areas that are key for the CoT's broad development logic over the next four decades. Outcome 1 pertains to this research study in that it focuses on a resilient and resource-efficient city. The outcome will be achieved by mastering the goals of preserving the city's natural heritage, managing its waste effectively, sustainable land use to support development and growth, water use and wastewater management and improving energy efficiency (CoT, 2012:3).

The remaining outcomes and goals are identified to serve as the foundation for informing the future planning approach, as well as to inform the strategic choice that the city will need to take when identifying, prioritising and implementing new policies and programmes of intervention. Table 5.1 provides the six outcomes and goals as approved for CoT Vision 2055.

Table 5.1: CoT Vision 2055 goals (CoT, 2012:3)

Outcome	Goal
Outcome 1:	i. Preserving the city's natural heritage, ii. Managing the city's waste effectively, iii. Sustainable land use to support development and growth,

A resilient and resource-efficient city	iv. Water use and wastewater management, v. Improving energy efficiency in CoT, and vi. Building CoT's climate resiliency capacity.
Outcome 2: A growing economy that is inclusive, diversified and competitive	i. De-racialising the ownership of the CoT's economy, ii. Developing the capacity to respond to the changing global economic order, and iii. Promoting economic agglomeration within Gauteng.
Outcome 3: Quality infrastructure development that supports liveable communities	i. A long-term and coordinated approach to infrastructure investment and development, ii. Mitigating the cost of urban sprawl, iii. Transforming the city's spatial form through densification, iv. Building sustainable human settlements, and v. Investing in public transport infrastructure.
Outcome 4: An equitable city that supports happiness, social cohesion, safety and healthy citizens	i. Improve the quality of life for all by means of being a family, ii. Child and youth-friendly city, iii. Tackling issues of inequality and poverty, drug and substance abuse, teenage pregnancy, and gender-based violence against women and girls, iv. Celebrate diversity, being a safer city, and v. Promote a healthy city.
Outcome 5: An African Capital City that promotes excellence and innovative governance solutions	i. Be a responsive leadership that manages change and enhance service delivery, ii. Address social and spatial inequalities, iii. Create a competitive city through strong and visionary leadership,

	iv. Develop a capable and developmental city that is responsive and accountable, v. Ensure financial resilience, and vi. Entrench a customer-centric approach to development.
Outcome 6: South Africa's capital with an activist citizenry that is engaging, aware of their rights and presents themselves as partners in tackling societal challenges	i. Create enduring development partnerships by promoting access and rights to the city, ii. Strengthening active citizenry for sustainable city development, iii. Responding to the changing face of local government governance, and iv. Adopting approaches that are rooted in communities.

To achieve Tshwane's Vision 2055, a new growth path in resilience to future shocks must be adopted; not only by the government but also by the sector of society partnering with the city. Coupled with this new paradigm is the implementation of spatial development approaches geared towards the realisation of spatial- justice, sustainability, resilience, quality and efficiency.

In 2016, a new political leadership took over CoT who did not refer to Vision 2055 in any form. On 25 May 2017, this leadership introduced and approved Vision 2030 *Tshwane: A prosperous Capital City through fairness, freedom and opportunity*. This vision adopted various elements of the South African NDP 2030 *Our future – make it work* (National Planning Commission, 2012). NDP 2030 takes an approach to holistically defining living standards through nine elements of a decent standard of living, namely a clean environment, nutrition, housing, water, sanitation, electricity, transport, education and skills, safety and security, healthcare, employment, recreation and leisure. The NDP 2030 is the narrative for a new growth and development trajectory for South Africa and provides a useful impetus for CoT to build on its own 2030 strategy.

5.4.2 Vision 2030: Integrated Development Plan

The CoT's Vision 2030 is intent on achieving a prosperous Capital City through fairness, freedom and opportunity. As a strategic framework for the city's development pathway and the achievement of the vision, the city developed an Integrated Development Plan (IDP) as guided by the Department of Cooperative Governance and Traditional Affairs. The IDP depends on the achievement of the following five strategic development pillars, as described in the city's five-year IDP (2017-2021) (CoT, 2017:3).

5.4.2.1 Strategic Pillar 1: Facilitate economic growth and job creation

The economic growth and creation plan for the city centres around five focus areas that the city believes will create economic growth, which in turn will be labour absorbing, providing many more residents with new employment opportunities and developing the city further. The focus of the pillar is to:

- i. Attract investment and encourage growth by making it easy to do business in Tshwane;
- ii. Revitalise and support Tshwane's entrepreneurs by enabling informal traders to trade in Tshwane through support and capacity development;
- iii. Empower individuals to take advantage of opportunities by introducing skills development programmes for unemployed youth;
- iv. Create infrastructure-led growth to catalyse and revitalise existing nodal economies by addressing infrastructure and service delivery inadequacies and enforce building environment policies and bylaws; and
- v. Encouraging tourism by aligning tourism industry efforts in the city to meet strategic demands.

5.4.2.2 Strategic Pillar 2: Create a caring environment and promote inclusivity

Although the city has managed to deliver on several basic service backlogs, many communities in Tshwane do not yet have access to basic services. The focus for this pillar is supported by the following priorities:

- i. Upgrading informal settlements by mainstreaming basic services to informal settlements;

- ii. Supporting vulnerable residents by providing broader support for poorer residents;
- iii. Building-integrated communities through the creation of spaces and housing opportunities that bring people together; and
- iv. Improving access to public healthcare services.

5.4.2.3 Strategic Pillar 3: Deliver excellent services and protect the environment

The city also has a responsibility to protect natural resources and the environment. Providing excellent services in a way that allows for sustainable expansion and development is a priority for the city. Water and energy resources should be protected in our bid to increase and improve service delivery. The focus for this pillar is thus supported by the following priorities:

- i. Delivering high-quality and sustainable basic services such as water, sanitation, electricity, housing and so forth;
- ii. Safeguarding water and energy security and protecting the natural environment; and
- iii. Ensuring agriculture and rural development by creating sustainable agriculture initiatives and supporting food security.

5.4.2.4 Strategic Pillar 4: Keep residents safe

The city focuses on utilising the metro police and law enforcement to increase visible policing in strategic areas, addressing the metro police's ability to respond to a variety of challenges, prioritising initiatives to deal with drug abuse and protecting residents effectively from disasters. The focus for this pillar is supported by the following priorities:

- i. Creating safe communities by improving policing and law enforcement efforts, involving communities in making the city safer and building safer communities; and
- ii. Protecting communities from disaster by improving planning to mitigate against natural disasters and emergencies.

5.4.2.5 Strategic Pillar 5: Being open, honest and responsive

The city prioritises being responsive to residents and working together on the issues that impact communities to find solutions together. The focus for this pillar is supported by the following priorities:

- i. Building a capable city government by establishing professional and effective government processes;
- ii. Fighting corruption by putting measures in place to root out corruption; and
- iii. Communicating regularly and effectively with residents.

In 2013, the National Treasury initiated a process to review, rationalise and streamline the reporting arrangement of metropolitan municipalities. Central to the work of the reporting reforms has been the focus upon municipal functions (water and sanitation, electricity and energy, housing and community facilities, roads and transport, environment and waste management, fire and emergency services and governance) which have informed the development of set indicators. Each indicator was developed by applying a set of principles and criteria considering their strategic value and importance. One such indicator was a strategy for climate change mitigation and adaptation. The following section introduces CoT's CAP as an integral part of its sustainability program.

5.4.3 City of Tshwane Climate Action Plan

In 2021, the city's Sustainability Unit, with support from the CSIR, developed a reviewed Climate Action Plan (CAP). The ultimate vision of the CoT's CAP is to ensure that the CoT is a net-zero carbon and climate-resilient city by 2050 (CoT, 2021:4). To achieve this vision, CoT has developed a comprehensive list of climate actions which address climate risk, build climate resilience and promote net-zero carbon emissions. The climate actions are divided into 10 thematic areas, each with a strategic outcome and programmes to achieve the outcome. The 10 strategic outcomes collectively deliver the CAP's vision.

5.4.3.1 Theme and Outcome 1: People and communities - Safe, healthy, prosperous and climate-resilient communities

The goal of this outcome is to promote the safety and health of communities in the face of climate change and extreme climate events. The programmes associated with this theme and outcome are:

- i. Investigate and identify ways to reduce climate-related disaster risk;
- ii. Promote public health and safety in the face of climate change and extreme climate events;
- iii. Increase local food production to improve food security;
- iv. Involve communities, raise awareness and conduct training on climate change; and
- v. Promoting investment in “green” buildings.

5.4.3.2 Theme and Outcome 2: Urban planning - Climate-smart urban planning and design

To promote climate-smart spatial planning and development, land-use management, growth and development control, as well as innovative designs for climate-resilient urban spaces. The programmes for this theme and outcome are:

- i. Climate-smart spatial planning for climate-resilient growth and development;
- ii. Innovative urban and township design and development; and
- iii. Ensuring climate-smart urban areas by developing/amending/enforcing regulation and monitoring implementation.

5.4.3.3 Theme and Outcome 3: Green transport - Resilient, efficient, and climate-smart transport and transit-orientated development

To promote increased uptake of public transport, and a transition to a resilient transport network, cleaner mobility, and transit-oriented development. The programmes for this theme and outcome are:

- i. Ensure the transport network is resilient to climate shocks;
- ii. Promote city-wide use of Non-Motorised Transport;

- iii. Promote efficient and affordable public transport in the city;
- iv. “Green” the city’s fleet and drive a city-wide shift towards net-zero carbon transport; and
- v. Promote investment in the quality of the public transport system.

5.4.3.4 Theme and Outcome 4: Resilient infrastructure - climate-proof infrastructure

To reduce climate impacts and protect infrastructure from extreme climate events by maintaining, retrofitting, replacing, and adapting infrastructure. The following programmes have been adopted for this theme and outcome:

- i. Identify climate-risk zones and hotspots with vulnerable city infrastructure and assets;
- ii. Develop and implement a long-term infrastructure and asset maintenance programme; and
- iii. Design, retrofit or replace infrastructure to ensure it is climate-resilient.

5.4.3.5 Theme and Outcome 5: Green buildings - Net-zero carbon-efficient and climate-resilient buildings and public facilities

To design, build and retrofit buildings to ensure that they are net-zero carbon, resource-efficient and able to withstand extreme climate events. The programmes for this theme and outcome are:

- i. Ensure all existing and new buildings (city-owned or otherwise) are net-zero carbon, energy-efficient and climate-resilient; and
- ii. Promoting green buildings and regulating new and existing buildings through bylaws and policies.

5.4.3.6 Theme and Outcome 6: Natural resources - Climate-resilient ecological infrastructure and protect natural resources

To protect natural resources and enhance the natural ability of ecosystems to buffer climate change impacts. The following are the programmes for this theme and outcome:

- i. Integrate critical biodiversity areas and ecological support areas into the spatial framework;
- ii. Conserve, protect and restore natural open spaces/resources, and ecosystems;
- iii. Enhance natural resources by improving the quality of air, soil, and water resources; and
- iv. Enforce compliance with biodiversity and natural resources guidelines and regulation.

5.4.3.7 Theme and Outcome 7: Water - Access to clean and sufficient water, water security and water efficiency

To ensure water security for all users and uses in the face of climate change, while reducing water demand, use, pollution and waste. The programmes for this theme and outcome are:

- i. 'One water' approach to water use and water management;
- ii. Protect and conserve water;
- iii. Diversify the water supply mix; and
- iv. Amend, enforce, and monitor water policies and guidelines.

5.4.3.8 Theme and Outcome 8: Energy - An energy-smart and secure city with sustainable access to clean, efficient, and affordable energy for all

To ensure energy security for all users and uses in the city in the face of climate change, while promoting energy efficiency and a transition to renewable energy. The programmes are:

- i. Implement energy conservation and response measures;
- ii. Plan for renewable energy implementation in the city;
- iii. Procure renewable energy from independent power producers;
- iv. Diversify the energy mix and promote uptake of clean and small-scale renewable energy; and
- v. Develop and implement finance mechanisms that promote investment in renewable energy.

5.4.3.9 Theme and Outcome 9: Waste - A zero-waste Capital City that promotes a circular economy

To promote circular economy initiatives, waste segregation and recycling, to manage natural resources effectively and reduce impacts on the environment. The programmes are:

- i. Promote climate-smart waste management - minimisation, separation, recycling, and transportation;
- ii. Drive a shift towards a circular economy; and
- iii. Ensure proper closure and rehabilitation of current near-capacity landfill sites.

5.4.3.10 Theme and Outcome 10: Enabling environment - Climate change is well-governed, mainstreamed and institutionalised

To establish enabling mechanisms that promote good governance and ensure climate mainstreaming and the implementation of climate change actions in the city. The programmes are:

- i. Create an enabling institutional environment;
- ii. Promote cross-sectoral collaboration to advance mainstreaming;
- iii. Raise awareness among and conduct training for officials, politicians, and residents; and
- iv. Establish a well-resourced climate-action research, graduate training, and communications programme.

The CAP requires effective governance arrangements to facilitate its uptake and mainstreaming. To date, political leadership for the climate change programme has been vested in the Executive Mayor of the CoT, which has been a key to attracting international support and mobilising resources. After the local government elections in the second quarter of 2021, the CAP will provide ample opportunity for the city's new leadership to place themselves at the forefront of transformative climate action, to create a climate-resilient, net-zero carbon city with a healthy and prosperous population, economy, and environment.

The next strategic report for discussion is the outcome of the CoT DR&VA. This assessment was conducted during the 2019/2020 financial year.

5.4.4 City of Tshwane Disaster Risk and Vulnerability Assessment Outcome Report

CoT ESD takes its guidance from the Disaster Management Act (No. 57 of 2002) (South Africa, 2002) as amended, and the national, provincial and CoT disaster management frameworks. It also adheres to the guidelines of the National Disaster Management Centre (NDMC) as it relates to disaster risk management. In this light, CoT ESD contracted DMS NPC and AGES Alpha Pty (Ltd) to undertake a comprehensive DR&VA, covering the entire CoT area of approximately 6 298 km², to achieve the following four main outcomes:

1. The identification of known priority risks so that the development of contingency plans and risk reduction measures may be implemented. This will ensure that the municipality is prepared for a significant event or disaster which may occur, or which threatens to occur;
2. The identification and analysis of vulnerabilities as a whole so that departments of the municipality and other municipal entities can prioritise their disaster vulnerability reduction planning and implementation for inclusion in the IDP;
3. The identification of high-risk groups, areas, households, communities and developments with multiple vulnerabilities; and
4. To provide the city with a comprehensive integrated implementation plan of the findings made in the DR&VA report and recommended risk reduction strategies and measures per identified municipal department as it relates to sustainable local development.

The priority hazards identified during the DR&VA for the CoT included veld fires, human disease (human immunodeficiency virus, acquired immunodeficiency syndrome [HIV/AIDs] and Tuberculosis [TB]), structural fire, storage, transport and usage of hazardous material, water pollution, transport accidents, illegal dumping, flooding, sinkholes, crime and civil unrest. These are not listed in order of priority. An analysis of each hazard is provided in the report, considering the frequency, probability and magnitude of the hazard, as well as the root causes, dynamic pressures and unsafe conditions that inform and influence the conditions of vulnerability. In addition, the capacity available to manage each risk is provided.

The outcomes of the DR&VA can ensure that all developmental initiatives, as well as contingency planning and practice for CoT, are informed by knowledge of disaster risk, enabling various stakeholders to contribute to the ultimate goal of DRR (CoT, 2019:264). DRR interventions were developed with the focus on addressing the requirements as set out by the SDGs, as well as achieving the outcomes of Tshwane's Vision 2055. In addition, DRR interventions in the DR&VA outcome report gave attention to key vulnerabilities due to climate change, informal settlements, child- and female-headed households, illiteracy rates, unemployment, households living below the poverty line and high-density areas, thus addressing the trans-disciplinary nature of disaster risks identified.

Included in the DR&VA are gaps identified in CoT in achieving the SDG targets related to disaster management. The self-explanatory table (Table 5.2) summarises the gaps identified throughout the assessment, based on consultations with stakeholders and research undertaken of reports and publications (CoT, 2019:288).

Table 5.2: CoT SDG gaps (CoT, 2019:288)

Sustainable development goal	Gap identified
1 No poverty	Persistent high rates of poverty, particularly in previously disadvantaged areas in the northern parts of Regions 1 & 2, western parts of Region 3, southern parts of Region 4, North-Western parts of Region 6 and northern parts of Region 7.
2 Zero hunger	A growing number of homeless people and hunger are associated with high rates of poverty.
3 Good health & well-being	High crime rates, HIV/AIDS and TB prevalence and civil unrest are indicative of inadequate sport and recreational facilities or activities in high-risk areas.
4 Quality education	DRM is not adequately integrated into the school curriculum, which needs to be addressed in the short term

	through DRR school campaigns. Inadequate education is a driver for unemployment and inequality.
5 Gender equality	Women continue to bear the burden of disaster risk-related impacts in high risk and disadvantaged areas.
6 Clean water & sanitation	Informal settlements continue to struggle without adequate clean water and formal sanitation, with many areas having to receive water via tanks temporarily. Upgrading of informal settlements is lengthy and complex, with short term interventions required in the interim for those undergoing upgrade processes, while land invasions and new informal settlements continue elsewhere.
7 Affordable & clean energy	Integration of DRM in climate response actions is lacking (such as the city's indigent register, the Food Bank and development of agri-parks to support urban agriculture in peri-urban areas and formalisation of informal settlements).
8 Decent work & economic growth	Persistent high unemployment in CoT, with Region 5 recording the highest percentage of unemployment, an indicator of low economic development. Socio-economic inequality and inadequate education also contribute towards a lack of employment opportunities and economic growth.
9 Industry, innovation & infrastructure	Requires mainstreaming of disaster risk management. Innovation in CoT is not adequately shared and integrated across all departments/sectors, especially those relating to disaster risk management.
10 Reduced inequalities	CoT has been unable to provide services to all residents in a sustainable manner, an indication of a lack of equitable distribution of resources (such as poor,

	disadvantaged areas that are left behind in terms of service delivery compared to middle to rich class counterparts).
11 Sustainable cities & communities	Greater integration and cooperation are required between DRM and the city's Sustainability Unit. Pervasive issue of land invasions and the growing number of informal settlements as a result of rapid urbanisation and population growth and the city's inability to keep pace with the demand of basic services.
12 Responsible consumption & production	Illegal dumping is an indicator of escalating consumption patterns coupled with insufficient waste disposal services.
13 Climate action	Requires greater cooperation and integration with DRM. Many commonalities must be aligned to avoid duplication and to encourage sharing of information and joint planning and decision-making.
14 Live below water	Pervasive water pollution issues in the city impact aquatic life and biodiversity below water.
15 Live on land	Pervasive littering and illegal dumping, frequent veld fires, urbanisation and population growth put a strain on the environment.
16 Peace, justice & strong institutions	Poor governance, competing administrative goals, lack of resources and lack of necessary community-based institutional arrangements, particularly on matters relating to DRM.
17 Partnerships for goals	Internally and between departments, a lack of cooperation, coordination and integration is evident, thus not upholding the principle of cooperative governance

	prescribed by the National Disaster Management Framework.
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The outcome report recommended that projects be developed that are prompted by the identification and awareness of the priority disaster risks and should be developed and implemented in such a way as to ensure progress is made in achieving the SDGs (CoT, 2019:290). The outcome report, adopted as a CoT strategic document for risk reduction, further advised CoT to review its current approved disaster management plan as the last approved plan dated back to 2007. This plan was developed for CoT by the African Centre for Disaster Studies with the research focus area of sustainable social development (CoT, 2007:ii).

5.4.5 City of Tshwane's Disaster Risk Management Plan

Section 26(g) of the Municipal Systems Act 32 of 2000 as well as sections 52 and 53 of the Disaster Management Act 57 of 2002 (as amended) compels each municipal entity to develop a DRMP as an integrated part of their IDPs. This plan establishes the arrangements for disaster risk management within CoT and has been prepared in accordance with the requirements of the Disaster Management Act, 57 of 2002 (the Act) and section 26(g) of the Municipal Systems Act, 32 of 2000 (South Africa, 2000).

The purpose of CoT DRMP is to document the institutional arrangements for disaster planning, which includes the assignment of primary and secondary responsibilities for priority disaster risks posing a threat in CoT. It further provides the broad framework within which the disaster risk management planning requirements of the Act will be implemented by the departments and other entities included in the organisational structure of CoT. It establishes the operational procedures for DRR planning as well as the emergency procedures to be implemented in the event of a disaster occurring or threatening to occur in the council's area. It aims to facilitate an integrated and coordinated approach to disaster risk management in the municipality which will ensure that CoT achieves its vision for disaster risk management. This vision is to build resilient people in CoT who are alert, informed and self-reliant by establishing risk reduction and resilience building as core principles, and developing adequate capabilities for readiness, as well as effective and rapid response and recovery. Lastly, the plan established contingency measures in the form of specific and generic

contingency plans in line with the indicative risk profile of the municipality, to ensure a coordinated approach to disaster response (CoT, 2007:7).

The DRMP provides clarity on the institutional capacity arrangements present in CoT which is in line with the requirements of the National Disaster Management Framework for a level 1 plan (South Africa, 2005:137). CoT DRMP further adopted four key performance areas (KPA) and three enablers as described in the Disaster Management Act (South Africa, 2002) for all divisions and departments in the city, as tabulated in Table 5.3

Table 5.3 Disaster Management Act key performance areas and enablers

Key Performance Area	Objective
Key Performance Area 1: Institutional capacity for disaster risk management	The objective of this KPA is to establish integrated institutional capacity within the city to enable the effective implementation of disaster risk management policy and legislation.
Key Performance Area 2: Disaster risk assessment	The objective of this KPA is to establish a uniform approach to assessing and monitoring disaster risks that will inform disaster risk management planning and DRR undertaken by the city and other role players.
Key Performance Area 3: Disaster risk reduction	The objective of this KPA is to ensure all disaster risk management stakeholders develop and implement integral DRMPs and risk reduction programmes in accordance with approved frameworks.
Key Performance Area 4: Disaster response and recovery	The objective of this KPA is to ensure effective and appropriate disaster response and recovery

Enablers	
Enabler 1: Information management and communication	The objective of this enabler is to guide the development of a comprehensive information management and communication system and establish integrated communication links with all disaster risk management role players.
Enabler 2: Education, training, public awareness, and research	The objective of this enabler is to implement education and training programmes pertaining to disaster risk management in all spheres of education systems.
Enabler 3: Funding arrangements for disaster risk management	The objective of this enabler is to provide funding mechanisms for different aspects of disaster risk management. Apart from the action and performance indicator provided for each city department in achieving the KPAs and enablers, the plan also contains an all-hazard contingency plan that provides for emergency procedures for the tactical and strategic management of disaster response and recovery operations. The last part of the plan contains CoT incident management model developed and required by the Disaster Management Act to ensure CoT has a coordinated approach to emergency response.

5.5 WEAKNESSES AND STRENGTHS OF THE CITY OF TSHWANE'S STRATEGIC DOCUMENTS

The CoT's strategic documents that were considered relevant to this research showed both weaknesses and strengths in CoT's approach towards disaster resilience planning and sustainable development.

One of the biggest weaknesses identified is the **silo approach** in the city's disaster resilience planning strategy. Different strategic documents address different aspects of disaster resilience and sustainable development. The separate nature of each document does not point to a combined and connected strategy with one goal in mind. The documents referred to in the chapter introduce various plans or outcomes to be

implemented in the city, without considering the same plan or outcome already included in another document. Therefore, proposed activities to implement or achieve outcomes are duplicated, causing confusion and frustration for the implementors. For instance, Vision 2055 Outcome 3 – Quality infrastructure development that supports liveable communities referred to the long-term and coordinated approach to infrastructure investment and development, Vision 2030 Strategic Pillar 1 – Facilitates economic growth and job creation through attracting investment and encouraging growth by making it easy to do business in Tshwane where the CAP requires actions to promote investment in 'green' buildings, transport systems and renewable energy. One consolidated document could assist the city in attracting investment in all areas of resilience and not in an isolated approach as reflected in the identified documents.

Another weakness identified is the provision for **continuity of services** should a disruption occur in the city. The DRMP and the CAP are the only documents that made provisions to plan for the continuity of service should a disruption occur. The DRMP, for instance, set requirements for the development of a contingency plan should prolonged electricity failure exist (CoT, 2007:36). The city, as a complex system, consists of sub-systems (departments) that are interdependent to provide service to the community (cf. 2.2.1). A disruption in any of the systems will influence the rest of the departments. The DR&VA report only provided a template to be used for contingency planning. Vision 2055 and Vision 2030 - IDP documents do not consider measures that must be implemented to (1) prevent the disruption of service (cf. 3.2.4) and (2) how the city will adapt to ensure that there is continuity of delivery of service should there be a disruption (cf. 2.2.4). Any disruption in the city will affect the achievement of the outcomes and objectives set in the strategic documents. Therefore, the interdependent systems approach to disasters (cf. 2.3) in all the strategic documents should be considered essential.

Sustainable development has been viewed as a process that requires iterative steps of **assessment, planning, monitoring, and re-assessment** to achieve desired long-term goals linked to system integrity, livelihood sufficiency, opportunity, resource maintenance, and adaptation (cf. 3.5). Apart from the CAP, none of the documents provide for measures to monitor the implementation of the outcomes or objectives. Having the strategies but not having the means to determine the implementation thereof is considered a shortfall identified in the CoT strategic documents.

The identified strategic documents also have various strengths that will be considered for the framework that can assist the CoT in developing its disaster resilience planning strategy. The city's strategic documents inform the adoption of **resilient and sustainable development policies** and program interventions that are closely linked to the SDG's. The IDP also provides for strategies for the city's development as it relates to some priority goals in the SDG. **Economic growth**, job creation, addressing service delivery inadequacies, **protecting the environment**, **enforce** build environment polices and keeping CoT **residents safe** are all considered essential for sustainable development.

CoT's climate action plan adopted an **evidence-based approach** that identify climate risk zones and direct actions to those zones with a view to **reduce the impact** of the hazard or to build coping capacity for the community of CoT. The **identification of priority risks** and analysis of **vulnerabilities** to prioritise disaster vulnerability reduction planning as provided for in the DR&VA are considered two strengths of value. This information will provide for the city's risk analysis that guides the city planners towards the high-risk areas that requires inclusion in disaster resilience and sustainable development planning.

The strategic documents have weaknesses and strengths that should be addressed and adopted for the CoT's city disaster resilience framework that can assist the CoT in developing its disaster resilience planning strategy. The strategy should thus focus on a comprehensive coalescence of DRR measures and the SDGs in the CoT.

5.6 CONCLUSION

This chapter introduced the CoT Metropolitan Municipality and shared some light on the city's geographical, demographical and risk profile in terms of its population, education and employment, economic, environmental and vulnerability profiles. CoT faces the challenge of providing for the needs of a growing population and economic sector while attempting to alleviate poverty and reduce inequality, particularly in the face of increasing climate change and other social, political and economic forces. To add to the complexity, CoT is required to address the needs of several diverse regions (the seven administrative regions), which include urban and peri-urban (Regions 1 to 4) and rural areas (Regions 5 to 7).

The population growth and demand for services in CoT place a huge strain on existing infrastructure networks and resources required to maintain services and ensure sustainable development. As a result, CoT and its regions face a huge challenge to sustain existing service levels and to eradicate water, electricity, sanitation and housing backlogs. The population growth also increases the demand for government and municipal services and widens the gap between delivery and existing services backlogs, thereby negatively influencing the risk profile of the city.

The chapter also provided an overview summary of CoT's strategic intent to disaster resilience and sustainable development through five strategic documents: (i) Vision 2055 that described CoT's vision in having a city that is liveable, resilient and inclusive; whose citizens enjoy a high quality of life, have access to social, economic and enhanced political freedoms and where citizens are partners in the development of the African Capital City of excellence. Vision 2055 also focused on a resilient and resource efficient city, growing economy, quality infrastructure development, among others, that is directly linked to this research that (ii) Vision 2030 through the IDP adopted the National Development Plan; (iii) Climate Action Plan; (iv) Disaster Risk and Vulnerability Assessment report and (v) CoT's Disaster Risk Management Plan. Chapter Six will provide a discussion and interpretation of the data analysis.

CHAPTER SIX: RESULTS PRESENTATION, INTERPRETATION AND DISCUSSION

6.1 INTRODUCTION

The previous chapter introduced the CoT as the case study and gave an overview of the city's geographical area, its demographics and vulnerabilities. It also presented an overview of the CoT's strategic documents that addresses disaster resilience and sustainable development planning strategies in CoT. The purpose of this chapter is to present and discuss the findings of the analysis of the CoT's disaster resilience and sustainable development strategic documents. The thematic analysis of these documents was based on the 17 SDG's and the Sendai Framework priorities.

The chapter identifies and discusses key themes that emerged from the analysis of the four international frameworks that influence the development of a city disaster resilience framework.

The chapter concludes with the findings and discussion of the one-on-one interviews with the key respondents identified.

6.2 DISCUSSION OF THE FINDINGS OF THE ANALYSIS OF THE CITY OF TSHWANE DISASTER RESILIENCE AND SUSTAINABLE DEVELOPMENT STRATEGIC DOCUMENTS

The research analysis focused on five CoT disaster resilience and sustainable development strategic documents. These documents made (in some way or another) reference to the four Sendai Framework priorities (and measures) for disaster resilience, as well as the 17 SDGs. Table 6.1 is a presentation of the CoT documents analysed for this research. The number of references or descriptions associated with the Sendai Framework's priorities and the SDGs were identified through content analysis. Keywords associated with the SDGs and the Sendai Framework priorities were used in the content analysis (cf. Addendum F).

The documents were also highlighted and considered important by the respondents who participated in the one-on-one interviews. Respondents 1, 2, 3, 4, 5 and 7 referred to the DRMP when asked about disaster resilience and sustainable development strategies in the CoT. Respondent 7 added, "there are disaster frameworks, disaster policies and strategies such as the DRMP that is part of planning to be resilient".

Reference to the CAP was made by Respondents 1, 2, and 9 with Respondents 1, 5, 8, and 9 referring to the IDP and Tshwane's Vision 2055.

Table 6.1: CoT disaster resilience and sustainable development strategic documents

SDGs	Tshwane Vision 2055 (CoT, 2012)	Vision 2033 IDP 2019/2020 (CoT, 2018)	CAP (CoT, 2021)	DR&VA report (CoT, 2019)	Disaster Risk Management Plan (CoT, 2007)
1 No poverty	137 (p. 7 ¹)	9 (p.124)	15 (p. 35)	51 (p. 34)	14 (p. 31)
2 No hunger	3 (p. 171)	1 (p. 59)	10 (p. 102)	2 (p. 278)	x (0)
3 Good health and wellbeing	119 (p. 230)	39 (p. 46)	13 (p. 40)	17 (p. 277)	5 (p. 64)
4 Quality education	71 (p. 26)	23 (p. 79)	13 (p. 121)	74 (p. 276)	7 (p. 24)
5 Gender equality	27 (p. 217)	4 (p. 82)	2 (p. 107)	2 (p. 284)	5 (p. 81)
6 Clean water and sanitation	239 (p. 192)	33 (p. 57; 44)	29 (p. 144)	21 (p. 271)	4 (p. 16)
7 Affordable and clean energy	108 (p. 192)	15 (p. 56; 58)	25 (p. 102)	20 (p. 262)	20 (p. 61)
8 Decent work and economic growth	142 (p. 120)	88 (p. 121)	3 (p. 142)	15 (p. 255)	8 (p. 11)

¹ The number shown before the bracket is the number of times the word(s) appear in the document that is being analysed. The page number shown in the bracket refers to the page that was used for reference purposes.

9 Industry, innovation and infrastructure	341 (p. 108)	101 (p. 128)	27 (p. 104)	169 (p. 286)	38 (p. 18)
10 Reduce inequalities	104 (p. 124)	1 (p. 41)	6 (p. 122)	2 (p. 285)	4 (p. 11)
11 Sustainable cities and communities	56 (p. 237)	28 (p. 125)	39 (p. 155)	3 (p. 289)	6 (p. 31)
12 Responsible consumption and production	19 (p. 123)	2 (p. 175)	9 (p. 41)	7 (p. 278)	9 (p. 37)
13 Climate action	62 (p. 134)	1 (p. 63)	56 (p. 30)	152 (p. 112)	x (0)
14 Life below water	1 (p. 193)	1 (p. 85)	19 (p. 63)	2 (p. 289)	x (0)
15 Life on land	117 (p.98)	65 (p. 56)	10 (p. 147)	2 (p. 288)	6 (p. 31)
16 Peace, justice and strong institutions	33 (p. 257)	9 (p. 117)	10 (p. 152)	1 (p. 289)	x (0)
17 Partnerships for the goals	34 (p. 254)	6 (p. 85)	21 (p. 120)	10 (p. 340)	1 (p. 50)
Sendai Framework Priorities					
1. Understand the risk	18 (p. 224)	7 (p. 108)	98 (p. iii)	9 (p.22)	28 (p. 7)

2. Strengthen disaster risk governance	99 (p. 253)	3 (p. 99)	12 (p. 12)	6 (p. 168)	5 (p. 80)
3. Investing in DRR	20 (p. 154)	8 (p. 338)	17 (p. 9)	20 (p.338)	60 (p. 28)
4. Enhance disaster preparedness for effective response and to build back better	4 (p. 145)	5 (p. 99)	4 (p. 181)	28 (p.66)	58 (p. 27)

Table 6.1 presents CoT documents analysed for this research. The SDGs and the Sendai Framework for disaster resilience were analysed to discover how SDGs and DRR form part of CoT's planning strategy. It was found from the five documents, four (Vision 2055, Vision 2030 IDP, CAP and the DR&VA) include all the SDGs. From the above table, it is evident that the document that has the least number of SDGs is the DRMP. This plan, for instance, has no reference to **climate action** which is clear in the literature as essential for disaster resilience in cities. Disaster resilience in cities has attracted a surge of interest due to the growing awareness of shock and threats in socio-economic environments emanating from **climate change**, shortage and depletion of resources, economic volatility and many other different kinds of crises.

Applicable to this study and considered the core purpose of sustainable development in cities is SDG 11: **Sustainable Cities and Communities**. This goal encapsulates essential factors, such as governance (adopting and implementing policies and plans toward inclusion), basic service delivery, disaster resilience, disaster risk management, mitigation and adaptation to climate change and the implementation of the Sendai Framework (cf. 3.5). Furthermore, SDG 11 seeks to provide for the **well-being** of its community through, for instance, basic needs for survival, security, health, social relations and so forth (Maslow, 1943:370; Johnson, 2012:358; Da Silva *et al.*, 2012:125; Friend & Moench, 2013:103).

The four Sendai Framework priorities were referred to in all five documents. The consideration of all the Sendai Framework priorities is supported by Wahlström (UNDRR, 2017:5) in the foreword of the UN Sendai Framework 2015 – 2030 where it is articulated that “the need for improved understanding of disaster risk in all its dimensions of exposure, vulnerability and hazard characteristics; the strengthening of disaster risk governance, including national platforms; accountability for disaster risk management; preparedness to ‘Build Back Better’”.

Understanding the risk which includes key factors, such as assessing disaster risks, vulnerability, capacity, exposure, hazards and the possible effects on social and spatial planning (cf. 3.2.4.2) was found to be an important priority in all the documents. Although there was no direct reference to understanding risk, Vision 2055 did refer to various elements associated with risk. The document demanded the safety of the resident and indicated that:

*“A **detailed diagnosis** of each situation is therefore required, containing information about the perpetrators, victims and the circumstances in which the crime has occurred, as well as an assessment of the community **safety risks** and levels of protection present in each community.”*

(CoT, 2012:224)

The following section highlights the findings of the different strategies as tabulated in table 6.1.

6.2.1 Vision 2055

Vision 2055's strategy referred to “the provision of **water, sanitation**, roads, **waste management, electricity**, housing, recreation, **health and safety** are primarily the focus areas of service delivery infrastructure for CoT” (CoT, 2012:192).

Vision 2055, as a long-term strategy, placed high emphasis on **governance**. It considered governance essential “because, if well construed, it is a tool that serves to manage and reconcile the long-term vision with short and medium-term challenges. **Governance** also serves to secure an amenable environment for implementation of plans” (CoT, 2012:253).

Investing in DRR that is linked to available **funding** was found to be one of the areas included in all the documents. Vision 2055's Outcome 5 made provision to ensure financial resilience (cf. 5.3.1). This document also referred to achieving economic investment:

*“To achieve liveability from an economic perspective, it requires that the City continue to **invest in economic infrastructure** that will contribute to becoming a **resilient economy** that can adapt to economic turbulence as well as an inclusive economy that fosters equitable access to economic opportunities within and beyond the city's boundaries.”*

(CoT, 2012:154)

Vision 2055 included that part of its long-term strategy is to “strengthen climate change adaptation programmes to safeguard the city's residents, infrastructure, natural resources, including **disaster preparedness**” (CoT, 2012:45).

6.2.2 Vision 2030 Integrated Development Plan

Vision 2030 and IDP's Strategic Pillar 3, for example, supports the delivery of high-quality and sustainable basic services such as **water** (CoT, 2018:57), **sanitation** (CoT, 2018:44), housing (CoT, 2018:62), **protecting the natural environment** (CoT, 2018:56), creating sustainable **agricultural initiatives** (CoT, 2018:59) and more. The Vision 2030's IDP provided for an **understanding of vulnerability** and risks as part of the plan. The plan required CoT to "provide for an **understanding of the broad service** delivery issues and challenges that are faced by the city in providing services in accordance with community expectations" (CoT, 2018:108).

Vision 2030's IDP made four direct references to **disaster risk governance**. The IDP required CoT to "strengthen disaster risk governance across mechanisms and institutions relevant to DRR and sustainable development" (CoT, 2018:99).

Vision 2030's IDP Strategic Pillar 1 is about attracting investment and encouraging financial sustainability in cities (cf. 5.3.1). The plan also encourages DRR measures but has no direct reference to investing in disaster reduction measures. The term DRR was referred to eight times in the plan. It required that "more attention be given to monitoring and evaluation of departmental responsibilities as it relates to their respective roles in the planning and recovery phases in order to assure alignment with **DRR** and mitigation principles" (CoT, 2018:338).

Vision 2030's IDP required that the city "enhance disaster preparedness for effective response, recovery, rehabilitation and restoration" (CoT, 2012:99).

6.2.3 Climate Action Plan

CAP also included the aspect of access to basic needs. Outcome 1 - People and communities: Safe, healthy, prosperous and climate-resilient communities (cf. 5.3.4.1) incorporated many aspects of basic services and the SDGs; promote public **health and safety** (CoT, 2021:40), increase local food production to improve food security (CoT, 2021:41) and provide for **affordable energy** (CoT, 2021:102). For the implementation of Outcome 6 - Natural resources, Climate-resilient ecological infrastructure and protecting **natural resources** (cf.5.3.4.6) will benefit the community as it will "contribute to the basic service delivery of **water and sanitation services**" (CoT, 2021:144).

The CAP included vulnerability 98 times and considered social, economic and environmental vulnerability important as part of **understanding risk**. The plan indicated that “Tshwane has embraced an evidence-based approach to climate action: the city regularly updates its Greenhouse Gas emissions inventory, has developed and will regularly update a **climate risk and vulnerability assessment** and has identified areas that require more in-depth understanding” (CoT, 2021:iii).

The CAP indicated that “effective climate action furthers climate justice and reduces social vulnerability, and enhances populations’ health, safety and prosperity. It **requires effective governance**, collaboration and strategic resource mobilisation” (CoT, 2021:12).

The CAP referred to “**investing** in energy efficiency reduces emissions and costs, creates jobs and provides new business opportunities” (CoT, 2021:9).

The CAP described CoT’s climate adaptation programme. This program adopted three themes emerging from climate risk assessments which are “the correlation between poverty, social vulnerability and climate impacts, disaster preparedness and the role of natural buffers in building resilience” (CoT, 2021:181).

6.2.4 Disaster Risk and Vulnerability Assessment report

The DR&VA report also considered access to basic services as essential. The report referred to the upgrading of water purification plants to allow for continuous provision of **clean water** to the community (CoT, 2019:271). “The delivery of **sustainable sanitation** services to overcome sanitation backlogs” were also included in the DR&VA report as measures to achieve the SDGs (CoT, 2019:271). This assessment included in its recommendation that CoT should “establish urban communal gardens to ensure adequate **food security** and nutrition” (CoT, 2019:278); and “create education and awareness campaigns for communities enforcing **well-being**” (CoT, 2019:277). The assessment report identified the need for CoT to provide for greater integration and cooperation between the Disaster Risk Management section and the city’s Sustainability Unit to provide for **sustainable cities and communities** (CoT, 2019:289).

The DR&VA report did not specifically refer to understanding disaster risk. However, the report referred to understanding CoT’s vulnerability. For instance:

*“...**understanding** the economic profile of CoT is important from a DRM perspective as it strongly influences the conditions of the economic **vulnerability** of the City, determining the sectors that could potentially be impacted by a major incident or disaster occurrence.”*

(CoT, 2019:22)

The DR&VA report paid more attention to the effect of poor governance in the city. The report, for instance said that a city’s risk increases due to “**poor governance** around water quality and the maintenance of decaying facilities and infrastructure” (CoT, 2019:168).

The DR&VA report referred to the need for funding 20 times. In terms of funding options for DRR, the report requires that the city have “**budgets** in all municipal departments and entities to include the costs of routine DRR measures and activities” (CoT, 2019:338).

The DR&VA report considered it imperative for the city to have **preparedness** and **response plans** in place. The report indicated that “it is imperative that preparedness, response and recovery plans be developed and implemented for all priority disaster risks that cannot be prevented (i.e., those derived from natural hazards)” (CoT, 2019:66).

6.2.5 Disaster Risk Management Plan

Even though the DRMP was found to be the document referring the least to the SDGs, it did cover aspects of access to basic services. The DRMP indicated the essence of maintaining both physical infrastructures, such as roads and rails, as well as basic services, such as **water and sanitation facilities** (CoT, 2007:16). This plan made provision for technical task teams to ensure the provision of basic services. The mission-critical system task team’s objective is to:

*“...ensure that basic service provision, for example, **water, sanitation, electricity** and public transport continue to operate, including during emergencies and disasters. Planning in this regard includes contingency planning, placing procedures/systems in place to reinstate and/or replace critical systems when they fail.”*

(CoT, 2007:61)

The inclusion of basic services in the documents is supported by Reader (2004:301) who said that “cities are dissipative systems, demanding a constant inflow of resources to permit their functioning”. These resources range from basics such as **water** and **food** to economic goods and information. Cut off these supplies to a modern city and it will rapidly collapse.

The DRMP considered **disaster risk assessment** as an important activity to determine the city’s vulnerability. This plan, for instance, required that all departments “conduct a scientific risk assessment of agreed division/department/municipal entity risks” (CoT, 2007:77) to “identify areas of vulnerability related to different economic activities” (CoT, 2007:82).

The DRMP required that the city “identify and implement mechanisms to ensure the application of the principles of **cooperative governance** in disaster risk management” (CoT, 2007:80).

The DRMP included the NDMF Enabler 3’s objective to provide funding mechanisms for different aspects of disaster risk management (cf. 5.5.7). The DRMP included **investing** in DRR where it placed a specific responsibility on the Chief Financial Officer to “allocate a percentage of the annual budget to implement developmental projects focussing on disaster risk management (capital as well as operational)” (CoT, 2007:28).

The DRMP elaborates on the general and specific disaster risk management responsibilities of each division in CoT to enhance disaster preparation, responding and recover from adverse events (Sharifi, 2016:629; Sharifi & Yagarnata, 2016:115) and not necessarily on “Build Back Better” as is asked for in the Sendai Framework. Every division is responsible to adhere to the standards for incident management and ensuring that all response personnel are trained in effective **responses**. Every division is responsible for “ensure[ing] that rehabilitation and **reconstruction plans** relating to the primary activities of the specific division are developed in line with disaster risk management plans” (CoT, 2007:27).

CoT's Vision 2055 is found to be a very good planning strategy that provides a comprehensive presentation of all the 17 SDGs and the DRR priorities and measures described in the Sendai Framework. Vision 2055's attention is to provide basic services such as water, sanitation, energy and health services to the community of Tshwane, which is considered essential for sustainable development (cf. 3.5). The inclusion of protection of infrastructure, social systems and environment in Vision 2055 are programs aimed at disaster resilience (cf. 2.2 & 3.3). It must be remembered that the city (James *et al.*, 2013:12) consists of complex sub-systems that include sanitation, utilities, land usage, housing and transportation. Additionally, the transition to sustainable cities depends on social, cultural, economic and climatic factors (cf. 2.2 & 3.4) because cities consist of physical, social and economic systems that are increasingly interconnected, resulting in complex interactions. Vision 2055 has extensive references to sustainable cities and communities and included all aspects of DRR as part of its long-term strategy.

However, the 2016 political leadership in CoT abstained from approving this strategy, which could result in senior management not accepting the inclusion of Vision 2055 as part of this study (cf. 5.3.1). Therefore, the CAP was found to be the best strategic document related to this study. This document places a lot of its focus on the sustainable provision of basic services such as health, water, sanitation and energy and is aimed at achieving all the SDGs. The strategy not only developed action details (implementation measures) to achieve all the SDGs but also to implement the Sendai Framework priorities and measures (cf. 5.3). The strategy adopted the complex adaptive systems approach in the city as it considered it essential for the city to develop a multi-sectoral approach (cf. 2.2.4), to ensure maximum efficiencies and ensure the effectiveness of implementing the plan (CoT, 2021:133). This plan also acknowledged the infrastructure interdependencies and interconnectedness in a system as referred to by Meadows (2008:12). A disruption in one system will result in a ripple effect on all other city systems, the economy, society and the environment. As agreed by Edson (2008:5); and Phelan (2001:132), simple changes or effects need not have a simple cause-effect relationship but can be, and often are, a result of complex non-linear interactions. For instance, the spread of polluted waters into households will impact the health of the community, health services, the city's human capacity due to absenteeism, the city's economy and so on. The CAP, therefore, considered it

essential to “minimise the spread of polluted waters into households as it will reduce the health and economic impacts in the city” (CoT, 2021:151).

This document and its action details provided the researcher with a basis for the development of the framework as it covers all aspects of this study (DRR and SDGs). CoT documents selected for this research study made reference to the 17 SDGs and the Sendai Framework priorities. It was indeed found that, apart from the DRMP that does not include any reference to SDG 2, SDG 13, SDG 14, and SDG 16, all the other documents included the 17 SDGs in one way or another. It was also confirmed that all the documents included many of the DRR measures as contained in the Sendai Framework priorities. CoT has plans in place to achieve the 2030 SDGs and the Sendai Framework priorities. It was, however, identified that various duplications exist within these documents, which is an indication of all city departments not being involved in the development of these documents. The city is a complex adaptive system that requires a multi-sectoral approach of all its departments to provide for a resilient and sustainable city.

6.3 DISCUSSION OF THE FINDINGS OF THE ANALYSIS OF THE FOUR FRAMEWORKS, SUSTAINABLE DEVELOPMENT GOALS AND THE SENDAI FRAMEWORK

The intention of the analysis of the **four frameworks, SDGs** and the **Sendai Framework** was to identify the emerging themes within and across them. The following section provides a discussion and interpretation of the categories and themes (cf. Table 6.2) that emerged after the analysis which are deemed essential for the city disaster-resilience framework. Key factors associated with each category are also discussed. The different categories identified in the four frameworks, the SDGs and the Sendai Framework priorities were grouped based on words, phrases and concepts with similar meaning (cf. Addendum G).

Table 6.2: Identified categories and themes (indicators)

Categories		Theme (indicator)
	Key factors of the categories	
Organise for resilience	Leadership Organisation Governance Policies Political Leadership	Governance & Legislation
Strong leadership and commitment		
Critical importance of leadership		
Local Government organisation		
Urban governance		
Strengthen participation in global governance		
Strengthen disaster risk governance		
Leadership and strategy		
Governance structure		
Involvement of political leadership		
Local government and stakeholders		
Effective leadership and management		
Implementation of policies and programmes		
Land-use policies, codes and laws		

Strengthen financial capacity	Financial capacity Financial resources Economic growth Investments	Financial Capacity
Availability of financial resources		
Economy and livelihood		
Urban economy and society		
Sustainable economic growth		
Investing in DRR		
Economic impact assessments		
Sustainable city economy		
Different economic outputs		
Resilient urban development	Urban development Urban planning Land management	Urban Development
Development plans and land use		
Urban planning and design		
Urban planning and land management		
Urban planning and management		
Land use and urban planning		
Urban elements		
Urban planning and environment		
Integrated development planning		

Land-use policies		
Safeguard natural buffer	Safeguard and protect the ecosystem Ecosystem management Environmental quality and planning CAP	Environment & Ecosystem management
Identify, protect and monitor ecosystem		
Ecosystem management		
Spatial context management		
Environmental management		
Sustainable management of water and sanitation		
Protect ecosystem		
Manage and maintain ecosystem		
Ecosystem services management		
Urban planning and environment		
Minimise damage to the environment		
Environmental quality		
Poor design and management		
Understanding vulnerability of ecosystem		
Climate action and adaptation		
Strengthen institutional capacity		Institutional capacity
Identify mutual support		

Capacity to face threats	Mutual support Education Awareness Stakeholders Commitment Partnerships	
Organisational capacity		
Improve education and awareness		
Implementation of capacity building		
Empower stakeholders		
Stakeholder mapping and relations		
Coordination and cooperation with stakeholders		
Political commitment		
Public-private partnerships		
Foster partnerships		
Understand and strengthen the social capacity	Strengthen social capacity Social inclusion Social protection Participation Capacity Social vulnerability	Social Capacity
Identify mutual support		
Promote social inclusion and protection		
Participation of civil society		
Increase capacity of local communities		
Promote health and well-being		
Diverse livelihood and employment		
Minimise social vulnerability		
Identify poorest areas		

Inclusive and equitable public education and awareness		
Gender equality /gender balance		
Increase infrastructure resilience	Infrastructure resilience Maintenance Contingency plans	Critical infrastructure
The capacity of infrastructure systems		
Resilient infrastructure		
Reduce damage to infrastructure		
Provide basic infrastructure		
Maintenance of infrastructure and contingency plan		
Continuity of critical services	Continuity of basic services Urban elements Safeguard infrastructure Institutional capacity	Basic service delivery
Provision of urban elements		
Reduce disruption to basic services		
Safeguard human health and safety		
Ensure healthy lives		
Good health and wellbeing		
Access to basic social services		
Resilient basic services		
Water & sanitation		
Energy		

Food security		
Include law enforcement, crime prevention and justice	Law enforcement Crime prevention Justice Peace Policies and programmes	Law enforcement
Urban safety		
Land-use policies		
Criminal justice and law enforcement		
Promote peace		
Identify and understand hazards and risk	Identify risk Risk reduction Risk management Safe cities Disaster response Disaster preparedness Disaster recovery Disaster reconstruction Awareness and education Risk governance	Disaster risk management
Reduce exposure and vulnerability		
Identify shock, stresses and challenges		
Urban disaster risk management		
Make cities and human settlements safe		
Disaster response plans		
Risk management and emergency response		
Preparedness and response		
Expedite recovery		
Recovery and reconstruction		
Reduce disaster risk		
Identify future risk scenarios		

Risk awareness and knowledge		
Disaster risk governance		
DRR		
Build back better		

6.3.1 Theme - Governance and Legislation

Within this theme, key factors that emerged through thematic analysis were **leadership, governance, organisational structures** and **policies**. The identification of these factors is an indication that a city needs to have **strong leadership** and **commitment** to enable government **structures** to develop and implement resilience **policies, codes** and **laws**. The key factors collectively refer to good **governance and legislation** that emerged as the overall theme. The systems approach aids all levels of government to **organise** disaster-related information that is crucial for leaders to improve their decision-making (Simonovic, 2015:81), especially when implementing their decisions through policies. A systems approach offers possibilities for improving disaster management in cities (cf. 2.2).

The review of literature further reveals that governance and legislation have a significant role to play in implementing disaster resilience and sustainable development initiatives in cities. The city requires **effective leadership** and commitment to manage and plan for disaster resilience and to achieve the SDGs (Godschalk, 2003:11). Scholars such as Gupta and Vijayalakshmi (2020:4) support the latter scholar and state: “building the adequate governance, coordination and financing mechanisms to guard against disasters is not easy and requires strong and committed leadership”. The Sendai Framework supports the securing of political commitment in a city as an essential process in applying proactive measures, such as prevention and mitigation (UNDDR, 2015:9).

The government is required to provide legal **policies, guidelines and strategic frameworks** with common rules, well-defined legal mandates and plans under which disaster resilience and sustainable development programs operate. Van Zeijl-Rozema *et al.* (2008:410) agree that, in the context of sustainable development, governance is regarded as an essential and indispensable steering tool in a city. Sachs *et al.* (2019:805) agree: “governments need a strategy to design and implement key interventions in organising for SDGs”. The development and implementation of **policies, guidelines and strategies** are essential in a system to provide for a holistic approach (cf. 2.2.1) that has inter-dependencies and interconnected services that require a multi-sectoral integrated approach to disaster resilience and sustainable development (Barnett & Bai, 2007:143).

This [Governance and Legislation] theme was also considered an essential component of disaster resilience and sustainable development framework by the respondents in the one-on-one interviews. Respondent 1 highlighted the inclusion of plans to “**manage** disasters, **political will** and **legislation**”. Respondent 3 referred to “**planning**, **resilient policies** and **plans**”. Respondent 5 mentioned “**leadership**, **governance structures**, **roles**, **responsibilities** and **planning**”. Respondent 8 said “the essence of having a **political will** as well **administrative capacity** to collaborate on **working together** will determine the city’s success in achieving the SDGs”.

6.3.2 Theme - Financial Capacity

The second most prominent category identified in the documents was for a city to have and to provide for financial ability to be a resilient city. Reference to **financial capacity**, financial **resources**, **economic** growth, **investments**, and sustainable city **economy** was made in the documents.

The 2013 *World Bank Development Report* (World Bank, 2014:194) placed a major focus on financial planning and the financial cost of DRR inaction in the face of growing disaster risk. **Financial inclusion** is positioned prominently as an enabler of other developmental goals in the 2030 SDGs, where it is featured as a target in eight of the 17 goals. These include SDG1 - eradicating poverty; SDG 2 - ending hunger, achieving food security, and promoting sustainable agriculture; SDG 3 - profiting health and well-being; SDG 5 - achieving gender equality and economic empowerment of women; SDG 8 - promoting economic growth and jobs; SDG 9 - supporting industry, innovation, and infrastructure; and SDG 10 - reducing inequality. Additionally, in SDG 17 - strengthening the means of implementation, there is an implicit role for greater financial inclusion through greater savings mobilisation for investment and consumption that can spur growth (UN, 2015). The Sendai Framework requires that local government assess the **financial capacity** to deal with the identified risks at the local and national levels and to understand the economic impact of disasters.

The four international frameworks extensively referred to financial capacity or budget availability for disaster resilience and sustainable development. The City Resilience Index Key Functions require cities to provide **access to finance** and the ability to **accrue savings** (Rockefeller & Arup, 2014:10). There is a need to understand the essence of investment in resilience, and to identify and develop **financial**

mechanisms that can support resilience activities (UNDRR, 2015:19). The CityRAP tool's pillar on Urban Economy and Society refers to the processes, mechanisms and activities that allow cities to become drivers of socio-economic development in a country or region, to **generate investments** (UN-Habitat, 2018:9). The City Resilience Profiling tools emphasised decision making and decision implementation on **financial governance** and strategic planning within the local governments and stakeholders priority (UN-Habitat, 2017:30).

The importance of investing and providing financial support for disaster resilience and sustainable development was identified as an essential theme in the one-on-one interviews. Respondent 5 responded that "it is possible for a city to be resilient if **sufficient budget** is allocated to DRR and sustainable development". Respondent 2 also referred to financial support and said:

"The city must have a threshold of 0,5% of its revenue. This threshold must then be used for DRR in the city. It must be used for disaster prevention and response as Province [Gauteng Provincial Disaster Management] will not always fund damages in the city. They will only fund damages if a disaster is declared."

Bahadur *et al.* (2015:1) agree: "increasing investments in resilience would ensure that people have resources and capacities to better reduce, prevent, anticipate, absorb and adapt to a range of shocks, stresses and uncertainties". The provision of financial resources and economic growth, utilising investments and different economic outputs to recover from a disaster is therefore considered essential for a city's disaster resilience strategy. The financial capacity theme, therefore, includes financial planning, budget allocation, financial investment and contingency funding.

6.3.3 Theme - Urban Development

Urban development and **planning, land use** and **land management** were found to have a direct impact on the **environment and the ecosystem**. Integrated development planning and **management** require the **protection and safeguarding** of the environment and the ecosystem, and should **minimise damage** to the environment (Eisenbeiss, 2016:1). Environment and ecosystem **vulnerability** to **poor planning** and **climate change**, for instance, should be **identified, protected and monitored**. The UN 2030 SDGs require that different levels of government be provided with

opportunities to collaborate to ensure inclusive, secure, resilient, and sustainable **urban development**.

The analysis identified urban planning, land management, land use and zoning as fundamental principles and concepts for disaster resilience and sustainable development. Sharifi and Yamagata (2016:1654) agreed that it is essential to integrate resilience thinking into urban planning and design to achieve sustainable development.

The City Resilience Action Planning tool (UN-Habitat, 2018:8) included **Urban Planning** and Environment aspects related to planning and design of the urban space, the quality of the natural environment (air, water, soil), public/green spaces and climate change. The UNDRR's Fourth Essential requires cities to pursue resilient **urban development** by assessing the **built environment** (UNDDR, 2017:18). The City Resilience Profiling Tool's Principles on City Identification requires the city to explore the **city's development** narrative through its historical background and its spatial context, specifically in the aspects of climate, ecosystems, urban areas and physical assets (UN-Habitat, 2017:30).

Climate-smart urban planning and design of the CoT's CAP (CoT, 2021:12) required the city to "promote climate-smart **spatial planning and development, land-use management, growth and development** control, as well as innovative designs for climate-resilient urban spaces". The programmes identified for this outcome are generally related to climate-smart **spatial planning** for climate-resilient growth and development, innovative **urban and township design and development**, ensuring climate-smart urban areas by developing/amending/enforcing the regulation, and monitoring implementation. CoT's Vision 2030's Strategic Pillar 2: Creating a caring environment and promote inclusivity, through **upgrading** informal settlements by mainstreaming basic services to informal settlements (CoT, 2018:21). Goal 1 of Vision 2055 (CoT, 2012:4) strives to have a resilient and resource-efficient city that provides for **sustainable land use** that supports the city's development and growth.

During the one-on-one interviews, it was also determined that urban planning is essential for the city's disaster resilience framework. Respondent 2, for instance, said "it is important to consider spatial development and the types of development as part of the city's framework. However, more importantly, is to ensure that we [Emergency Services] are included from the inception phase of development in the city".

Land-use planning has a direct link with the previous theme of Governance and Legislation. A disaster-resilient city that wants to achieve the SDGs must have elements of effective **land use planning**; and enforcement of **planning regulations** in place (cf. 3.6). Therefore, there is an increasing need to integrate DRR into development, not only for resilience but for sustainability. This integration requires measures to analyse the progress of performance, programs and strategies and to monitor implementation (Bendimerad, 2003:28).

Keywords that emerged from these two categories were urban development, urban planning, land management, safeguard, protect the environment and the ecosystem.

6.3.4 Theme – Environment and Ecosystem Management

In the preamble to the 2030 Agenda, world leaders affirmed that they are determined to protect the planet from degradation. This would be achieved through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change so that the planet can support the needs of present and future generations. Sustainable development aims to manage the environment and natural resources and is linked by complex relationships and disturbances (Kates *et al.*, 2001:641; Gunderson & Holling, 2002:47). Reduced exposure and fragility indicated by **environmental** stewardship; appropriate infrastructure; effective land-use planning; and enforcement of planning regulations are considered essential for this theme (Rockefeller & Arup, 2014:8). The sustainability of a system must represent an optimal balance between economy, society and the environment (cf. 3.4). The NDP 2030 also took the approach of providing for a clean environment in defining a decent standard of living (National Planning Commission, 2012:34).

The management and protection of the environment and ecosystem were clear in all the documents that were analysed and therefore considered essential for the framework. CoT Vision 2030's IDP Strategic Pillar 3 commits to protecting the natural **environment** and to create sustainable agriculture initiatives in the city (CoT, 2018:56). The CAP provided for one entire outcome (outcome 6) on the protection of natural resources and to provide climate-resilient ecological infrastructure and protected natural resources (cf. 5.3.4.6). This plan also incorporated the protection of the environment in other themes and outcomes such as Outcome 9 that requires the city to manage natural resources effectively and to reduce the impact on the

environment (cf. 5.3.4.9). The DR&VA report found that in CoT, pervasive water pollution in the city impacts aquatic life and biodiversity below water. The report also indicated pervasive littering and illegal dumping, frequent veld fires, urbanisation and population growth are putting strain on the city's environment (cf. 5.3.5).

The frameworks also provided cities with tools to incorporate environmental and ecosystem protection in their planning strategies. The City Resilience Profiling tool's priority four (Urban Elements) included all elements of **ecology** protection (UN-Habitat, 2017:30). The City Resilience Index considered infrastructure and **environment** as an essential dimension of urban resilience (Rockefeller & Arup, 2014:9). SDGs 13, 14 and 15 also set out goals associated with the protection of the environment as part of the 2030 SDGs.

As alluded to, this theme is interconnected with the previous theme of urban planning. It is concluded that poor urban planning will have a direct impact on the environment and ecosystem. For instance, urban growth, when not considering the environment, may result in damage to the environment (cf. 5.2.1.5). Therefore, understanding and protecting the environmental profile of CoT is considered an important theme for the city's disaster-resilience framework and strategy as resilience contributes to achieving economic, social and **environmental** targets.

This theme further depends on the first theme of Governance and Legislation. Vision 2055 recognised the importance of governance and indicated that "governance serves to secure an amendable environment for implementation plans" (CoT, 2012:253). Sendai Framework Priority 2 – Strengthening disaster risk governance to manage disaster risk (UNDRR, 2015:17) included, "implement DRR strategies and plan with target indicators and time frames, to prevent the creation of risk, reduce existing risk and strengthen the economic, social, health and **environmental resilience**" as one of the DRR measures.

This theme, therefore, included variables such as environmental planning, resources and management. The resiliency of an ecosystem, and thereby its sustainability, can be reasonably measured at junctures or events where the combination of naturally occurring regenerative forces (solar energy, water, soil, atmosphere, vegetation and biomass) interact with the energy released into the ecosystem from disturbances.

6.3.5 Theme – Institutional Capacity

The study identified that understanding a city's institutional background regarding risk reduction, building resilience and sustainable development can help detect current gaps in local **capacity** to coordinate and act towards prevention, mitigation, response and recovery in the case of disasters, as well as identifying the best and most effective approaches to strengthen relevant institutions to achieve the SDGs (UNDDR, 2015:34; Schofield & Twigg, 2016:5). The SDGs require individuals and organisations across society to acquire new **capacities** to integrate all dimensions of sustainable development in their work, partner across sectors, and monitor, evaluate and report on efforts in line with SDG targets and indicators. The Hyogo Framework of Action (UNISDR, 2005:4) defines disaster resilience as “the **capacity** of a system (in this instance the city), community or society potentially exposed to hazards to adapt by resisting or changing in order to reach and maintain an acceptable level of functioning and structure”. Blaikie *et al.* (2003:3) see disasters as unnatural events that are produced and intensified by the process of risk accumulation and, among others, limited **institutional capacity**.

The City Resilience Profiling tool aims to support local governments and relevant stakeholders to transform urban areas into safer and better places to live, as well as to improve their **capacity** to absorb and rebound quickly from all potential shocks or stresses, leading them towards sustainability (UN-Habitat, 2017:30). The UNDRR's sixth essential (UNDRR, 2015:34) requires cities to strengthen **institutional capacity** for resilience: “it is important to ensure that all institutions relevant to a city's resilience have the capabilities they need to discharge their roles”. The CityRAP tool refers to “the ability of the local government and communities, in terms of capacity, knowledge, processes and systems in place, to prevent, anticipate, respond to and recover rapidly from the impacts of natural or manmade threats in the city” (UN-Habitat, 2018:19).

Respondent 1 referred to an **institution's capacity** to be disaster-resilient and highlighted the inclusion of volunteers and reservists for additional capacity. Respondent 9 referred to “proper **utilisation** of **resources** and **capacity** for a multi-disciplinary approach is critical for a disaster-resilient and sustainable city”. Thus, when hazards and vulnerability are high, it will cause disaster but when capacity is present, it will decrease the impact of the disaster (cf. 3.2).

This theme is, therefore, essential to allow the city to identify all the strengths, attributes and resources available within the city to manage and reduce disaster risks and strengthen resilience (UNDRR, 2015:8). This theme also provides for the city to have measures in place which would ensure full capacity to adapt when there is a disturbance; and to respond where required. This theme therefore supports the establishment of integrated institutional capacity where departments within the city are dependent on the capacity of each department to recover from a disturbance.

This theme is also linked to Governance and Legislation in the sense that it is the responsibility of cities to have a governance system that ensures that there is capacity and sufficient capability to provide leadership (CoT, 2012:4). The key factors that form part of this theme are institutional structures, the city's resources, adequate skills and experience and community and private sector involvement that include taking community and sector capacity into account.

6.3.6 Theme – Social Capacity

Ensuring understanding and strengthening of societal capacity for resilience emerged as a theme for this study. Cultivating an environment for social connectedness promotes a culture of mutual help through recognition of the role of cultural heritage and education (UNDRR, 2014:34).

There is a need to better understand social resilience in a city (Hosseini *et al.*, 2016:48). Social vulnerability is the result of pre-disaster social factors that create a lack of capacity or capability to prepare for, respond to, and recover from emergencies. Social vulnerability includes people who are more likely to suffer disproportionately because of their existing social circumstances such as those associated with age, gender, race, medical illness, disability, literacy and social isolation (UNDRR, 2014:25). Based on the principles of equity, equality and fulfilment of human rights, the analysis in this theme allows for assessing population's access to their basic developmental rights - translated into access to basic social protection and social services (such as education, health, food and social care) whilst anticipating potential shocks and stresses in order to build their social resilience (UN-Habitat, 2017:42). Social protection referred to in SDG 1 - End poverty in all its forms everywhere, requires cities to build the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to extreme climate-related events and other

economic, social and environmental shocks and disasters. Additionally, SDG 10.4 calls for the adoption of policies, especially fiscal, wage and social protection policies, to progressively achieve greater equality.

The CityRAP tool encourages the city to have processes, mechanisms and activities in place that allow cities to become drivers of social capacity developers by, for instance, creating jobs, reducing social tensions and crime, increasing equality and inclusion and enhancing security and safety, among other aspects (UN-Habitat, 2018:9). The tool further places the responsibility on the city to capacitate the community through knowledge, processes and systems to prevent, anticipate, respond to and recover rapidly from impacts of threats. City Resilience Index requires that the city supports human relationships and identity through active community engagements, strong social networks and social integration, as well as to support livelihoods by providing access to skills training, business support and social welfare (cf. 3.7.2).

Society must have the capacity to adapt in the presence of disturbance. **Social vulnerability** is the result of a lack of capacity or capability to prepare for, respond to and recover from emergencies (cf. 3.2.2). It is therefore essential for the city, in terms of understanding its risk to disasters, to assess the vulnerability and capacity, exposure and possible effect on the community. The importance of this theme for the city is therefore to ensure its understanding of social capacity in the city and to provide for means to strengthen the social capacity for resilience, whilst providing for means to assist and support the capacity of the vulnerable to absorb and rebound quickly from all potential disturbances.

The UNDRR seventh essential requires a city to understand and strengthen its **social capacity** for resilience (UNDRR, 2015:13). The essence of this essential goes beyond understanding and strengthening; it also places the responsibility to cultivate an environment for **social connectedness** that promotes a culture of mutual assistance within the community through training the community in DRR, for example. It is, therefore, important for the city to capture the importance of being a sustainable city in its disaster resilience strategy; one that is capable of creating and maintaining **social capacity** for all in the city.

The social capacity theme interrelates with all the previous themes. For instance, the city should have plans (governance) and the capacity (institutional capacity) in place to provide for its community by means of financial support (financial capacity), training and education, proper land and housing (urban development) and environmentally safe areas (environment and ecosystem). Key areas in this theme identified are strengthened social capacity and providing for social inclusion and protection.

6.3.7 Theme – Critical Infrastructure

Several references were made to **infrastructure** capacity, infrastructure **protection** and **resilience** and the continuous provisioning of **basic services** in the documents, alongside the importance of **maintaining infrastructure** to provide **resilient basic services**. Keywords identified in the infrastructure category were infrastructure resilience, maintenance and contingency plans that, in a city, have a direct impact on the delivery of basic services. Therefore, keywords in the basic service category also included **continuity of basic services**, **safeguard** infrastructure and **institutional capacity**.

This theme identified critical infrastructure inventory, protection and maintenance plans as an essential indicator (critical infrastructure). Infrastructure appears as an explicit SDG (Goal 9) but also underpins seven other SDGs: Affordable and Clean Energy (Goal 6), Clean Water and Sanitation (Goal 7), Sustainable Cities (Goal 11), Good Health (Goal 3), Quality Education (Goal 4) and nature-based solutions Life Above Land (Goal 15) and Life Below Water (Goal 14) and provides the basis for Decent Work and Economic Growth (Goal 8). Essential services provided through infrastructure are critical for all three dimensions of sustainable development (economic, environmental and social).

It is now clear that in a city, one system depends on other systems to enable the city to provide services (Lewis & Petit, 2019:6). Disasters can disrupt services and cause networked infrastructure damages; therefore, the city system must have a resilient infrastructure to limit or reduce the effect of the disruption in the city. The disruption in networked infrastructure in a city, as a complex system, impacts the interdependencies of systems in the city (cf. 2.2.1).

Vision 2055's Outcome 3 is to provide quality infrastructure development that supports liveable communities. The outcome sets targets for the city to provide for a long-term

and coordinated approach to infrastructure investment and development (cf. 5.3.1). Vision 2030's IDP focused on catalysing and revitalising existing economies by addressing infrastructure inadequacies and enforcing building environment policies and bylaws (CoT, 2018:21). The CAP provided for a resilient infrastructure focusing on climate-proof infrastructure that will reduce climate impact on infrastructure. This plan specifically requires the development and implementation of a long-term infrastructure and asset maintenance programme (CoT, 2021:4).

The frameworks analysed also considered, as part of the resilience strategy, the maintenance and protection of the city's infrastructure as essential. The UNDRR's eighth essential requires the city to assess the capacity, adequacy and upgrading of critical infrastructure systems (UNDRR, 2015:34). The City Resilience Index included the responsibility to protect and maintain assets through the diversity of provision, redundancy, active management and maintenance in its framework (cf. 3.7.2). The CityRAP tool included the design and maintenance of infrastructure as it relates directly to the continuous provisioning of basic services (cf. 3.7.4).

The resilience of the city's infrastructure is linked to the themes identified above. The city must have policies, plans and services in place to ensure the infrastructure is maintained and cared for. The city must have the financial capacity to maintain or replace the infrastructure in the event of a disturbance. The urban development planning should be done in such a way as to ensure infrastructure is not exposed to hazard-prone areas.

Therefore, this is an important theme in the disaster resilience strategy, as it links resilience and sustainability (by providing for sustainable and resilient infrastructure) (cf. 3.4). Key factors associated with this theme are infrastructure resilience, maintenance, safeguard(ing) and protection.

6.3.8 Theme – Basic Service Delivery

SDG 11.1 requires local government to ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums. The International Organisation for Standardisation (ISO) 37101 categorially states that progress towards sustainable development through maintaining and improving city services is a core component of a resilient city (ISO, 2016:3). Matoso and Jobbins (2016:1) agree: "the delivery of basic health, education, clean water and sanitation services and social

protection (social safety nets to livelihood enhancing programs) is a critical component of strengthening resilience”. The basis of the systems thinking approach is to consider the relationship between systems (city departments) and the integration of these relationships to achieve the outcome or objective, in this instance **delivery of services** to the community (cf. 2.2.1).

Vision 2055's Outcome 5 is to be an African Capital City that promotes excellence and innovative governance solutions by being a responsive leadership that manages change and enhances service delivery. This outcome aims to provide access to basic services for the CoT community (CoT, 2012:76). The Vision 2030's IDP provides for a spatial development plan and service delivery commitment to the CoT community. The IDP also included a development plan to address service delivery inadequacies in the city and ensure that basic services are delivered. Specific reference in the IDP is made to the delivery of high-quality and sustainable basic services such as water, sanitation, electricity, housing and so forth and that resources should be protected in the city's bid to increase and improve service delivery (CoT, 2018:32). The DR&VA report summarises the **backlog** in providing access to **basic service** delivery in CoT, with specific reference to refuse disposal, electricity, housing, water and sanitation (cf. 5.2.1.4). The report identified that greater integration and cooperation are required between city departments in providing continuous basic services. The report further confirmed that the growing number of informal settlements as a result of rapid urbanisation and population growth in the city contributes to the city's inability to keep pace with the demand for **basic services**.

This theme of providing continuous basic services to the community was clear in CoT's DRMP. Under the Health and Medical cluster, the DRMP states that “this cluster assists communities in identifying and meeting the **public health** and **medical needs** of victims of disasters, including the assessment of public health and medical needs, the provision of personnel, public health surveillance, medical equipment and supplies” (CoT, 2007:64). The Service Delivery Departments are expected to, among others, ensure continuous **water supply** in the CoT; develop and maintain stormwater infrastructure and maintain maximum water discharge capacity (CoT, 2007:35). The DRMP provided specific objectives for the provisioning of basic services.

*“The planning cluster's objective is to ensure for **basic services** provision, for example, **water, sanitation, electricity, and public transport** continue to*

operate, including during emergencies and disasters. Planning in this regard includes contingency planning, procedures/systems in place to reinstate and/or replace critical systems when they fail.”

(CoT, 2007:61)

The CityRAP tool places the responsibility on the city to provide for resilient infrastructure and basic services by ensuring equal **access to basic services** to meet the vital needs of the urban population and to allow a city to function and develop properly. The CityRAP tool expressed the importance that the design and management of infrastructure and basic services are fully integrated into the concept of city resilience (UN-Habitat, 2018:9). A key function identified for cities in the City Resilience Index is to provide an adequate and dependable supply of essential services and **basic needs** to a city's whole population (cf. 3.7.2).

Respondents during the one-on-one interviews also referred to the necessity to provide basic services to the community and that, without continuous delivery of basic services, the city will not be resilient and will not be able to achieve the SDGs. Respondent 1's view on the delivery of basic services is “that the city must have more effective means of dealing with the shortage of water in the city. The water infrastructure is poor and we [CoT] cannot manage to resolve the issues”. Respondent 3 said, “we [CoT] still struggling to make sure that the people in Hammanskraal have clean water. This is affecting our people”. Respondent 2 said that “**maintenance of infrastructure** such as water, energy, electricity and transport system and spatial development is crucial” when asked about essential areas to include in a disaster resilience framework.

The first and foremost responsibility of a municipality is to provide basic services to its community. This theme adopted the ISO standard and included business continuity plans and disaster management plans to services such as municipal health, water and sanitation, waste management, energy, transport and communication as key factors. The focus of this theme is to ensure that the city has measures in place to continuously provide basic services by means of, for instance, redundancy of the systems and services, effective and efficient leadership and management, access to financial capacity to maintain and replace infrastructure for basic services, institutional capacity and equal access to basic services to all members of the community.

6.3.9 Theme – Law Enforcement

Bello *et al.*'s (2021:23) planning for DRR of the 2030 Agenda for Sustainable Development study identified law enforcement as essential measures to be included in a governance framework for resilience (cf. 3.6). The 2030 Agenda for Sustainable Development explicitly affirms that there can be no sustainable development without peace and no peace without sustainable development. It draws together the strands of peace, the rule of law, human rights, development and equality into a comprehensive and forward-looking framework. Through the adoption of the 2030 Sustainable Development Agenda, the UN recognised the importance of justice and the rule of law within the wider social sustainable development framework. To provide for personal safety, security from natural and man-made hazards, secure resource access, order, law and stability are all elements identified as the purpose of an urban system (cf.2.2.1).

Law enforcement as a theme also emerged in the UNDRR's 10 essentials. Strengthening disaster risk governance to manage disaster risk (UNDRR, 2015:17) requires the integration of DRR in local frameworks of laws, regulations and public policies, in addition to formulating public policies aimed at addressing the issues of prevention or relocation of human settlements in disaster risk-prone zones, subject to **national law and legal systems**.

Vision 2055 is also committed to providing for an equitable city that supports happiness, social cohesion, **safety** and healthy citizens in its Outcome 4. Vision 2030's IDP included that attention will be given to the enforcement of building environment policies and bylaws to ensure a safe city. Strategic Pillar 4 specifically addresses means of keeping the city's residents safe. The city must focus on utilising the metro police and law enforcement to increase visible policing in strategic areas, addressing the metro police's ability to respond to a variety of challenges, prioritising initiatives to deal with drug abuse and protecting residents effectively from disasters (cf. 5.3.2.4). The CAP's contribution to law enforcement was found to be more toward the enforcement of policies and bylaws as it relates to green buildings (cf. 5.3.4.5).

The City Resilience Index identified the enforcement of the rule of law, justice and equity as a key function for cities. This includes law enforcement, crime prevention,

justice and emergency management (cf. 3.7.2). Respondent 1 indicated that, in the response to the need for a disaster resilience framework:

“Compliance and implementation of the DRR and SDGs have to be enforced through internal law enforcement. It is well and good for every department to have plans and for the city to have an overall plan, but how compliant are the different structures in the city to these plans? There must be measures to enforce the compliance these plans.”

Having strategies and practices are therefore of paramount importance to embrace the 2030 SDGs. Therefore, the role of law enforcement is to ensure compliance to policies and programmes were identified as key factors for this theme.

6.3.10 Theme – Disaster Risk Management

The category that was identified last, disaster risk management, is considered the most important category for **DRR** and **disaster resilience**. This is due to the fact that it provided keywords that should assist the city to **identify** and **understand** the hazards and risks in a city, to **reduce** the exposure and vulnerability through **awareness** and **education**, provide for **preparedness** to **respond**, to **recover** and **Build Back Better** should there be a disaster.

Disaster risk management involves actions to both reduce disaster risk and to manage the remaining residual risk, to strengthen long-term disaster resilience and secure sustained progress towards the achievement of a country’s sustainable development. As is made evident by the 2030 Agenda, disaster risk influences several different dimensions of development. Targets included in nine of the 17 SDGs of the 2030 Agenda are directly related to disaster risk management, and many of the other targets allude to the importance of disaster management as a pivotal element in development (Bello et al., 2021:22). SDG 11b states that:

“By 2030 the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusions, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for DRR 2015-2030, holistic disaster management at all levels.”

(UN, 2015)

The Sendai Framework priorities on DRR focus on disaster risk management and provide for measures for disaster **preparedness** (understanding risk, risk assessments,) risk **management** (risk governance), **mitigations** (investing in DRR), **response** (disaster preparedness for effective response), **recover** (recovery, rehabilitation and reconstruction) **monitor** and **evaluate** (through regular preparedness, response and recovery exercises) (cf. 3.2.4.2). The goal of disaster management in a city is the long-term survival of city systems as the impact of a disaster has the possibility of impacting the city's ability to provide services to the community. Disaster risk management involves multiple interdependent systems and processes for preparedness, response, recovery and mitigation, aiming to reduce the negative impacts and consequences of the disruption on the city and the community (cf. 2.8).

Although Vision 2055 focused more on **disaster preparedness** towards climate change, the plan does require city departments to focus on **disaster management** and safety interventions as part of the urban design (Outcome 4 – An equitable City that supports happiness, social cohesion, safety, and healthy citizens) (cf. 5.3.1); as well as Vision 2030's IDP Strategic Pillar 4 of keeping residents safe by protecting them effectively from **disasters** by improving planning to **mitigate** against natural **disasters** and emergencies (cf. 5.3.2.4). The CAP's Outcome 1 on providing safe, healthy, prosperous and climate-resilience communities' goal is to promote the safety and the health of communities in the face of climate change and extreme climate events. The programme associated with this outcome requires the city to investigate and identify ways to reduce climate-related disaster risk (cf. 5.3.4.1). The objectives for the DR&VA that was conducted in CoT in 2019 were to **identify** known priority risks in the city to ensure that it is **prepared** for disasters that may occur and to **identify** and **analyse** vulnerabilities to allow departments to prioritise their vulnerability **reduction** planning (cf. 5.3.5). CoT's DRMP provides a broad framework in which disaster risk management planning must be implemented in the city and its structures. The DRMP includes KPAs of **disaster risk assessment**, **DRR**, **response** and **recovery** (cf. 5.5).

The four international disaster resilience frameworks recognised disaster management to be an essential element for a disaster-resilient city. The UNDRR Resilience Scorecard's 10 essentials identify priorities of disaster management. These priorities include, among others, having structures in place in the city to **identify** and

understand current risks in the city; identify mechanisms to **prevent** and **mitigate** the identified risk; to provide for effective disaster **response** and expedite **recovery** and **Build Back Better** (cf. 3.7.1). The City Resilience Index is developed to provide cities with the basis to conduct **assessments** on its current risks and to make investment decisions on urban **planning** in order to survive, no matter what shock or stress the city encounters (cf. 3.7.2). The City Resilience Profiling tool focuses on providing tools and knowledge to cities to **prepare, respond** and **recover** from all shocks and stresses that should lead the city to sustainability (cf. 3.7.3). The City Resilience Action planning tool is developed to assist cities in **reducing risks** and enhancing **adaptation** to promote sustainable development. The urban disaster risk management pillar of this tool is to assist the city by having capacity, knowledge, processes and systems in place, to **prevent, anticipate, respond** to and **recover** rapidly from an incident in the city (cf. 3.7.4).

During the one-on-one interviews, Respondent 4 also emphasised disaster management and said, “the city must have ways in **reducing** disaster in the city through **strategies** and ways dealing with disasters **pro-actively** through **disaster management** in the first instance”. Respondent 7 had a similar view and said: “I think disaster **planning** and **disaster risk assessments** are very important for a framework where you want to know the city’s level of disaster resilience”. The means of **identifying climate risk, economic risk, social risk** and **disaster risk** in a city were added by Respondent 8. Respondent 9 also referred to disaster **identification** and **response** measures as essential in measuring a city’s disaster resilience.

Integrated disaster risk management in a city (as a system) requires the multi-sectoral acceptance of the importance of all the elements of disaster risk management. This theme requires the city to develop strategies to address disaster pre-event planning, disaster preparedness, disaster mitigations, disaster response measures and plans to recover and rehabilitate as an essential chapter in the disaster resilience strategy. The indicators in this theme have also been informed by the disaster cycle, which is pre-disaster event planning, disaster preparedness, hazard assessment, disaster mitigation, response, recovery and rehabilitation.

Through the document analysis of the CoT’s strategic documents and the four international frameworks, 10 indicators for a city disaster resilience and sustainable development framework have been identified. The next section will discuss the findings

of the case study based on the response from respondents during the one-on-one interviews.

6.4 FINDINGS AND DISCUSSIONS ON THE ONE-ON-ONE INTERVIEWS

The analysis of the one-on-one interviews found references made to various themes applicable to the study. Some of the themes that emerged from the one-on-one interviews were discussed above, as they were relevant to the discussion. This section will provide a discussion on further findings made from the interviews.

6.4.1 Prospect of City of Tshwane achieving the Sustainable Development Goals

Even though the city does not have a *single* comprehensive disaster resilience and sustainable development strategy (it has five separate documents Vision 2055; Vision 2030 IDP, CAP, DR&VA report and the DRMP), there is an indication that the CoT is in a position to be disaster-resilient and achieve the SDGs if strategies are implemented. The latter statement is supported by a response received from Respondent 5, when asked if the city will achieve the SDGs and if the Sendai Framework priorities are being implemented in the city. Respondent 5 agreed that the CoT can be resilient and achieve the SDGs: “but we [CoT] have to make sure that the city **prioritises** those goals where there is not full compliance such as **poverty eradication**. It is also possible if **sufficient budget** is allocated to DRR and sustainable development”. The South Africa 2019 Voluntary National Review conducted on South Africa’s implementation of the 2030 Agenda for SDG (UNDESA, 2021:12) states:

*“One of the main challenges for the implementation of the SDGs, is the lack of provisioning and mobilising of new and additional, adequate and predictable **financial resources**. This has not been catered for within the UN system and must be a priority as part of the commitments made in the context of the global partnership for development.”*

In addition, Respondent 7 said:

*“I have a strong belief that the city will be able to achieve these goals [SDGs] because the City has **different departments** dealing with most of the goals. We have a department responsible for **clean water** and **sanitation**. Also, a*

*department dealing with **gender equality**. So, I can easily say the city will be able to achieve the goals.”*

On the implementation of the Sendai Framework, respondent 7 said:

*“In ESD we have the **Disaster Management** which is dealing with the four indicators. The Municipal Disaster Advisory Forum is one of the **governance structures** established in the CoT. Disaster Management in the City is responsible for **DRR** and also the **response** and **recovery**.”*

Respondent 9 agreed that the CoT has the potential to be disaster-resilient and to achieve the SDGs and added:

*“You cannot talk of a resilient city where there is poverty and hunger. However, you as a city must make sure that you have **implementation plans** and that key **departments work together** to achieve these goals. A very strong **governance system** therefore needed.”*

A research study conducted with 50 cities participating in the UNDRR Making Cities Resilient program reported that the institutionalisation of DRR and disaster management is most effective where specific people or departments within local government are made legally responsible for implementation and coordination among all relevant departments or sectors (UNDRR, 2014:35). However, not all respondents agreed that the city will be disaster-resilient or be able to achieve the SDGs. According to Respondent 1, the city does not have enough contingency plans in place to be resilient. Reference was made to COVID-19 as an example: “If you look at the COVID-19 as an example. The city was certainly not ready for it despite our business continuity plans and processes. We [CoT] did not have sufficient Personal Protective Equipment”. Being in the Emergency Medical Operations in the CoT, the respondent used this division as an example of not being resilient. This respondent further elaborated, “it is difficult to sustain to provide continuous medical operations in the midst of a pandemic. Your staff would get exposed and so many are out of service. So, we are definitely not resilient”. The respondent also referred to the water infrastructure in the CoT, stating:

“If you look at the problems the City is having with the water infrastructure and the supply of water. We [CoT] have a long way just to correct that [supply of water] before we [CoT] can be resilient or sustainable for the future.”

Respondent 8 also supports the view of the other respondents - that the City is not ready to achieve the SDGs. The respondent said “we [CoT] only currently starting with localising the SDGs. We are running a very real risk of not attaining any of the SDGs by 2030. We [CoT] might be able to achieve these goals closer to 2055”.

Respondent 3 also referred the researcher to the water challenges in Hammanskraal. The respondent said, “we [CoT] are still struggling to make that the people in Hammanskraal they have the clear water.” The respondent referred to the unemployment of youth as a reason for CoT not being a disaster-resilient city. Respondent 4 stated: “I can say there is an appetite for achieving the goals. But whether the City is fully capacitated to reach the goals and be resilient is something to leave much to be desired”.

However, Respondent 2 did not agree, nor did the respondent disagree with the city’s ability to be disaster-resilient and to achieve the SDGs. The response was “I can say partially, I can’t say fully achieve. Maybe owing to the recent socio-economic impact of this COVID-19. It may take time for the City to recover.” This respondent does agree that the city’s Disaster Management Centre is already implementing the four Sendai Framework indicators. Respondent 10’s response was that the city has many departments which all function in silos:

“At my level, it is hard to answer this question, as we currently do not have an integrated information and communication system that shares individual department’s targets, goals and actuals. The 17 goals cut across all departments’ mission statements but feedback on achievement status is unknown to some of us.”

Most of the respondents believe that the CoT can achieve the SDGs and implement the Sendai Framework priorities. The CoT’s organisational structure consists of operational departments where the SDGs and the Sendai Framework priorities form part of their operational activities. For instance, the Department of Water and Sanitation is responsible for providing clean water in the city. These operational departments have business continuity plans and should be able to implement those plans should a disturbance occur. However, other respondents disagree and are of the view that the city’s departments do not have sufficient contingency plans, resources and the capacity to achieve the SDGs or to implement the Sendai Framework priorities.

As seen in the study, cities consist of physical, social and economic systems that are interconnected. Cities are adaptive, socio-technical systems comprising of various elements, which combined have qualities that may not be present individually (cf. 2.2). Cities, therefore, do not function in isolation but are organised in areas characterised by strong interdependencies, interconnections and interactions (Meadows, 2008:12).

The responses obtained during the interviews on especially question 4 and 5 that is relating to the 17 SGD's highlight that there is a lack of awareness and communication of these goals. Even though reference was made to some of the goals, none of the respondents was able to refer to all 17 goals. Respondent 1 said, "I have heard of them. I am aware of some of them but not in much detail unless it is related to my department". Respondent 3 also said, "I have heard about it but do not know all of them".

The same was found regarding knowledge about the Sendai Framework priorities. Only three respondents (2, 8 and 9) were able to refer to the four priorities. When asked about the Sendai Framework, Respondent 3 said, "To be honest with you, I did not go into detail about them".

CoT consists of various departments (such as Water and Sanitation, Energy and Electricity, Community and Social Development and so forth) that are all, knowingly or unknowingly, already addressing the 2030 SDGs in their daily operations in providing basic services delivery. The DR&VA report identified that the city, as part of its responsibility in providing services to the community, already addresses the 2030 SDGs. The assessment report also revealed current gaps in achieving the 2030 SDGs (cf. 5.3.5) of which one gap identified is the integration of disaster risk management in cities' operations. The disaster resilience framework aims to address these gaps identified and to provide a tool that will allow the city to integrate resilience and SDGs into the city systems and operations through the disaster resilience strategy. A holistic approach to the city disaster resilience strategy is therefore required.

6.4.2 Measuring disaster resilience

Even though the study did not focus on measuring the CoT's level of disaster resilience, it was found to be an omission in the CoT's strategic planning. Vision 2055 described how the outcomes will be implemented and monitored (CoT, 2012:120). It states, "the implementation of the strategy will be monitored regularly and it is our

commitment that we will report back on an annual basis”. The document, however, did not provide any measurable indicators to implement and measure compliance to the strategy. The CoT document that was found to provide evidence of measuring and reporting compliance to its action indicators was the CAP.

The UNDRR’s Disaster Resilience Scorecard for cities was developed to enable cities in establishing a baseline to measure their current level of disaster resilience. Each essential identifies priorities and actions to track progress in improving the cities’ disaster resilience over time (UNDRR, 2015:67). The City Resilience Index was developed to enable cities to carry out an objective assessment of their resilience and measure progress against an initial baseline (Rockefeller & Arup, 2014:8). The CityRAP tool developed a self-assessment tool for the city to determine the current status of its resilience (cf. 3.7.4). The City Resilience Profiling tool uses data sets to obtain useful information regarding the city’s profile and then generate existing gaps in the city’s disaster resilience (cf. 3.7.3). Strategic measures for monitoring and reporting progress made towards resilience are therefore essential (Marzi *et al.*, 2019:3).

Different views were given on the question of measuring disaster resilience. Respondents 4, 5, 7 and 8 agreed that a city’s disaster resilience and sustainable development can be measured. Respondent 5, for instance, said: “yes, you know it will be difficult but there is a possibility of measuring it [disaster resilience and sustainable development]”. Respondent 7 said:

“Yes, I do believe that it [disaster resilience and sustainable development] can be measured and it is already done. For example, doing risk assessments will show the level of resilience. Or if a department measures its response to disasters is a reflection of the city’s ability to be resilient.”

Respondent 8 strongly felt that disaster resilience and compliance to sustainable development can be measured: “yes, most definitely it can be measured. I am referring to the Rockefeller foundation framework developed to measure a city’s resilience and sustainability”. Respondent 9 also agreed and said: “yes, I think it can be measured. I might not have the knowledge of appropriate tools, but it should be possible for us to have the basic measuring tools”. Sharifi (2016:629) agrees that cities should be provided with means of determining their level of resilience; they should also be prepared to continue providing essential services should a disaster incident occur.

However, some respondents (1 & 3) stated that it is not possible to measure a city's resilience to disasters. Respondent 1 said:

"I think it is difficult to measure resilience because you need to have a disaster to see how you respond and recover, to see how successful your plans were. I think it is easier to possibly measure how sustainable your plans are that you've put in place. You can only measure how long it took to recover once there was a disaster."

Respondent 3 agreed and said, "we cannot measure, because we don't know what is going to strike tomorrow". The two responses have merit; however, disaster resilience can be measured (Flax *et al.*, 2016:2). Each city's approach to building resilience looks a bit different, but common among them is a need for resilience measurement all along the journey. This research study aims to develop a city disaster resilience framework as a disaster resilience planning strategy by introducing a coalescence of sustainable development and DRR for the CoT. Yet, Respondent 2 was undecided in the response: "I can say no and yes. I am in between. To an extent you can measure it. Assessing the preparedness on how to cope with the threatening or impeding disaster may be difficult". The respondent is of the view that "it is very difficult to say you are resilient because disasters are dynamic and not static".

In summary, this section provided for a possible new theme that emerged from the one-on-one interviews on (i) the prospect of CoT achieving the SDGs and (ii) measuring disaster resilience. Even though the study is not to measure CoT's disaster resilience, SDG 11 requires that cities should be facilitated to determine their **level** of resilience. The city must have strategic measures for **monitoring and reporting** progress made in DRR; thus, enhancing resilience is a core element of disaster risk management and sustainable development (Bello *et al.*, 2021:49).

Although CoT has no disaster resilience strategy, is it evident that the CoT's current approach to DRR and the SDGs are encapsulated in different CoT documents. City departments might not be aware that their current operations are already contributing to the city's disaster resilience strategy or that they are in the process of achieving the 2030 SDGs. The different strategic documents are an indication that the city departments' approaches to disaster resilience are not consolidated, as each strategy has different outcomes and objectives to be a safe city.

6.5 CONCLUSION

The purpose of this chapter was to present and discuss the findings from analysed data that was gathered during this research study. The chapter presented an analysis of CoT disaster resilience and sustainable development strategic documents where the number of references associated with the SDG's and the Sendai Framework priorities were used in the content analysis. Reference to the latter in each strategic document were highlighted that assisted the researcher in identifying possible themes from the documents.

The chapter then provided for an analysis of the four international disaster resilient frameworks, the SDG's and the Sendai Framework to again identify possible themes. The analysis of the CoT strategic documents, the four international disaster resilience frameworks, the SDG's and the Sendai Framework resulted in themes for high leverage areas were identified for a city disaster resilience and sustainable development framework.

The chapter concluded with the findings and discussion on the one-on-one interviews with the respondents. Key words associated with disaster resilience, sustainable development and measuring of the city's disaster resilience has been highlighted.

The next chapter therefore presents the design of the CoT disaster resilience framework.

CHAPTER SEVEN: A SYNTHESIS: COALESCENCE OF SDGS AND DISASTER RESILIENCE IN THE CITY OF TSHWANE – A DISASTER RESILIENCE PLANNING STRATEGY FRAMEWORK

7.1 INTRODUCTION

This chapter synthesises the study and will address the research question and research objectives of the study. The research aim will be addressed employing an explanation and analysis of the literature described in the previous chapters, together with a reflection on the findings presented in Chapter Six. Theoretical statements will also be used to justify the explanation and analysis through cross-referencing of the data in Chapter Six and the literature study in the preceding chapters. The chapter will conclude with a disaster resilience planning strategy framework designed for the CoT, highlighting its purpose, and indicating the DRR measures and the SDGs that should be included in the framework after the findings of this research study. The design of the disaster resilience planning strategy framework is discussed based on a graphic representation.

7.2 A DISASTER RESILIENCE PLANNING STRATEGY FRAMEWORK FOR THE CITY OF TSHWANE THAT INCLUDES SUSTAINABLE DEVELOPMENT GOALS AND DISASTER RISK REDUCTION MEASURES

In order to address the research questions, this section will provide theoretical statements to synthesise the insights gained through this study to attain the research aim and objectives. The theoretical statements represent justification of the claims that should be made from the CoT case in this research study. The key research question and the secondary questions are addressed in this section.

7.2.1 Key research question: How can the coalescence of the Sustainable Development Goals and disaster risk reduction form part of the City of Tshwane's disaster resilience planning strategy?

Theoretical statement: *"There has been increasing recognition of the need to integrate DRR into development for the reason of not only resilience but also sustainability. This integration requires measures to analyse the progress of performance, programmes and strategies and to monitor implementation"* (Bendimerad, 2003:28). The key research question and the theoretical statement are addressed by means of an

explanation and analysis of the case study through several secondary questions, as discussed below.

7.2.1.1 What disaster risk reduction measures and Sustainable Development Goals form part of City of Tshwane's disaster resilience strategy?

The first secondary question is addressed in this section utilising an explanation and analysis of CoT, and a general discussion. The findings from CoT case study analysis revealed that the DRR measures and SDGs do form part of the different CoT's planning strategies. All 17 SDGs are found in CoT's five planning strategy documents (cf. 6.2). The case study research revealed that CoT also incorporated the Sendai Framework's DRR measures into its planning strategy (cf. 6.2). The findings show that different CoT planning strategy documents consist of measures to achieve disaster resilience and the SDGs.

It was, however, found that the city does not have a specific disaster management model that could provide for a consolidated strategy to address disaster resilience (cf. 3.2.4.1) and to achieve the 2030 SDGs (cf. 3.5). The consequence of not having a consolidated strategy was evident during the one-on-one interviews. The CoT, maybe unbeknownst to CoT's strategic management, have segmented measures in place to achieve the 2030 SDGs and to be a disaster-resilient city. There is, however, a need to have one consolidated disaster resilience planning strategy that is a combination of strategic activities required to implement DRR measures and to achieve the 2030 SDGs. The framework presented in this chapter aims to assist CoT to ensure that the **DRR measures and SDGs** feature in its disaster resilience planning strategy.

7.2.2 How are the disaster risk reduction measures and the Sustainable Development Goals applied in City of Tshwane?

The CoT case study and the one-on-one interviews with CoT respondents addressed the second secondary question and revealed that the long-term sustainability strategy, Vision 2055, translated into six broad outcomes (cf. 5.3.1) that apply all 17 SDGs and the disaster resilience measures. However, since the new political leadership took over CoT in 2016, no reference is made to Vision 2055 as part of management's planning strategy. Vision 2055, therefore, is no longer considered applicable in CoT which is unfortunate as the vision encapsulates strategies that will assist the city in implementing disaster resilience measures and achieving the 2030 SDGs.

The IDP that was formulated to achieve Vision 2030, is a strategic document describing the city's commitment towards service delivery (cf. 5.3.2). Although reference is made to all 17 SDGs and DRR measures, the focus is more directed towards economic growth, job creation and service delivery. The IDP provides strategic guidelines to achieve key deliverables which form the basis of the Service Delivery and Budget Implementation Plan - also known as the scorecard. The scorecard consists of key performance indicators with annual and quarterly targets to be achieved by identified departments. It was found in the case study that the scorecard is limited in not addressing the 17 SDGs and disaster resilience measures. The scorecard's focus is more directed at addressing access to basic services (cf. 5.2.1.4) such as water, waste removal, electricity, sanitation, stormwater drainage, roads and transport, income-earning opportunities, investments, social services, emergency and law enforcement response times. The scorecard also sets financial targets regarding expenditure and revenue. In comparing the Service Delivery and Budget Implementation Plan scorecard with the 17 SDGs and the DRR measures, it is evident that a gap exists in implementing all the SDGs and implementing the DRR measures.

The CAP (CoT, 2021) addresses all the Sendai Framework priorities and all 17 SDGs. Within the plan is a monitoring and evaluation framework, with timelines and management processes for mainstreaming, monitoring and implementation of the plan by all departments (cf. 5.3.3). The elements of the monitoring and evaluation framework were adopted for the disaster resilience framework for CoT.

In addition, the CoT's comprehensive DR&VA report identified known priority risks, identified and analysed city vulnerabilities and identified high-risk areas in the city. The DR&VA also provided a comprehensive implementation plan and recommended risk reduction strategies and measures per municipal department as they relate to sustainable local development (cf. 5.4). Although the report referred to all SDGs and the elements of DRR measures, it does not provide measurable indicators to implement the goals of the DRR measures (cf. 6.2). As with the CAP, the DR&VA is not linked to any performance expectation plan and might result in senior managers again considering these proposed risk reduction strategies as non-essential.

The CoT's DRMP was one of the documents that made the least reference to the SDGs (cf. 6.2). The DRMP seeks to achieve the integration of disaster management functions into the strategic and operational planning and project implementation of all line

functions and role players within the municipality against assessed disaster risks. It further seeks to promote the integration of fast, efficient and effective responses to disasters (actual or impending) by all role players. This plan establishes operational procedures for DRR planning as well as emergency planning procedures to be implemented in the event of a disaster (cf. 5.5). The plan adopted the four elements of the disaster management cycle: prepare, mitigate, respond, and recover (cf. 3.2.4.1) derived from the four KPAs (cf. 5.5.1 – 5.5.4) and the three enablers (cf. 5.5.5 – 5.5.7) described in the Disaster Management Act. The implementation of the DRMP in the CoT is, unfortunately, limited to CoT's Emergency Services and not incorporated in the city departments' strategic plans. This finding reiterates the need to have a CoT disaster resilience planning strategy that incorporates DRR measures and the SDGs in all departments.

7.2.3 How can a city disaster resilience framework complement the existing disaster risk reduction measures and Sustainable Development Goals that are applied in City of Tshwane?

Theoretical statement: *“DRR efforts are multi-sectoral efforts within a city and must be incorporated into ongoing development programs to ensure the city's resilience to disasters and sustainable development”* (Benson & Twigg, 2009:23).

The study revealed that, even though CoT has various strategic documents addressing disaster resilience and measures for implementing the 2030 SDGs, no consolidated and comprehensive strategy for the city's disaster resilience and achievement of the SDGs is available. It will, therefore, be difficult for CoT to determine its level of disaster resilience. It will also not be possible to determine the achievement of the 2030 SDGs. Having a framework for implementing DRR measures and the SDGs can provide the CoT with practical guidance on actions needed for its disaster resilience planning strategy (cf. 6.2.1 – 6.2.4). A disaster resilience framework intends to guide cities toward optimal resilience and to eliminate complacency whilst reminding authorities and stakeholders that there is always more to be done to ensure lasting resilience (cf. 6.2.1). A disaster resilience framework can assist a city to determine its resilience and develop actions for resilience through the implementation of DRR measures and the SDGs (cf. 6.2.3). Apart from developing actions to implement DRR and the SDGs, a disaster resilience framework can assist the city in developing a comprehensive

strategic plan to provide a broad picture of what must be achieved (cf. 3.2.4.1), as well as enable CoT and its departments to monitor and consider the implementation of identified measures to enable it to become a disaster-resilient city (cf. 3.5, 3.6).

7.2.4 What indicators of the city disaster resilience framework can be identified in City of Tshwane to determine its disaster resilience?

The definition of disaster resilience is the ability of a system exposed to hazards to resist, absorb and recover from the effects of a hazard (cf. 3.3.1). Risk identification through risk assessments must be done to determine the hazard a system is exposed to (cf. 3.3.1, cf. 6.2.1). Once the risk is identified, risk reduction measures should be put in place to reduce the risk (cf. 6.2.1, 6.2.2., 6.2.3, 6.2.4). The indicators of city disaster resilience that were identified for CoT (which emerged in the findings of this research study) are highlighted below.

For the successful implementation of risk reduction measures, the system must ensure organisational buy-in (**governance**) with strong leadership and commitment through stakeholder engagement (**leadership**), awareness and education (**capacity**), risk identification and risk mapping (**disaster risk management**) to identify vulnerable infrastructure (**basic services delivery infrastructure**) and vulnerable areas (**social vulnerability**) (cf. 6.2.3, 6.2.4). The system must confirm its resource **capacity** and identify resources needed (**assets, finances**) to implement risk reduction measures (**investments, planning, policies, law enforcement**) (cf. 6.2.1), to safeguard current resources (**infrastructure, environment, assets**) and provide the ability to respond to (**capacity, disaster risk management**) (cf. 6.2.4) and recover from a disaster, whilst Build(ing) Back Better (**financial capacity, contingency planning**) (cf. 6.2.1).

7.2.5 Discussion of what a City of Tshwane disaster resilience framework should look like to assist the city to incorporate disaster risk reduction measures and the Sustainable Development Goals in its disaster resilience planning strategy.

Theoretical statement: *“There has been increasing recognition of the need to integrate DRR into development for the reason of not only resilience but also sustainability. This integration requires measures to analyse the progress of performance, programmes and strategies and to monitor implementation”* (Bendimerad, 2003:28).

This research study identified indicators that should be incorporated in the envisaged city disaster-resilience framework that will allow CoT to determine its disaster resilience and the achievement of the 2030 SDGs. The research study revealed 10 indicators with variables that support the city in determining its disaster resilience and achievement of the SDGs:

1. **Governance and Legislation** - that emphasise legislation, city management, leadership and commitment (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
2. **Financial Capacity** - to provide for disaster resilience and sustainable development in the city (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
3. **Urban Development** - to ensure that urban planning and land management are considered essential in the city's development strategy (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
4. **Environment and Eco-system Management** - to ensure that the city can identify its environmental resources and have measures in place to protect those resources (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
5. **Institutional Capacity** - which will allow CoT to identify and maintain all available resources, including the current skills/ lack thereof, to achieve disaster resilience and to implement the 2030 SDGs (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
6. **Critical Infrastructure** - considered as an indicator to provide CoT with a tool to identify its critical infrastructure and to have measures in place to protect that infrastructure considered critical (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
7. **Social Infrastructure** - considered as an indicator to allow CoT the opportunity to not only promote social inclusion and protection but also to capacitate the community to be self-resilient (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
8. **Basic Service Delivery** - allow CoT to have measures in place to ensure continuous delivery of basic services, should there be a disruption of any kind (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).
9. **Law Enforcement** - essential to ensure that sufficient measures are put in place to enforce the city's legislation on disaster resilience and sustainable development (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).

10. Disaster Risk Management - if implemented correctly, will provide the CoT with a measurable indication of its readiness to prevent, mitigate, respond to and recover from any emergency incident (cf. 6.2.1, 6.2.2, 6.2.3, 6.2.4).

The CoT's disaster resilience framework (with its 10 indicators) is presented in the next section. The framework consists of 10 indicators with guidelines that assist CoT in its endeavour to be a disaster-resilient city. Even though the framework does not provide for measuring CoT's level of resilience, the framework provides a good indication of the city's ability to be disaster-resilient and to achieve the SDGs.

7.3 KEY INDICATORS FOR A CITY DISASTER RESILIENCE FRAMEWORK FOR CITY OF TSHWANE

In order to facilitate the implementation of the 10 indicators in the disaster resilience framework, the researcher has developed a city disaster resilience framework for CoT (Figure 7.1) that takes into account the priorities of the key factors as well as the order in which the different indicators should occur on a linear timeline. The framework indicates the logical sequence and linkage of activities that need to be followed so that a disaster resilience strategy can be developed. The figure is a snapshot of all 10 indicators with a reflection of how Sendai Framework priorities and the 17 SDGs were incorporated in the framework. Where an indicator or key factor is aligned to a Sendai priority or SDG, such Sendai priority or SDG is illustrated with a symbol  or

 SD

Each indicator and success factor will be discussed in detail.

It should be noted that many of the success factors of each of the indicators are interrelated and interdependent of each other. Figure 7.1 also aims to illustrate the relationship between all indicators and success factors in a complex adaptive system, as described in Chapter Two.

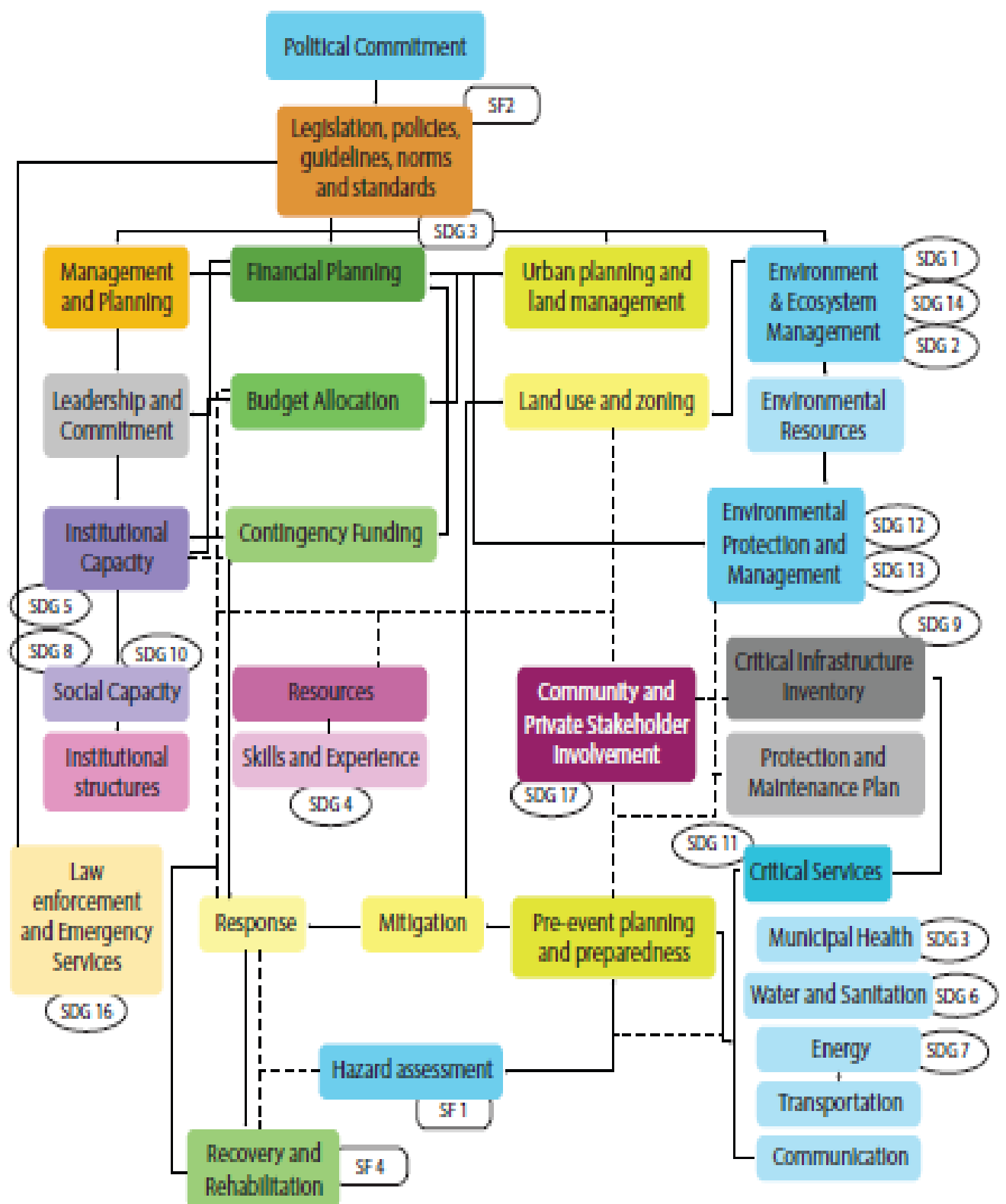


Figure 7.1: Key indicators for a CoT disaster resilience framework

7.3.1 Indicator 1: Governance and Legislation

This research study found that there is a direct link between the local government's commitment to disaster resilience and the actual application of DRR measures and SDGs. For this reason, governance and legislation will receive top priority in the proposed framework (cf. 3.2.4.2, 3.6, 6.4).

Figure 7.2 on the following page indicates that there are certain areas of priority within the governance and legislation indicator of the framework. The need for local government's commitment towards disaster resilience is imperative. The local government drives the city's administrative and strategic planning processes (cf. 3.2.4). Once local government's commitment to city disaster resilience and sustainable development is ensured, the legislative process can commence. Legislation supported and implemented by local government leadership provides the foundation for, not only disaster resilience and sustainable development, but also the institution's DRR capacity (cf. 3.6).

Any legislation developed and published by the government needs to be implemented and followed by all spheres of government. Legislation is therefore interpreted and implemented through regulations, policies, codes and standards. The development of appropriate policies, codes and standards gives motivation to the development of guidelines and procedures that drive the city's disaster resilience and sustainable development framework in this instance. Management and planning for disaster resilience and sustainable development need to be undertaken and enforced by multi-sectoral role players and stakeholders (cf. 2.4, 3.6). Equally important in this theme is political will and commitment towards disaster resilience and sustainable development (cf. 6.2.3). Political will drives the political process and could influence communities' undertaking of city processes. Once a political commitment to disaster resilience and sustainable development is ensured, the legislative processes, approval of policies, guidelines, norms and standards can commence (cf. 6.4.1). Sendai Framework Priority 2 is linked to this indicator.

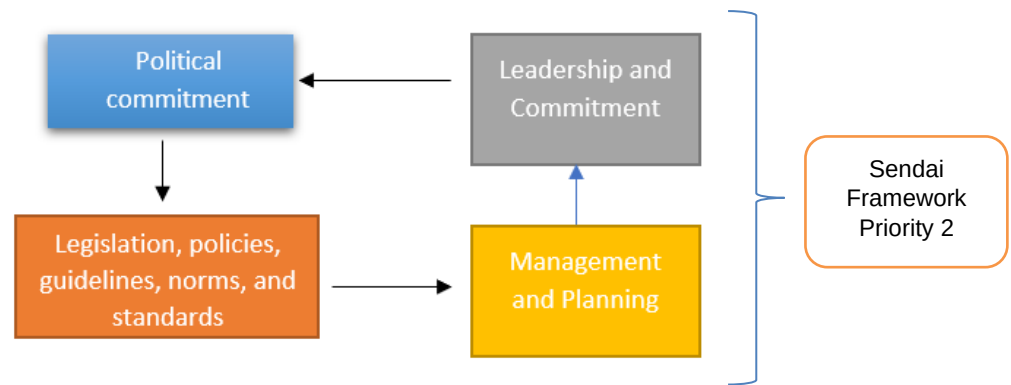


Figure 7.2: Indicator 1 - Governance and politics

7.3.2 Indicator 2: Financial Capacity

Financial capacity is imperative for DRR measures, to implement the SDGs and ultimately for a disaster-resilient plan to succeed. The second indicator of the framework aims to direct the city toward the aspects that should be in place in terms of financial capacity.

Financial planning makes it possible for departments to engage in DRR measures and sustainable development in the city. Financial planning should be regarded as an enabler to the disaster resilience strategy process. Financial planning allows budget allocation to take place based on departments' DRR measures and sustainable development planning process. Financial capacity further provides the city an opportunity to plan for contingency/reserve funding required to increase response and recovery from disaster events. Figure 7.3 maps the interaction between the financial capacity success factors; the indicator is linked to Sendai Framework Priority 3.

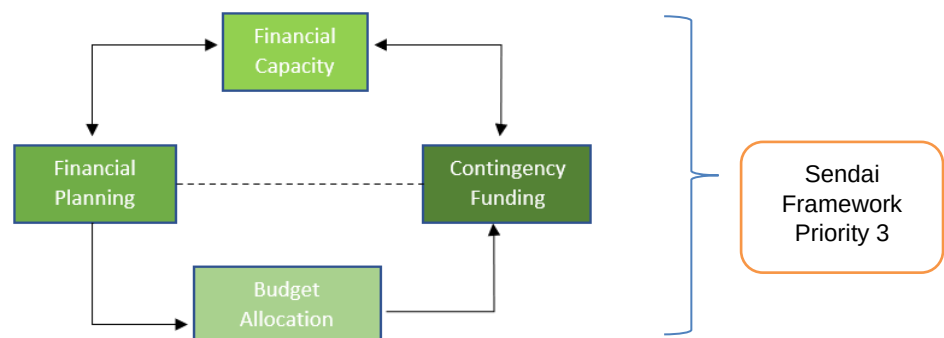


Figure 7.3: Indicator 2 - Financial Capacity

7.3.3 Indicator 3: Urban Development

Urban development and land management are instruments that cities use to coordinate and control urban development and guide future developments (cf. 2.4, 3.6). This indicator gives strategic guidance to ensure development projects and programmes in the city are aligned with disaster resilience and SDGs. Integrated and flexible land use and zoning plans ensure appropriate development of the city (cf. 6.2.1, 6.2.3, 6.4.3). Figure 7.4 indicates the interaction between the urban development success factors; SDG 15, life on land, is linked to this indicator.

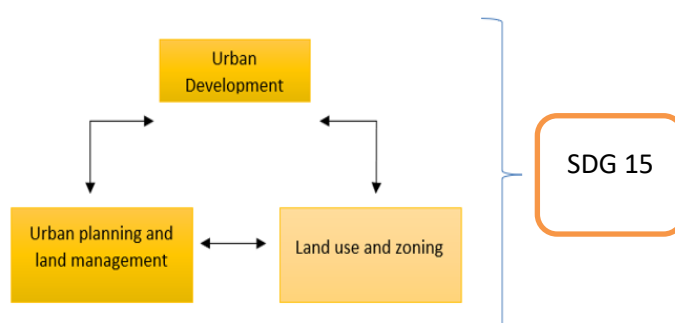


Figure 7.4: Indicator 3 - Urban Development

7.3.4 Indicator 4: Environment and Ecosystem Management

Many environmental and ecosystem resources also relieve chronic stresses in a city – for example, wetlands help to remediate water pollution, forests help to remediate air pollution, and so forth. Where chronic stresses degrade the city’s disaster resilience (for example, where pollution reduces water availability), then ecosystem services concerned should also be monitored. Well-developed environmental protection and management plans provide physical protection to the city (cf. 3.5, 6.2.2, 6.2.3, 6.2.4, 6.2.5, 6.4.4). Figure 7.5 maps the interaction between environmental resources protection and management plans; SDGs 1, 2 and 14 are linked to this indicator.

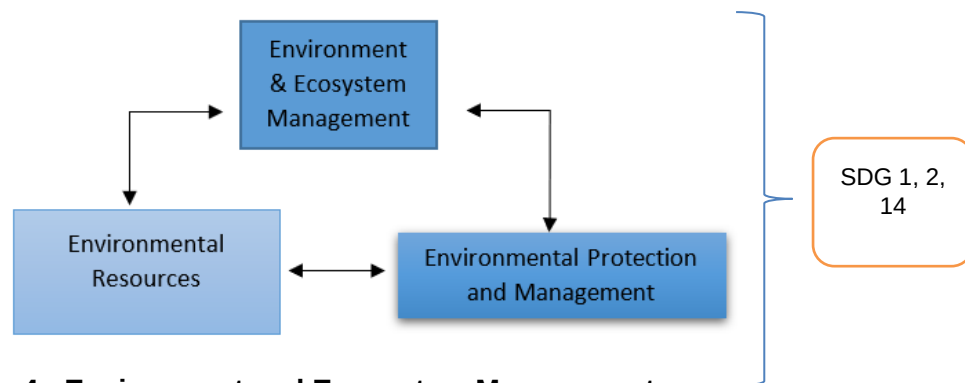


Figure 7.5: Indicator 4 - Environment and Ecosystem Management

7.3.5 Indicator 5: Institutional Capacity

A well-educated and skilled government structure that makes decisions based on sound evidence enables a city to thrive from day-to-day, as well as to respond effectively to emergencies (cf. 3.2, 3.2.3, 3.2.4.1, 6.2.3, 6.4.5). This is enabled by sufficient resources (cf. 6.2.1), skilled and experienced individuals (cf. 6.4.5) and multi-stakeholder consultation (cf. 6.2.1, 6.2.4).

Inclusive and constructive collaboration between all stakeholders involved will strengthen the city's ability to achieve its disaster resilience and SDGs, as communities and private stakeholders are better positioned to act, learn and adapt. Figure 7.6 maps the interaction between the success factors and the indicator; SDG 1 is linked to this indicator.

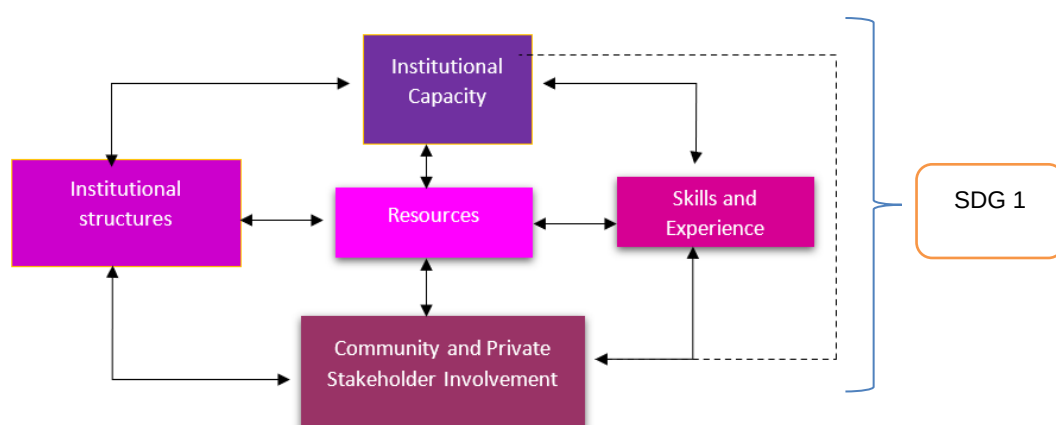


Figure 7.6: Indicator 5 - Institutional Capacity

7.3.6 Indicator 6: Social Capacity

The social capacity indicator addresses building the capacity of vulnerable parties to be able to learn, adapt, cope and progress. This indicator focuses on supporting the involvement of the community in efforts to enhance their own resilience. It recommends that the city recognise the importance of capacitating the vulnerable to better use their resources (such as for food security), increase local competence and commitment and increase the ability to respond to emergencies (education and awareness) (cf. 2.2, 2.4, 6.2.1, 6.2.2, 6.2.3, 6.4.6). Figure 7.7 maps the process of social capacity for the framework; SDGs 5, 8 and 10 are linked to this indicator.

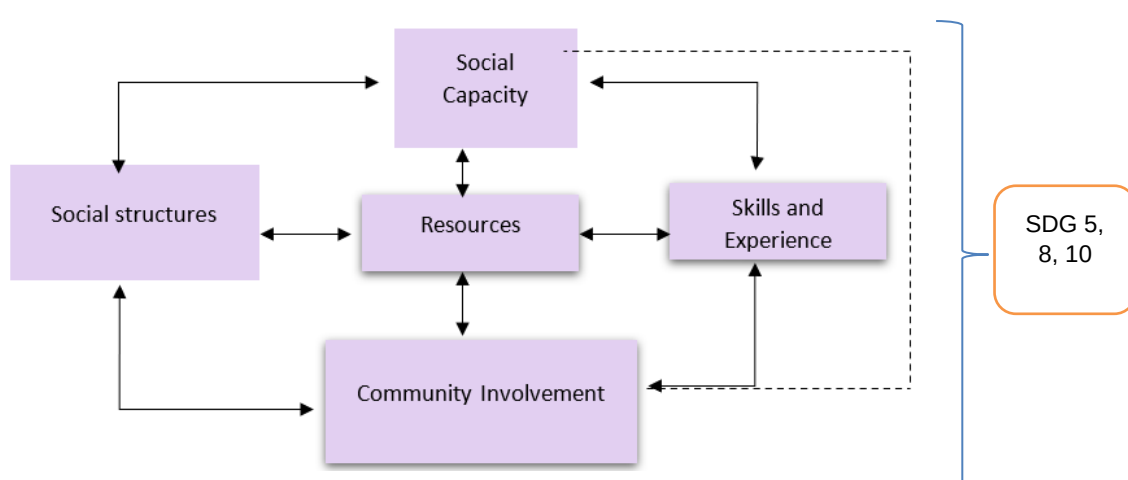


Figure 7.7: Indicator 6 - Social Capacity

7.3.7 Indicator 7: Critical Infrastructure

This indicator relates to the city's infrastructure that provides for services in the city. The critical infrastructure indicator considers the robustness of the infrastructure that protects the city from hazards (cf. 2.3.4.4, 3.2, 3.2.4.2, 6.2.1, 6.2.2, 6.2.4). Adequate continuity for critical assets and services under shock or stress situations (through infrastructure protection and diligent maintenance plans) are an important aspect of this indicator. Figure 7.8 maps the interaction between the success factors; SDGs 3,6,7 and 11 are associated with this indicator.

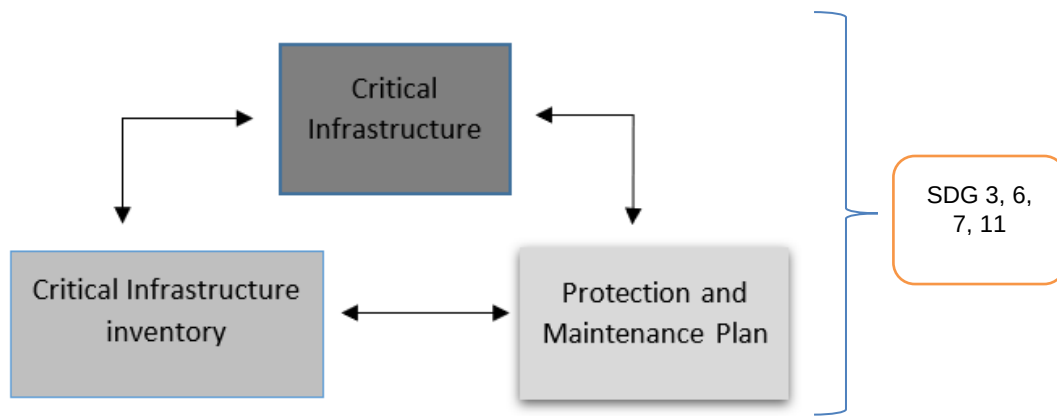


Figure 7.8: Indicator 7 - Critical Infrastructure

7.3.8 Indicator 8: Basic Service Delivery

Some infrastructure may become central to the city's functioning during a time of stress. Well-maintained systems are better able to accommodate abnormal demand, withstand unusual pressures and continue functioning. Well-established management practices create enhanced knowledge of system components so that infrastructure management is better prepared to restore disrupted services. Basic services within the city are supported by diverse and robust infrastructure, which has been appropriately planned and delivered (cf. 2.3.4, 3.5, 3.6, 6.2.2, 6.2.4, 6.4.8).

Figure 7.9 maps the adequate continuity of critical assets to provide for basic services through resourceful, reflective and flexible continuity plans to maintain critical services and critical assets during emergencies. SDGs 3, 6, 7 and 11 are also linked to this indicator.

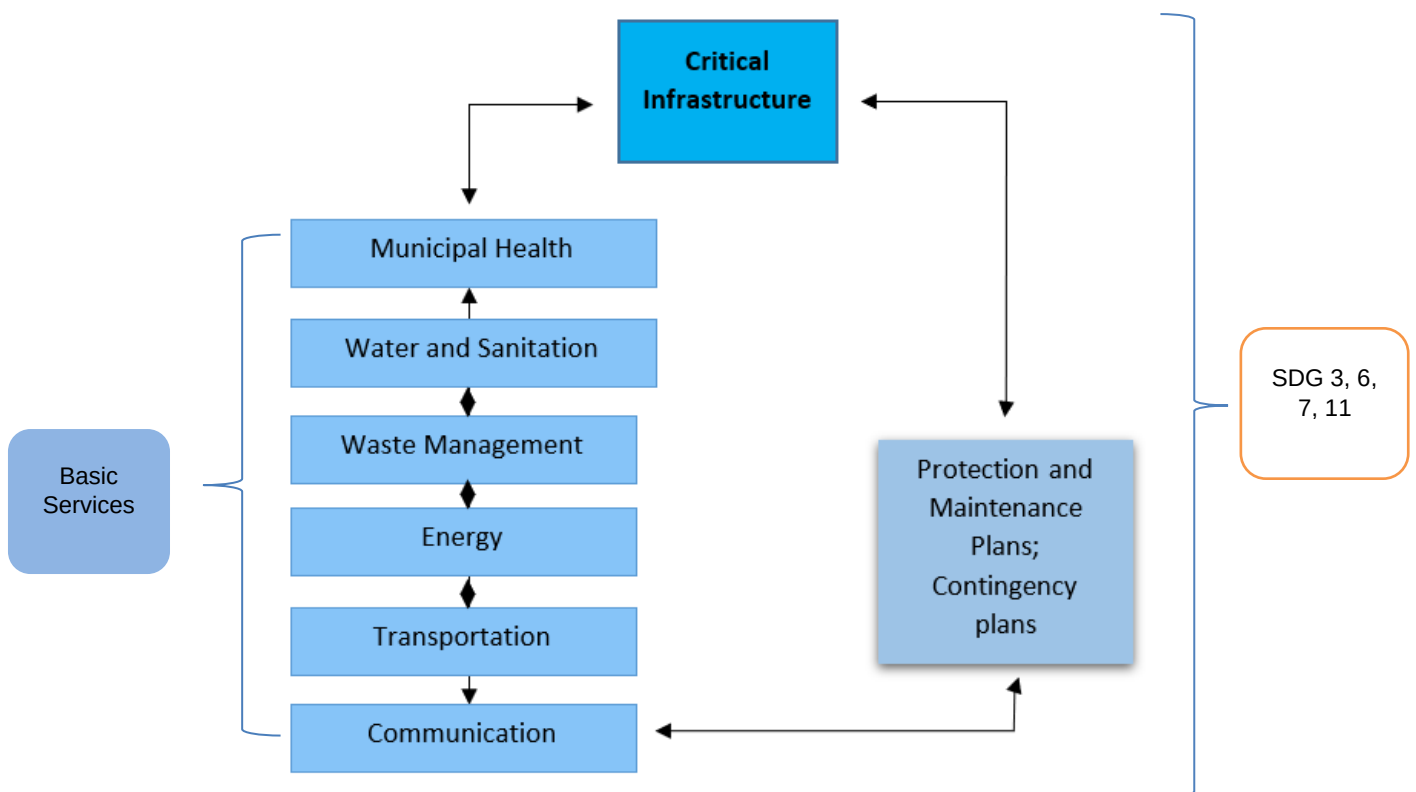


Figure 7.9: Indicator 8 - Basic Service Delivery

7.3.9 Indicator 9: Law Enforcement

A comprehensive and contextually appropriate approach to multi-model law enforcement may enable the city to uphold the rule of law and compliance with legislation. Well-planned and resourced emergency service facilitates disaster risk management in a city (cf. 2.2.1, 2.4, 3.6, 6.2.2, 6.4.9). Figure 7.10 maps the interaction between the success factors. SDG 16 is linked to this indicator.

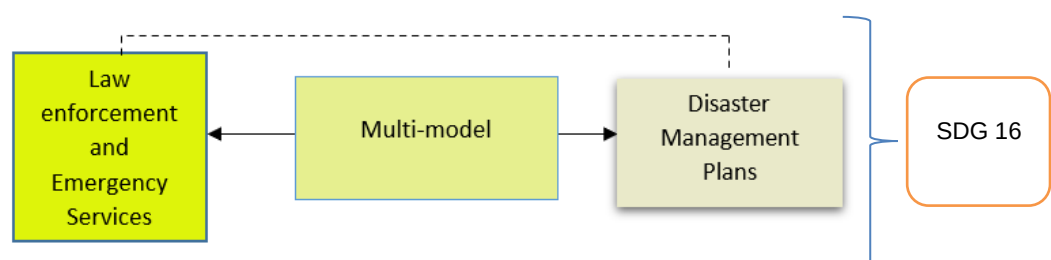


Figure 7.10: Indicator 9 - Law enforcement

7.3.10 Indicator 10: Disaster Risk Management

The definition of disaster risk management as per Chapter One indicated that pre-event preparedness and response form an integral part of disaster resilience and sustainable development. Indicator 10 contains the success factors, namely

preparedness, hazard assessments, disaster response, recovery and rehabilitation. Figure 7.11 makes it clear that the preparedness for a given event should receive priority (cf. 3.2.4.1, 3.3). Preparedness involves hazard assessments with sufficient plans in place to mitigate eventuality. Hazard assessment aims to create an indicative risk profile which will, in turn, contribute to disaster resilience and sustainable development practice (cf. 3.2.4, 3.2.4.1, 6.2.1, 6.2.2, 6.2.3, 6.2.4). Once an indicative risk profile is determined, the risk needs to be constantly monitored and assessed. Response to an event should be well-planned and coordinated followed by recovery and rehabilitation. Sendai Framework 1 and 4 and SDG 11 are all associated with this indicator.

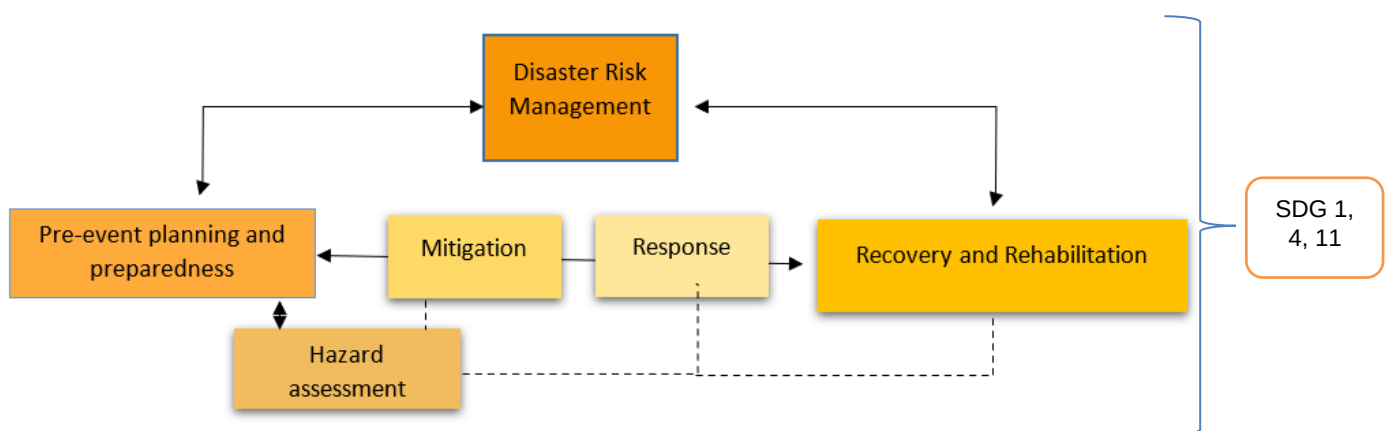


Figure 7.11: Indicator 10 - Disaster Risk Management

7.4 A COMPREHENSIVE CITY DISASTER RESILIENCE FRAMEWORK FOR CITY OF TSHWANE

The following proposed comprehensive disaster resilience framework for CoT consists of three components: Indicators – which define the overarching focus of city disaster resilience and sustainable development (Figure 7.1); key factors – which describe the indicators; and guidelines (that appear in the comprehensive framework) – which serve as performance gauges to give guidance to the level of implementation of city DRR measures and the SDGs.

It is critical to understand that the success factors are not input or output driven performance indicators but merely serve as qualitative strategic guides to CoT departments with regard to the requirements to develop a disaster resilience strategy

as a measure towards a disaster-resilient city. These success factors are unique in that they address DRR measures and the SDGs.

Another important aspect to take cognisance of, especially with regards to the outcome of the document analysis of the different international city disaster resilience frameworks, is indicator duplication. Indicator duplication refers to two or more identified indicators which, in application, measures similar aspects. It, therefore, becomes a needless exercise to include both (or more) indicators. As a result, in this research certain indicators that were duplicated were grouped to make logical sense (for example infrastructure and basic service delivery were combined).

The comprehensive CoT disaster resilience framework was developed on an Excel spreadsheet that allows CoT teams, dealing with sustainable development or resilience in the city, to amend the content as their risk profile changes (cf. Addendum H). The layout of the framework was adopted from the UNDRR's Disaster Resilience Scorecard (UNDRR, 2017). Figure 7.12 contains elements for the proposed city disaster resilience framework for CoT that addresses the DRR measures and the SDGs. Each indicator is represented by an icon that is associated with such indicator (Figure 7.12).



Figure 7.12: Excel spreadsheet introducing CoT disaster resilience framework

Figure 7.13 contains action icons that, when selected, open a specific sheet. These action icons represent several actions.

	This action icon takes the reader to the first sheet of the framework.
	This action icon takes the reader to the first sheet, City's Profile of the framework. The purpose of this sheet is to include demographic information, geographic information and so forth of CoT.

Figure 7.13: Action icon to the first sheet of the framework

7.4.1 City of Tshwane Profile Sheet

The first sheet of the framework provides an overview of CoT's profile. It allows the reader (person completing the framework) to respond to the city's profile as it relates to demographics, known disaster risks and stakeholder information. Figure 7.14 is the action icon that will open the CoT Profile sheet when selected.



CITY OF TSHWANE PROFILE












This Assessment	Response
City name	
Type of city (municipality, metropolitan areas, etc)	
Country	
Date of assessment	

City Profile (Required)	Response	Source Date
Title of the highest level of authority (e.g. Mayor, etc)		
Total city population:		
City square kilometers:		
Population density (per square kilometer):		
Population that are youth (15-24) (%):		
Population that are senior citizens (65+) (%):		
Gender (female-headed households):		
Literacy rate (% literate population):		
Poverty rate (% population not in poverty):		
Ave. household income (USD):		
Residents who are not citizens (%):		
Most likely (probable) known disaster risk:		
Most severe disaster (known):		

City Profile (Optional)	Response	Source Date
Total number of households:		
Persons per unit:		
Cost of living (USD):		
Country's GDP per capita (USD)		
Gini coefficient:		
City product per capita (USD):		

Local Government Disaster Risk Reduction and Resilience Team	Response
Name of person leading / coordinating completion of the scorecard assessment:	
Organization:	
Contact details:	

Stakeholder Information
Please list all stakeholders that have supported this assessment below.

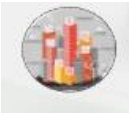
NOTES AND INSTRUCTIONS

- The look and feel of this framework is adopted from the **UNDRR Disaster Resilience Scorecard (UNISDR, 2017)** developed by IBM and AECOM. Actions identified during the City's disaster risk and vulnerability assessment (2019), and climate action plan developed by CSIR (2021) were consolidated in this framework.
- The first step is to start by completing the City's profile on this tab.
- This proposed framework was developed as part of a research study
- This proposed framework was developed to assist the city to consider various categories when considering disaster resilience
- Nine essential categories were identified and is contained in this framework. Clicking through each resilience category using the navigation buttons at the top of each screen
- A scoring system can be developed for each category that will assist the city in summarising its resilience level
- Each of the 9 Resilience Categories has a set of areas to consider, comments and responses. Each field allows to add additional fields such as notes, actions, action owners and time frames
- Further information tab can be used to provide additional information on the department completing the framework.

Figure 7.14: City profile action icon

At the top of each sheet, an action icon that represents an indicator as identified as essential for the framework is provided. The reader will be directed to the icon of choice when selecting such icon. The description of each action icon is provided in Table 7.1.

Table 7.1: Action icon and indicator

Icon	Icon Indicator
	Home page
	CoT Profile sheet
	Indicator 1: Governance and Legislation
	Indicator 2: Financial Capacity
	Indicator 3: Urban Development
	Indicator 4: Environment and Ecosystem Management
	Indicator 5: Institutional Capacity
	Indicator 6: Social Capacity

	Indicator 7: Critical Infrastructure
	Indicator 8: Basic Service Delivery
	Indicator 9: Law Enforcement
	Indicator 10: Disaster Risk Management

Selecting the preferred indicator will open the Excel sheet containing key factors and guidelines for the specific indicator. The purpose of the guidelines is to provide the reader with direction on achieving the key factor and the indicator. Figure 7.15 is an example of an indicator sheet with key factors. The guidelines on how to achieve the indicators are displayed on the right-hand side of each sheet. The blue arrow indicates to the reader which indicator sheet is open.

Indicator	
 INDICATOR 1 GOVERNANCE & LEADERSHIP	
This theme focusses on local government's effectiveness in achieving policy objectives. It is required that legal and policy frameworks with common-rules, well-defined legal mandates and plans under which disaster resilience and sustainable develop programs operate.	
1.1 Legislation, policies, guideline, norms and standards	
Areas for consideration	Provide means of verification (explanation and evidence)
1.1.1 National and Provincial legislation, standards, municipal by-laws and regulations	Legislation, standards, by-laws regulating disaster resilience and sustainable development in the City Do building codes or standards exist, and do they address specific known hazards and risks for the city? Are these standards regularly updated?
1.1.2 City policies and guideline	Policies addressing city disaster resilience and sustainable development Alignment and coordination between city policies and guideline with other spheres of government
1.1.3 Norms and standards	City norms and standards developed for assessment and compliance to disaster resilience and sustainable development in order to determine indicative resilient profile eg building codes, safety standards, spatial development planning, etc. How often are guideline, norms and standard reviewed?
1.1.4 Compliance	Measures in place to continuously assess compliance to legislation, policies, guideline, norms and standards.
	Responsible department
	Time frame

Figure 7.15: Extract of an indicator sheet

Every indicator page allows the reader to move to the next indicator by selecting such indicator at the top. Each indicator page provides the key factors and guidelines and

allows the compiler to allocate responsible departments and timeliness required to submit the information as recommended by the guidelines.

Each indicator could be identified as a chapter for the disaster resilience strategy for the city. The key factors should guide the city on the content of the chapter, with the guidelines providing information on how the indicator is or should be implemented in the city. The framework should be able to assist the disaster resilience strategy and illustrate how the Sendai Framework priorities and SDGs are part of the city's planning.

7.5 CONCLUSION

This chapter described the comprehensive city disaster resilience framework for CoT. The findings of Chapter Six were interpreted, and a framework was developed. Subsequently, each of the identified indicators illustrated how each variable connects to it. In conclusion, a framework containing all indicators was drawn, taking into consideration the dependencies and interactions of all the guidelines such as the DRR measures and SDGs. This chapter presented a disaster resilience framework for CoT that was developed to ensure that there is an incorporation of DRR measures and the SDGs in a CoT disaster resilience framework for the city's disaster resilience planning strategy. The next chapter provides a summary and conclusion to the research study.

CHAPTER EIGHT: SUMMARY, CONTRIBUTION, RECOMMENDATIONS, LIMITATIONS AND CONCLUSION

8.1 INTRODUCTION

The preceding chapter presented a disaster resilience framework for CoT that was developed to ensure that there is an incorporation of DRR measures and the SDGs in a CoT disaster resilience framework for the city's disaster resilience planning strategy. The analysis revealed the importance of integrating DRR measures and the SDGs, starting from governance structures to development plans and initiatives, to disaster risk management. Chapter One indicated that this study applied theoretical and empirical perspectives respectively, while Chapter Two to Six dealt with the theoretical and methodological aspects of this study. Chapter Seven discussed the key aspects needed for a proposed city disaster resilience framework wherein the DRR measures and SDGs are integrated.

In addition to the discussion on the findings as outlined in Chapter Seven, the current chapter explains the contribution of the theoretical and empirical study to integrate DRR measures and SDGs in CoT's disaster resilience planning strategy. This is achieved through the verification of the study's objectives. It should also be noted that each chapter of the research was structured to achieve the objectives of the study. The purpose of Chapter Eight therefore will be to provide evidence that the objectives of the study have been achieved in full. The chapter further presents conclusions and recommendations on mechanisms to integrate DRR measures and SDGs in national disaster resilience planning and strategies. The chapter also stipulates how the study contributes to the body of knowledge in the field of disaster resilience in cities.

The chapter commences with an overview of the chapters in which the study has been divided. This is then followed by presenting how the overall and individual objectives of the study have been achieved. Thereafter, the chapter reflects on the contribution of this study to the field of disaster resilience. The chapter also identifies the limitations of the study followed by the areas for further research. Subsequently, the chapter closes with an overall conclusion.

8.2 PURPOSE OF STUDY

The purpose of this study was to synthesise how the coalescence of the SDGs and DRR can form part of the CoT's disaster resilience planning strategy. Local government is best placed in the process of making cities disaster-resilient; however, local government needs support and guidance to operationalise the resilience building process (cf. 1.2). The research study's objective was to develop a CoT disaster resilience framework that can assist the city in incorporating DRR measures and the SDGs in its disaster resilience planning strategy. The framework that was developed incorporates DRR measures and the SDGs in the planning strategy.

The city disaster resilience framework presented in this study is not generalisable, but it may be adopted and adapted by cities in South Africa if they, upon reading this research study, decide whether the findings can apply to their situation. It will mean that the generalisability is determined in terms of the reader of the study. The inclusion of DRR measures and the 2030 SDGs in the disaster resilience planning strategy of a city are also not limited to CoT.

8.3 SUMMARY OF LITERATURE AND EMPIRICAL RESEARCH

In Chapter Two, the city as a complex adaptive system was conceptualised. The chapter also explained the type of economic, governance and social complexities within a city system. The focus of the chapter was on the complexity theory concerning the notion of cities as complex adaptive systems. The chapter revealed that a city infrastructure's interdependencies and interactions influence the city's sustainability. A disruption in the city's interdependencies and interactions results in a break in the city's sustainability.

Chapter Three discusses the emergence of DRR and introduces disasters and their management. The chapter then explains how DRR enables disaster resilience with an extensive discussion on resilience. An analysis of the integrated link between resilience, sustainability and sustainable development is followed by a discussion on disaster resilience for sustainable cities.

Chapter Four provided a brief discussion on the methodology that was applied to strengthen discussions regarding the methodology presented in Chapter One. With this in mind, the chapter explained the interpretivist research paradigm, as well as the case study design. Document analysis and one-on-one interviews as data generation

methods were explained in the chapter. The strategies to establish trustworthiness were also discussed.

Chapter Five introduced the CoT Metropolitan Municipality as the case study by providing an overview of the geographical area, its demographics and vulnerabilities. The chapter summarised five CoT strategic documents that address disaster risk management, resilience, and sustainable development in the city, to determine how disaster resilience and sustainable development is addressed. The chapter revealed that the city has various documents that address, in some way or another, components of DRR and sustainable development but that there is no consolidated strategy for disaster resilience in the CoT.

Chapter Six presented the findings alongside a discussion by using narratives and tables to present data and describe the data from the single case study and document analysis. The four international disaster resilience frameworks and the five CoT strategic documents were analysed to derive indicators for the disaster resilience framework. The study revealed 10 disaster resilience indicators that were found eminent in the frameworks and strategic documents. The research objectives, to *determine how a city disaster resilience framework can complement the existing DRR measures and SDGs applied in CoT*; and *identify indicators of a city disaster resilience framework that will allow the CoT to determine its disaster resilience* were addressed in this chapter.

Chapter Seven contained a synthesis of the study by presenting the contribution to knowledge. This was done by means of a proposed CoT disaster resilience framework, where DRR measures and the SDGs have coalesced.

This chapter concludes the study by summarising the literature study and empirical research. It also summarises the contribution of this study to new knowledge, which includes recommendations for further research. The limitations of this study are indicated and the chapter ends with a conclusion.

8.4 ACHIEVEMENT OF THE OVERALL OBJECTIVES OF THE STUDY

This study developed a comprehensive disaster resilience framework that allows for the integration of the DRR measures and SDGs in CoT's disaster resilience planning strategy. Through this framework, understanding CoT's disaster resilience and the alignment of strategies and measures to reduce disaster risks, as well as integration

of DRR measures and SDGs into planning initiatives and systems, various city departments may be enhanced. While recognising the city as a complex system, the development of the framework considered the fact that some city departments have primary responsibilities in view of disaster resilience.

The overall aim of the study was achieved by addressing the individual objectives of the study, through the development of a disaster resilience framework in Chapter Seven. The development of the framework was done via a study of literature, one-on-one interviews and document analysis as demonstrated in Chapters Two to Six. Thus, the ensuing section demonstrates how each of the individual objectives were addressed.

8.5 ACHIEVEMENT OF INDIVIDUAL OBJECTIVES OF THE STUDY

The study was founded on the achievement of five objectives. All of the objectives were formulated to complement one another in order to achieve the main aim of the study - to synthesise how the coalescence of the SDGs and DRR can form part of the CoT's disaster resilience planning strategy. To realise the objectives of the study, chapters were systematically sequenced and contextually aligned to ensure a link between them, thereby progressively contributing to the development of the disaster resilience framework. The achievement of each objective as summarised in Chapter One of the study is outlined below.

8.5.1 Objective 1: To identify the existing disaster risk reduction measures and Sustainable Development Goals that form part of City of Tshwane's disaster resilience strategy

Chapter Five of the study presented CoT as the case study for this research. The chapter introduces the main principles the city believes to be critical in maintaining its resilience; building a resilient community that can adapt to difficult circumstances, creating a resilient environment system that can withstand environmental changes and disasters, planning for a resilient social urban system and ensuring a resilient governance system through leadership as well as institutional support. Chapter Five also provided an overview of CoT and presented, amongst others, its vulnerabilities, risks, hazards and disaster profile developed during the 2019 DR&VA.

Within Chapter Five, CoT strategic documents and programmes were introduced as the main documents used in the city that addresses DRR and sustainable development with the view of identifying measures to be resilient. The first strategy is CoT long-term strategy known as Vision 2055. The long-term vision for CoT is to have a city (in 2055) that is liveable, resilient and inclusive; where citizens have access to social, economic and enhanced political freedom. The vision is made of six outcomes that are closely linked to the SDGs. Outcomes included, amongst others, a resilient and resource-efficient city (SDGs 6, 7, 9, 11), growing economy (SDGs 1, 2, 3, 8), quality infrastructure (SDGs 6, 7, 9, 14, 15), equitable city (SDGs 4, 5, 10, 11, 16, 17), innovative governance solutions (SDGs 5 - 17) and an engaging city (SDG 16, 17). Although Vision 2055 has no direct objective for DRR measures, it does require the safety of residents (community safety and protection of the community); provision of governance structures to secure an amenable environment for the implementation of disaster plans; investment in a resilient economy that can adapt to change, and strategies to assist climate change adaptation programs with an emphasis on disaster preparedness.

Vision 2030's IDP was the next strategic document that includes aspects of DRR measures and the SDGs. The IDP stipulated five strategic pillars: facilitate economic growth and job creation (SDGs 1 - 5, 8, 10), creating a caring environment and promoting inclusivity (SDGs 1-7, 10, 12), delivering excellent services and protecting the environment (SDGs 6, 7, 9, 11, 13, 14, 15), keeping residents safe (SDGs 11, 13, 16), and being open, honest and responsive (SDGs 16, 17). Vision 2030 sets requirements for the city to understand its vulnerability and risks and to provide disaster plans to prevent these risks. Strengthening disaster risk governance, implementing measures that are aligned with DRR and mitigation principles are included in the document.

In 2021, the city partnered with CSIR to develop a CAP for CoT. The plan was developed with 10 themes and outcomes to address climate action matters. The themes and outcomes focused on people and community's safety, health and climate resilience (SDGs 1, 2, 3, 6 – 13, 15, 16). Climate-smart urban planning and design, resilient, efficient and climate-smart transport and transit orientated development outcomes covered all 17 SDGs in the programs to be implemented. The goal of Outcome 4, climate-proof infrastructure, is to reduce climate impact and protect

infrastructure (SDG 6, 7, 9, 11, 13) and provides for extensive programmes to achieve the outcome. Outcome 5, net-zero carbon, efficient and climate-resilient buildings and public facilities' focus is to achieve SDGs 3, 7, 8, 9, 11, 12, 13, whilst Outcome 6, climate action resilient ecological infrastructure and protected natural resources' emphasis is on conserving, protecting and enhancing natural resources (SDGs 2, 3, 6, 9, 11, 13-16). Outcome 7's goal is to ensure water security for all users while reducing water demand, use, pollution and waste (SDGs 6, 11, 13). Outcome 8, an energy-smart city with sustainable access to clean and affordable energy for all, is directly linked to SDG 7. The programmes identified for this outcome are also linked to SDGs 1, 9, 10 – 13, 17. Outcome 9, a zero-waste Capital City that promotes a circular economy, sets the goal to promote circular economy initiatives, waste segregation and recycling to manage natural resources effectively and reduce the impact on the environment (SDG 1, 2, 3, 6, 7, 9, 11, 12, 13, 15). The last outcome, Outcome 10, focuses on climate change which must be well-governed, mainstreamed and institutionalised in CoT (SDG 11, 13, 16, 17). In terms of DRR measures, the importance of understanding the city's vulnerability and risks, investing in DRR efforts and disaster preparedness are all well covered in the CAP.

CoT contracted the Disaster Risk Management Non-Profit Company (known as DMS NPC) to conduct a comprehensive DR&VA in the city with the aim of, amongst others, providing an integrated implementation plan to reduce disaster risks in the city. DRR interventions with a focus on achieving the SDGs were developed and provided to the city. The report further advised the city to review its current disaster risk management plan, which also formed part of the documents analysed in this research study.

The DRMP provides clarity on the institutional capacity arrangements in CoT and adopted the key performance indicators and enablers described in the Disaster Management Act. This was the only document used in the study that did not address all the SDGs. SDGs 2, 13, 14 and 16 were not included in CoT DRMP. However, all the Sendai Framework priorities for DRR were found to be extensively covered in the plan.

8.5.2 Objective 2: Determine how the disaster risk reduction measures and Sustainable Development Goals are applied in City of Tshwane

Chapters Five and Six of the study provided an extensive overview of how the city intends to apply DRR measures and achieve the SDGs. Respondents who participated in the research study also provided an overview of how they believe the city is applying the DRR measures and the prospect of achieving the SDGs by 2030. Whilst the city has various strategies that address DRR and sustainable development, the research could not identify one consolidated plan or strategy that provides measures for both DRR and sustainable development. The research, however, identified various duplications within these documents but not a document that could be considered the strategy to implement DRR measures and the SDGs. The conclusion made is that the city and its departments approach DRR and sustainable development in isolation and not as an entity or as a system. As determined in Chapter Two, the city is a complex adaptive system, consisting of departments that are integrated and dependent on each other for disaster resilience. An individual or isolated approach to DRR and sustainable development will result in the city not having a comprehensive disaster resilience strategy, which was found to be the case in CoT.

8.5.3 Objective 3: Determine how a city disaster resilience framework can complement the existing disaster risk reduction measures and Sustainable Development Goals applied in City of Tshwane

Chapter Six contextualised four international disaster resilience frameworks developed over the years to assist cities to measure their resilience to disasters. The frameworks were considered essential in helping planners and decision-makers understand where the city stands in terms of resilience to disasters, as well as to develop strategies and action plans for creating more resilient cities. The research study determined that CoT does not have a consolidated strategy that addresses DRR and sustainable development and therefore needs a framework that (i) provides for the consolidation of actions required by different city departments in implementing DRR measures and the SDGs in its daily operations; (ii) will allow the city to identify disaster risk and sustainable development gaps and (iii) will assist the city in implementing DRR measures and SDGs to become disaster resilient.

8.5.4 Objective 4: Identify indicators of a city disaster resilience framework that will allow City of Tshwane to determine its disaster resilience

Chapter Three provided an extensive description of disaster resilience and what a resilient and sustainable city is. Considering the expectation of a resilient and sustainable city, the document analysis and the one-on-one interviews that were analysed revealed several indicators as described in Chapter Seven. These indicators together form the basis for the disaster resilience framework that may assist CoT in developing its disaster resilience planning strategy. The 10 indicators identified in this study are:

Table 8.1: Ten indicators identified for the study

Indicator	Goal
1. Governance and Legislation	To ensure the inclusion of local governments' commitment towards disaster resilience and to develop legislative processes towards a disaster-resilient city.
2. Financial Capacity	To ensure that financial planning and capacity is provided to allow the city to prevent, mitigate, respond to and recover from events that could or have disrupted operations.
3. Urban Development	To ensure the strategic guidance in development projects and programmes that are aligned with disaster resilience and that sustainable development is provided.
4. Environment and Ecosystem Management	To ensure that integrated, well-developed environmental protection and management plans are provided and implemented.
5. Institutional Capacity	To ensure that the city has sufficient resources, skilled and experienced employees and multi-stakeholder consultation in disaster resilience and sustainable development.

6. Social Capacity	To build the capacity of the vulnerable to be able to learn, adapt, cope and progress towards disaster resilience.
7. Critical Infrastructure	To ensure adequate continuity of critical assets and services through infrastructure protection and diligent maintenance plans.
8. Basic Service Delivery	To ensure adequate continuity of services through resourceful, reflective and flexible continuity plans to maintain critical services during disruptions.
9. Law Enforcement	To ensure for a multi-model law enforcement model to enable the city and its citizens to uphold the rule of law and compliance to legislation before, during and after a disruption.
10. Disaster Risk Management	To provide for a comprehensive disaster risk management plan that includes factors of risk reduction, prevention, mitigation, preparedness, response, recovery and rehabilitation.

8.5.5 Objective 5: Develop a City of Tshwane disaster resilience framework that will be able to assist the city in incorporating disaster risk reduction measures and the Sustainable Development Goals in its disaster resilience planning strategy

A comprehensive city disaster resilience framework for CoT was presented in Chapter Seven. The framework provides for 10 indicators (as indicated above), as well as key factors which describe the indicator, what the expectation is and guidelines that serve as performance gauges.

CoT disaster resilience framework was developed on an Excel spreadsheet where the layout was adapted from the UNDRR Ten Essentials Scorecard. Chapter Seven illustrated the layout of the home page that allows the reader to select any of the 10 indicators. Each indicator is represented by an icon that is used throughout the spreadsheet.

The second sheet of the spreadsheet is the CoT profile, where the compiler of the sheet would be able to populate information such as demographics, population, team members and so forth. The sheets following the “info” sheet are the 10 indicators, where each indicator is displayed on its own sheet, consisting of an indicator number and name, the focus or goal, key factors and guidelines that assist in achieving the indicator. The entire spreadsheet is unrestricted, meaning that the framework can be amended or edited should there be a need.

8.6 CONCLUSIONS OF THE EMPIRICAL STUDY

The theoretical and empirical study revealed that CoT has various regulatory and institutional systems that address DRR and sustainable development, however no integrated disaster resilience planning strategy exists. The conclusion of the empirical study also found that:

- Achieving disaster resilience and the SDGs is a multi-sectoral process hence mainstreaming it in planning strategies involves integration across all city departments. The indicators identified as essential for the disaster resilience framework revealed that for the CoT to be considered resilient it should include the SDGs and the implementation of DRR measures as part of the local government planning and execution framework (cf. 2.2.1, 6.4) in its disaster resilience planning strategy.
- DRR measures and the achievement of the SDGs require multi-sectoral efforts (cf. 2.2.4 & 6.3) and effective leadership (cf. 3.6 & 6.4) within a city and must be incorporated into ongoing development programs. Therefore, the essential need to develop a city disaster resilience planning strategy and the implementation thereof requires the involvement and commitment of all stakeholders (cf. 3.6, 7.3.1).
- There has been increasing recognition of the need to integrate DRR into development, not only for resilience but also sustainability. The integration of DRR measures and SDGs will assist in consolidating multi-sectoral efforts to determine the progress of performance, programmes and strategies and to monitor implementation (cf. 3.6, 6.4, 7.3.4, 7.3.10).
- It can be concluded that the implementation of the disaster resilience framework presented in Chapter Seven will assist the CoT to develop a disaster resilience

planning strategy, as the strategy contains DRR measures and the SDGs considered essential for a disaster-resilient city (cf. 3.4, 3.5, 7.3.1).

8.7 CONTRIBUTION OF THE STUDY

This study demonstrated that DRR measures and SDGs were not systematically integrated into a consolidated city disaster resilience strategy for CoT. In order to address CoT disaster resilience planning strategy, the primary contribution of this research study is a disaster resilience framework that integrates DRR measures and the SDGs. The secondary contribution of this research study is that the knowledge gained from CoT case study shows that:

- From the framework design for this study, the components of all levels of management play a central role in the implementation of the framework (cf. Figure 7.2). Proper management in the face of a disaster in cities necessitates a transformation of attitude towards disasters risk reduction and sustainable development and actions necessary to deal with them in an integrated system (cf. 2.4).
- The study reaffirmed that efforts to implement DRR measures and achieve the SDGs are complex, as a city requires a multi-disciplinary and multi-sectoral endeavour that is integrated into a planning strategy (cf. 7.3).
- This study also contributes to internal disaster risk management awareness and training as all departments will be introduced to DRR measures and the SDGs through the implementation of the 10 indicators in the disaster resilience framework. All departments must contribute to the development of the disaster resilience strategy (cf. 7.3, 7.5).

8.8 LIMITATIONS OF THE STUDY

Any research project has unique limitations and restrictions linked to its environment and dynamics. The study undertook research in CoT, that has the responsibility to respond to and implement national legislation such as the Disaster Management Act. A limitation is that not all CoT departments were included in the study. Only employees of CoT Emergency Services and the Sustainability Unit who have first-hand experience in disaster risk management in CoT took part in the research. Owing to the complexity and interrelatedness of management, employees from CoT who are senior managers

(for example, the mayor), could also be included in the sample in future research, and hence it can be seen as a limitation to the current study. The research outcomes could have been interesting if the researcher had the opportunity to obtain wider department representatives' views.

8.9 RECOMMENDATIONS FROM THIS STUDY FOR FURTHER RESEARCH

The principles that underpin the integration of the various dimensions of development are what make it a sustainable process. Those principles, which are mirrored in the 2030 Agenda for Sustainable Development and the Sendai Framework, also inform the adoption of system-based approaches and a fuller understanding of the nature of disaster risk, thereby opening the way for new lines of research, methodologies and opportunities for planning before, during and after a disaster. The areas of further research are outlined below:

- This study has revealed that the design and implementation of a disaster resilience framework is a multi-sectoral endeavour that should take DRR measures and the SDGs into consideration. Given this, it is important that further research be undertaken to explore the interface between DRR measures and sustainable development in a national disaster resilience planning strategy in-depth; and
- The researcher would recommend that integrating DRR and sustainable development in national sectoral planning in South Africa could contribute to disaster resilience in the country.

8.10 REFLECTION ON THE RESEARCH STUDY

Considering the background of the researcher and her motivation for undertaking this research study, the researcher believes that the study was necessary because it provided insight into the importance of disaster resilience in a city as an integrated effort of DRR measures and the SDGs in development planning. An analysis of international city resilience frameworks revealed the importance of city planners with regards to developing strategies and investment decisions that enhance, rather than undermine, the city's resilience.

The researcher learnt that producing a meaningful framework for something as complex as the resilience of a city reflects the reality of the shortfalls in the system as

they relate to disaster risk management. The framework developed in this research study will form the basis of a tool that should enable the city's planners to convene around a common understanding of what matters most when creating a disaster-resilient city. The framework is intended to facilitate the process of engagement within the city, as the indicators and variables will generate dialogue and a deeper understanding of what constitutes a disaster-resilient city and how it can be achieved. Achieving the SDGs and implementing DRR measures may minimise the impact, as well as the economic and social effects of disasters by reducing the city's vulnerability to disasters by enhancing the city's coping capacity.

The framework designed for this research study will be presented to the Departmental Head of CoT Sustainability Unit as a tool to assist the city in localising DRR measures and the SDGs. The framework will then be introduced to CoT's Executive Committee with a request to be adopted as the city's tool in the form of a disaster resilience framework, with the suggestion that it form part of the city's disaster resilience planning strategy. The feedback will be disseminated to the respondents in the study and all Departmental Heads in CoT.

8.11 CONCLUSION

This research study aimed to answer the research question: *How can the coalescence of the SDGs and DRR form part of CoT's disaster resilience planning strategy?* It endeavoured to answer this question by explaining how DRR measures and the SDGs are presently applied in CoT. It was established that CoT addresses elements of DRR and the SDGs in many strategic documents but does not have a consolidated disaster resilience planning strategy.

The research question was also answered by showing that key indicators of a city disaster resilience framework can be identified that will allow CoT to determine its disaster resilience. These indicators included the essence of leadership and political buy-in and the importance of integrated and multi-sectoral planning between all city departments, business sectors, the community and other spheres of government. Lastly, this research study aimed to contribute to a coalescence of the SDGs and DRR for CoT which it achieved by designing and presenting a disaster resilience framework that will assist the city in the development of its disaster resilience planning strategy.

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ADDENDA

ADDENDUM A: ETHICS APPROVAL LETTER OF STUDY



Private Bag X1290, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222

Fax: 018 299-4910

Web: <http://www.nwu.ac.za>

Senate Committee for Research Ethics

Tel: 018 299-4849

Email: nkosinathi.machine@nwu.ac.za

ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCORE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: A coalescence of sustainable development goals and disaster risk reduction in the City of Tshwane
Study Leader/Supervisor: Dr L De Sousa
Student: N Terblanche

Ethics number:

N	W	U	-	0	1	6	2	9	-	2	0	-	A	9
Institution				Study Number					Year			Status		

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Application type: Single **Risk Category:** Minimal

Commencement date: 01/02/2020

Expiry date: 01/10/2022

Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
 - Research proposal
 - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

ADDENDUM B: APPROVAL TO CONDUCT RESEARCH IN CITY OF TSHWANE



City Strategy and Organizational Performance

Room CSP22 | Ground Floor, West Wing, Block D | Tshwane House | 326 Mediba Street | Pretoria | 0002 | PO Box 440 | Pretoria | 0001

My ref: **Research Permission/ Terblanche**
Contact person: **Pearl Maponya**
Section/Unit: **Knowledge Management**

Tel: 012 358 4559
Email: PearlMac3@tshwane.gov.za
Date: 21 February 2020

Ms Tanja Terblanche
PO Box 11320
Die Hoewes
0163

Dear Ms Terblanche,

APPROVAL TO CONDUCT RESEARCH ON "THE COALESCENCE OF SUSTAINABLE DEVELOPMENT GOALS AND DISASTER RISK REDUCTION"

Permission is hereby granted to Ms Tanja Terblanche, a Doctor of Philosophy in Science with Disaster Risk Science in the Faculty of Natural and Agricultural Sciences at the North West University to conduct research in the City of Tshwane Metropolitan Municipality.

It is noted that the study aims to explore the coalescence of sustainable development goals and disaster risk reduction into City of Tshwane's resilience framework. City of Tshwane further notes that all ethical aspects of the research will be covered within the provisions of the North West University Research Ethics Policy. You will be required to sign a confidentiality agreement form with the City of Tshwane prior to conducting research.

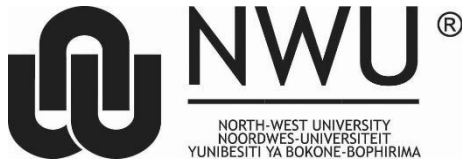
Relevant information required for the purpose of the research project will be made available as per applicable laws and regulations. The City of Tshwane is not liable to cover the costs of the research. Upon completion of the research study, it would be appreciated that the findings in the form of a report and or presentation be shared with the City of Tshwane.

Yours faithfully,

PEARL MAPONYA (Ms.)
DIRECTOR: KNOWLEDGE MANAGEMENT

City Strategy and Organisational Performance • Stadsstrategie en Organisasatoriese Prestesie • Lefapha la Thulaganyo ya Tiro le Togamatsano ya Toropokgolo • UmNyango wozokuSobanza namaqhinga aMeliwoko kaMasipala • Kgona ya Leanopeakanyo la Toropokgolo le Bodiragatli la Mmasipala • Muhashe wa Vhupulani ha Dorobo khutlwane na Mashumele • Ndzavulo ya Maqhinga ya Dorobakulu na Matirhele ya Masipala • UmNyango Wezeqhinga Ledolobha Nokusebenza Kwesikhungo

ADDENDUM C: RESPONDENTS INFORMED CONSENT LETTER



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2020

The Faculty of Health Sciences Ethics Office of the North-West University is acknowledged for the use of their document with minor adjustments made by the North-West University Education, Management and Economic Sciences, Law, Theology, Engineering and Natural Sciences Research Ethics Committee (NWU-EMELTEN-REC).

INFORMED CONSENT DOCUMENTATION FOR PARTICIPANTS REGARDING THEIR INVOLVEMENT IN A RESEARCH STUDY

TITLE OF THE RESEARCH STUDY: The coalescence of disaster risk reduction and sustainable development goals in City of Tshwane

ETHICS REFERENCE NUMBERS: NWU-01629-20-A9

PRINCIPAL INVESTIGATOR: Dr LO de Sousa

ADDRESS: Private Bag X1290, Building C6 – office 105, Potchefstroom, 2520
luiza.desousa@nwu.ac.za

CONTACT NUMBER: 0182994727/0834686726

POST GRADUATE STUDENT: Ms N Terblanché (28037618)

We hereby request your permission to take part in this research study. Please take some time to read the information presented here, which will explain the details of this research study. Please ask the researcher or person explaining the research to you any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research is about and how you might be involved. You are free to deny the request not to take part. If you agree not to take part, you will not in any way whatsoever be negatively affected.

This study has been approved by the North-West University's Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) (**NWU-01629-20-A9**) and will be conducted according to the ethical guidelines and principles of Ethics in Health Research: Principles, Processes and Structures (DoH, 2015) and other international ethical guidelines applicable to this study. It might be necessary for the research ethics committee members or other relevant people to inspect the research records. What is this research study all about?

- The research aims to explore how the coalescence of the sustainable development goals and disaster risk reduction can form part of the City of Tshwane's disaster resilience planning strategy.

Why have you been invited to participate?

- You have been invited to be part of this research because on account of your position, and operational knowledge and experience, you have adequate information about all aspects of disaster risk management, disaster resilience, sustainability and sustainable development in the city of Tshwane.
- In addition, you are a person that should be able to effectively communicate orally or in writing and be willing to take part in the study and co-operate with the researcher

What will be expected of you?

- Participants will be expected to take part in a one-on-one interview with the researcher.
- The interview will take less than one hour.
- The one-on-one interview will be conducted on Microsoft Teams due to the COVID-19 pandemic that prohibits face-to-face engagements.

Will you gain anything from taking part in this research?

There will be no direct gains for you in the study.

Are there risks involved in you taking part in this research and what will be done to prevent them?

- There will be no risks to you by involving in this study.
- There will be no harm to any participants in this study.
- There are more gains for you in joining this study than there are risks.

How will we protect your confidentiality and who will see your data?

- Anonymity of your data will be protected by the use of pseudonyms from the onset. Your privacy will be respected by not availing your contact details to anyone else. Your results will be kept confidential by the researcher even when articles are published. The final transcript will be made available to you for correctness (member checking). Only the researcher, supervisor and co-supervisor will be able to look at your data. Data will be kept safe by locking hard copies in locked cupboards in the researcher's office and for electronic data it will be password protected. As soon as data has been transcribed it will be deleted from the recorders. Data will be stored for five years in an electronic format.

What will happen with the data or samples?

- The data of this study will only be used for this study.

How will you know about the results of this research?

- We will give you the results of this research when we have completed this research study and, on your request a report can be emailed to you.

Will you be paid to take part in this study and are there any costs for you?

- You will not be paid to take part in the research study.
- You have no travel expenses and do not need to be refunded for traveling.
- The only cost involved for you, if you do take part in this study, will be the use of data for the online one-on-one interview.

Is there anything else that you should know or do?

- You can contact Ms Tanja Terblanché on Tel: 083 965 3183 or email: tanjat@tshwane.gov.za if you have any further questions or have any problems.
- You can also contact the North-West University's Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) on 018 299 4269 if you have any concerns that were not answered about the research or if you have complaints about the research.
- You will receive a copy of this information and consent form for your own purposes.

Declaration by participant

By signing below, I agree to take part in the research study titled: **The coalescence of disaster risk reduction and sustainable development goals in City of Tshwane**

I declare that:

- I have read this information as it was explained to me by a trusted person in a language with which I am fluent and comfortable.
- The research was clearly explained to me.
- I have had a chance to ask questions to both the person getting the consent from me, as well as the researcher and all my questions have been answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be handled in a negative way if I do so.
- I may be asked to leave the study before it has finished, if the researcher feels it is in the best interest, or if I do not follow the study plan, as agreed to.

Signed at (place) on (date) 20....

Signature of participant

Declaration by person obtaining consent

I (name) declare that:

- I clearly and in detail explained the information in this document to(.....)
- I did/did not use an interpreter.
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I gave him/her time to discuss it with others if he/she wished to do so.

Signed at (place) on (date) 20....

Signature of person obtaining consent

Declaration by researcher

I (*name*) declare that:

- I explained the information in this document to the participant
- I did/did not use an interpreter
- I was available should he/she want to ask any further questions.
- I encouraged him/her to ask questions and took adequate time to answer them.
- The informed consent was obtained by an independent person.
- I am satisfied that he/she adequately understands all aspects of the research, as described above.
- I am satisfied that he/she had time to discuss it with others if he/she wished to do so.

Signed at (*place*) on (*date*) 20....

Signature of researcher

ADDENDUM D: INTERVIEW SCHEDULE AND DURATION INTERVIEW QUESTIONS

Question 1	In which department are you working and what is your role in the department?
Question 2	What is your understanding of the following terms? 2.1 Disaster risk reduction 2.2 Sustainability 2.3 Sustainable development 2.4 Resilience 2.5 Disaster resilient city
Question 3	In your view, what areas are of concern in the City of Tshwane as it strives to be a resilient city? Please elaborate on your view.
Question 4	The Sustainable development agenda identified 17 goals to be implemented by 2030. In your view, how will the City achieve these goals? Elaborate your response.
Question 5	Goal 11 of the SDG refers to ensuring a safe and resilient city. To your knowledge what has been done in Tshwane to ensure it is a disaster resilient city? What disaster resilience planning strategies does Tshwane have? Share your knowledge of how they are addressed.
Question 6	There are four priority actions of the Sendai Framework for disaster risk reduction. Share how these strategies are implemented in Tshwane.
Question 7	In your view, how can a city's resilience to disasters be measured? Elaborate your view.
Question 8	What criteria would you consider important when developing a comprehensive city disaster resilience framework? Please elaborate.

RESPONDENT	INTERVIEW DATE	INTERVIEW DURATION
1	12/06/2020	23 min 12 sec
2	28/05/2020	21 min 39 sec
3	29/05/2020	25 min 18 sec
4	03/06/2020	28 min 17 sec
5	06/04/2020	43 min 14 sec
6	Written response	-
7	27/05/2020	24 min 10 sec
8	29/05/2020	54 min 28 sec
9	02/06/2020	1h 13 min 19 sec
10	Written response	-

ADDENDUM E: EXCERPT OF A ONE-ON-ONE INTERVIEW WITH PARTICIPANT

Researcher: Thank you so much for showing interest in participating in this research study that is being conducted. I would just want to make a few announcements before we start so that you are aware of it. First of all, there was approval received from City of Tshwane and the North West University's Ethics committee to do this research. Secondly, I would like to record this session because it is going to be easier when I do write up and data analysis, then I have the recording. Are you ok with it?

Respondent: *Yes, I am.*

Researcher: Ok thank you. The last thing is that if you don't feel comfortable you can stop any time. So, if you feel no that you don't want to answer the question. It is fine, you can skip anytime. And then also, there is no wrong answer. This interview is just to determine where the city is in terms of their resilience and what you think, from a disaster risk management point of view, and how you see the city's resilience towards disasters.

Researcher: Are you fine with the ground rules?

Respondent: *Yes, I am.*

Researcher: Ok let's then continue. I've sent you a consent form where I described what the research is all about. The first part of the interview is to learn about you as the participant. So if you could state which department are you working in.

Respondent: *Emergency Services Department.*

Researcher: And what is your role in the department?

.....

Researcher: The Sustainable development agenda identified 17 goals to be implemented by 2030. In your view, how will the City achieve these goals? Elaborate your response.

Respondent: *Mmm, I can say partially. I can't say fully achieve. Just partially. Mmm I can just say some of them partially. For example, this COVID-19 that was declare. It might take time for the city's economy to recover. The city should rather focus on implementing other projects later. And the issue of interdependencies. The city depends on other spheres of government and cannot implement them on its own.*

Researcher: So you think with partial implementation there are areas of concern if the city does not fully achieve these goals. In your view, what areas are of concern in the City of Tshwane as it strives to be a resilient city? Please elaborate on your view.

Respondent: *Mmm by 2030, I don't think the city will be fully resilient. I think the city should localise the 17 goals and focus on achieving the goals. And remember these goals are 2030, the city planned to be resilient by 2055 with Vision 2055. Maybe by 2055 all spheres of government will be resilient.*

Researcher: Goal 11 of the SDG refers to ensuring a safe and resilient city. To your knowledge what has been done in Tshwane to ensure it is a disaster resilient city?

Respondent: *In terms of goal 11, the city has some strategies that was put in place. For example, the disaster management plan that is in place. Also, the disaster management policy framework of which all departments are aware of. That is one of the strategies that we are using.*

Researcher: What disaster resilience planning strategies does Tshwane have? Share your knowledge of how they are addressed.

Respondent: *Other than in disaster management? Yes. I am not aware of any other strategies, but I can give them to you later. I don't want to misrepresent other departments. But there are others like the city sustainable unit that is dealing with sustainability and making the city resilience. They are involving all the departments and coming up with resilient plans in how to make the city liveable.*

Researcher: Yes, I remember both of us participated in the climate change strategy. Remember?

Respondent: *Yes, I remember the city has developed a climate change strategy and are part of the C40. These are some of the strategies that can make the city resilience. But again, it will depend on what the different departments bring toward the city being resilience as they all are participating through the office of the City Sustainability unit.*

Researcher: There are four priority actions of the Sendai Framework for disaster risk reduction. Share how these strategies are implemented in Tshwane.

Respondent: *Yes, yes there are. For example, if you look at priority 1, I would say we went through the disaster risk assessment, the macro one. Where we have identified 10 top priority risks. And recently we are reviewing those risks through a comprehensive risk and vulnerability assessment that was conducted. Disaster risk assessments are also continuously conducted in the city by the disaster officers in the vulnerable communities. That is the example I can give on priority nr 1. Then on the priority nr 2. We have the disaster management policy framework of which all the departments where informed of their roles and responsibilities with regards to disaster management. And also, how to implement the plan. They were workshopped on how to promote disaster risk in their own departments. And we also involved the structures such as the non-governmental organisations, so that they can also participate in the disaster risk management of the city.*

And then priority nr 3. The city has a disaster management plan of which forms part of the IDP. We also have the primary school guide pack that was implemented of which the city was also acknowledge by the NDMC as best practice. The city has also participated annually in the international strategy for disaster reduction. If I can give

you an example of the theme. We receive themes every 2 years. It is an international thing. The theme of 2010/2011 was building cities resilience. It was an urban risk reduction building resilient cities. Where different role players and departments were invited on how to get collaboration on how to make the cities resilient. Again, we have the integrated awareness campaigns that includes the seasonal awareness campaigns at schools and communities. We involve different departments to form part of the integrated awareness campaigns.

On the priority nr 4. The city has adopted the women and girls in risk reduction leadership program. So, this program is annually in August. So, this is where it focusses on preparing and capacitating women to analyse the range of social vulnerability of the communities. It also focusses on preparing and capacitating women in dealing with social vulnerability and addressing disaster risks within their own community. Again, as an example, the compilation, updating and reviewing of the contingency plans is also priority nr 4. With the contingency plans, they are also seasonal like winter and summer plans.

We also have the critical infrastructure contingency plans. For now, we have started with electrical substations in the city. Lastly, we have a very good relationship with South African Weather services. We do receive the forecasting and the early warnings from them. We then disseminate them through the public information liaison office. That are some of the examples of how we implement the Sendai framework.

Researcher: That is good. Thank you.

Researcher: In your view, how can a city's resilience to disasters be measured? Elaborate your view.

Respondent: *Hmmm please repeat the question*

Researcher: Can we have a system in place to determine what is our resilience to disaster?

Respondent: *I can say no and yes. I am just in between. I can only say to an extent you can measure it. Maybe by measuring or assessing the ability or the preparedness of the city on how to cope with a disaster.*

Researcher: Ok, so there is a way?

Respondent: *Yes, we can come up with a way to say how do we assess and measure our ability to respond and even the preparedness of the community. But it is very difficult to say you are resilient. Disasters are dynamic, they are not static.*

Researcher: What criteria would you consider important when developing a comprehensive city disaster resilience framework? Please elaborate

Respondent: *Alright what we can look at is the social issues, including the demographics in the community so that you can know the social vulnerability; we can look at the infrastructure for example maybe the water, energy, electricity, our transport network. Our spatial development, our buildings and even the types of the buildings*

under infrastructure. We can also look at the security as one of the matters on the framework. Even the environmental, economic and institutions that includes planning and governance. Ok that is good. And all these criteria will then eventually determine the resilience of the city? Yes yes to an extent. As I said, disasters are not static it is dynamic.

Researcher: Thank you so much. Is there anything else you want to add or that I can include in the research in terms of disaster resilience?

Respondent: *Hmm for now, I don't think so. You have covered everything.*

Researcher: Ok thank you.

ADDENDUM F: THE UTILISATION OF DOCUMENT ANALYSIS IN THIS STUDY

In this study, document analysis was used to analyse the following City of Tshwane documents:

Document	Description
CoT Vision 2055 (CoT, 2012)	This document described the CoT's long-term strategy.
CoT Vision 2030: IDP (CoT, 2018)	The IDP provides for the spatial development plan and service delivery commitment to the community of CoT.
CoT CAP (CoT, 2021)	CAP, which combines climate actions and climate adaptation plans.
CoT DR&VA Report (CoT, 2019)	A comprehensive report on the findings of the 2019 DR&VA conducted in the city.
CoT DRMP (CoT, 2007)	Disaster risk management plan articulating compliance to the Disaster Management Act in terms of key performance indicators and KPAs.

The list of keywords used in the content analysis are related to the 2030 SDGs and the DRR measures described in the Sendai Framework. The review of literature relevant to the study assisted the researcher in identifying the keywords. The researcher discovered that the phenomenon of resilience is not an isolated concept. Resilience is related to other concepts, themes and subjects. The following keywords were used:

From the 17 Sustainable Development Goals			Sendai Framework Priorities	
SDG 1 Poverty			Understand risk	
SDG 2 Hunger			Risk governance	
SDG 3 Health & Wellbeing	Health Wellbeing		Invest	
SDG 4 Education	Training Awareness		Disaster preparedness Disaster response	
SDG 5 Gender equality			Build back better	
SDG 6 Water & Sanitation	Water Sanitation		Disaster recovery	
SDG 7 Energy	Power Electricity		Disaster rehabilitation	
SDG 8 Work & Economic growth	Employment Economic growth		Disaster reconstruction	
SDG 9 Industry Innovation & Infrastructure	Innovation Infrastructure			
SDG 10 Inequality	Discrimination			
SDG 11 Sustainable cities & Communities	Sustainable cities Sustainable communities Adequate housing Public transport Solid waste collection			
SDG 12 Consumption & Production	Consumption Production Food availability			
SDG 13 Climate action	Climate response			
SDG 14 Life below water	Water pollution			
SDG 15 Life on land	Urban planning Land management			
SDG 16 Peace, justice and institutions	Enforcement Peace Justice			
SDG 17 Partnership	Stakeholders			

ADDENDUM G: PROCESS OF DOCUMENT ANALYSIS

The following international city resilience frameworks formed part of the document analysis:

- United Nation's Disaster Resilience Scorecard (UNDRR, 2017);
- Rockefeller Foundation's City Resilience Index (Arup, 2014);
- UN-Habitat's City Resilience Profiling Tool (UN-Habitat, 2018); and
- UN-Habitat's City Resilience Action Planning Tool (UN-Habitat, 2019).

Each of the above frameworks contain categories that are considered essential in a city resilience strategy. Each framework, although having the same meaning, uses different descriptions for its category. The United Nations Office for Disaster Risk Reduction refers to “essentials” (UNDRR, 2017:4); the City Resilience Framework refers to “categories” and included goals, indicators and variable (Rockefeller & Arup, 2015:7); the City Resilience Profiling Tool is divided in four SET's that provides an in-depth picture of a city (UN-HABITAT, 2017:26) and the City Resilience Action Planning Tool refers to pillars (UN-HABITAT, 2018:09). For this study the descriptions are referred to as “codes”.

The description used for all the frameworks was “code” so as to identify reference to similar “codes” in the different frameworks. For example:

Essential 1 Organise for disaster resilience as considered in the Disaster Resilience Scorecard is the first code. This code description in the Disaster Resilience Scorecard is to put in place an **organizational structure** and identify the necessary **processes** to understand and act on reducing disaster risks. A further description of the code includes, among others, “*exercising **strong leadership** and commitment at the highest elected level within the city authority, such as the Mayor*”. The assumption of this description is that **strong leadership** and **commitment** from city authority is requested. Also found in the description of this code is “*to establish necessary strategies, acts, laws, codes*”. The assumption from this description is to have **legislation** of disaster resilience included into existing policies.

The City Resilience Framework referred to “leadership and coordination” and emphasised the critical importance of **leadership**, in the form of a committed city government”. The City Resilience Profiling Tool included the **role and place** of the

different public administrators in their code of local government and stakeholders. The City Resilience Action Planning Tool referred to **urban governance** that is processes and **structures** that allow all local actors to participate in the decision-making process. The first theme “**Governance and Legislation**” was informed by key words such as organizational structure, strong leadership, commitment, legislation, role and place, structure. Governance encompasses the system by which an organisation is controlled and operates and the mechanisms by which it, and its people, are held to account.

The analysis process described above was undertaken with all four frameworks’ unique pillars, essentials, categories, and sets, respectively that are referred to collectively as codes. Each has been highlighted in a different colour. See table 1 below.

The analysis took place in the following phases as described by Braun and Clarke (2006:87):

- **Phase One - Familiarising with data:** The researcher identified read and re-read the four different international frameworks for disaster resilience in cities, the Sendai Framework and the SDG several times, noting initial ideas.
- **Phase Two - Generating initial codes:** In this phase, the researcher generated initial codes by coding interesting features of the respondents’ responses.
- **Phase Three - Searching for themes:** The researcher then used the different codes and grouped them so that categories and themes could begin to emerge.
- **Phase Four - Reviewing themes:** After a few weeks’ break, the researcher reviewed the categories and themes to ensure that the themes were, in fact, themes.
- **Phase Five - Defining and naming themes:** In this phase, the researcher refined the themes to identify the core of what each theme was about and ensure that its name captured what it was meant to.
- **Phase Six - Producing the report:** The researcher then began to write up the data with supporting verbatim quotations from the transcriptions.

From the analysis, as indicated in the table below, ten themes emerged that are regarded as indicators. Also, to note is that it was found that some indicators are a duplication.

The meaning of the colours in the table is to identify the applicable framework and its codes and to show how the rest of the frameworks refers to such code.

Code	Disaster Resilience Scorecard (UNDRR, 2017)	City Resilience Framework (Rockefeller & Arup, 2014)	City Resilience Profiling Tool (UN-Habitat, 2017)	City Resilience Action Planning Tool (UN-Habitat, 2018)	Sustainable Development Goal	Sendai Framework	Themes are the Indicators that emerged
Essential 1 Organise for disaster resilience	Strong leadership and commitment at the highest elected level within the city authority, such as the Mayor. Establish necessary strategies, acts, laws, codes (p. 10)	Critical importance of leadership in form of committed city government (p. 5)	Role and place of the different public administrators (p. 32)	Urban Governance (p. 9)	Broaden and strengthen the participation of developing countries in the institutions of global governance (p. 30)	Strengthening disaster risk governance to manage disaster risk (p. 17)	Governance & Legislation
Essential 2 Identify & understand risk	Identify hazards, exposures and vulnerabilities in at least the “most probable” and “most severe” (p. 18)	Reduce exposure & fragility (p. 12)	Identify Shock, stresses & challenges (p. 34)	Urban disaster risk management (p. 9)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	Understanding disaster risk (p. 14)	Disaster Risk Management
Essential 3 Strengthen financial capacity	Understand the economic impact of disasters and the need for investment in resilience (p. 26)	Availability of financial resources and contingency funds (p. 11)	Economy & livelihood (p. 30)	Urban economy and society (p. 9)	Promote sustained, inclusive and sustainable economic growth , full and productive employment and decent work for all (p. 25)	Investing in disaster risk reduction for resilience (p. 18)	Financial Capacity
Essential 4 Pursue resilient urban development and design	The built environment needs to be assessed and made resilient (p. 34)	Development plans and land use regulations (p. 13)	Urban planning and design (p. 36)	Urban planning & land management (p. 9)	Direct participation structure of civil society in urban planning and management (p. 14)	Addressing land use and urban planning , building codes, environmental and resource management and health and safety	Urban development Governance & Legislation

						standards , and update them (p. 17)	
Essential 05: Safeguard natural buffers to enhance the protective functions offered by natural ecosystems	Identify, protect and monitor critical ecosystems services that confer a disaster resilience benefit (p. 42)	Ecosystem management (p. 12)	Protect Spatial context (p. 30)	Environmental management (p. 37)	Ensure availability and sustainable management of water and sanitation for all (p. 22)	It is urgent and critical to anticipate, plan for and reduce disaster risk in order to more effectively protect ecosystems (p. 10)	Environment & Ecosystem Protection
Essential 6 Strengthen institutional capacity	Ensure that all institutions relevant to a city's resilience have the capabilities they need to discharge their roles (p. 48)	Collective identity and mutual support (p. 11)	Identify city's capacity to face those threats (p. 34)	Organisational capacity (p. 40)	Improve education, awareness raising and human and institutional capacity (p. 27)	Means of implementation in capacity-building (p. 10)	Institutional Capacity
Essential 7 Understand & strengthen social capacity	Ensure understanding and strengthening of societal capacity for resilience (p. 56)	Collective identity and mutual support (p. 11)	Promoting the social inclusion and protection (p. 36)	Participation & Civil society (p. 25)	Increasing the capacity of local communities to pursue sustainable livelihood opportunities (p. 29)	Investing in social, ... capacity (p. 11)	Social capacity
Essential 8 Increase infrastructure resilience	Assess the capacity and adequacy of, as well as linkages between, critical infrastructure systems and upgrade these as necessary (p. 64)	Continuity of critical services (p. 12)	Urban elements (basic services) (p. 36)	Resilient Infrastructure (p. 18)	Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation (p. 22)	Substantially reduce disaster damage to critical infrastructure and disruption of basic services (p. 12)	Critical Infrastructure Basic Service Delivery
Essential 9 Ensure effective disaster response	Disaster Response Plans (p. 80)	Reduced physical exposure and vulnerability (p. 12)	Risk management & emergency response (p.35)	Preparedness and response (p. 35)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	improving preparedness (p. 10)	Disaster Risk Management

Essential 10 Expedite recovery & build back better	Ensure sufficient pre-disaster plans according to risks identified (p. 90)	Business continuity planning (p. 11)	Recovery (p. 35)	Recovery and reconstruction (p. 35)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	Use post-disaster recovery and reconstruction to “ Build Back Better ” (p. 10)	Disaster Risk Management
Category 1 Health & Wellbeing	Strengthen institutional capacity for resilience (p. 30)	Safeguard human health and safety (p. 10)	Basic infrastructure (p. 39)	Health & Education (p. 28)	Ensure healthy lives and promote well-being for all at all ages (p. 18)	Improving the social, health and economic well-being of individuals, communities and countries (p. 25)	Basic Service delivery Institutional Capacity
Category 2 Economy & Society	Strengthen financial capacity for resilience (p. 18)	Includes law enforcement , crime prevention, justice, and emergency management (p. 11)	Urban elements (basic services) (p. 36)	Urban Economy & Society (p. 32)	Promote sustained, inclusive and sustainable economic growth , full and productive employment and decent work for all (p. 21)	Taking into account economic, social, structural, technological and environmental impact assessments (p. 19)	Financial capacity Social Capacity
Category 3 Urban systems & Services	Essential 05: Safeguard natural buffers to enhance the protective functions offered by natural ecosystems (p. 26)	Active management and maintenance of ecosystems and infrastructure , and contingency planning (p. 12)	Ecosystem services (p. 44)	Urban planning and environment (p. 25)	Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation (p. 22)	It is urgent and critical to anticipate, plan for and reduce disaster risk in order to more effectively protect ecosystems (p. 10)	Critical infrastructure Environment & Ecosystem protection
Category 4 Leadership & Strategy	Organise for resilience (p. 10)	Effective leadership and management (p. 13)	Local Government and Public administration (p. 30)	Governance structure (p. 24)	Broaden and strengthen the participation of developing countries in the institutions of global governance (p. 30)	Involvement of political leadership in every country at all levels (p. 12)	Government & Legislation

Set 1 City identification	Identify & Understand risk (p. 14)	Reduced exposure & fragility (p. 12)	Identify Hazards & Challenges (p. 30)	Planning information systems (p. 25)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	Understanding disaster risk (p. 14)	Disaster Risk Management
Set 2 Local government & stakeholders	Institutional capacity (p. 30)	Empowered stakeholders (p. 13)	Stakeholder mapping (p. 32)	Coordination & cooperation with stakeholders (p. 24)	Broaden and strengthen the participation of developing countries in the institutions of global governance (p. 30)	Generating political commitment and focusing and catalysing actions by a wide range of stakeholders at all levels (p. 9)	Institutional Capacity Societal capacity
Set 3 Shock, stresses & challenges	Identify & Understand risk (p. 14)	Reduced exposure & fragility (p. 12)	Stress and shock identification (p. 34)	Urban disaster risk management (p. 34)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction (p. 21)	Disaster Risk Management
Set 4 Urban elements (Basic Services)	Identify & Understand risk (p. 14)	Continuity of critical services (p. 12)	Basic infrastructure (p. 36)	Resilient infrastructure & basic services (p. 28)	Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation (p. 24)	Substantially reduce disaster damage to critical infrastructure and disruption of basic services (p. 12)	Basic Service Delivery Critical infrastructure
Pillar 1 Urban governance	Organising & Coordination (p. 10)	Effective leadership and management (p. 13)	Local government & stakeholders (p. 32)	Governance structures (p. 24)	Broaden and strengthen the participation of developing countries in the institutions of global governance (p. 30)	Strengthening disaster risk governance to manage disaster risk (p. 17)	Governance & Legislation
Pillar 2 Urban planning and environment	Pursue Resilient Urban Development (p. 22)	Integrated development planning (p. 13)	Vulnerability reduction measures (p. 35)	Urban planning and land management (p. 25)	Make cities and human settlements inclusive, safe ,	Address land use and urban planning , building codes,	Urban development

					resilient and sustainable (p. 25)	environmental and resource management and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management (p.17)	Environment & Ecosystem protection Disaster Risk Management
Pillar 3 Resilient Infrastructure & basic services	Increase infrastructure resilience (p. 38)	Integrated development planning (p. 13)	Urban elements: Basic infrastructure (p. 36)	Resilient infrastructure & basic services (p. 28)	Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation (p. 24)	Substantially reduce disaster damage to critical infrastructure and disruption of basic services (p. 12)	Critical infrastructure Basic service delivery
Pillar 4 Urban Economy and society	Strengthen financial capacity for resilience (p. 18)	Availability of financial resources and contingency funds (p. 11)	Economy & Livelihoods (p. 30)	Urban economy, safety & basic services (p. 32)	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (p. 21)	Taking into account economic, social, structural, technological and environmental impact assessments (p. 19)	Financial capacity Social capacity
Pillar 5 Urban disaster risk management	Identify, understand and use current and future risk scenarios (p. 14)	Risk management (p. 12)	Risk management & emergency response (p. 35)	Urban disaster risk management (p. 34)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 25)	To assign, as appropriate, clear roles and tasks to community representatives within disaster risk management institution (p. 17)	Disaster Risk management

1 No poverty	Strengthen societal capacity (p. 34)	Minimal human vulnerability (p. 10)	Access to social protection (p. 42)	Environmental & risk mapping high areas of poverty (p. 17)	End poverty in all its forms everywhere (p. 18)	Building of resilience to disasters with a renewed sense of urgency within the context of sustainable development and poverty eradication (p. 9)	Social capacity
2 No hunger	Strengthen societal capacity (p. 34)	Minimal human vulnerability (p. 10)	Social inclusion and protection (p. 42)	Identify the poorest areas of the city (p. 17)	End hunger , achieve food security and improved nutrition and promote sustainable agriculture (p. 18)	To strengthen and broaden international efforts aimed at eradicating hunger and poverty through disaster risk reduction (p. 20)	Social capacity
3 Good health and wellbeing	Health care centres, hospitals (p. 38)	Adequate safeguards to human life and health (p. 10)	Access to basic social services (p. 42)	Resilient infrastructure and basic services (p. 18)	Ensure healthy lives and promote well-being for all at all ages (19)	To enhance the resilience of national health systems (p. 19)	Basic Service delivery
4 Quality education	Public education and awareness (p. 31)	Adequate safeguards to human life and health (p. 10)	Access to basic social services (p. 42)	health and education facilities (p. 28)	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (p. 20)	To develop effective global and regional campaigns as instruments for public awareness and education (p. 16)	Social capacity Institutional capacity
5 Gender equality	Social networks “Leave no one behind” (p. 35)	Diverse livelihoods and employment (p. 10)	Gender equality and women’s participation (p. 46)	Participation and Civil Society - systematic gender-balance in decision making processes (p. 25)	Achieve gender equality and empower all women and girls (p. 22)	Promote gender equitable (p. 21)	Social capacity

6 Clean water and sanitation	Basic infrastructure deficits such as water, drainage and sanitation (p. 22)	Minimal human vulnerability (p. 10)	Basic infrastructure (p. 39)	Water , drainage and sanitation (p. 29)	Ensure availability and sustainable management of water and sanitation for all (p. 22)	To promote the resilience of new and existing critical infrastructure , including water (p. 21)	Basic Service Delivery Critical Infrastructure
7 Affordable and clean energy	Energy infrastructure corridors remain safe (p. 40)	Minimal human vulnerability (p. 10)	Basic infrastructure (p. 39)	Mechanisms in place in case of major disruption of energy supply (p. 30)	Ensure access to affordable, reliable, sustainable and modern energy for all (p.23)	To ensure the continuity of operations and planning, including social and economic recovery, and the provision of basic services in the post-disaster phase (p. 21)	Basic Service Delivery Critical Infrastructure
8 Decent work and economic growth	Business continuity and economic reboot. (p. 48)	Diverse livelihoods and employment (p. 10)	Economic stability & diversity (p. 43)	Urban economy and society (p. 9)	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (p. 23)	Improving the social, health and economic well-being of individuals, communities and countries (p. 25)	Social Capacity Financial Capacity
9 Industry, innovation and infrastructure	Infrastructure plan (p. 11)	Continuity of critical services (p. 12)	Basic infrastructure (p. 39)	Resilient infrastructure and basic services (p. 9)	Build resilient infrastructure , promote inclusive and sustainable industrialization and foster innovation (p. 24)	Investing in disaster risk reduction for resilience (p. 36)	Critical Infrastructure Basic Service Delivery Financial Capacity
10 Reduce inequalities	X (0)	Social stability and security (p. 11)	Access to sustainable basic physical infrastructure for all, without discrimination (p. 39)	Tackle inequality through the provision of inclusive, safe and accessible public spaces (p. 28)	Reduce inequality within and among countries (p. 25)	More dedicated action needs to be focused on tackling underlying disaster risk drivers, such as the consequences of poverty and inequality (p. 10)	Social Capacity

11 Sustainable cities and communities	Incorporating exemplary sustainable design principles into new development (p. 22)	Sustainable city economy (p. 11)	Address for more inclusive, resilient and sustainable cities (p. 46)	Different economic outputs provide cities with the ability for sustainable growth (p. 32)	Make cities and human settlements inclusive, safe, resilient and sustainable (p. 26)	To incorporate disaster risk reduction measures into multilateral and bilateral development assistance programmes within and across all sectors, as appropriate, related to poverty reduction, sustainable development (p. 25)	Urban development Financial capacity Institutional Capacity Social Capacity Disaster Risk Management
12 Responsible consumption and production	Land use zoning – agricultural production (p. 23)	Minimal human vulnerability (p. 10)	Ecological footprint (p. 44)	Food security (p. 33)	Ensure sustainable consumption and production patterns (p. 26)	The development, strengthening and implementation of relevant policies, plans, practices and mechanisms need to aim at coherence, as appropriate, across sustainable development and growth, food security (p. 13)	Environment & ecosystem management
13 Climate action	Anticipating changes from climate trends (p. 26)	Integrated development planning (p. 13)	Preventing climate change and reducing further loss of biodiversity (p. 46)	Data on natural hazards and the effects of climate change (p. 26)	Take urgent action to combat climate change and its impacts (p. 27)	To incorporate disaster risk reduction measures and adaptation to climate change (p. 25)	Environment & ecosystem management
14 Life below water	Damage to environment is minimized (p. 3)	Active management and maintenance of ecosystems and infrastructure (p. 12)	Environmental quality (p. 44)	Water pollution impacts due to poor design and management (p. 29)	Conserve and sustainably use the oceans, seas and marine resources for sustainable development (p. 28)	Policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. (p. 14)	Environment & ecosystem management

15 Life on land	Suitable land for future development (p. 22)	Active management and maintenance of ecosystems and infrastructure (p. 12)	Environmental quality (p. 44)	Urban planning and land management (p. 25)	Protect, restore and promote sustainable use of terrestrial ecosystems , sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss (p. 29)	To promote the mainstreaming of disaster risk assessments into land-use policy (p. 19)	Urban planning Environment & ecosystem protection
16 Peace, justice and strong institutions	Strengthen Institutional Capacity (p. 30)	Law enforcement, crime prevention, justice , and emergency management. (p. 11)	Criminal justice and law enforcement (p. 41)	Policies and legislation (p. 54)	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels (p. 30)	To encourage the adoption of policies and programmes addressing disaster-induced human mobility to strengthen the resilience of affected people and that of host communities, in accordance with national laws and circumstances (p. 20)	Institutional Capacity Law enforcement Governance & Legislation
17 Partnerships for the goals	Public-private partnerships (p. 19)	Collective identity and mutual support (p. 11)	Stakeholder relations (p. 33)	Participation & civil society (p. 24)	Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development (p. 30)	Strengthening disaster risk governance for prevention, mitigation, preparedness, response, recovery and rehabilitation is therefore necessary and fosters collaboration and partnership across mechanisms (p. 17)	Institutional Capacity

Priority 1 Understanding disaster risk	Understand risk scenarios (p. 14)	Reduced physical exposure and vulnerability (p. 12)	Hazards & challenges (p. 30)	Risk awareness and knowledge (p. 34)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 26)	Understanding disaster risk (p. 14)	Disaster Risk Management
Priority 2: Strengthening disaster risk governance to manage disaster risk	Governance and financial capacity (p. 4)	Effective leadership and management (p. 13)	Empowers comprehensive and meaningful participation in all governance processes in order to develop resilience (p. 23)	Urban governance (p. 46)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 26)	Strengthening disaster risk governance to manage disaster risk (p. 17)	Governance & Legislation Disaster Risk Management
Priority 3: Investing in disaster risk reduction for resilience	Invest in reducing the risks (p. 18)	Availability of financial resources and contingency funds (p. 11)	Risk reduction measures (p. 35)	Urban economy and society (p. 9)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 26)	Investing in disaster risk reduction for resilience (p. 18)	Financial capacity Disaster Risk Management
Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction	Lessons learnt - Helping city understand how it can build back better (p. 49)	Effective leadership and management (p. 13)	Risk management & emergency response (p. 35)	Urban disaster risk management (p. 9)	Make cities and human settlements inclusive, safe , resilient and sustainable (p. 26)	Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction (p. 21)	Disaster Risk Management Governance & leadership

ADDENDUM H: CITY OF TSHWANE DISASTER RESILIENCE FRAMEWORK

[CoT Disaster Resilience Framework November 2021.xlsm](#)



CoT Disaster
Resilience Framework

ADDENDUM I: LETTER FROM THE LANGUAGE EDITOR VERIFYING THE CORRECT LANGUAGE USE IN THE THESIS

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Edit: Tanja Terblanche

To whom it may concern,

I, Marielle Tappan, trading under the name MT Editorial, hereby confirm that I am a language editor:

I have extensive experience in the field of language and publishing and received my Bachelors of Information Science in Publishing from the University of Pretoria. I am also a registered member of the Southern African Freelancer's Association.

I hereby declare that the editing done for any client is done with the utmost diligence and the full appreciation of the English language and all of its intricacies, as was done for edited sections of this document.

If there are any other queries, please do not hesitate to contact me.

Kindest Regards,

Marielle Tappan
Owner, MT Editorial
(BIS) Publishing
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Marielle Tappan

ADDENDUM J: LETTER FROM REFERENCE EDITOR VERIFYING THE ACCURATE CONTROL OF THE REFERENCES

University Editor (CC)

Certificate of English Editing

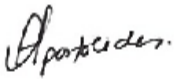
This document certifies that we edited the manuscript indicated below for references only.

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The author's contents and intentions were unaltered during the editing process. Manuscripts with this certification should be grammatically ready for publication; however, the author/s have the final choice to accept or reject our suggestions and changes. If you have any questions regarding the edited document, kindly contact info@uedit.org or visit us at www.uedit.org

 Signed by the editor in Pretoria

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