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Exploring Custodianship Roles and Responsibilities for Cadastral Data in the Context of the South African Spatial Data Infrastructure

By

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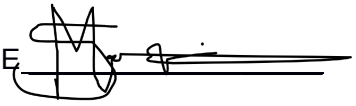
DECLARATION

I, Mokgethi Sam Motswenyane, declare that the dissertation, which I hereby submit for the degree MSc (Geoinformatics) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

SIGNATURE  Date 11/05/2021

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ABSTRACT

Cadastral data describe the legal boundaries of properties, are the basis for land administration, and are essential for land reform. In South Africa, the *Land Survey Act* assigns responsibility for cadastral data to the Provincial Surveyor-General (SG) and responsibility for consolidating a national cadastral data set to the Chief Surveyor-General (CSG). However, in practice, some municipalities, especially metropolitan municipalities, maintain and manage cadastral data for their areas of jurisdiction and share their data sets with the respective Provincial SG Offices. The metropolitan municipalities need cadastral data that are up to date because of rapid urbanisation, land development and sustainable development. Presently, there is no clear co-ordination and co-operation among stakeholders, there are no collaborative agreements regarding activities of mutual interest, and organs of state are working in silos.

The *Spatial Data Infrastructure Act*, (No. 54 of 2003) (SDI Act), establishes the *South African Spatial Data Infrastructure* (SASDI) as a national technical, institutional and policy framework to coordinate the collection and management of geospatial information and its significance is to promote coordination and collaboration amongst organs of state in order to avoid duplication of geospatial data capture and to save costs. The SDI Act also underlines the importance of promoting access to spatial information. The *Base Data Set Custodianship Policy* makes provision for the appointment of organisations as base data set custodians, and to hold them accountable for the geospatial data they are entrusted with. The lack of working collaboratively fosters uncertainties around respective custodianship roles and responsibilities of municipalities for cadastral data within the SASDI.

Cadastral data are one of the SASDI base data sets and this presented an opportunity to clarify custodianship roles and responsibilities. To achieve this, the study commenced with a literature review of the legislative and policy environment for local government, cadastral data and the SASDI. Thereafter, data were collected through questionnaires, interviews, and observation. The data were then analysed to understand how three Gauteng metropolitan municipalities, the CSG and the Gauteng Provincial SG Office, currently understand and perform their roles and responsibilities for cadastral data. Based on the results, it is recommended that municipalities should be appointed as contributing base data set custodians for cadastral data and that they should be made responsible and accountable for the management and maintenance of data sets under their jurisdiction. A coordinating custodian should be appointed to consolidate data from different municipalities into a national data set. The results of this dissertation pave the way for further studies into SASDI collaboration models and the cadastral data value chain in South Africa.

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The following Setswana idiom does not have a word to word translation of English because it loses its inherent richness when it is directly translated. However it has a meaning and its meaning is presented in English below:

"Kgetsi ya tsie e kgonwa ka go tshwaraganelwa."

"Working together through collaborative efforts, many issues can be addressed."

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GLOSSARY OF ACRONYMS

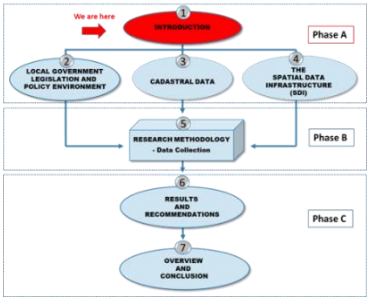
2D	Two–dimensional
3D	Three-dimensional
4D	Four-dimensional
AGIZO	Agizo Solutions Professional Consultancy
APIs	Application Programming Interfaces
APSDI	Asia-Pacific Spatial Data Infrastructure
ARDSI	African Regional Spatial Data Infrastructure
AUVs	Autonomous Underwater Vehicles
BDSCs	Base Data Set Custodians
CAD	Computer-aided design
CCDM	Core Cadastral Domain Model
CCNLIS	Coordinating Committee for the National Land Information System
CDCS	Cadastral Data Content Standard
CGIS	Corporate Geo-Informatics
CIS	Cadastral Information System
CLTP	Communal Land Tenure Policy
CoE	City of Ekurhuleni
COFUR	Cost of Fulfilling User Request
CoJ	City of Johannesburg
COGTA	Department of Cooperative Governance and Traditional Affairs
CoT	City of Tshwane
CSDGM	Content Standard for Digital Geospatial Metadata
CSG	Chief Surveyor-General
CSI	Committee for Spatial Information
CSIR	Council for Scientific and Industrial Research
CSM	Cadastral surveys management
DAFF	Department of Agriculture, Fisheries and Forestry
DALRRD	Department of Agriculture, Land Reform and Rural Development
DC	District Council
DFA	Development Facilitation Act
DG	Director General
DLA	Department of Land Affairs
DMAs	District Management Areas
DMP	Disaster Management Plans
DOI	Digital Object Identifier
DPCR	Data Capture Project Register
DPLG	Department of Provincial and Local Government
DPME	Department of Performance Monitoring and Evaluation
DRDLR	Department of Rural Development and Land Reform
DRS	Deeds registration system
EGII	European Geographic Information Infrastructure
EMC	Electronic Metadata Catalogue
Erf	a piece of land registered in a deeds registry as an erf, lot, plot or stand.
Esri-SA	Environmental Systems Research Institute – South Africa
EU	European Union

EUROGI	European Umbrella Organisation for Geographic Information
FFC	Financial and Fiscal Commission
FGDC	Federal Geographic Data Committee
FIG	International Federation of Surveyors
GAP	Gap analysis
GGIM	Global Geospatial Information Management
GI	Geo-information
GIS	Geographic Information Systems
GISc	Geographical Information Science
GISSA	Geo-Information Society of South Africa
GLTN	Global Land Tool Network
GNSS	Global Navigation Satellite System
GNP	Gross national product
GPS	Global Positioning System
GPSSBC	General Public Service Sector Bargaining Council
GSDI	Global Spatial Data Infrastructure
G&S	Goods and Services
ICA	International Cartographic Association
ICT	Information and Communication Technology
ID	Identifier
IDP	Integrated Development Plan
IHO	International Hydrographic Organisation
INSPIRE	Infrastructure for Spatial Information in Europe
ISO	International Standard Organisation
JR	A farm portion is classified by a Registration Division
LADM	Land Administrative Domain Model
LAS	Land Administration Systems
LASDAP	Local Authority Service Development Action Plans
LATF	Local Authorities Transfer Fund
LIS	Land Information System
LISM	Land Information System Management
LIDAR	Light Detection and Ranging
MAYCO	Mayoral Committee
MDB	Municipal Demarcation Board
MFMA	Municipal finance management Act
MIIF	Municipal Infrastructure Investment Framework
MPC	Multipurpose Cadastre
MPRA	Municipal Property Rates Act
mSCOA	Municipal Standard Chart of Accounts
MSDF	Municipal Space Development Framework
MSL	Mean Sea Level
NA	National Assembly
NCOP	National Council of Provinces
NCSS	National Control Survey System
NDP	National Development Plan
NES	National Exchange Standard
NGI	National Geo-spatial Information
NGMS	National Geomatics Management Services
NGO	Non-Governmental Organisation
NHBRC	National Home Builders Registration Council
NICT	National Information and Communication Technology

NLIS	National Land Information System
NPM	New Public Management
NPRS	National Programme for Remote Sensing
NRF	National Research Foundation
NSDI	National Spatial Data Infrastructure
NSIF	National Spatial Information Framework
OCIO	Office of the Chief Information Officer
O&C IMS	Oceans and Coast Information Management System
OECD	Organisation for Economic Cooperation and Development
OGC	Open Geospatial Consortium
PAIA	Promotion of Access to Information Act
PCGIAP	Permanent Committee on GIS Infrastructure for Asia and the Pacific
PGMA	Preliminary General Management Area
POPI	Protection of Personal Information
PSC	Project Steering Committee
QMS	Quality Management System
Rem.	Remainder
RDP	Reconstruction and Development Programme
RFI	Request for Information
ROI	Return of Investment
RRRs	Rights, Restrictions and Responsibilities
SABS	South African Bureau of Standards
SADRS	South African Deeds Registration System
SAEON	South African Environmental Observation Network
SAGC	South African Geomatics Council
SAGI	South African Institute of Geomatics
SAGIMS	South African Geospatial Information Management Strategy
SANBI	South African National Biodiversity Institute
SANS	South African National Standard
SANSA	South African National Space Agency
SASDI	South African Spatial Data Infrastructure
SDF	Spatial Development Frameworks
SDI	Spatial Data Infrastructure
SG	Surveyor-General
SHR	Spatial Hierarchy Reasoning
SIU	Special Investigations Unit
SPLUM	Spatial Planning and Land Use Management
STD	Standard
STDM	Social Tenure Domain Model
TC	Technical Committee
TUT	Tshwane University of Technology
UCT	University of Cape Town
UJ	University of Johannesburg
UML	Unified Modelling Language
UN	United Nations
UN ECOSOC	United Nations Economic and Social Council
UN-GGIM	United Nations' Initiative on Global Geospatial Information Management
UN-HABITAT	United Nations Human Settlements Programme
UPI	Unique Parcel Identifier
URISA	Urban and Regional Information Systems Association
USA	United States of America

USNRC	United States National Research Council
UUVs	Unmanned Underwater Vehicles
VGI	Volunteered Geographical Information
WGS84	World Geodetic System 1984
Wits	University of the Witwatersrand
XML	Extensible Mark-Up Language

CHAPTER 1
INTRODUCTION



1.1 Introduction

In South Africa, recent topics such as urbanisation, human rights, governance, customary rights, and land expropriation without compensation expose deep divisions and inequalities present in the ownership of land. These inequalities, caused by apartheid land law and government-driven land reform programmes, trigger disputes over rightful claimants of land and have left many South African citizens without secure land ownership rights (Hull, 2018). To address these land ownership inequalities and to ensure good governance, decision-making and the creation of economic opportunities in both rural and urban populations, it is vital to implement new fruitful land policies. Additionally Bennett et al. (2010) emphasises that there is also need for continual modification of these policies to meet arising land challenges and land administration systems.

Cadastral data refers to all data related to the value, ownership and use of the land administration subsystems (Kalantari et al., 2005). It is described as part of the engine of land administration systems and it is composed of land parcels (otherwise known as the building blocks of cadastral data) (Williamson et al., 2010; Enemark, 2005a). Well-maintained cadastral data are considered as one of the essential data sets for modernising government services. Therefore, it is important that cadastral data stakeholders, through a coordinated and collaborative effort, continuously work at improving the integrity, quality and usability of the cadastral data.

The South African cadastral system is well-supported by legislation. *The Land Survey Act* (No. 8 of 1997) regulates the cadastral system and cadastral surveying of land. The cadastral system is also well-maintained by regulated processes, sufficiently documented and has beacons that physically demarcate the ground in different sizes for different uses. However, the system is not fully integrated because of silos among the organs of state that result in map and register separation. According to *Cadastre 2014*, such separation needs to be abolished; an initiative that is prevalent in the transformation of cadastral systems in many countries (Kaufmann and Steudler, 1998).

To eradicate silos, Williamson et al. (2010) posit that data and information pertaining to land should be organised in a spatial data infrastructure (SDI). SDI can be described as a mechanism that "facilities, services, systems, and installations provide a country, city, or area, with geospatial data and services that is required for the functioning of society" (Coetzee at al., 2019, p.1). In most instances, SDIs are defined in line with "the aspirations and information needs of the societies that they serve at local, national, regional, and global levels" (Kumar and Jailia 2018, p.2).

In South Africa, section 16 of the *Spatial Data Infrastructure Act* (No. 54 of 2003) (SDI Act) echoes similar sentiments, empowering organs of state that are appointed as data custodians to exchange geospatial information in terms of collaborative agreements, and to support one another towards accomplishing synchronised updates of geospatial data sets (Coetzee, et al., 2019). All data custodians are required to comply with the SDI Act and more specifically, to share geospatial data. Currently, however, data custodians are experiencing challenges in the sharing of geospatial data.

The SDI Act further establishes the *South African Spatial Data Infrastructure* (SASDI) and the *Committee for Spatial Information* (CSI). The significance of the SASDI is largely based on roles and responsibilities of base data set custodianship and it is a framework for guiding the sharing of geospatial data (Fourie, 2015b). In principle, the purpose of the SASDI is to promote coordination and collaboration between spatial data producers, from the local level to the national level. However, the reality is that there are uncertainties around the roles and responsibilities of most organs of state for SASDI involvement, and unresolved ambiguities pertaining to the relationship between organs of state in matters relating to their mandates, data ownership, pricing, custodianship, as well as base data set custodianship roles. Consequently, there is limited co-ordination and co-operation among stakeholders.

1.2 Problem Statement

Cadastral data describes the legal boundaries of properties and is the basis for land administration. In South Africa, the *Land Survey Act* assigns responsibility of cadastral data to the Provincial Surveyors-General (SGs) and the responsibility of consolidation of cadastral data to the Chief Surveyor-General (CSG). However, in practice, municipalities maintain and manage the cadastral data for their jurisdictions and share their data sets with the relevant SG. The municipalities need to do this because of rapid changes in the cadastral data caused by urbanisation and land development. Unfortunately, the management and maintenance of cadastral data by municipalities is often done in isolation, resulting in data differences and potential data conflicts. The CSI has identified the cadastral data set as one of the base data sets for the SASDI, and for each base data set, the CSI is identifying and appointing base data set coordinators and base data set custodians. However, there are already underlying uncertainties around custodianship roles and responsibilities of municipalities for cadastral data in terms of SASDI involvement. Consequently, there is no clear co-ordination and co-operation among stakeholders.

1.3 Research Question

To what extent can municipalities be considered to have custodianship roles for cadastral data within the SASDI?

1.4 Research Aim and Objectives

1.4.1 Research Aim

The intent of the study is to understand how cadastral data are currently maintained and to make recommendations on custodianship roles and responsibilities of municipalities for cadastral data within the SASDI.

1.4.2 Research Objectives

The following objectives assisted to achieve the research aim:

1. To understand the legislative and policy environment for:
   1.1 Local government (particularly South African local government)
   1.2 Cadastral data (particularly South African cadastral data)
   1.3 SDI (particularly SASDI)
2. To analyse the current roles of metropolitan municipalities, the CSG and Provincial SGs in handling cadastral data.
3. Based on the results, recommend how municipalities can contribute to custodianship roles and responsibilities in the SASDI, and make conclusions.

1.5 Significance of the Research

It is anticipated that the results of this research will contribute to the general body of knowledge and establish a deeper understanding of the strengths and limitations of South Africa's cadastral data governance. This dissertation is also crucial for building knowledge in the fields of land surveying and geographic information science (GISc) it is linked to current research agendas in both disciplines.

The study also contributes to the understanding of the governance framework for base data set custodianship principles and custodianship roles and responsibilities. Studies dealing with SDI base data set coordinator and custodian governance models, within the South African context, are lacking. The research embraces the custodian governance model as it promotes cooperative relationships among base data set custodians and other organisations to ensure access to, and availability of, relevant base data sets. Moreover, this study contributes to the understanding of geospatial information-related legislation and policies in South Africa, thus raising awareness of applicable policies and regulations governing spatial technologies and areas of practice. In exchange, this will protect intellectual property, ensure that spatial data sets are used efficiently and ethically.

This research is driven by the need to contribute to resolving what is widely acknowledged as a big problem to local SDI implementation, namely the roles and responsibilities of municipalities for cadastral data. The research further highlight the fact that a properly implemented local SDI provides an enabling decision making and accountability structure through which a local geospatial information community cooperates to achieve shared interests. The thematic and spatial scope, extent of mandate and funds, and technological expertise of these municipalities vary. It is impossible to create appropriate, scalable, generally accepted local SDI governance solutions without a clear theoretical foundation for understanding local SDI governance and its priority issues.

1.6 Outline of the Study

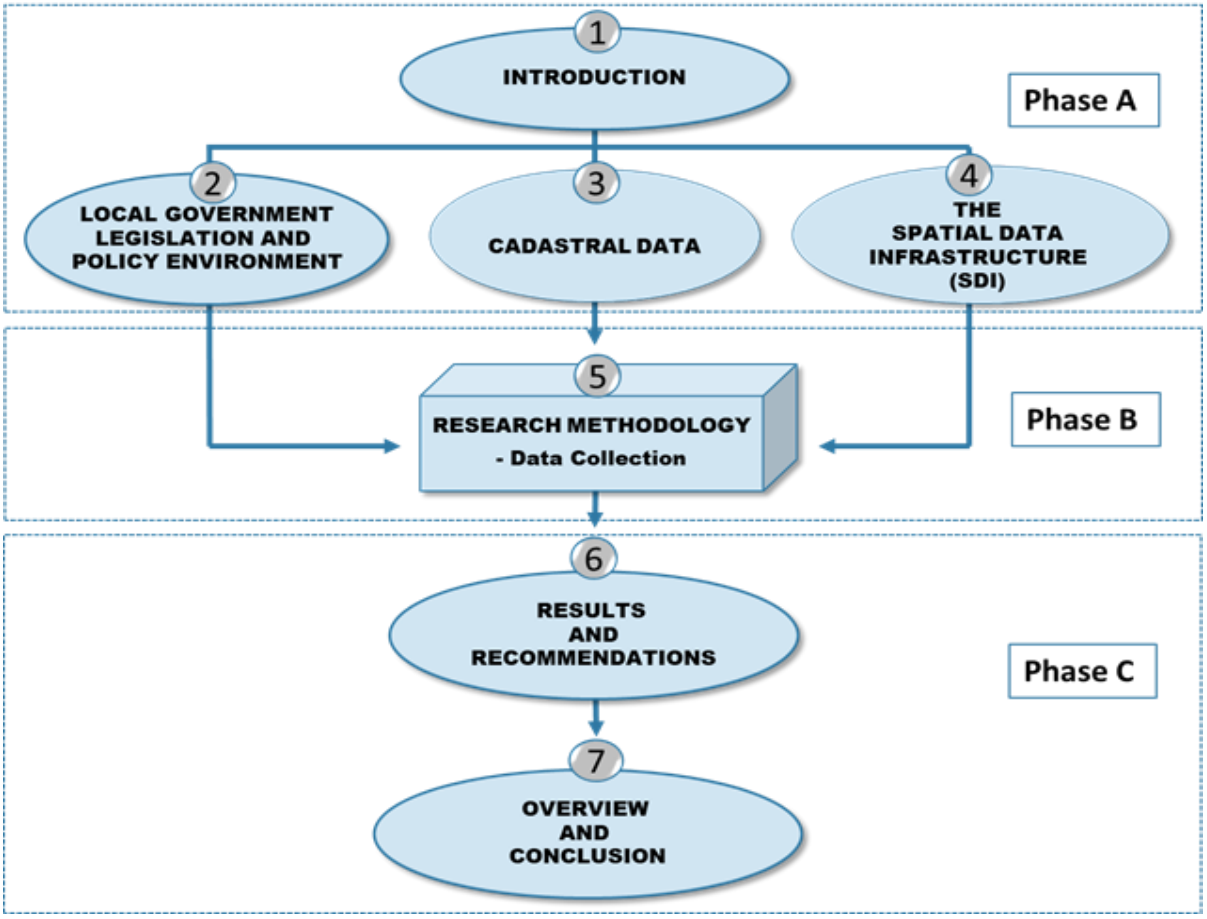


Figure 1: Outline of the study

Figure 1 illustrates the structure of the dissertation. The intention of the study is to identify all relevant legislation and policies that define the role of a municipality in South Africa and to describe the legislative and policy environment that defines how cadastral data should be captured, collected, maintained and managed in South Africa. There are four research objectives. The first objective is to understand the legislative and policy environment for local government, cadastral data and the SASDI. The second objective is to analyse the current roles of metropolitan municipalities, the CSG and Provincial SGs in handling cadastral data. The next objective is to propose how municipalities can contribute to custodianship roles and responsibilities in the SASDI. And the final objective is to make recommendations and draw conclusions based on the results.

The research follows a systematic review of literature, questionnaires, interviews, and non-participation observations at the SASDI workshop. This research was exploratory, inductive or qualitative in nature. This research is based on the relationship between theoretical practicalities and functional evidence. The empirical review was shaped by the theoretical basis of the study, which influenced the development of the research methods, and the research results. In Chapters 5 and 6, all of these data collection channels, as well as the implementation of the analysis, are comprehensively explained, for example, through the flowchart or research matrix and the results.

The theoretical foundation of the dissertation was established by a literature review, which is covered in chapters 2, 3, and 4. The literature review was conducted using a variety of sources, including the internet, journals, and articles, to name a few. Different pieces of legislations were reviewed in order to understand the legal requirements of local government, cadastral data and SASDI. This is important because the legislation influences the roles and responsibilities of parties involved in cadastral data development or management in the context of SASDI. The research data in this research is drawn from international literature, local literature (from municipal, provincial to national government).

The investigation, comparisons, and benchmarking were all part of the analysis. The three Gauteng province metropolitan municipalities were chosen as the study area to explore custodianship roles and responsibilities for cadastral data in the context of South Africa's spatial data infrastructure. This was done so that the issues could be investigated at the municipal or local government level. It should be noted that figure 1 takes into account all of the study's topics and aligns them with a data collection approach and an analytical framework in order to proffer solutions to the problem statement.

This dissertation is divided into three phases (Phase A, Phase B, and Phase C). This is provided to help readers decide where to begin their exploration. Phase A comprises of the introductory chapter as well as the literature review. The introductory chapter presents the problem statement, research question, research aim and objectives, significance of the study, dissertation overview and outline of the study. The following three chapters review the legislative and policy environment for local government (particularly South African local government), cadastral data (particularly the South African cadastral handling), and spatial data infrastructures (particularly SASDI), respectively. Together, these three chapters contribute to achieving the first objective of the study.

The literature review also provides the theoretical background and preceding discoveries in the field of study. Phase B constitutes the methodology chapter. The chapter clarifies the conceptual structure of the research and offers explanation pertaining to data collection and data analysis methods. In Phase C, the results and findings are described and discussed, the overall conclusion is drawn, and recommendations made. The overall outline of the study is composed of seven chapters, including this introductory chapter:

Chapter 1: The objective of this chapter is to introduce the research described in this dissertation and to give a brief overview of the background to the research. The chapter commences by highlighting the legislative environment and policy environment of local government, cadastral data, and the SASDI. The problem statement, research question, research aim and objectives, significance of the study, the outline of the study, and the maps used in the study are also presented in this chapter.

Chapter 2: The objective of this chapter is to understand the legislative and policy environment of local government in South Africa. This chapter provides an overview on the general context and definition of local government. It then discusses the roles and responsibilities of local governments worldwide and presents the reasons for local government creation. Lastly, the chapter briefly gives an outline of South Africa’s local government administrative framework that guides it as a distinct and independent sphere of government.

Chapter 3: The primary objective of this chapter is to investigate the legislative and policy environment that defines how cadastral data should be captured, collected, maintained, and managed throughout the cadastral value chain in South Africa. It also discusses the capacities of the role

players to maintain and manage the data. The following topics are investigated: cadastral data, historical perspective of cadastral data or information, multipurpose cadastre, cadastral systems, land information systems, e-cadastre, marine cadastre, cadastral data standards, *Land Administrative Domain Model* (LADM), *Social Tenure Domain Model* (STDM), and the South African cadastral systems.

Chapter 4: In this chapter, the main objective is to understand the legislative and policy environment for the SASDI. The chapter starts with a discussion on spatial data infrastructure (SDI), with the intention of clarifying the broader understanding of the origin and concept of SDI, as well as presenting a brief overview of SDI definitions. Included in this chapter are also discussions on the components and nature of SDI, and an overview of the SDI roles, arrangements, and role players. The chapter concludes with information on the South African National SDI (NSDI), incorporating a discussion of the SDI Act, SASDI and its components and framework.

Chapter 5: This chapter constitutes the methodology chapter. This chapter focuses on the research methods that were applied to collect and investigate the information that was essential in addressing the research objectives. The methods included an extensive desktop review of pertinent literature, application of a questionnaire, individual interviews, and observational research. The process which informed how the research data were collected, collated, and analysed are presented in the form of a research methodology flowchart and a research matrix. The chapter concludes by addressing the various ethical considerations that needed to be adhered to whilst conducting the research.

Chapter 6: This chapter sets out the results of the desktop survey, questionnaire, interviews, and observational research. The survey instruments provided a broad spectrum of understanding regarding the information needed to answer the research objectives and the research question. The results and discussions in this study are widely divided into local government, cadastral data and the SASDI, including CSG and SG Offices.

Chapter 7: The final chapter provides a retrospective look on the work presented in this dissertation and concludes the research by providing some suggestions on the way forward in terms of the custodianship roles and responsibilities of municipalities for cadastral data within the SASDI. Drawing from the research findings and results, further recommendations for future research are presented.

References: Kindly note that this dissertation has been written over the past 3 years and includes several URL references. Unfortunately, for long-standing websites, at least a number of broken links are likely to occur. The sites are constantly updated and revised, and a blog post that's there one day can easily be gone the next.

Annexures: are presented at the end of this dissertation. A questionnaire is provided in Annex A which was used to take stock of the current status of the role and responsibilities of SASDI in terms of cadastral data in a local municipality. A signed ethics submission letter of approval from the research or ethics committee is also provided in Annex B.

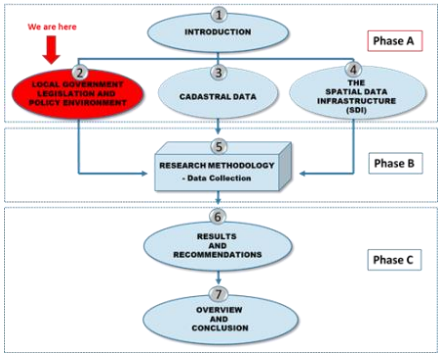
1.7 Maps in the Study

In compilation of the maps used in this study, every effort has been made to offer the most current and accurate information. The maps provided in this dissertation are intended for research purposes only and are presented in Chapter 2 as part of the literature review and Chapter 5 to demarcate the study area. The boundary status has been verified against various sources of information. Table 1, provides an overview of the maps used in this dissertation.

Table 1: Overview of the maps in this dissertation

No.	Item	Description
1	Data Source	The South African Municipal Demarcation Board data sets were used to compile the following maps: • Figure *9*: The map of South African Metropolitan Municipalities (Category A) • *Figure 10*: The map of South African Local Municipalities (Category B) • *Figure 11*: The map of South African District Municipalities (Category C) • Figure 38: Map of the study area
2	Data format	Shapefiles (shp.)
3	Data set names	2016 Boundaries – District Municipalities (South African Municipal Demarcation Board, 2016)
		2016 Boundaries – Local Municipalities (South African Municipal Demarcation Board, 2016)
		2016 Boundaries – Metropolitan Municipalities (South African Municipal Demarcation Board, 2016)
		2007 Boundary – African Continent (Esri, 2016)
4	Software	ArcGIS 10.3

CHAPTER 2
LOCAL GOVERNMENT LEGISLATION AND POLICY ENVIRONMENT



2.1 Chapter Overview

The preceding chapter outlined a skeletal structure for what this research aims to accomplish and how it will be conducted. Understanding the legislative and policy environment of local government in South Africa is the subject of this chapter. The chapter details the definition and understanding of the concept of local government. The South African legislation which envisioned the local government sphere to play a developmental role, by being an instrument of effective and responsive service delivery, is discussed.

In South Africa, local governments maintain and administer information for their jurisdictions, and they share the information with the appropriate government department. Currently, however, there is no clear coordination or cooperation among state organs. As a result, attempts are made in this chapter to fulfil the chapter's objective and relate it to the problem statement, providing the theory behind how and why local government has been and is currently organised. The sections that follow are an attempt to achieve the aim of this chapter and will be useful when compiling the result of this research.

2.2 Local Government

2.2.1 Definition and Characteristics

This section aims to explain the meaning of local government and the reasons behind it, as well as how local government is formed and its characteristics. A definition is essential to ensure a common understanding among different scholars. Without consensus on a definition, discussion about local government is problematic.

Local government is essential because it is the government sector which is nearest to its inhabitants. For the purpose of this study, the definition of local government proposed by Shah and Shah (2006) is adopted, namely, it "refers to explicit countries, societies or entities created by either, conventional legislation of a higher sphere of the centralised government (including national constitutions), by state constitutions, by state or provincial legislation, or by executive order, to deliver a variety of stated services to a relatively small geographically demarcated area" (Shah and Shah, 2006, p.1). Within the context of a local government, it is important to understand traditional governance.

The term can be traced back to ancient times (King, 1990). Before the colonial era in Africa, societies were ruled by traditional leaders (Bennett, 2004). Categories of traditional leadership include king, chief, headman, and sub-headman. Traditional leaders oversaw decision making in terms of customs and traditions of people living under customary land tenure and administered under customary law. According to Hull (2019), customary law is a set of guidelines that is usually not documented but is rather drawn on tradition and is continually evolving.

In most instances around the world, the role of traditional leaders in the governing of people has been weakened by colonial masters. The erosion of the role notwithstanding, traditional leaders have continued to govern their people and land. Thus, traditional governance is a part of local governments in most democratic governments and traditional leaders look after the welfare of their local communities (Bennet, 2004). This definition resonates with that of Goss (2001), who suggests that local government incorporates local or grassroots governance and is found not only in federal or unitary states, but also in most forms of government and political systems.

In this study, the definition of a local government from a customary law or traditional leaders' perspective will be considered the same as any other form of local government definition. This decision is based on the definitions of authors such as Mallon (2005), who posits that a local government consists of local people who have the authority to make decisions or pass laws within their geographic areas.

Several authors (Rhodes, 1997; Stoker, 1999; Dollery and Wallis, 2001; Shah and Shah, 2006) have argued in the literature that the existence of a large network of non-governmental agencies involved in local service delivery or quality of life problems makes it impractical to consider local government as a single entity (Goss, 2001; Shah and Shah, 2006). Thus, the definition of local government should comprise two aspects the authority responsible for local governance and the jurisdictional area that is occupied by residents.

As far as the authority responsible for local governance is concerned, the seminal author Wraith (1964) indicates that local government includes politically appointed councils whose primary objective is to manage services with a high degree of autonomy as contemporary circumstances allow. Humes and Martin (1969) describe local government as an infra-sovereign geospatial structure within a sovereign jurisdiction, with basic divisions like municipalities. More recently, Hasluck (2010) asserts that local government is indeed the sector of government where certain local authorities are empowered, by statute, to issue acts or decisions to modify governance.

Thornhill et al. (2014) posit that a local government tier exists within the complex, interrelated and interdependent tiers of government. Local government is typically the second or third level of government in unitary states, although it is the third or even fourth level of government in federal

states. The United Nations Human Rights Council (2015), however, suggests that local government is commonly defined as the lowest tier of public administration within a given state.

For Shah and Shah (2006), a local government refers to specific national constitutions, institutions or entities, state constitutions, normal legislature of an advanced level of the national government, to the provision of a variety of defined services to a relatively limited geographically delineated region by provincial or state legislation or by executive order. This definition encompasses the second aspect in defining local government, namely the spatial nature of the concept and builds on Golding (1959), who states that local government is the administration of the affairs of the people for their locality.

Several other scholars have tried to build on and give more meaning to the descriptions provided above. According to Mohanty (2001), local government can be seen as a public body, be empowered to determine and manage a limited set of public policies in a relatively small area. Therefore, it can be said that a local government has its local area, local authority, local inhabitants, local autonomy, and local finances. Countries throughout the world make use of local governments for administrative purposes and service delivery. Local government can be defined as a municipality or entity that has legislative authority and functions within a defined geographical region in a State.

Thornhill (2008) indicates that the local government sphere is the principal point of communication between a citizen and a government organisation. This communication enhances the quality of people's lives by delivering legitimate services effectively and efficiently. According to the definition given by the *Organisation for Economic Cooperation and Development* (OECD), a local government is based on fiscal governance and has legislative and executive authority over an area corresponding to a territorial limit and a certain group of people (OECD, 2016). Ndreu (2018) concurs, adding that local government is a government body elected by the people.

Local governments need funds commensurate with their duties, transparency, and obligations to be sustainable, but also suffer from acute funding shortages. In general, funds are collected from national grant subsidies, local government user fees, local taxes, loan capital financing and private financial partnerships. Local governments have divisions dedicated to deal with their operating budget, tax operations and local financial needs (OECD, 2016).

According to Schaeffer (2004, p.7) "local governments are to be kept accountable to governments at higher levels. Government departments at the highest level also set out the rules under which local governments work. Additionally, higher-level governments allocate almost a quarter of their funds by fiscal transfers to local governments. As a consequence, local governments still have a degree of oversight and accountability to higher departments".

In certain nations, the areas are not well defined between the local governments and central government. For example, when a province is under military rule the government level is not separate from the central government. By definition, an entity is regarded as local government only if it has the right to own assets and raise funds, has some control in spending and is able to appoint its own officers, regardless of external administration (Schaeffer, 2004).

The examination of the meanings referred to above indicates that the term local government combines a number of elements, namely the presence of a local authority governed by statute, with independence restricted by the state government and a local population across a given territory

(Wilson and Game, 2006). Some of these meanings clarify the fact that local government is facing issues related to the delivery of services. For example, by municipalities, local councils may offer goods and services to citizens living within their particular jurisdictions. From the review the following main common characteristics of local government emerge:

a. Local government has statutory status; hence it is defined, recognised and functions based on the laws of a country.
b. Local governments have the right to decide local rates and local taxes.
c. Local governments are characterised by local community participation in the decision-making process of local affairs.
d. Local governments have the capacity to act independently from central government bodies, within the limits set by law, through the decentralisation process or the principle of local autonomy.
e. Local governments serve the general interest of their citizens, that is, the common interest.
f. Municipalities have their finance, operating budget, and fiscal policy.

The local government systems in the European countries share some common characteristics and that their roots can be identified in history. Table 2, illustrates the basic characteristics of European local government systems, including the dual dependencies of local government with state and citizens (Lidström, 1998).

Table 2: Basic characteristic of European local government systems (Lidström, 1998)

No.	Criteria of local governments	The dual dependencies of local governments	
		The state	**The citizens**
1.	Clearly defined territory	Regulates the drawing of territorial boundaries	Members of/belong to the local authority
2.	A level of self-government	Sets limits to autonomy	Make claims on and uses local government services
3.	Authoritative power over citizens	Allows authoritative powers	Subject to authoritative powers
4.	Directly elected decision-makers and/or municipal assemblies	Regulates the procedures of decision-making	Elects decision-makers and/or participate in municipal assemblies

The criteria to define a local government comprise a clearly defined territory, the execution of a certain degree of self-government, authoritative power over its citizens, and elected decision-makers and/or municipal assemblies. According to Lidström (1998), the state regulates the drawing of territorial boundaries, sets limits to autonomy, allows authoritative powers to flourish, and regulates the procedures of decision-making. The citizens fall under the local authority and they use local government services and are subjected to authoritative powers. Lastly, the citizens are entitled to elect decision-makers and/or participate in municipal assemblies (Lidström, 1998).

2.2.2 Roles and Responsibilities of Local Governments Worldwide

This section explains the roles and responsibilities of local governments worldwide in order to elucidate best practices. Local governments play a crucial role in society and deliver many of the basic public services. Local governments deliver governance to grassroots level and empower people

to engage effectively in decision-making that affects their daily lives. As a level that is nearest to the people, local governments are in principle, "in a far better area than other different levels of government to address problems that require local information and policy at the root of local pre-eminence and needs" (United Nations Human Rights Council, 2015, p.4) .

Throughout the world, local governments provide a range of services such as transport, welfare, education, and housing, to name just a few (Nemec and de Vries, 2015). Local governments also address pressing issues in their communities, such as food security, public health, public safety, migration, resource depletion, violence, land issues, adaptation to climate change, and rapid urbanisation. According to Salva (2012), local governments further provide the following functions:

a. Enable greater political participation from people in lower level communities.
b. Impart socio-economic services for their constituencies that are consistent with national government policies.
c. Offer a means of dividing power, responsibilities, and functions by geographic area or locality of the state.
d. Confer political distinction among disparate local communities.

Local governments, nevertheless, differ across developing countries in their functions and responsibilities. The most extensive expenditure duties are granted to local governments by China. In China, local governments are responsible for social security (predominantly pensions and unemployment benefits) in addition to customary local and municipal services and are granted an even greater share of local economic growth than local governments in other nations. In India and South Africa, for instance, the role of local governments in providing local services is primarily based on the delivery of municipal services.

In Kazakhstan, central-local duties are shared by all local services; local governments have no separate budgets and no budgetary control (Shah and Shah, 2006). In the European Union, the local authorities are responsible for more than two-thirds of all public investments. There, the local level is viewed as an important investor in infrastructure. To provide these services and perform functions effectively, local governments must generate finances. These can be obtained from rates and taxes as well as from state subsidies (Foreman and Godwin, 2015).

Local governments not only have to develop and implement local policies and strategies, but they are also obliged to implement the policies adopted by other spheres of government. Local governments initiate and have control over policy conception and implementation phases in their municipalities. They can develop working models that match the local structure in the public and political arenas. Municipalities' functions include the construction and maintenance of roads, primary education, parks, commentaries, markets, water supply, waste collection, culture, sports, health centres, and others. However, these functions are not mandatory and can vary according to the size of the municipality.

To be recognised as a town, a municipality (aside from requirements mentioned above) must provide a water supply, electricity, possess a cemetery, a market, and a health centre. Municipalities must also possess a well-developed road network, provide basic sanitation, and other services. Even when municipalities face a variety of challenges, they must encourage and formulate programmes to promote public participation in local government decisions (Thornhill and Madumo, 2011).

2.2.3 Reasons for the Creation of Local Governments

The importance of local governments can hardly be overemphasised when the range, character, and impact they have upon the daily lives of citizens is considered. Local governments provide public amenities and services which are necessary for the convenience, healthful living, and welfare of individuals and communities (Sitek, 2014). If municipal services breakdown, dislocation of the social and economic life of a community normally results. When services suddenly cease to exist, chaos follows. Though at times, self-governing bodies, especially in villages, inflict the rule of man over the rule of law, and the fact that they are the grassroots of democracy cannot be denied.

Local governments, both in urban and rural areas, shoulder manifold and complex responsibilities (Sitek, 2014; Brand, 2016). One manifold role that local governments have is the creation of favourable environments for business success and jobs. In implementing this role, local governments in turn also create an enabling local development environment through community self-help services, entrepreneurial initiatives and enabling freedom of participation by community members (Mashamaite and Lethoko, 2018).

Salva (2012) emphasises that local governments are legal authorities constituted by by-laws for providing services and the rights and necessary organisations to regulate their own affairs. Local governments are established, or organised, consistently with the principles of decentralisation. Therefore, they came into existence for the following reasons:

a. To provide administrative convenience to the state creating them, particularly in the delegation of administrative functions to field agencies. Local governments are therefore more accountable to the local people and more capable of promoting the better and effective delivery of social and welfare services.
b. To clarify and serve the interests of the people living in common political units. Certainly, local officials are more informed of the needs and interests of the local population. Thus, they can easily come up with local ordinances in response to specific area concerns. This is in contrast to national governments whose concerns are much broader.
c. To boost the civil morale of the local population as they enable public participation in political affairs and processes which encourages more efficient local governance at grassroots level.
d. To partner with the national government in harnessing not only community development and growth, but also national development and growth. The closer the people are to the government, the better the governance should become.
e. To provide a better understanding of the relationships between the desired project objectives and the resources available to implement them. In the process of mobilising local resources, local governments can promote public participation.

The system of local governance is important because it contributes to the strengthening of democracy. Local legislation and policies can best be formulated and executed by local officials who are located at the grassroots level. Local government is a tool for political and popular education, whereby local people can be taught about and participate in local affairs. The system reduces the burden at the national and provincial levels. It serves as the ideal stage of communication between the province and the national government. Local government ensures people's participation in the affairs of local governments through the devolution of powers at the lower levels and ensures the empowerment of weaker sections of society at the grassroots level (Ndlela, 2008; Smit et al., 2011).

The local government system provides administrative and financial autonomy to local levels and is the supplier of civic services because it better understands the needs of the local people (UN-HABITAT, 2015). No government structure, whatever its character, can be complete without some form of local institution. A system of local government is found in every nation as a part of its governmental or constitutional structure. At the bottom of the pyramid of organs of state, is where municipal governments reside.

National governments are at the top, followed by intermediate provincial or state governments. It is important to have the involvement of many people in the decision-making process for democracy to work properly. This implies that local governments can be preparation platforms and have the ability to educate future leaders. Young people can gain experience and knowledge of the art of government policy making and governance, thereby transitioning to the national platform. Local governments contribute to the ongoing growth and enhancement of the sustainable well-being of individuals within their communities by creating a platform for governments to effectively engage with their communities at the grassroots level (Cordero et al., 2016).

Local governments are an integrant of political mechanisms for governance in a country. It has been pointed out that local governments are organised social entities with a feeling of oneness. As body corporates with juristic personality, they represent a legal concept (Muttalib and Khan, 1983). Local government is ideally positioned to respond to threats, provide outstanding public services and guide society to a stable future. It is also a type of public administration that exists as the lowest level of administration within a specific jurisdiction. Similarly, the geography and demography of a local area, along with economic factors, offer some important dimensions in the conceptual articulation of local governments. Figure 2 illustrates this multi-dimensional concept of local government.

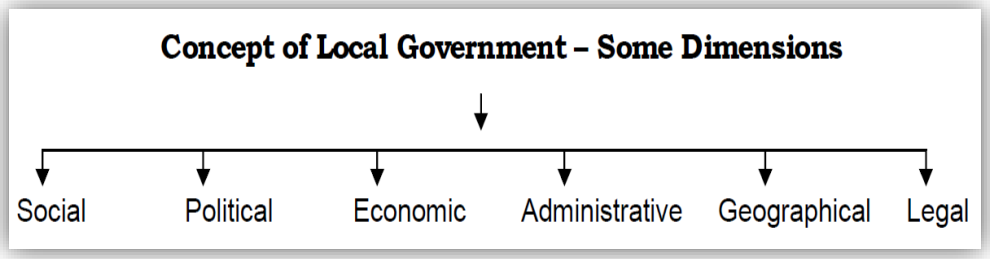


Figure 2: The concept of local government - some dimensions (Muttalib and Khan, 1983)

2.3 South African Local Government

This section briefly offers an overview of South Africa's three spheres of government, and the local government legislative and policy environment that guides it as a distinct and independent sphere of government. The section is divided into four parts. Firstly, it describes the legislative context in which three spheres of government in South Africa were founded and presently exist. Secondly, it discusses local government in South Africa. Thirdly, it reviews the legislative and policy environment for local government, followed fourthly, by a description of the types of local government categories (municipalities). It will be noted from this section that local government in South Africa has a comprehensive legislative framework and a relatively supportive environment.

2.3.1 Three Spheres of Government in South Africa

The nation of South Africa is a constitutional republic. It is also a three-tier government system with an autonomous judiciary. The institutional structure for the government of South Africa was formed in 1996 with the introduction of its first democratic constitution. (DPLG, 2007). The country's highest authority is the Constitution of the Republic of South Africa Act (No. 108 of 1996). It allows for the division of the government's legislative, executive and judicial powers.

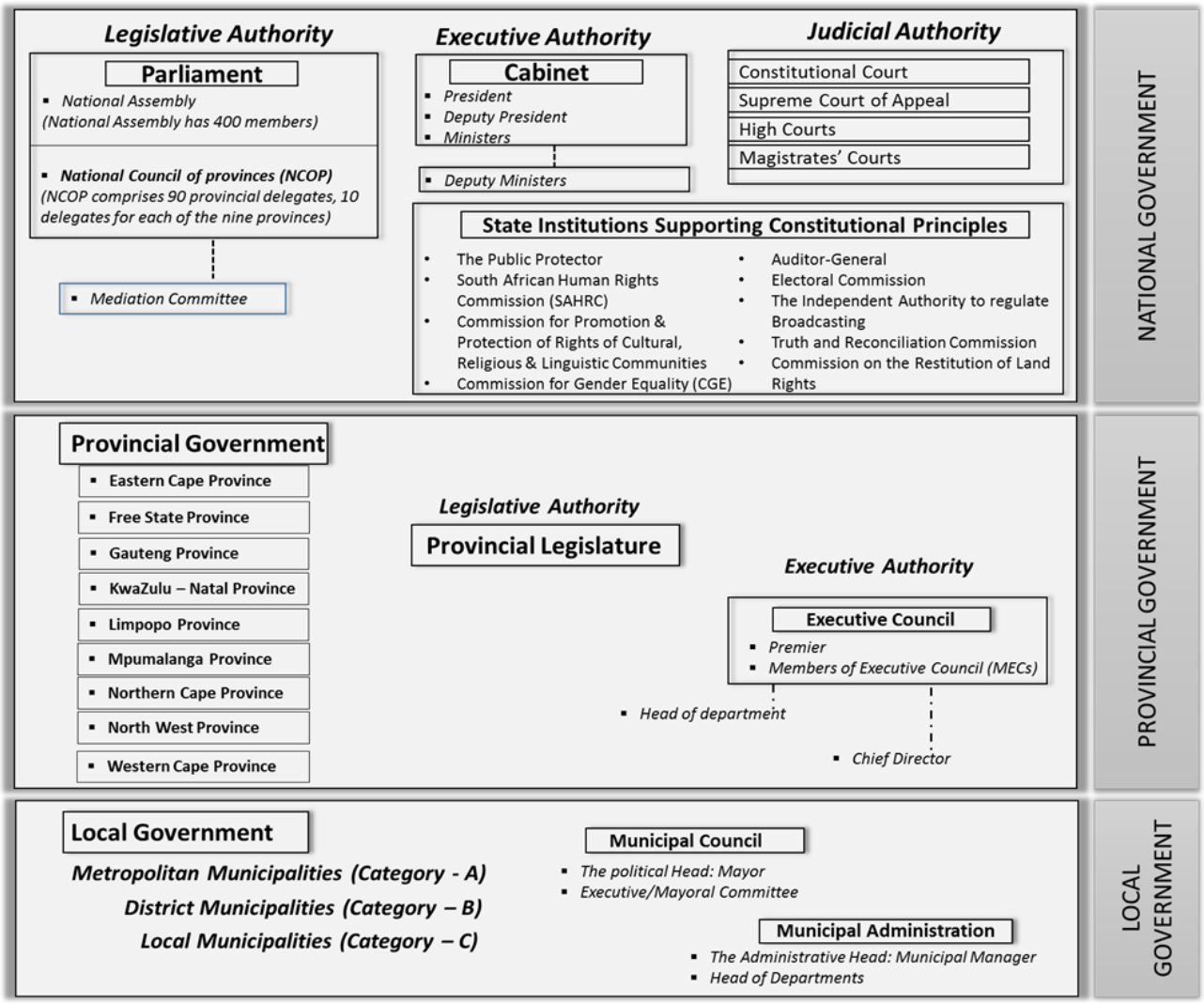


Figure 3: South African government's organisation and responsibilities (DPLG, 2007)

Figure 3 illustrates the South African government's organisation and responsibilities. The executive component comprises the establishment of an elected government for that particular sphere of government. The government consists of national, provincial, and local spheres. Legislative, executive, and administrative structures make up each sphere of government. The powers of the lawmakers (legislative authorities), government (executive authorities), and courts (judicial authorities) are separate from one another (DPLG, 2007). Section 41(1) of the Constitution requires that the three spheres should "co-operate with one another in mutual trust and good faith". Thus, although the spheres are distinctive and independent, they are also interdependent and must work

together when deciding on budgets, policies, and activities, particularly in areas that cut across all spheres. Furthermore, Section 41(1) explains that they must facilitate and assist each other; notify each other of matters of mutual concern and consult each other on them; coordinate their activities and legislation with each other; comply with negotiated procedures and prevent legal proceedings against each other" (South African Constitution, 1996, p.21).

The legislative component of the national tier is vested in Parliament. In terms of section 44 of the South African Constitution, Parliament is made up of two compartments, namely, the *National Assembly* (NA) and the *National Council of Provinces* (NCOP). The provincial legislature is responsible for the legislative power at the provincial level. In the local government tier, the municipal councils hold the legislative (and executive) authority following section 43(b) and section 43(c) of the South African Constitution (Freedman, 2014).

The national government functions include providing an overarching policy and growth framework, and regulation and supervision of the provincial and local spheres. The provincial sphere provides support to local government and jurisdiction over various functional areas, both exclusively and concurrently, with the national government. The focus of local government is on growing local economies, providing infrastructure and services, and making and administering by-laws. The provincial and local government powers are restricted to their jurisdictional boundaries and limited to the functions listed in schedules 4 and 5 of the South African Constitution (DPLG, 2007). Figure 4 shows the three spheres of the South African government.

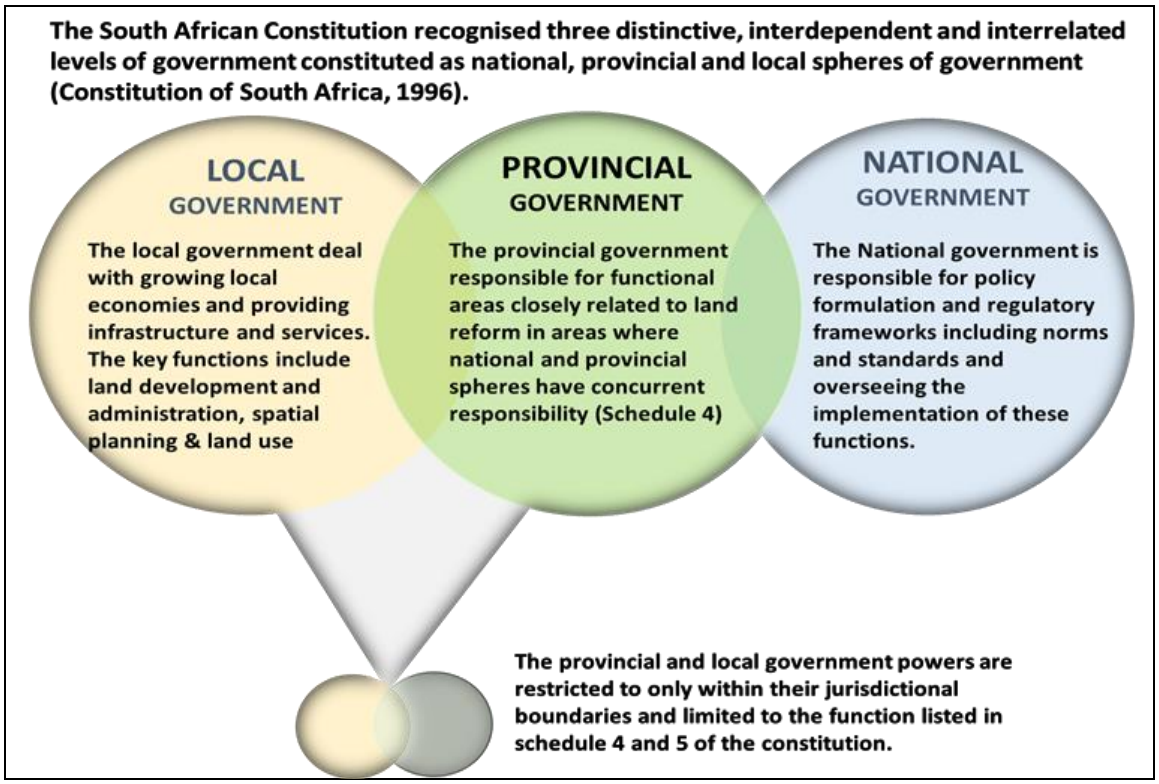


Figure 4: The three spheres of Government (DPLG, 2007)

Executive authority is bestowed on the President who is the Head of the national executive (sections 83 and 85 of the South African Constitution). In addition, Section 125 of the Constitution of South Africa specifies that in each provincial sphere, the executive power is to be delegated to the premier of that province. The executive authority is delegated to the municipal council in the local government sphere. This is also very distinct from the responsibility of the executive powers in both the provincial and national tiers. Judiciary powers are delegated to the various courts created by law in accordance with Section 165 of the Constitution of South Africa., suggesting that there is one system for the judiciary to govern and adjudicate laws across every level of the South African government (Madumo, 2017).

The legislative and executive authority of the numerous spheres of the presidency is decided in accordance with the functional areas outlined in schedules 4 and 5 of the South African Constitution (1996). Legislative competence refers to the authority to pass legal rules while executive competence is the power to give effect to legal rules. The national legislative authority is delegated to the parliament and confer upon the national assembly the legislative authority to amend the Constitution of South Africa, to delegate legislative powers to other spheres of government and to enact legislation on any matter.

These matters encompass those within functional areas listed in schedule 4 as “functional areas of concurrent national and provincial legislative competence” but exclude matters within functional areas listed in schedule 5 as “functional areas of exclusive provincial legislative competence” (van Wyk, 2012). Through schedules 4 and 5, the South African Constitution delivers shared or inherent overlapping mandates between the spheres as well as between areas of exclusive competence and function. Examples of functional areas of concomitant national and provincial legislative competencies include agriculture, health services, housing, tourism, disaster management, regional planning and development, trade, and education at all levels excluding tertiary education.

It is the responsibility of all levels of government to ensure the sustainability of communities and the delivery of services in various ways. In this way, each sphere is assured of its constitutional status. However certain parts of the South African Constitution establish overlaps that can affect the distinctive existence of the spheres and their respective capacity to fulfil their constitutional responsibilities as foreseen during the creation of the framework (van Wyk, 2012).

Fortunately, the national legislature retains its legislative power consistently and may override provincial legislation in the event of conflicts. Exclusive provincial legislative competence is only reserved for minor issues such as abattoirs and liquor licenses (Freedman, 2014). Other ways in which the provinces can exercise their legislative competence is through their participation in the NCOP which is the second house of Parliament of South Africa.

The division of legislative authority between different spheres of government significantly restricts the legislative power of each sphere to pass legislation. These restrictions, otherwise referred to as 'federal limits,' provide that the legislature (such as parliament or a specific provincial legislature or local council) does not enact legislation that falls beyond its competence. A significant implication of this is that if the legislature adopts legislation that falls outside its competence, the legislation in question will be invalid (Freedman, 2014). This is an example of the elements of federalism in the government of South Africa.

The multi-level government that was adopted by South Africa as it emerged into a democratic state has been criticised for reaping few of the democratic benefits that federalism promises and also that it does not lead to more effective governance because of the limited capacity of the government and the complexity of the system. However, given that this is a governance structure, it is better to focus on gradual change and to create a culture in which the commitments expressed in Chapter 3 of the Constitution are genuinely part of modern governance culture (Murray and Simeon, 2011).

It is important to remember that South Africa has a traditional tribal system that does not easily fit into modern democracy. Ancient tribes and nations embody the culture, practices and values of early African communities and are a significant part of the traditions of South Africa (van Wyk, 2012). The South African Constitution (1996) acknowledges this by setting up six provincial houses of traditional leaders. These houses are situated in the *Eastern Cape*, *Free State*, *KwaZulu-Natal*, *Mpumalanga*, *Limpopo*, and *North West*. The institution, status, and function of traditional leadership in terms of customary law is recognised as articulated in section 211 of the South African Constitution. Traditional authorities that follow customary law may operate according to all applicable laws and custom laws, including amendments to or revocation of those laws or customs laws (van Wyk, 2012). Figure 5 demonstrates how the South African Constitution has elements of federalism.

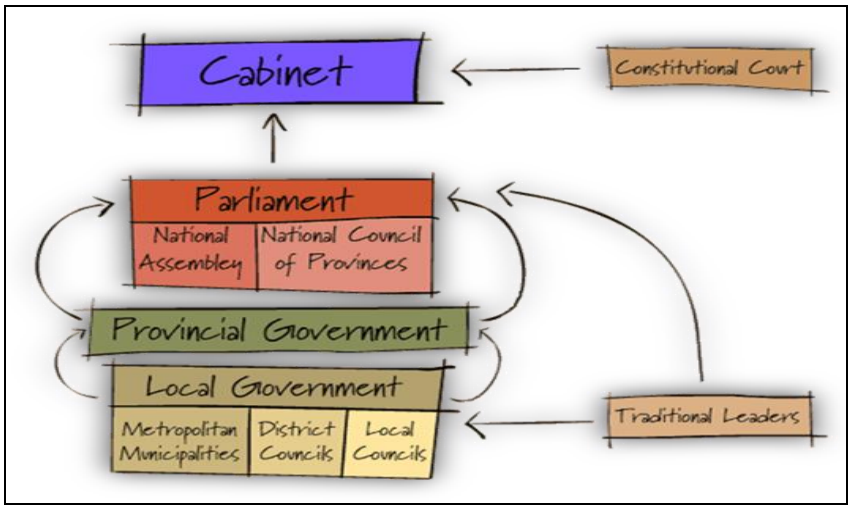


Figure 5: South African Constitution - federalism (BBC - South Africa: Political Issues, 2014)

By implication, traditional authorities might be regarded as a fourth sphere at the local level. As such, traditional authorities should be expected to partner with local municipalities (Chhibber, 1997). The *White Paper on Local Government, 1998* grants traditional authorities a role to play in local government. Additionally, section 5 (1) of the *Traditional Leadership and Governance Framework Act* (No. 41 of 2003) compels both national and provincial governments to promote partnerships between municipalities and traditional councils.

Section 20(1) of the *Traditional Leadership and Governance Framework Act* gives traditional authorities power to promote socio-economic development. *The Municipal Structures Act* (No. 117 of 1998) goes further to place as a requirement that traditional authorities attend and participate in local council meetings. The *Municipal Structures Act* also demands that traditional authorities should participate in the *Integrated Development Plan* (IDP) policy implementation. This is because it is believed that traditional authorities ought to be part of the decision-making process in local

government. Section 212 of the South African Constitution reinforces this by ensuring that national legislation will play a role for traditional leadership as an institution at the local level in matters concerning local communities. Given the different legislation which parliament has promulgated, traditional leadership should play a role within the third sphere of government, namely local government.

2.3.2 Local Government in South Africa

The local sphere of government remains at the core of the attainment of basic services within any government dispensation. In South Africa, the local government is responsible for delivering services necessary for the livelihood of local communities. The South African local government system is tasked with a developmental mandate in delivering these services. A developmental mandate refers to the application of inter-related tools and approaches which assist municipalities to become more efficient. They include encouraging community participation and adopting integrated development planning and performance management to monitor and evaluate government performance (Sebola, 2015). This arrangement is different from the common system of local government. The traditional system requires municipalities to deliver functionally specialised services like the provision of potable water, maintenance of streetlights and refuse removal. However, this approach requires municipalities to also play a developmentally oriented role.

Another reason why local governments are important is because they reflect the national government. Thornhill (2010) posits that the perception of the quality of government and government institutions is mostly measured by the quality and administration of the local government. Therefore, in South Africa, several policies in the form of legislation, white papers, and other operational policies, have been developed as a way of transforming the institution of local government. Comprehensive programmes to ensure that municipalities maximise their capacity to deliver services to their residents are already in place. Legislation, local regulations and internal procedures comprise these. Municipalities have a huge task implementing these policies and ensuring speedy delivery of services (Thornhill, 2010).

Local governments in South Africa are allocated functions and powers either by assignment or delegation. Assignment refers to complete authority being handed over by transferring the function to the local government. This can happen as a "general assignment" where all local governments in the country have a function. Optionally, this can happen as a "specific assignment" whereby a function is given only to specific municipalities. Delegation occurs when the responsibility to perform a function is diverted to local governments, but the authority over that function remains at a different level of government. As a result, some functions, such as policy-making, legislation, control and allocation of funds, remain under the jurisdiction of national and provincial governments, notwithstanding the involvement of local governments (Carter and Ajam, 2003).

In the transition of democratic local government, development is thought of as a process in which local people expand their personal and institutional capacity to mobilise and administer resources to achieve sustainable and equitably represented improvements in their wellbeing in line with their ambitions" (Binza, 2004, p.81). Despite the assertion, the challenges facing developmental municipalities entail insufficient organisational capacity caused by a lack of institutional, managerial and technical expertise to use resources to enhance and maintain growth. Consequently, the roles of the three spheres of government in South Africa have clarified a new model of growth and governance that is seen as a way of addressing underdevelopment, poverty and landlessness.

2.3.3 The Legislative and Policy Environment for Local Government

A slew of local government legislation was implemented following the final Constitution and the White Paper. Dozens of statues practically have a direct or indirect effect on local government, this section aims to investigate the legislative and policy environment of local government in South Africa as tasked by the South African *Constitution of 1996* and the *White Paper 1998*, as well as other specific policies such as the *Municipal Structures Act*, the *Local Government Municipal Demarcation Act* (No. 27 of 1998), *Intergovernmental Relations Framework Act* (No. 13 of 2005), the *Local Government Municipal Systems Act* (No. 32 of 2000), the *Local Government Municipal Finance Management Act* (No. 56 of 2003), and the *Local Government Municipal Property Rates Act* (No. 6 of 2004).

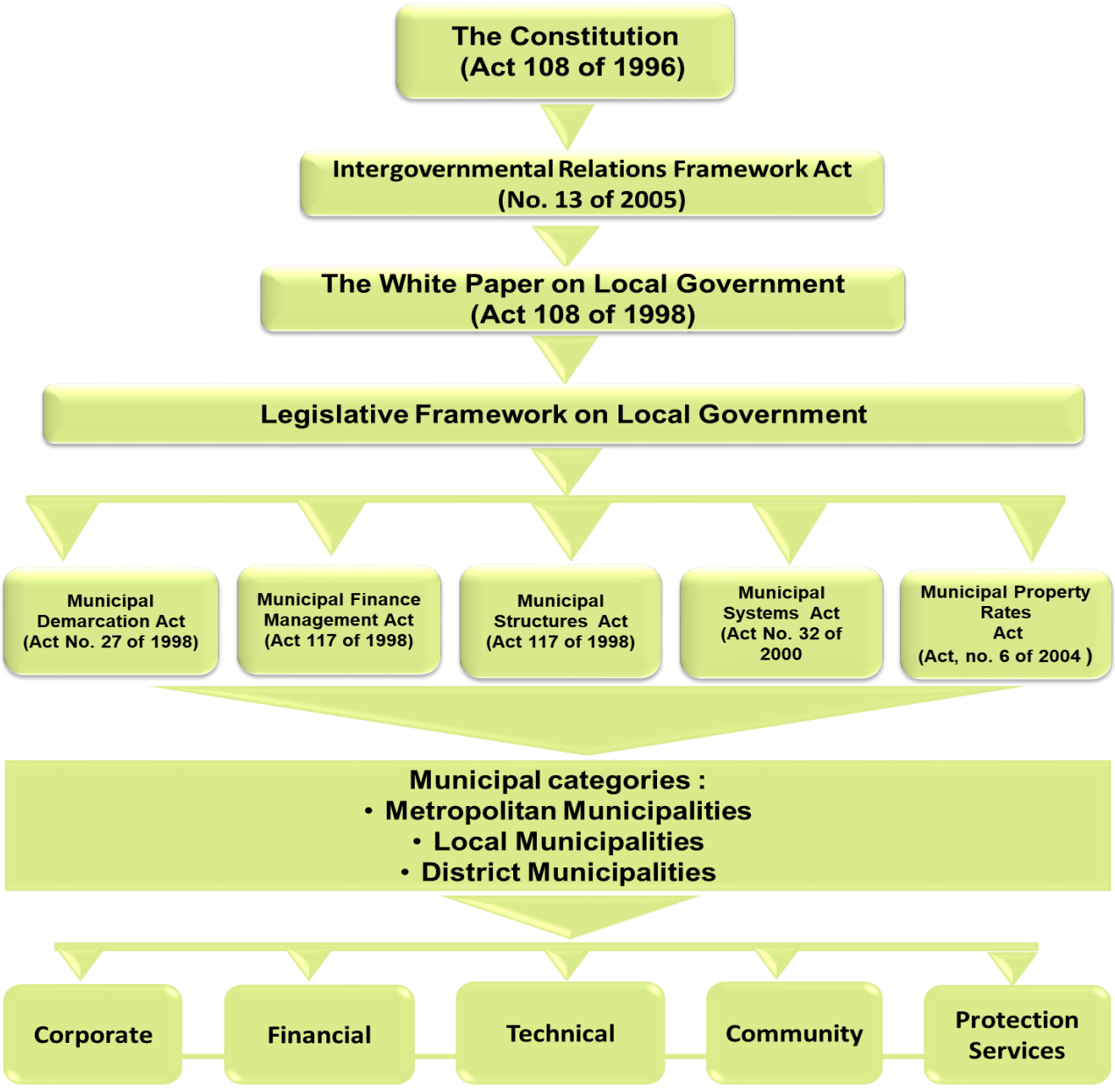


Figure 6: the legislative and policy framework for local government in South Africa (DPLG, 2004)

Figure 6 depicts the legislative and policy framework for local government in South Africa. South African local government is established constitutionally, and so, as De Visser (2005) acknowledges, it offers high institutional status for local government. Subsequently it does not and should not operate in isolation; nor does it function according to its leaders' whims. The legislative and policy environment in which local government operates in South Africa is highly structured, which means that some policies and pieces of legislation have been established to ensure that communities fulfil the demands of their residents in order to accomplish them efficiently and effectively (De Visser, 2005).

The legislative environment for municipal government is very broad in South Africa (South African MDB, 2018). According to the Department of Cooperative Governance and Traditional Affairs (COGTA), the South African Constitution includes mainly the existing policy and legislative provisions concerning local government such as the White Paper 1998, the Municipal Structures Act (No.117 of 1998), the Local Government Municipal Systems Act (No. 32 of 2000), Municipal Systems Act (No.32 of 2000), the Local Government Municipal Demarcation Act (No. 27 of 1998), the Local Government Municipal Finance Management Act (No. 56 of 2003), and the Local Government Municipal Property Rates Act (No. 6 of 2004).

They provide a statutory framework for local government and establish a mechanism for municipalities to administer their administration. They also describe political decision-making processes and establish standards for the structuring of administrations. An integral part of these laws of government is the creation of an enabling environment for the local government (Siddle and Koelble, 2016).

A complex legislative structure arises from legislation that basically reflects, ostensibly, a decentralised local governance model, addressing issues ranging from the demarcation of jurisdictional areas of local government, funding (through all state bodies), frameworks of local government , processes and execution procedures (Siddle and Koelble, 2016).

The conceptual view of this framework is that it offers a decentralised type of government targeted at shifting key functions and a substantial measure of autonomy to local authorities, while at the same time strongly reflecting the concept of developmentalism. According to Siddle and Koelble (2016, p.49) in this interpretation, "South Africa has embraced core values that have been endorsed by international organisations and donor governments."

2.3.3.1 Constitution of the Republic of South Africa (No. 108 of 1996)

The Constitution sets out the fundamental principles of the Republic of South Africa, including amongst others the ideals of the democratic state, the superiority of the Constitution, citizenship, and the Bill of Rights. This makes it both foundational and comprehensive. It also includes a local government developmental agenda.

Consequently, any legislation or behaviour that is inconsistent with the Constitution is null and requirements imposed by the Constitution must be respected (Section 2, the Constitution). All legislation, including municipal by-laws, should also be consistent with the principles embodied in the Constitution. As asserted by Malefane and Mashakoe (2008, p.476), "the Constitution is by far the most significant piece of legislation that governs different laws, policy papers, and regulatory structures".

Chapter 3 of the Cooperative Government (Section 41), Chapter 7 of Local Government (sections 151 to 164) and Chapter 6 of the Provinces (Section 139 deals with provincial engagement in local government) comprise sections of the Constitution that directly refer to municipal roles and responsibilities. They deal with issues concerning the founding operations and the local government system. Section 152 focuses on local government objects; section 155 discusses the creation of municipalities; and section 157 elaborates the structure of municipal councils and their election. These mandates aim to:

a. “Providing a fair and transparent government to local communities.
b. Promote sustainable service delivery.
c. Encourage socioeconomic growth.
d. Endorse a protected and sustainable environment.
e. Promote the participation of citizens and community-based groups in local government relations” (Constitution, 1996, p.75).

Municipalities are guided, by this provision of the Constitution, to "aspire, under their financial and administrative resources, towards the achievement of the objectives set out in these sections." These sections of the constitution also acts as a framework for local economic growth and institutionalisation as a strategic feature of municipalities (Malefane and Mashakoe, 2008).

In section 156 of the Constitution of South Africa, the legislative powers of municipal councils are described. Section 156(1) states that a municipality has constitutional powers in relation to the matters of local government referred to in Schedule 4, Part B, and Schedule 5, Part B, and in relation to any subject delegated to it by the provincial or national legislation.

In addition, Section 156(2) of the South African Constitution also specifies that a municipality can establish and adopt by-laws for the efficient administration of affairs it has the right to oversee. Section 156(5) further provides, in addition to sections 156(1) and (2), that a municipality has the right to assert any power in respect of a matter which is fairly needed or incidental to the effective exercise of its duties.

Municipalities have three types of power. Firstly, those derived directly from the South African Constitution, referred to as “original powers”. Secondly the powers assigned in terms of national or provincial legislation, referred to as “assigned powers”, and lastly, powers that are fairly essential or incidental to the effective execution of the operations of a municipality (The South African Constitution, 1996).

Section 84(2) of the South African Constitution provides that a local municipality has the powers and functions set out in Schedule 4 Part B and Schedule 5 Part B, with the exception of certain functions and powers conferred by section 84(1) in the district municipality in which territory it is situated. Further, to encourage the separation of powers, the Constitution provides that each sphere may not usurp the powers of another. Accordingly, the national government has the exclusive authority to enact and enforce legislation on any matter not set out in Chapter 7, Schedules 4 and 5 of the Constitution. Figure 7 outlines the South African local government competencies (The South African Constitution, 1996).

SCHEDULE 4: FUNCTIONAL AREAS OF **CONCURRENT NATIONAL AND PROVINCIAL** COMPETENCE	**SCHEDULE 5:** FUNCTIONAL AREAS OF EXCLUSIVE **PROVINCIAL** LEGISLATIVE COMPETENCE
PART B: LOCAL GOVERNMENT MATTERS (as set out in s.155 (6) (a) and (7)	PART B: LOCAL GOVERNMENT MATTERS As set out for provinces in s. 155 (6) (a) and (7)
Air pollution Building regulations Child care facilities Electricity reticulation Fire-fighting services Local tourism Municipal airports Municipal planning Municipal health services Municipal public transport Municipal public works(as assigned) Pontoons, ferries, jetties, piers & harbours (excluding the regulation of international and national shipping matters) Storm water management in built- up areas Trading regulations Water and sanitation services limited to potable water supply systems and domestic waste- water and sewage disposal systems.	Beaches and amusement facilities Billboards and the display of adverts in public places Cemeteries, funeral parlours and crematoria Cleansing Control of public nuisances Control of undertakings that sell liquor to the public Facilities for the accommodation, care and burial of animals Fencing and fences Licensing of dogs Licensing and control of undertakings that sell food to the public. Local amenities Local sport facilities Markets Municipal abattoirs Municipal parks and recreation Municipal roads Noise pollution Pounds Public places Refuse removal, refuse dumps and solid waste disposal Street trading Street lighting, Traffic & parking

Figure 7: South Africa local government competencies (The South African Constitution, 1996).

2.3.3.2 Intergovernmental Relations Framework Act (No. 13 of 2005)

The governmental architecture of South Africa upholds the values of intergovernmental relations and cooperative governance (see Figure 8 on how it works in practice). It is in this context that the *Intergovernmental Relations Framework Act* (No. 13 of 2005) was implemented. This Act aims to "create a structure for national governments, regional governments, and local governments to encourage and support intergovernmental relations; to provide for processes and procedures for facilitating the resolution of intergovernmental disputes, and to provide for matters relevant to them" (*Intergovernmental Relations Framework Act*, 2005).Intergovernmental relations are conventionally defined as important interactions between governmental functional units of various types and levels. Other scholars simply define intergovernmental relations as an interacting network of institutions at national, provincial, and local spheres. According to Thornhill (2002), intergovernmental relations consist of all the actions and transactions of politicians and officials in national and sub-national units of government and organs of the state.

The roots of intergovernmental ties within the context of South Africa may be traced back to section 41(2) (a) of the Constitution of South Africa. This section requires the three government spheres to create, by an act of parliament, mechanisms, and institutions to foster and encourage intergovernmental interactions to foster cooperative government values while performing their daily operations. Parliament passed numerous pieces of legislation to give effect to this. The *Intergovernmental Fiscal Relations Act* (No. 97 of 1997) and the *Intergovernmental Relations Framework Act* were passed to permit the promotion of co-operation between the three spheres of government. The *Intergovernmental Fiscal Relations Act* (1997) has as its objective to:

a. Promote collaboration on political, budgetary, and financial matters between the three spheres of government.
b. Prescribe a mechanism for assessing an equal share and distribution of the nationally generated revenue.

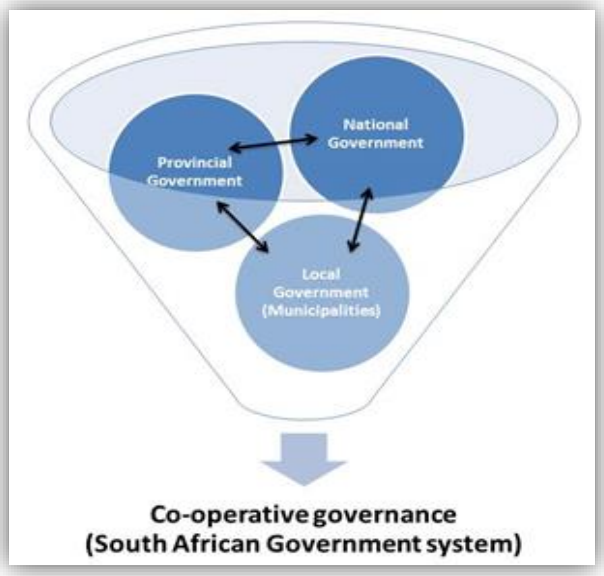


Figure 8: illustration of co-operative governance in South Africa (Siebritz and Helena, 2015)

Figure 8 shows the illustration of co-operative governance in South Africa. This legislation is important as it can include a structure to determine how the government's national, provincial, and local spheres develop acceptable revenue-sharing arrangements to provide services efficiently and effectively. Thus, cooperative government concepts are essential in providing an enabling atmosphere for successful functioning of municipal councils. Inevitably, the concept of cooperative governance and intergovernmental relations means that each sector has a wealth of policies, services, codes of practice and values that direct and inform its activities; and local government in South Africa is no different (Intergovernmental Fiscal Relations Act, 1997). That is, while South Africa's local government has a sphere-specific, distinct policy framework, such as the *Municipal Systems Act,* there are many generic policies, services, codes of good practice and standards, mostly maintained by the next levels of government and superstructures that have repercussions for the country's local governments.

2.3.3.3 White Paper on Local Government (1998)

The White Paper (1998) is a document that serves as the basis for the latest dispensation of local government in South Africa. Its aim is to promote a local government development system dedicated to working with all role players, even communities, to creating a sustainable human settlement that provides a decent quality of life, both socially and economically. The *White Paper* gives substance to the mandate through its compartmentalisation. Moreover, it sets out statutes on how to organise local government, how to discharge responsibilities assigned, and how to choose what outcomes to pursue.

The *White Paper* (1998) has identified key outcomes that apply to all municipalities within the realm of the development of local government imperatives and goals. The provision of long-term household infrastructure and basic services is the first outcome, as these are the foundations of social and economic growth. The development of integrated local areas, which resolve the spatial differences between urban and rural settlements, is the second outcome. This is of critical importance for the overall acceptance, success, and prosperity of South African communities. The provision of special services and the enhancement of local economic growth is the final outcomes

As part of transforming local government, the *White Paper* (1998) also addresses how to improve municipal functionality. This includes the promotion of co-operative governance, the improvement of municipal administrative, political, and institutional systems, and the initiation of municipal transformation. As a result, the essence, function and framework of the existing local government in South Africa has been influenced by this strategy. It further identifies the IDP as a critical mechanism for ensuring the alignment of local government initiatives with other areas of development planning at the provincial, national and international levels, as it acts as a framework for coordination and interaction. The IDP, therefore, provides a potential for the integration of land reform delivery with local level delivery of services and infrastructure to the land reform beneficiaries (White Paper 1998).

2.3.3.4 Local Government: Municipal Structures Act (No.117 of 1998)

The local government *Municipal Structures Act (No.117 of 1998)* was enacted to provide for the different types and categories of municipalities in South Africa, as envisaged and legislated in sections 151, 155, (6) and (7) of the Constitution of South Africa. It defines the division of power and functions in municipal settings, electoral systems and structures, as well as in municipal office holders. The functions, powers and delegations of both internal and external stakeholders in the municipality are therefore outlined and defined. The municipal council, which is the primary focus of the platform, is of critical importance.

The municipal council shall, in compliance with the general principles of representative governance, decide on the basis of local elections. The Municipal Manager (Section 55), serving as Head of Administration and Accounting Officer, shall be elected by the Municipal Council (Municipal Structures Act, 1998). It should also be recalled that the Executive Committee (section 42) is formed to guide the agenda of the municipality and to represent the general interests of the electorate, consisting mainly of 10 councillors but not less than 3 councillors (section 43).

The Act also emphasis the enhancement of service delivery by resolving the differences between the communities concerned and the municipal structures. Chapter 2, section 19 of the local government: the *Municipal Structures Act* (1998) enables municipalities to function with their capacity to attain the

goals set out in section 152 of the Constitution, which is to establish structures or means for engaging with community and community bodies in the execution of their roles and responsibilities. It is expected that through this alliance, citizens will be able to engage effectively in the enhancement of participatory democracy in local government.

2.3.3.5 Local Government: Municipal Property Rates Act (No. 6 of 2004)

The local government *Municipal Property Rates Act* (MPRA) (No. 6 of 2004) governs a municipality's ability to enforce property rates, exclude such properties from national interest ratings, provide inclusive and fair methods of valuing properties, and provide municipalities with a transparent and reasonable system of exemptions and rebates through their rating policies. As amended by the local government *Municipal Property Rates Amendment Act* (Act No 29 of 2014), the MPRA legalises the authority of a municipality to enforce rates on property.

The Act provides legislation relating to the valuation of land and the levying of rates by municipalities on property owners. As rates constitute an essential part of municipal financial management, a prosperous application of the Act is important to all councillors. The MPRA controls the authority of municipalities to enforce rates on properties and maintain uniformity throughout each municipality in the country. The primary goal is to establish economically viable municipalities that can fulfil their service-delivery obligations (*Municipal Property Rates Act*, 2004).

In terms of section 23 (1) of the MPRA, each municipality must draw up and maintain a municipal register of properties. Under the terms of MPRA, it is the responsibility of the municipal valuer to maintain the property register regularly (Municipal Property Rates Act, 2004). This includes regular checking against Deeds Office data, billing and other financial information, the valuation roll, and the updating of the spatial property register. Within the municipal property register, every property record must be represented and completed with current attribute details. Spatial data capture and database manipulation is conducted via the service provider who must demonstrate the necessary database experience and Geographic Information Science (GISc) qualifications.

2.3.3.6 Local Government: Municipal Systems Act (No. 32 of 2000)

The local government *Municipal Structures Act* (No. 32 of 2000) seeks to professionalise local government in order to enhance service delivery and performance management while also inculcating in communities a mind-set of local government focused on the citizens. A main purpose of this Act is to effectively integrate local administration and human resource management processes with those of the national and provincial public service. The *Municipal Systems Act* also seeks to formalise and modernise local government by guaranteeing the municipal administrative infrastructure is filled with suitably trained and skilled individuals to enhance service delivery.

The other intent of the Act is to provide the basic values, structures, and processes required to allow municipalities to gradually shift towards the social and economic advancement of local economies. This is achieved with the goal of ensuring equitable access to public services that are accessible to everyone, and for the overall social and economic upliftment of the local communities (Municipal Systems Act, 2000). Accordingly, section 4 of the Act provides that duties of municipal councils are to, inter alia:

a. "Exercise the executive and legislative power of the municipality and use the municipal services for the benefit of the local community.
b. Encourage community participation or engagement.
c. Strive to ensure that the local municipality provides public services in an economically and environmentally sound manner to the local community.
d. Offer local community members equitable access to the services they are entitled to.
e. Encourage and perform municipal development.
f. Promote a safe and sustainable local municipal environment.
g. "Make a contribution to the progressive fulfilment of fundamental rights, together with other organs of state for the property, housing, health care, food, water, social security, environmental, and education;" (Municipal Systems Act, 2000, p.20).

The local government *Municipal Systems Act* (2000) requires employment contracts and municipal managers' performance agreements (and managers who are directly accountable to municipal managers) to be aligned with the nationally defined standardised systems and procedures. It expands the regulatory power of the Minister to make legislation relating to macro-benefits such as medical aid and pension benefits after consultation with health and finance ministers.

Under section 2 of the local government *Municipal Structures Act* (2000), a municipality exercises legislative and executive power within a particular demarcated area of jurisdiction when it is referred to as an entity. The municipality consists of the political and administrative structures, the public, roles, political office-bearers and their administration, and a separate legal personality. However, within the Act, administrative categories of municipalities are based on criteria of spatial, cultural, economic, social, and special and management.

In a business context, the local government *Municipal Systems Act* establishes a framework for planning, performance-management systems, effective resource utilisation and organisational change. It also sets up a system for municipalities to report on their performance and provides an opportunity for residents to compare that performance with that of other municipalities. It is also regulating public-private-partnerships. The Act also provides for the significant power of municipalities to corporatise their services, create service delivery facilities or enter into collaborations with other service providers. Moreover, the Act provides for municipalities to enact a credit-control policy to permit termination of services in the event of a non-payment. Municipalities have the authority to pass by-laws and bring this policy into effect. It also allows for IDP implementation. The *Spatial Planning Frameworks* (SDF) and *Disaster Management Plans* (DMP) are called for as part of the IDP. The *Municipal Systems Act* first implemented the definition of the *Municipal Space Development Framework* (MSDF) as part of the compulsory IDP that each municipality would implement.

2.3.3.7 Local Government: Municipal Finance Management Act (No. 56 of 2003)

The local government Municipal *Finance Management Act* (MFMA) (No. 56 of 2003) seeks to reform budget and financial management procedures in municipalities to improve municipalities' ability to provide services to all residents, consumers and users. It also gives effect to the accountability principle provided by sections 215 and 216 of the Constitution of South Africa. The MFMA's goal is to ensure sound and sustainable management of the tax and financial affairs of municipalities and local bodies as well as to establish treasury standards and norms for the local government sphere. The MFMA does this by setting policies and guidelines and other criteria to ensure transparency,

accountability and clear lines of liability, revenue control, expense management, assets and liabilities, budgetary and financial planning procedures, borrowing, coping with local financial concerns, supply chain management, and other related financial matters (Municipal Finance Management Act, 2003).

It seeks to revitalise budget and financial management activities through putting local government revenues on a sustainable basis in order to improve communities' ability to offer services to all their residents, clients, users and stakeholders. It also seeks to create a sound structure for financial governance by clarifying and defining the functions and responsibilities of the mayor, officials, and executive and non-executive councillors (Municipal Finance Management Act, 2003).

According to the MFMA, the national treasury can track its budgets and the execution of its budgets, including spending, revenue collection and borrowing, in respect of any municipality or municipal entity. It can also investigate any system of financial management and internal control, and suggest improvements. As well as taking appropriate steps if a municipality or municipal body commits an infringement of the *Preliminary General Management Area* (PGMA), including stopping funds to a municipality if it commits a significant or recurrent material infringement of relevant legislation and regulations; and, lastly, taking all other reasonable measures required to efficiently execute its functions (Municipal Finance Management Act, 2003).

2.3.3.8 Local Government: Municipal Demarcation Act (No. 27 of 1998)

The Local government *Municipal Demarcation Act* (No. 27 of 1998) provides for policies and procedures for the *Municipal Demarcation Board* (MDB) to define municipal boundaries, which is also defined by the *Municipal Demarcation Act*. Additional geographical boundaries need to be addressed when deciding the municipal boundaries. These spatial boundaries include residential areas consisting of traditional and rural communities; public transportation routes; amenities, recreational facilities, and infrastructure; operational boundaries comprising provincial, magisterial and voting districts; health, education, police, and census enumeration areas; and topographic, cultural, and physical features (South African Municipal Demarcation Act, 1998). The MDB was set up to perform the following functions to establish municipal boundaries pursuant to the *Municipal Demarcation Act* (1998) and other applicable legislation enacted pursuant to Chapter 7 of the South African Constitution; to provide advice on matters covered by the Act; and where requested, to provide other suitable legislation.

The MDB is an autonomous body which is responsible for determining municipal boundaries. The role of the board as an autonomous body is also covered by the constitutional court through the *Municipal Demarcation Act* and various judgments. In addition to defining and redetermining municipal boundaries, the board is also required to designate "*District Management Areas"* (DMAs), delimit local election wards and determine municipalities' ability to execute their functions. Although the MDB has been appointed separately to perform its legislative functions, preferably the demarcation of local government boundaries should be connected to particular local government goals. Any local government review should consider the objectives or principles at the outset which provide the basis for local government and its relationship to other levels of government (Municipal Demarcation Act, 1998).

In summary of this section, South African local government enjoys constitutionally endowed and assured autonomy and a comprehensive legislative and policy environment. The sphere of local government is undoubtedly assisted from the organisation to functional aspects, and its powers are guaranteed (DPLG, 2004). The legislative and policy environment often appears to be aligned with the notion of developmental and decentralised governance. Another issue is whether this is enough to transform policy priorities into concrete service delivery and deliver on its developmental function. The state and nature of local government in South Africa is dynamic, and as local government develops, it is imperative that legislation governing it be amended to provide for change. The progression in developmental local government may require constitutional amendments from time to time (DPLG, 2004).

2.4 Types of Local Government Categories

This section presents an overview of the types of local government categories. This is conducted to develop a comprehensive picture of how local government categories are legislatively constituted and to identify the salient issues that distinguish them. Every inch of South Africa, with the exception of national parks, is within the jurisdiction of wall-to-wall municipalities. A municipality is an arm of government that plays a vital role by providing the basic infrastructure and amenities that are needed by its residents. Madumo (2017) describes the term "municipality" in two distinct ways, first of all as a demarcated geographic area, and subsequently as a territorial governing body. Nevertheless, the two descriptions are indistinguishably connected.

As a geographic area, a municipality refers to a district or city that has been delineated and its scope can be measured in terms of the land area it subjugates. As a governing body, the concept refers to the social body (legal person) that supports the authority to make, enforce and adjudicate legislation in a given jurisdiction based on arrangement and example. A municipality may also apply to the organisations that trade their services to a social institution for remuneration (Madumo, 2017). Table 3, illustrates the total number of municipalities in South Africa.

Table 3: ***Total number of municipalities in South Africa*** (South African MDB, 2018)

Provinces	No. of Metros	No. of Districts	No. Local Municipalities	Total
Eastern Cape	***2***	***6***	***31***	***39***
Free State	***1***	***4***	***18***	***23***
Gauteng	***3***	***2***	***6***	***11***
KwaZulu-Natal	***1***	***10***	***43***	***54***
Limpopo	***0***	***5***	***22***	***27***
Mpumalanga	***0***	***3***	***17***	***20***
Northern Cape	***0***	***5***	***26***	***31***
North West	***0***	***4***	***18***	***22***
Western Cape	***1***	***5***	***24***	***30***
Total	***8***	***44***	***205***	***257***

Local municipalities are formed within the geographical region of all nine provinces in South Africa, as the basic units of the governmental system. This implies that each municipality that is formed within the country's territory has a valid right to self-governance. Valid right to self-governance is used in

compliance with the South African Constitution (1996), which gives municipalities the power to manage their communities' local government affairs on their own initiative. Local government should not, however, contradict national and provincial legislation, as approved in the Constitution (Madumo, 2017). Local municipalities have been reduced in numbers due to the South African government's demarcation process.

Section 155 of the Constitution provides for local government to be constituted in the form of municipal categories, namely metropolitan, local and district municipalities (also recognised as categories A, B, and C). In the most recent era of boundary redetermination from 2011, culminating in the 2016 local government elections, the overall number of municipalities was reduced from 278 to 257 municipalities, comprising 8 Category A, 205 Category B and 44 Category C municipalities (South African MDB, 2018).

This meant that of the 114 municipalities that changed, 72 had relatively small changes, and the remaining 42 municipalities were reduced to only 21 municipalities, which amounted to 22 fewer municipalities and one new entity (South African MDB, 2018). The South African Constitution (1996) provides that national legislation must create the means of determining when an area should have a single Category A municipality or whether it should have both Category B and Category C municipalities; and establishes an independent authority's criterion and procedures for determining municipal boundaries. Table 4, provides an outline of the municipal categories and definitions.

Table 4: Municipal categories and definitions (South African MDB, 2018)

Municipal Category	Explanation
Category A	A municipality in its jurisdiction that has exclusive executive and legislative power, e.g. a metropolitan municipality,
Category B	A municipality that shares municipal executive and legislative power in its jurisdiction with a municipality of category C within whose jurisdiction it falls, e.g. district and local municipalities.
Category C	A municipality with a municipal executive and legislative power in an area comprising of more than one municipality, e.g. local and rural municipalities.

2.4.1 Metropolitan Municipalities (Category A)

Section 155.1(a) of the South African Constitution (1996) describes metropolitan municipalities' municipalities (also known as "Category A") as any municipality which has exclusive legislative power in its territory. The *Municipal Structures Act* (1998) states that local government of this type should be used for conurbations and centres of economic activity areas for which IDP is ideal for areas with significant interrelated social and economic linkages. The Act also stipulates that category A municipalities may be formed only in metropolitan locations.

The term metropolitan applies to large urban settlements or places with large population density, highly diverse economies and a greater standard of functional integration across a broader geographical region (Vries et al., 2008). Metropolitan councils have similar municipal budgets, common property rates and tariff-service schemes and one-employer bodies. In metropolitan areas, there is a variety of executive system styles that include the mayoral executive structure in which

executive authority is delegated to the mayor, or the joint executive committee system in which the powers are transferred to the executive committee. South Africa has eight metropolitan municipalities, namely, the City of Johannesburg Metropolitan Municipality; City of Tshwane Metropolitan Municipality; City of Cape Town Metropolitan Municipality; City of Ekurhuleni Metropolitan Municipality; Nelson Mandela Bay Metropolitan Municipality; Buffalo City Metropolitan Municipality; Mangaung Metropolitan Municipality; and eThekwini Metropolitan Municipality (South African MDB, 2018).

Metropolitan municipalities in South Africa were created during the reforms of the 1990s so that cities could be governed as single entities, in response to apartheid policies which had broken up municipal governance (South African MDB, 2018). Presently, the metropolitan municipalities are responsible for all local services, development, and delivery in the metropolitan area. They execute duties of local government for a city or conurbation. This is by contrast to areas which are primarily rural, where the local government is divided into district municipalities and local municipalities.

Economic and social activities overlap municipal boundaries in metropolitan municipalities and the residents can live in one municipality, work in another, and use recreational facilities throughout the area. Municipalities in Category A have exclusive and administrative power in their territories, and are generally referred to as uni-cities or mega-cities. According to the White Paper 1998, the following reasons are identified for the establishment of a metropolitan government:

a. “A metropolitan municipality makes basis for equitable and socially just metropolitan administrative governance, consequently avoiding circumstances where the poor are not properly serviced with economic, recreational, and social amenities. Metropolitan municipalities offer means of addressing such challenges and ensure a more equitable and just form of redistribution of resources that benefits every resident.
b. A metropolitan council endorses strategic land use planning and coordinates public investment in physical and social infrastructure. Metropolitan areas are big areas, which are highly functionally integrated such that (investment in) physical and social infrastructure may benefit all, for instance, the use of public infrastructure cannot be private. Metropolitan governments enable activities such as integrated planning to take place.
c. A metropolitan council can develop a city wide framework for financial and social development and improve the economic competitiveness and stability of a city. This is done through an integrated development plan” (White Paper, 1998).

Section 8 of the *Municipal Structures Act* (1998) sets out the following forms of metropolitan municipalities or Category A:

a. “A municipality with a system of collective executive.
b. A municipality with a collective executive structure joint with a sub-council system.
c. A municipality with a collective executive system combined with award participatory system.
d. A municipality with a collective executive structure, together with a sub-council and a participatory ward administration.
e. A municipality with a mayoral executive system.
f. A municipality with a mayoral executive structure coupled with a participatory sub-council.
g. A municipality with a mayoral executive structure combined with a participatory award system.
h. A municipality with a mayoral executive structure, together with a sub-council and a participatory ward administration.” (Municipal Structures Act, 1998, p.18).

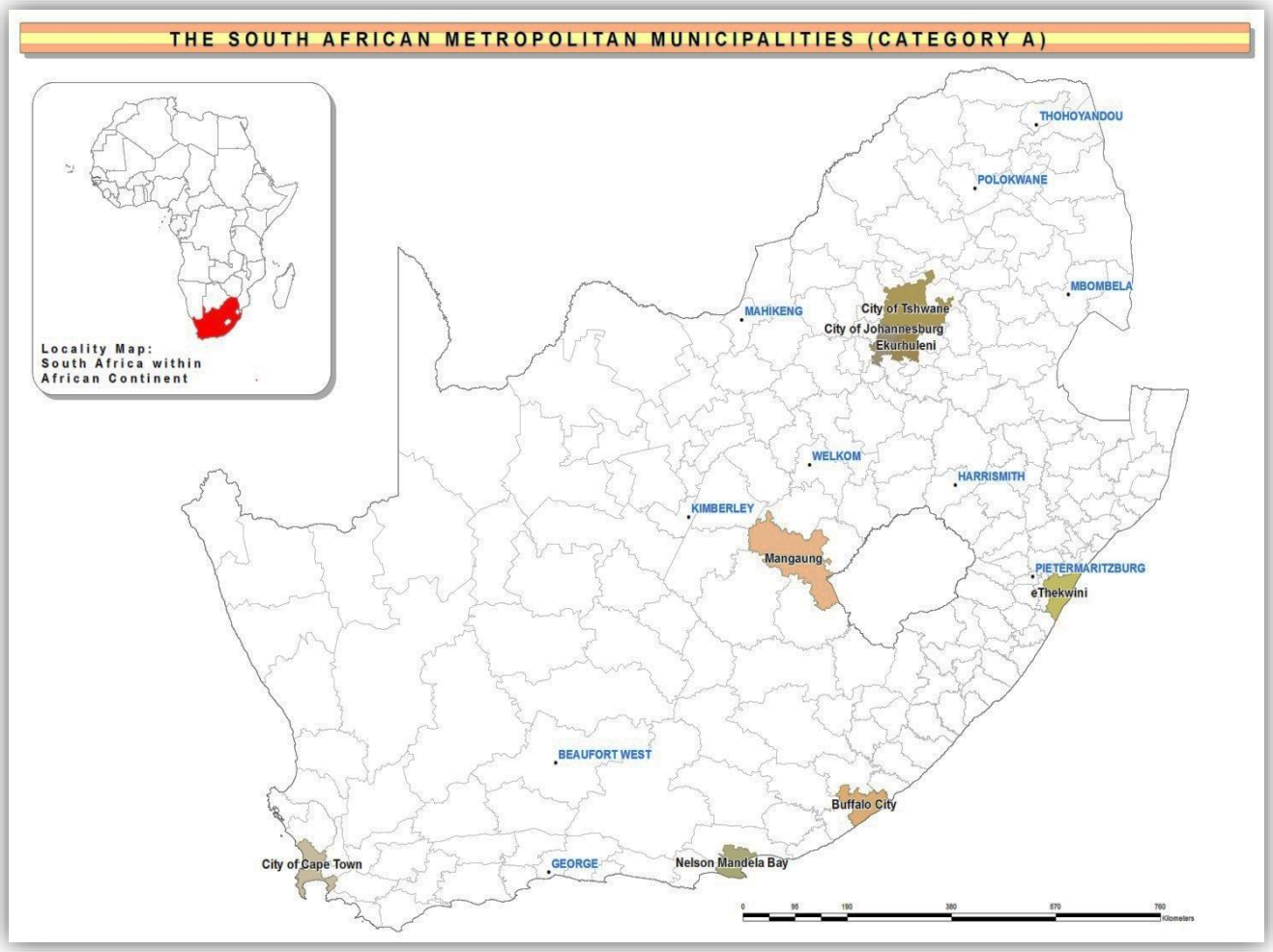


Figure 9: Map of metropolitan municipalities (Category A)

Figure 9 illustrates the map of the South African metropolitan municipalities. Presently the developmental directive of local government is realised through metropolitan municipalities which constitute the eight biggest urbanised and industrialised epicentres in the country. They are given the responsibility of addressing the main challenges described in the local government white paper, specifically, the legacy of urban apartheid by establishing a basis for equitable and inclusive developmental metropolitan governance. They have legislative competence for all the areas set out in Schedules 4B and 5B.

2.4.2 Local Municipalities (Category B)

In South Africa, Category B municipality or a local municipality is a form of municipality that operates as the lowest and most important level of local government. Local municipalities can include rural areas and also one or even more towns or smaller cities. Section 155(1) of the Constitution specifies that a municipality of category B shares a local executive authority in its area with a municipality of category C within the area in which it resides. Therefore, a Category B municipality is normally referred to as a “Local Municipality” (South African MDB, 2018).

Areas that falls beyond the eight metropolitan jurisdiction are split into numerous municipalities. There are 205 local municipalities in total and each municipality is divided into wards. Although the people living in low-density areas, such as game parks, do not fall under local municipalities. These areas are referred to as DMAs and emerge directly under district municipalities (Local Government Handbook, 2019).

Further classifications were made, including the classification of the *Municipal Infrastructure Investment Framework* (MIIF). This divides Category B municipalities into four groups in which bigger or more resourced groups wield more control than smaller, less resourced ones (B1 through B4). The MIIF classification for the local municipalities is precisely as follows:

1. B1: Secondary cities representing the 19 most budgeted local municipalities.
2. B2: It represents 26 local municipalities with a large town as their base or centre.
3. B3: It represents 101 local municipalities with a relatively small population and a large urban population, but not a big city at its heart.
4. B4: Represents 59 mainly rural municipalities with at most one or two small towns in their region (South African MDB, 2018).

In South Africa, local municipalities are ruled by two systems that coexist. This include the executive team led by the municipal managers and the political structure headed by the mayors (Mahlangu, 2016). Local municipalities are responsible for all municipal planning activities that include development planning, local economic development and corporate investment projects within municipalities, in compliance with section 42 of the South African Constitution.

Municipalities use different mechanisms and instruments to drive economic and physical growth as municipalities continue to seek competitiveness both in the local and international contexts. There is, however, a current void in the planning phase for further spatial analysis that can enhance scenario construction by spatial analytics for better project choices, location and magnitude of projects (Mahlangu, 2016).

The two-tier local government, namely the local municipalities merged into district municipalities, undertakes the mandate of the local government, sharing the functional competencies specified in schedules 4B and 5B. The division of duties between the two levels of local government is mandated by the Municipal *Structures Act* of 1998, which must take into consideration the need to equitably and sustainably provide municipal services.

This Act does so by transferring the duties of district municipalities to those that are not specified but instead fall under local municipalities. The following two subsection presents the literature review on district municipalities. (Municipal Structures Act, 1998). Figure 10 illustrates the map of South African local municipalities (Category B).

Figure 10: Map of South African local municipalities (Category B)

2.4.3 District Municipalities (Category C)

A district municipality is created by a number of local municipalities that fall under a single district. National legislation sets out requirements and procedures for the determination of municipal boundaries by an independent body and provides for an effective separation of powers and functions between municipalities, pursuant to section 229 of the *Municipal Structures Act*. Section 155.1(2) of the Constitution describes municipalities under "category C" the *Municipal Structures Act* specifies that there must be a district municipality in areas not entitled to have a metropolitan municipality. District municipalities are accountable for overseeing development and service delivery across all local municipalities within their district. They are responsible for delivering bulk public services and have municipal executive and legislative authority that apply to all their local municipalities (South African MDB, 2018).

Normally, there are between four and six local municipalities which together constitute a district council. There are also nature reserves and district conservation areas in several district municipalities. District municipalities have a municipal code consisting of "DC" letters accompanied by 1 to 48 letters (DC1 to DC48). The term *District Council* (DC) stems from the fact that they were initially referred to as *District Councils*. DC refers to the local ruling body of an urban or rural district (South African MDB, 2018). Figure 11 illustrates the South Africa district municipalities, also referred to as category C municipalities.

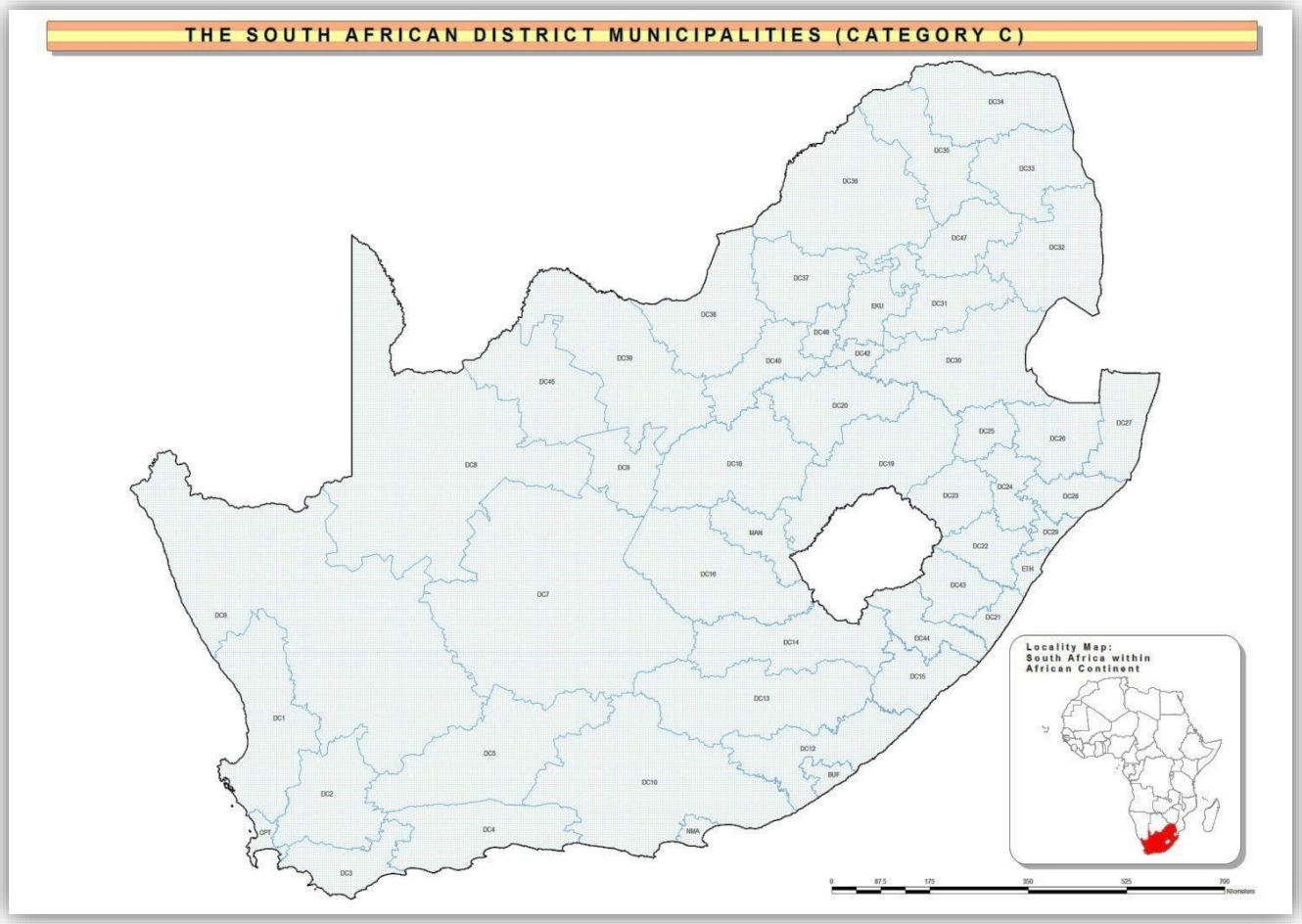
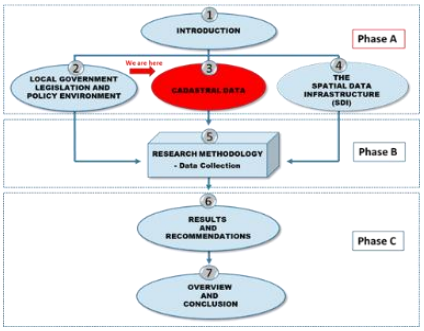


Figure 11: Map of South African district municipalities (Category C)

2.5 Conclusion

This chapter investigated the legislative and policy environment for local government. The chapter exploited examples from an international perspective to clarify local government roles and responsibilities. Local governments deliver governance to the municipal level and allow for public participation in every community organisation or project's activities. This chapter described and investigated the positions of South Africa's three spheres of government. It has been shown that local government is an autonomous sphere of government with powers derived from the South African Constitution rather than being delegated by the national or provincial government. The Constitution guarantees the freedom of municipalities. However, such freedom is not complete. South African legislation specifically provides for, inter alia, co-operation between the spheres of government to realise the constitutional mandate of local government. The chapter also defined the three categories of municipalities in South Africa and provided a map of each category. The whole country is separated into local municipalities. The following chapter addresses the legislative and policy context in which cadastral data are used, distributed, managed, and maintained.

CHAPTER 3
CADASTRAL DATA



3.1 Chapter Overview

In the previous chapter, the local government legislative environment was discussed, as well as its role and significance in terms of the classification of municipalities. This chapter provides further context for the rest of the research and all subsequent chapters draw on it. Specifically, this chapter examines cadastral data and accentuates how cadastral data are defined, how it has evolved, and how it is currently used, disseminated, and governed across all levels of government. However, the roles and responsibilities of cadastral data stakeholders in the South African government are currently unclear. As a result, this chapter discusses the various roles and responsibilities of mandated cadastral data stakeholders.

This chapter aims to provide detailed theory on how and why cadastral data has been and is still managed in order to answer the research questions. The primary objective of this chapter is to investigate the legislative and policy environment that defines how cadastral data should be captured, collected, maintained, and managed throughout the cadastral value chain in South Africa, and the capacities of the role players to do so. Cadastral data are the preferred term used in this chapter and research as it relates to the objectives of this dissertation.

Review of the literature indicates broad use of the terms cadastre, land parcel(s), cadastral systems, and e-Cadastre, but in most instances, the differences amongst them are insignificant. This statement is confirmed by Barry (1999), who found that the distinction is sometimes blurred between the meanings given to those words. Consequently, in this dissertation, the terms are employed as per their use in the literature but imply cadastral data unless otherwise specified.

The sections of this chapter contribute towards the overall objective of this research by elucidating the importance of current legislation that governs the cadastral data and shows how the cadastral system in South Africa functions. The next sections represent an attempt to satisfy the objective of this chapter and assist to answer the problem statement.

3.2 Cadastral Data

3.2.1 Historical Perspectives

This section highlights how the use of cadastral data has evolved. During the primitive periods of human settlement, land was undisputedly the primary source of capital and authority. Historically, as resources became scarce or limited, the role of cadastral data evolved in response to the growing need to provide communities with comprehensive information about their resources, economies, and sustainable land use administration. More recently, the introduction of information technology has also contributed to the cadastral data evolution, creating a new meaning of multipurpose usage. “Cadastral data evolution is directly related to its modernisation (such as upgrading and modern application), and this generates significant costs (Dawidowicz and Źróbek, 2012, p.2).

The answer to understanding the evolution of modern cadastral data is to acknowledge that in one form or another, cadastral information feeds into an essential instrument for managing the relationship between people and land. It is also important to note that the relationship is dynamic and varies between different societies (Ting and Williamson, 1999; Williamson and Ting, 2001).

The evolution of the modern concept of cadastral data may be classified into four broad phases that correlate with major stages in economic development, namely the agricultural revolution, feudalism, the industrial revolution, and information technology revolution (Ting and Williamson, 1999). As such, the cadastral approach in the feudal period was mainly fiscal. In order to satisfy the growth of land markets, a legal requirement was introduced; and as private land became scarce after the *Second World War*, a planning provision was added. In addition, after the *Second World War*, cadastral activities were carried out primarily to support the land tenure reform policy of converting land from customary land tenure to statutory freehold individual ownership into trust land areas.

Cadastral data have traditionally been used as an ownership record and as a fiscal tool (Wily, 2012). It is important to remember that the purpose of the record has been to have some ownership protection. This record has been known and respected by the general public. Thus, land occupation had to take place among primitive tribes in the presence of the chief and the elders (Larsson, 1991). The earliest land-ownership records date back to the beginning of the agrarian revolution. The royal registry was created in roughly 3000BC in Egypt. Around 700AD China used land survey records for its crop yield based taxation scheme. By 300AD the *Romans* also used surveying as a basis for their fiscal records and the creation of a registry of the land they held.

The *Normans* had developed and extended the feudal system after the conquest of England in 1066. Every piece of land had been owned directly or indirectly by the king, who allowed his subjects to use the land in return for military service. During the feudal period the authority was entrusted with the organisational and legal structures formed by the combined interests of the landholders and the sovereign. *William the Conqueror* had to finance defence against the marauding of Danish armies in the 11th century and was interested in knowing how much tax he was receiving and how much he might get from the countryside (Steudler 2004).

He commissioned a popular land record called *Domesday Book* in 1086, which was completed in a relatively short period of time. This book was created "to establish a land register (there were no maps) specifying the name, tenure, area and details of the owner to determine the property for the

purpose of extracting feudal duties" (Steudler 2004, p.8). Therefore the cadastral register existed for fiscal purposes and as a record of the kingdom's territories (Williamson et al., 2010).

Mapping was not common during the industrial revolution until 1807, when Napoleon Bonaparte laid the foundations of a European cadastre. During the Napoleonic era bodies were entrusted with the task of recording transfers and ownership deeds. The records showed both the physical location and ownership of parcels of land across France. The records were arranged per owner based on parcel numbers, area, land use, and land values. It was this combination of records and maps which laid the foundation for modern cadastral systems (Ting and Williamson, 1999; Williamson et al., 2010). Figure 12 illustrates the development of cadastre.

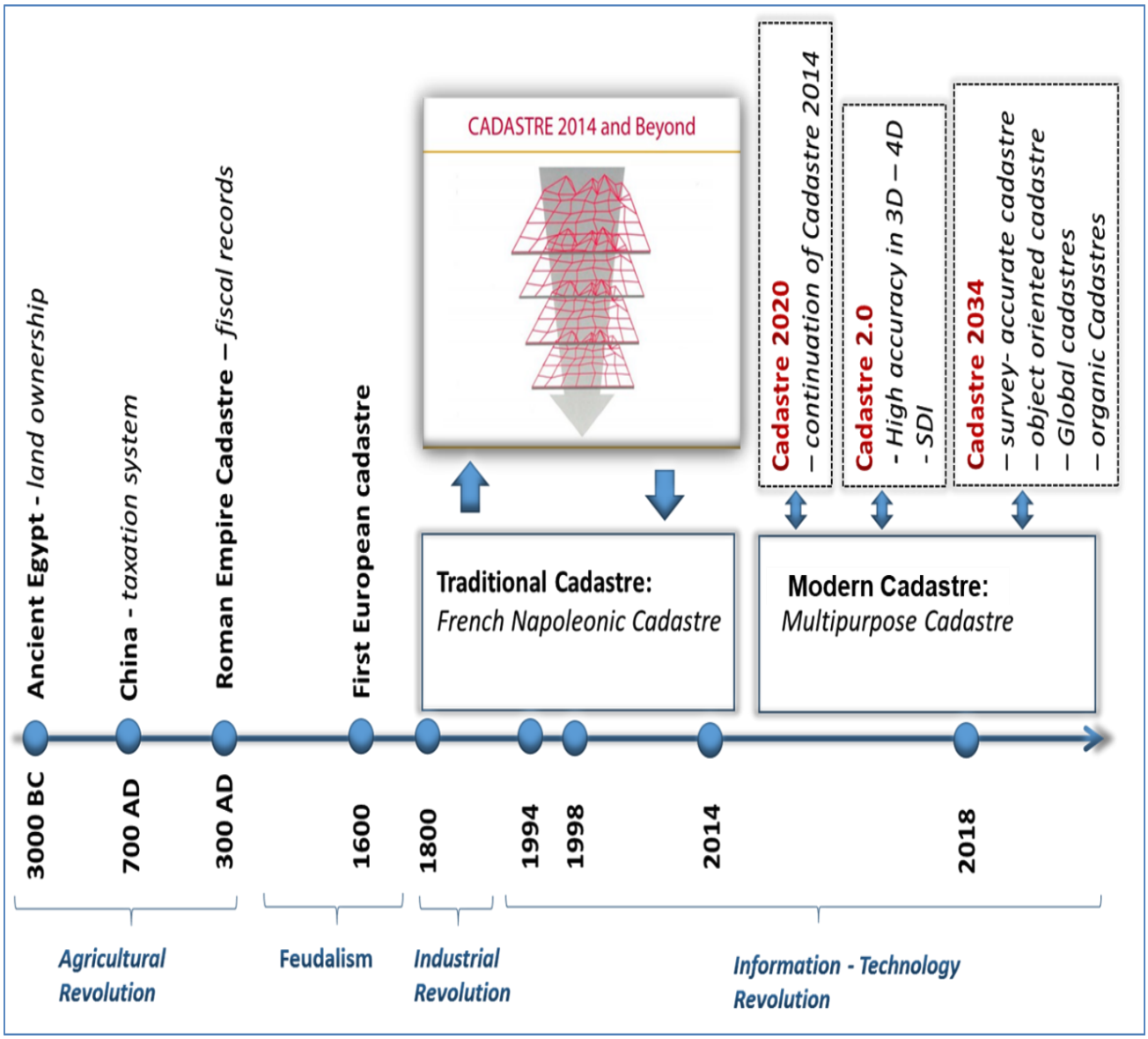


Figure 12: Development of cadastre (Williamson, 2001)

The Napoleonic cadastre is the first general cadastre, created under the law on September 15, 1807. The contemporary cadastres of today have evolved from the European cadastres of the 18th, 19th and 20th centuries. During those centuries, the *French Napoleonic* cadastre and the *Maria Theresia* cadastre were introduced by the *Austro-Hungarian Monarchy* However, it was not until the last 40 years or so that the English-speaking world actually "unearthed" cadastres, and started systematically to adopt and apply cadastral principles to their land management systems. The consequence is that today, virtually every country in the world is conscious of the importance of cadastral systems to some extent. This global understanding of cadastral principles has coincided with the growing influence played by cadastral systems in contributing to economic growth, environmental management and social stability (Williamson, 2001).

The 1980s were marked by the development of the *Digital Cadastral Data Base* (DCDB), and the computerisation of cadastral records. In the 1990s, there was an enhancement in land administration triggered by the development of internet online services. Alongside other computational technologies, cadastral maps and cadastral data were developed using the internet after the year 2000 (Enemark, 2009). The period before 2001 was branded by the computerisation of cadastral maps through various computer programmes. In the middle of 2002 to 2007, the usage of digital cameras in papers linking to land registration gradually increased. During 2005, keyword network map for cadastral maps were used as a reference source of information that incorporated various government-led initiatives, such as land, real property, and local operations (Zhang et al., 2017). Capacity for managing property, ownership, boundaries, and responsibilities was established during this time, which formed the foundation for sustainable development.

3.2.2 Defining Cadastral Data

Cadastral data are referred to as "the geographic extent of real property rights and interests in the past, present, and future; it provides geographical details sufficient to define geographic extent" FGDC (1997, p. 21). Although Schwabe and Govender (2012) maintain that cadastral data are a survey, map, or plan of land parcel boundaries, their meaning specifically refers to spatial boundaries, with no relation to the register of deeds. Lemmen (2012, p. 49) argues that cadastral data refers to three components "the subject matter of personal or collective ownership of non-defined membership; the rights of recognition of non-formal and informal rights; and the subject matter of units other than valid and known parcels." In this study, the definition of cadastral data developed by the *Federal Geographic Data Committee* (FGDC) is adopted.

Cadastral data can be considered as a public asset since it is part of information from the public sector (Bennet et al., 2013; Kurwakumire, 2013). Cadastral data are also often considered as one of the essential data sets needed for modernising government services. It is normally created for the purpose of supporting property taxation and is typically integrated with property ownership records. Cadastral data usually comprises two types of data the graphic, or geometric, representation of the land objects and the attribute data describing them.

This collection of data are usually referred to as cadastral data. The graphic representations may be in the form of paper or digital maps and are commonly referred to as geospatial data. The base of the cadastral system is without a doubt the cadastral data, both spatial and tabular, that is descriptive attributes, in kind. Table 5, summarises the two main components of cadastral data.

Table 5: Two main components of cadastral data (Bank and Mataraci, 2004)

No.	Cadastral data are focused on immovable properties and have two main components:	
1	Geometry of properties	Geometric data includes village borders, blocks, plots, divisions of parcels, parcel corner points, ground control points and buildings.
2	Attributes of properties	These are metadata which define the geometry and give it details. The metadata is not restricted but at the very least owner, rights, mortgages and annotations should be specified and recorded at the same time with geometric data.

Many organisations worldwide manufacture and preserve cadastral data. Bank and Mataraci (2004), state that cadastral data are generated during primary cadastral activities through fieldwork through skilled surveying. Two main products are produced during primary cadastral activities, namely, the cadastral maps and title deeds. Cadastral data are subsequently shown on the maps by cadastral activities carried out by cadastral offices and the title data are also shown on the registration of land registration activities carried out by land registration offices.

Cadastral data activities consist of "the creation of new geometric data; geometry modifications such as subdivision or combining parcels; parcel renovations and corrections; the provision of plan layouts; the preparing of application sketches, and the development and discontinuance of servitude" (Bank and Mataraci, 2004, p.2). Title deed activities include "changing ownership; rights and restrictions; sales, grants, transactions, contracts for lifetime ownership, transfer of immovable property by inheritance, mortgage, establishment of individual ownership of apartments, restrictions on immovable property and the right of use" (Bank and Mataraci 2004, p.2). It is important that cadastral data are able to be updated and kept current (FGDC, 2008).

Cadastral data modelling is a significant strategy for exchanging information amongst different cadastral data stakeholders and its users (Williamson et al., 2010). According to Tjia and Coetzee (2013), for a cadastral data model to have an impact, the model must not only describe simple data but must also support business needs. Cadastral data models today emphasise the integration of flexible and informal land arrangements and social tenure. In the way of accomplishing ecological, economic, social, constitutional and tax policy priorities, cadastral data are being used to address decision-making challenges. Without access to cadastral data, such priorities cannot be attained. Cadastral data are important to linking land parcel rights, restrictions, and responsibilities, is often used for taxation in most cities around the globe, and also provides vital ancillary information for government and private operations, including districts of flood abatement, areas of soil conservation, and many more. For all the benefits presented by the cadastral data, it still faces many challenges (Choi, 2020).

Cadastral data currently faces challenges which include use, storage, security, management maintenance and dissemination. Therefore provision for the secure storage and backup of cadastral data needs to be made. In addition, land policies should ensure that cadastral data are protected, paying attention to electronic signatures, digital copies, copyrights and liabilities. Tjia and Coetzee (2013), in reference to Hess and de Vries (2006), also reported that a lack of common vocabulary previously hindered the exchange of cadastral data. Today's systems that use cadastral data have developed vocabulary for cadastral data that allows data to be exchanged seamlessly in different contexts, particularly across national borders, while adopting internationally recognised vocabulary enhancing land administration communication (Hull and Whittal, 2013).

3.2.3 Cadastre and the Cadastral Concept

In the introduction of this chapter, it was stated that the terms cadastre and cadastral may be used interchangeably. Substantial attention in current times to the cadastral concept, and particularly the cadastre, has resulted in numerous activities internationally, including platforms such as workshops, journal articles, academic courses to name just a few in hope to reach consensus on the definitions (Williamson, 2000).

Dempsey (2020) argues that the word cadastral is an adjective to define the type of spatial data set or map that comprises of property line information. For instance, a cadastral map is a map displaying the parcels and ownership information for a particular location. While the term cadastre is a noun that refers to a data set that contains the property information such as metes and bounds, dimensions, and property owner details.

However, the etymology of the word cadastre is uncertain, and it has various definitions according to different scientific sources. For example, Munkhbaatar and Lee (2015) refer to cadastre as a description of a methodically arranged public inventory of data concerning properties within an area of jurisdiction, based on a survey of their boundaries. Mika (2016, p.68) submits that a cadastre “is simply an innovative mechanism by the real estate management using an information system that is driven by local land information systems and other databases concerning real estate”.

Gwilym et al. (2019, p.4) describe the cadastre as "an official record of the landowners and the quantity and value of the property they own, used to measure the amount of tax due." Although Enemark (2003, p.3) defines cadastral as "a record describing individual land parcels or properties in order to identify taxes (European cadastral is a good example) or land rights protection (Australia is a typical example)." In essence, a cadastre is a structured and registered definition of land parcels containing, for each parcel, a unique identifier and text record of each parcel’s attributes. It is clear from the definitions that there are three main forms of cadastre:

1. *Legal cadastre*: a parcel definition of property interests or rights; usually accompanied by titles or deeds, and registration.
2. *Fiscal cadastre*: a property valuation and land taxation.
3. *Multi-purpose cadastre*: a methodically organised public collection of data relating to all lawful land objects in a given country or region on the basis of a survey of its boundaries (Deininger et al., 2010).

Despite all these attempts at clarity, the concept of "cadastre" is still difficult to grasp. It can be defined in a number of ways, based on the origin, historical and cultural changes of the country or area of jurisdiction. (Enemark et al., 2005b). Legal systems are created around the original administrative systems in most parts of the world, and use the cadastre to describe the dimensions and location of parcels of land described in legal documentation.

Land parcel, or cadastral parcel, is described as a “continuous area or perhaps more properly, a volume identified by a single set of uniform property rights" (Dale and McLaughlin, 2000, p.26). The concept of a cadastre includes parcels of land and textual elements such as title deed documents. As such it is also a fundamental source of data in landowner disputes and lawsuits. Table 6, provides the traditional and evolving definitions of cadastre.

Table 6: Traditional and evolving definitions of cadastre

Definition of cadastre 1985	**Definition of FIG in 1995**	**Definition of *Cadastre 2014***	**Definition of *Cadastre 2.0***	**Definition of *Cadastre 2034***
The cadastre is a methodically formalised public inventory of property data centred on a census of their boundaries within a given country or district; these properties are regularly identified using a different designation. Typically, the outline of the property and the location of the parcel are seen on large scale maps. (UN, 1985; Steudler, 2004).	Cadastres imply a parcel-based up-to-date record of rights and responsibilities in the land (FIG, 1995; Steudler, 2004).	The cadastre is a systematically organised public inventory of data relating to every legal land objects in a country or district, based on a survey of its borders (Kaufmann and Steudler, 1998; Tjia and Coetzee, 2013).	*Cadastre 2.0* exploits numerous new technological advancements utilising experience from the past. *Cadastre 2.0* provides the framework and capabilities to meet the land administration problems of the present and future (Jones and Land, 2012).	*Cadastre 2034* vision, is aimed at providing essential services expected from the cadastre such as knowing all rights, restrictions, and responsibilities, related to real estates, and with these components, access to the property and positional content and to direct the future cadastre with the developed policies, models and standards (Aien, 2013; Alkan et al., 2018).

Figure 13 demonstrates the close, explicit linkage between textual and spatial data that together form the cadastral concept. The mapping component is an outcome of property border surveying and the borders of land parcels. The textual side is a product of ownership registration organised according to land parcels, cadastral designation, and area of land parcels. The spatial framework is a useful tool for verifying the textual aspect or data. For example, it distinguishes parcels where numerical data are not available. This is a basic principle, but it can be very difficult to apply in reality. There is a weak or non-existent spatial framework in many countries, and this is a major cause of confusion in land rights (Deininger et al., 2010).

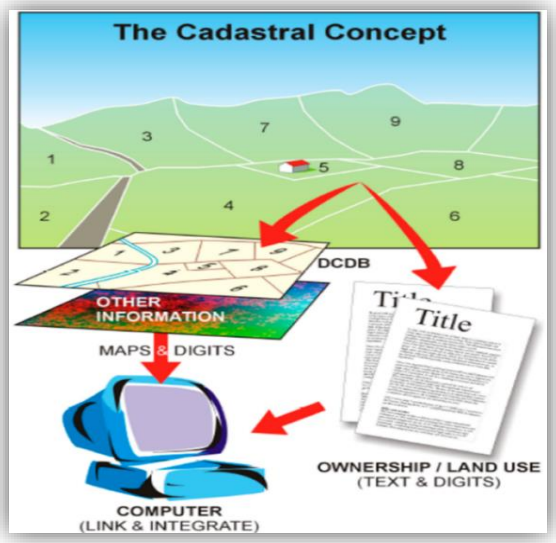


Figure 13: The cadastral concept (FIG, 1995)

According to Kaufmann (2004), land parcels are the main focus of the traditional cadastre. This means that a cadastre is more specifically focused on the ownership, value, or use of land parcels. In contrast, the properties of modern cadastres include legally defined land objects. These changes are currently applied in versions of *Cadastre 2014, Cadastre 2.0*, and even *Cadastre 2034*. The concept of cadastre has evolved in response to the vicissitudes in people-to-land relationships; from simply being utilised as evidence of registration of ownership of land for fiscal purposes, to being used in the transfer of land and land markets, planning, land use and various purposes (Choi, 2020). This subsection has shown that cadastres offer a useful way to uniquely classify each parcel of land while preserving integrity. Cadastres are focused on recording certain information pertaining to parcels of land and provide the connection for security rights in land. The literature has also shown the prevalent lack of agreement on a common definition of the cadastral concept.

3.2.4 Advancements in Cadastral Concepts

Nowadays, global drivers like urbanisation, globalisation, information technology, and sustainable development, have a very significant influence on the advancements in cadastral concepts. Historical, political and legal influences, as well as the complexities of the socioeconomic development of each country or region, have influenced the current status and functionality of the cadastral concepts (Luo et al., 2017). Some innovations and their effect on a particular dimension, like cadastral surveys methods and data modelling as well as database structures, or even the legislation, are often the focus of cadastral visions and scenarios. Recognising the importance of cadastral data in the relationship between humanity and land is the cornerstone to understanding the advances in cadastral concepts. The field of cadastral research has grown with the advent of the digital era, through advances in land administration and ownership data (Choi, 2020). In order to resolve the problems of poverty, environmental sustainability, good governance and economic prosperity, more innovative cadastral concepts should constantly evolve (Luo et al., 2017).

Traditional techniques of cadastral concepts and management are frequently believed to be time-consuming and labour intensive. Nonetheless, mechanisms often made responsible for mapping and documenting millions of land parcels within the jurisdiction, often take longer to accomplish, and even then they frequently prove insufficient. In terms of the cadastral concept, several smaller nations face difficulties in delivering services and information to the public primarily because of the costs and time it requires to develop systems and deliver these data and services through the Internet (Hay, 2016). Innovative and automated methods are therefore in high demand to improve and accelerate the advancements in cadastral concepts (Luo et al., 2017).

The cadastral concept has been further advanced as a consequence of advances in *information and communication technology* (ICT). Thanks to the efforts of cooperation and coordination with other fields or industries and a participatory partnership with all stakeholders (Choi, 2020). To improve the effectiveness of the organisations responsible for implementing them, contemporary cadastral standards should be simple, precise and consistent. Recent technical advances, including drones, GPS technology and cloud computing, make it easier for organisations to maintain and manage cadastral data done ever before.

The convergence of big data analytics, cloud computing, semantic web technology and mobile devices provides exciting new possibilities for land registry progression and the application, theory and practice of cadastral information systems (Hay, 2016). These include, in general, the cost-

effective requirement and sharing of sophisticated resources and facilities in resource-poor circumstances, the increased access to information and processing automation, and thus the sustainability of land information and management, and the possibility of reliability and timely documentation of the true reality of land use and tenure in support of the fight against corruption and other goals associated with sustainability.

According to Hay (2016), the cloud concept is primarily concerned with computational resourcing, which involves the processing and storage of vast quantities of data, their high availability and reduced latency in their recovery, and the production of reusable resources. The promotion of smart technology in the standardisation of cadastral related services is one feature which has lately emerged popular in cadastral data management (Choi, 2020). This relates to the implementation of policies in different countries, including open data, although policies face some limitations depending on the conditions of land administration in each country. Another factor is the direct involvement of civilians in the development of cadastral maps such as in *Volunteered Geographical Information* (VGI). A developing concept of automation includes the identification, extraction or reconstruction, as patterns or artifacts, of apparent boundaries from physical objects depictions in imagery or point cloud data.

Cadastral work is moving from a government-led, top-down field with passive participation to a field involving active civilian involvement. The position of land administration is evolving into a system that maintains new 3D and 4D registration issues, above and below the subject land, along with systems in which real-time updates are possible (Paulsson and Paasch, 2013). The characteristics of areas where cadastral data are utilised today include survey-accuracy, object-oriented design, 3D/4D arrangements, real-time information, global linkages, and organic characteristics. Together, they provide a preliminary vision for the role and nature of cadastral data today (Choi, 2020).

Although the nature of cadastral data has not changed over time, the approaches have been diversified. Today, the field of cadastral data has evolved from paper-based *Land Administration Systems* (LAS) to online land administration systems using the internet. Contemporary literature about cadastral data reveals that there are common parameters, such as property rights, SDI, and the *Land Administrative Domain Model* (LADM). Maintenance of these parameters has emerged, with a growing interest in the creation of open data. Methods of cadastral studies are evolving rapidly with the advancement of technologies (such as photogrammetric, remote sensing, and 3D). In addition, the literature indicates that different methods used in modern aerial and marine surveying techniques will be integrated into cadastral surveying (Stoter et al., 2016).

In order to manage vertical villages and the expansion of property interests, the integration of elevation and time into cadastral structures is currently essential (Billen and Zlatanova, 2003). Interestingly, technological advances have made it possible to extend traditional 2D cadastres to new dimensions, e.g. a sustainability analysis requires third- and fourth-dimensional modelling and visualisation. Further benefits of advancing technology are a drastic reduction in administrative stress caused by confusion and misunderstanding of property interests, and a reduction in planning and construction time. Thus it is not unexpected that initial research to explain the legal, diplomatic and technical barriers to 3D/4D cadastres has already been undertaken (Billen and Zlatanova, 2003; Lemmen et al., 2004; Oosterom et al., 2006; Stoter et al., 2016).

Today, the 3D and 4D representation of information has been recognised in cadastral data management as a feasible means of dealing with space administration. The 3D cadastres strive to

overcome the problems facing current 2D cadastres (van Oosterom, 2013). The ascending complex urban spaces make the existing 2D rights and other interests' registration less efficient, or even redundant. Exploration was carried out to incorporate legal and physical 3D systems into cadastral models (Aien et al., 2013).

In order to overcome existing uncertainty in terms of terminology and key concepts, scholars such as Aien et al. (2013) recognise a need to establish formal semantics in the 3D cadastre domain. Bennett et al. (2010) and the co-authors of *Cadastre 2014* agree that future cadastres will integrate much more than cadastral data; they will manage not only land parcels but also all Rights, Restrictions, and Responsibilities (RRR) affecting the territory as independent objects. Figure 14 shows how the 3D and 4D cadastres will mitigate administrative function as well as provide valuable assistance towards making decisions.

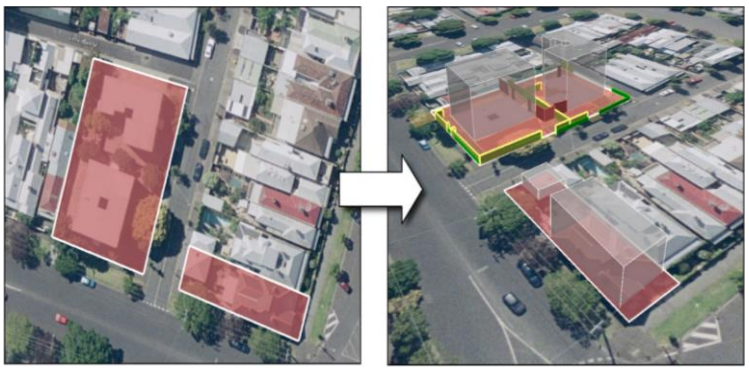


Figure 14: How the 3D and 4D cadastres will mitigate administrative function (Bennett et al., 2010)

Cadastral data management was revolutionised in the final years of the 21st century, geospatial information technology and sustainability concept contributed to the development of new cadastral data visions, models, and functions. These includes innovations such as the "*Multi-purpose Cadastre*" by Williamson (1985) and *CADASTRE 2014 and Beyond* by (Steudler, 2014). As well as the seminal documentations that included the *FIG Statement on the Cadastre* and the *Bogor Declaration* by FIG (1995 and 1996), the *Bathurst Declaration* by UN-FIG (1999), and the *Land Management Paradigm* by Enemark et al. (2005b).

The other innovations and documents are the *Core Cadastral Domain Model* by van Oosterom et al. (2006), the *Towards Cadastre 2034* by (Lemmens, 2010) and by Bennett et al. (2010), and lastly the *Cadastre 2.0, Cadastre 2020 – New Trends in Germany's Cadastre?,* and "*Cadastre 2020 - Coordinate Cadastre 2070"*, which all contributed towards the radically altered understandings of cadastral data management and its potential (Hawerk; 2002; Steudler et al., 2004; Thomson, 2016). In land administration systems such as the cadastral systems of both developed and developing countries, practical implementations are evident (Bennett et al., 2010, p.16).

Cadastre 2014 presents a blueprint for today's cadastral data (Kaufmann and Steudler, 1998). It provides a vital route towards the creation of the new cadastral data models and provides an upgrade to today's conventional models to enable cadastral data to effectively respond to a rapidly shifting humankind-to-land relationship. The improvement of information related to the legal situation of land, so that it can in turn improve the information of tenure, is amongst the main objectives of *Cadastre 2014* (Kaufmann, 2004).

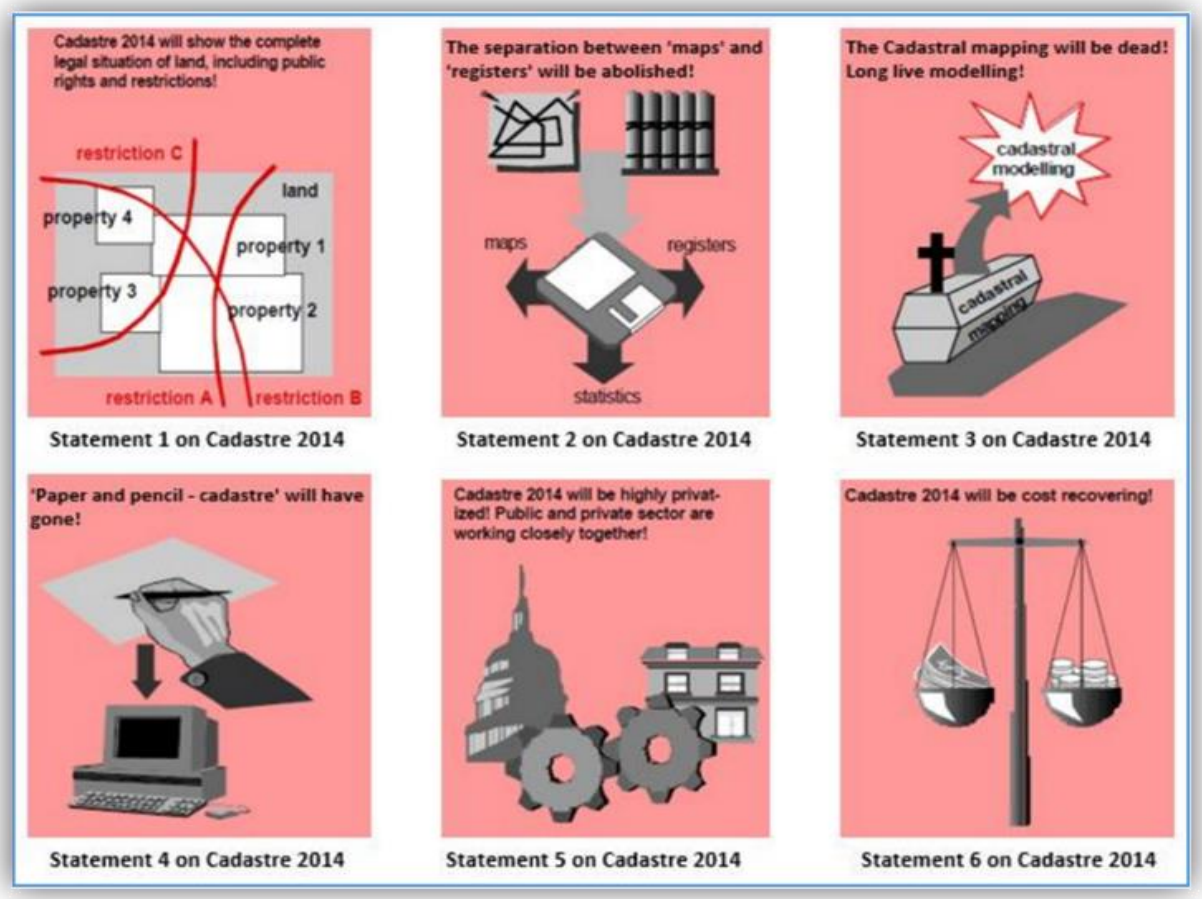


Figure 15: The six statements of Cadastre 2014 (Kaufmann and Steudler, 1998)

Figure 15 illustrates the six statements of Cadastre 2014. The *Cadastre 2014* document is based on six statements. According to Kaufmann (2004), statement 1 is very significant. The rapidly growing global drivers, such as urbanisation and globalisation, have drastically put pressure on land resources. This has led to the restriction of these resources by public interest. Thus not merely individual rights and restrictions, as well as every public rights and restrictions across the land need to be incorporated into today's cadastral structures. This initiative would certainly upgrade the security of land tenure. Statement 1 also highlights the purpose of arranging the various legal land objects in compliance with the legislation under which they are specified. This would allow instant change of cadastral data in order to support the development of legislation (Kaufmann and Steudler, 1998; Ting, 2002; Bennett et al., 2008).

Statement 3 coincides very similarly with Statement 1. This statement works by its model with the advancement of cadastral mapping. The model method allows Statement 1 to be realized. Technical innovations including the *Core Cadastral Domain Model* (CCDM), *Land Administration Domain Model* (LADM), and the *Social Tenure Domain Model* (STDM) are also evolving in relation to Statement 3. These reflect object-oriented models within the cadastral system intended for the organisation of property interests. These methods of modelling are primarily adaptive and dynamic (Kaufmann and Steudler, 1998).

The development of the *Global Land Tool Network* (GLTN) modelling of social tenures demonstrates adaptation. Other statements made in Cadastre 2014 include *Statement 2* on 'abolishing the separation between maps and registers'. As well as *Statement 4* on 'the abolition of pencil and paper cadastres' and Statement 5 on ‘a move toward the privatisation of the cadastral elements', and lastly *Statement 6* 'the requirement that the cadastral recover costs'. The other statements are more argumentative (Kaufmann and Steudler, 1998; Oosterom van et al., 2006; Kalantari et al., 2008).

The paper and pencil cadastres in all advanced economies are now obsolete. Since then, several nations have sought to remove institutional obstacles around maps and registers. Political inertia and entrenched government silos, however still ensure that this distinction continues. Overall, *Cadastre 2014* was an exceptionally valuable study for the generalisation of technological advances in the contemporary sense for the cadastre (Kaufmann and Steudler, 1998; Bennett et al., 2008).

Cadastre 2.0 is multipurpose. This is because, beyond merely documenting land ownership or identifying parcels for taxation, it serves a wide range of needs. It enables the full spectrum of rights and parcel definitions to be modelled and managed within the system. *Cadastre 2.0 t*akes advantage of several recent technical developments, building on previous learning and experience. It recognises the specific circumstances of land tenure in each country or territory, and permits implementation that is responsive to and accepts cultural differences (Polat et al., 2015).

Cadastre 2.0 is definitely not really a 'hard-coded' system, but an adaptable, optimised system that enables the latest technology to be used when it becomes available. *Cadastre 2.0* offers, based on global data standards, the cloud, commercial off-the-shelf applications, as well as open data provided by states, the private sector, residents, the infrastructure and technologies to address the land administration challenges of today and tomorrow (Polat et al., 2015).

Bennett and co-authors from the *University of Melbourne* identified six design elements concerning the function and existence of potential cadastres at the FIG 2010 congress in Sydney, Australia, as presented in *Cadastre 2034*. One of these design elements was survey accuracy (Alkan et al., 2018). *Cadastre 2034* outlines a vision for a broader cadastre where information is readily accessible and people have confidence in the spatial extent of the various rights, restrictions, and responsibilities related to their land and real property (Lemmens, 2010). *Cadastre 2034* will guide the evolution of jurisdictional systems and ensure a coordinated and consistent approach to future policies, legislation, standards, models, and research, and provide clear direction for the sector (Lemmens, 2010).

Cadastre 2034 also has the vision to enable people to understand their RRRs related to land and property in a survey accurate and 3D environment (Lemmens, 2010). This vision leads to changes in current sub-divisional processes. However, *Cadastre 2034* is still a long way to go before implementation, bearing in mind that circumstances are bound to change. From the process point of view as well, 3D and 4D data must be available to provide accurate information on the land and property. In a study called "Beyond Cadastre 2014," six statements were outlined for Cadastre 2034, in the context of the cadastre's function and structure (Lemmens, 2010; Bennett, 2014). Figure 16 illustrates the six *Cadastre 2034* statements and provides an explanation of each.

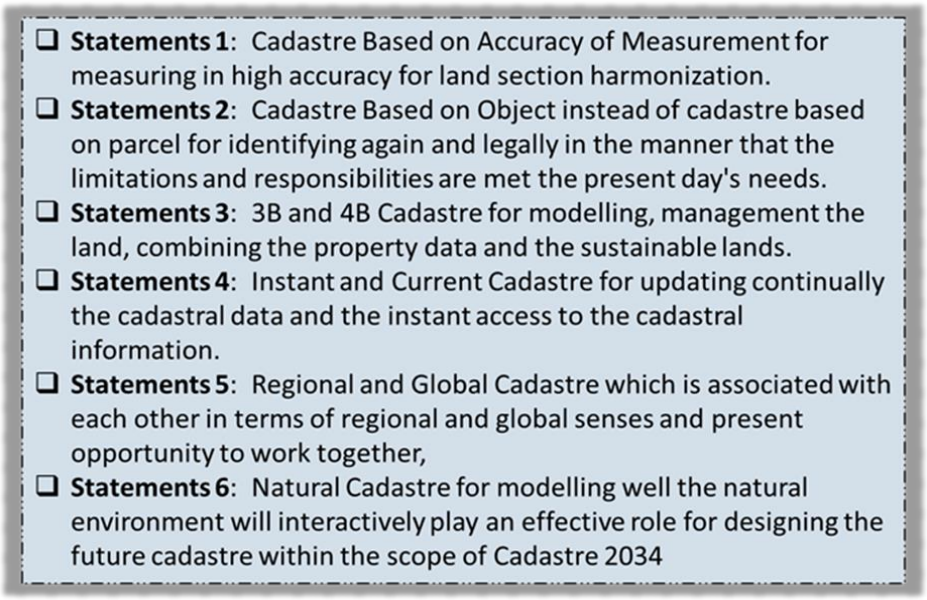


Figure 16: Cadastre 2034 six statements (Lemmens, 2010)

In summary, the literature in this section revealed that today, the development of e-Government and a *'Spatially Enabled Society'* is intensively based on cadastral data. The propositions put forward by *Cadastre 2014, Cadastre 2020, Cadastre 2034*, *Cadastre 2.0* and *Beyond Cadastre 2014* represent very good examples. These cadastral documents seem to have emerged from the consideration of developing countries' largely urbanised areas whereby needs and wants can be summed up in three main terms namely real-time, information (for example 3D, 4D, RRR) and accuracy (Lemmen, 2010).

Moreover, it was shown that "globalisation induces cadastral output adjustment concentrated on multilateral standards of compatibility" (Alkan et al., 2018, p.6). In developing nations, however, entirely different social requirements emerge, and design concepts for those areas cannot be drawn up with anything. The responsibility of land and land usage is increased in the wake of foreign problems, irrespective of several concerns, such as the way to calculate accuracy and the data layers which are covered within the context of Cadastre 2014 (Steudler, 2010). These problems include population increase, climate change, and food security and nutrition. As a result, Cadastre 2034 needs to be more comprehensively considered in the principles emphasised with Cadastre 2014.

It can be inferred that ensuring the durability of cadastral data are the core elements of Cadastre 2014, Cadastre 2.0, Cadastre 2020, and Cadastre 2034. This requires a strong effort to strengthen the sustainability and sharing of cadastral data and a commitment to safeguard this valuable resource for forthcoming descendants (Alkan et al., 2018). The fundamental concept is that land and even real property is the medium for social interaction and that it is necessary for informed choices in a modern society to acquire advanced land-related information. Future cadastral data is seen as an extremely important component of tomorrow's supporting structures for decision-making, growth and investment, ownership of land and real estate management. Today’s overall literature on cadastral data has shown that strategic analysis, creative planning and a collaborative approach to data or information custodianship would be needed (Alkan et al., 2018).

3.3 Cadastral Systems

3.3.1 Defining a Cadastral System

A cadastral system is a method of recording the physical location of real properties and of listing real property rights (Lemmen et al., 2017). It is the 'where' component of the property rights system, securing the legal status of real properties and providing the foundation for effective land tenure transactions. Similarly, Silva and Stubkjær (2002) argue that the cadastral system contains the cadastral details with its spatial emphasis and the land record with its legal emphasis. Barry (1999), with reference to Dale (1976), portrays a cadastral system as operationally defined embracing a set of human resources, institutions, technical resources, and processes that support land tenure security.

Based on the cadastral system definitions given above, in this dissertation, a 'land administration system' is described as the incorporation of land register and cadastral data, in which the land register is legally focused and cadastral is spatially orientated. The land administration system is a vital infrastructure that helps both developed and developing countries enforce land policies (Enemark, 2009). It involves not only the cadastral system's roles and operations, but also higher level aggregation, management, and distribution of cadastral information, as well as the institutions and operations that promote these (Williamson et al., 2010; Hull and Whittal, 2013).

The cadastral system describes the spatial and non-spatial entities of land and parcels information. Krigsholm (2020) maintains that cadastral systems are mostly researched or studied from a juridical and technical perspective. The technically focused studies have provided knowledge on the effective ways of registering land and property interests (Stoter et al., 2017). The legal studies have contributed towards the creation of the 3D property idea and the system vocabulary across many platforms.

Whittal (2008) points out that the cadastral system's interpretation is not limited to systems of formalised, registered land rights. In a cadastral system of sorts it is conceivable that unregistered, customary land rights can also be documented. According to Whittal (2008), such off-register cadastral systems contain all the components of registered, formally defined cadastral systems, utilizing methodologies and techniques that are relevant to their various circumstances. A cadastral system should therefore not be interpreted as applying solely to formalised property rights systems, but may also be applying to non-exclusive, customary property rights. Further research could be conducted to establish if this could be the basis for converting from legitimate social tenure to legal tenure. On the basis of this clarification, Whittal (2008) extends the meaning of cadastral systems to a definition that includes off-register rights and interests and addresses the tension within a constitutionally pluralist society between institutional land law and reality.

Since colonial times, the cadastral system has primarily been a means of providing a spatial and written description of land parcels for acquisition and registration of land rights. Enemark et al. (2005b) define the role of cadastral systems in promoting the management of the three important duties of land tenure, land value, and land use. A cadastral system includes a way to integrate all functions of administration using specific identifiers. Lemmen (2010) argues that the cadastral system can also be referred to as a documentation system for data collection of authentic official data stored in a digital database. Habib et al. (2017, p.1) maintain that a "cadastral system is a basis used for the protection of the property using title registration and cadastral maps".

The cadastral system can also be considered as a subsystem of a land information system (Whittal, 2008). It covers all aspects of the legal, financial, and regulatory cadastral details, as well as the cadastral information of political, legislative, economic, technical, social, and relationships established and assessed. For this research, the term cadastral system is described as an official sub-system of land administration that comprises the institutional system (a group of role players with accountable responsibilities to facilitate cadastral activities and maintain cadastral systems), procedures, standards, and regulations which collectively guarantee that the cadastral system is kept up-to-date. Hence, a cadastral system is considered as an institutional system that usually refers to the operations that a cadastral organisation is conducting (Chekole, 2020). Cadastral systems produce and utilise cadastral information which is essential for the making and implementing of various decisions on land. This includes the location of land parcels, parcel sizes, and describes boundaries.

According to Borgaerts and Zevenbergen (2001), cadastral systems vary worldwide, and no two systems are truly alike. Instead, each is a variant or an adaption of more than one system, ensuring a cadastral system that fulfils the needs of government and the private sector. Around the world, cadastral systems are organised in various ways, especially with regard to the component of land registration.

Enemark et al. (2014) argue that there are two types of cadastral systems, known as the deeds system and the title system. The dissimilarities between the two principles are in relation to the country's cultural growth and judicial environment. The biggest distinction is whether only the transaction (the deeds system) is recorded, or the title itself (the title system) is documented and secured. Table 7, provides a breakdown of the variation that exists between cadastral systems (Bogaerts and Zevenbergen, 2001).

Table 7: Breakdown of the variation between cadastral systems (Bogaerts and Zevenbergen 2001)

No.	A breakdown of the variation that exists between cadastral systems
1	The decentralised versus the centralised cadastral system, which defines whether the cadastral system for a country is managed locally i.e. in each of its regions or provinces, or whether data are managed in a central location and then distributed to the various regions.
2	The land registration and the cadastral system may exist as one system or be viewed as two separate entities.
3	The cadastral system may be established for fiscal or legal purposes. A fiscal cadastral system is established for taxation reasons which is the sector within which most cadastral systems are established and are cheaper and simpler to maintain and establish compared to a legal cadastral which is established to prove ownership. It is these legal systems that require constant updating to ensure accuracy.
4	The cadastral system of fixed or general boundaries. “Whether it is in deeds, for land registration or on cadastral maps, the unit of land that makes up a certain property (parcel) has to be defined and identified” (Borgaerts and Zevenbergen 2001, p. 26).
5	The cadastral system may be government-controlled or self-supported. In a government-controlled system, such as with many European countries, the government maintains the system and any income goes directly into the state treasury. This implies that the government provides funding for the cadastral system. On the other hand, in the Netherlands, the national cadastral system has been privatised and has become an independent organisation.

The deeds system is essentially an owner registry based on "who owns what," while the title system is a property registry showing "what owns who." The cultural and judicial dimensions apply if either a country is founded on Roman law (deed systems), or Germanic or Common-Anglo law (title system). This also applies, of course, to colonial history (Enemark et al., 2014).

Three specific approaches to cadastral systems suggest foreign experience. These approaches are based on countries that have a common history and legal context (*German-style, Torrens or English approach, and French or Latin-style approach*). Although each structure has its own unique characteristics, it is possible to group most cadastres under one of these three methods. There are three different land registration systems types, as well. These translate into three separate roles per function the cadastral information plays (Enemark et al., 2014).

Table 8: Three basic approaches to cadastral systems (Enemark 2010, p. 5)

STYLE OF SYSTEM	LAND REGISTRATION	CADASTRE
French/Latin/U.S. style	Deeds system Registration of the transaction Titles are not guaranteed Notaries, registrars, lawyers, and insurance companies (U.S.) hold central positions Ministry of justice Interest in the deed is described in a description of metes and bounds and sometimes a sketch, which is not necessarily the same as in the cadastre	Land taxation purposes Spatial reference or map is used for taxation purposes only. It does not necessarily involve surveyors. Cadastral registration is (normally) a follow-up process after land registration (if at all) Ministry of finance or a tax authority
German style	Title system Land book maintained at local district courts Titles based on the cadastral identification Registered titles guaranteed by the state Neither boundaries nor areas guaranteed	Land and property identification Fixed boundaries determined by cadastral surveys carried out by licensed surveyors or government officers Cadastral registration is prior to land registration. Ministry of environment or similar
Torrens/English style	Title system Land records maintained at the land registration office Registered titles usually guaranteed as to ownership Neither boundaries nor areas guaranteed	Property identification is an annex to the title • Fixed boundaries determined by cadastral surveys carried out by licensed surveyors (Torrens) • English system uses general boundaries identified in large-scale topographic maps Cadastral registration integrated in the land registration process

Table 8, lists the summary of the three basic approaches to cadastral systems. The position of the cadastral systems and the styles of land registry are not exhaustive. Henssen (1995) describes land registration as the method of formally registering land rights by deeds, or as the property title. On the

basis of this description, Henssen (1995) offers an arbitrary classification of cadastral systems based on the discrepancies in land registration laws and the corresponding spatial cadastral data supporting these land registration legislation. Henssen (1995) points out that these classes have the same values on land registration but mostly vary in procedures. The disparity in the related spatial cadastral data substantially shows this procedural discrepancy.

Over the last two decades, the global trend was to shift from manual information systems to electronic information systems to improve the quality of knowledge and usability (Borzacchiello and Craglia, 2012). In addition, Williamson (2000) states another pattern in cadastral systems of developed countries. Cadastral systems are important in developing countries because they promote increased investment and growth in agriculture, more productive land use, improved sustainable development, foster increased gross national product (GNP) through higher agricultural productivity, facilitate land reform, and provide significant social and political benefits to a more stable society.

The cadastral system underpins an effective and durable registry of land based property rights. Cadastral systems historically serve as the basis for successful land tenure transactions and in ensuring the legal status of property boundary lines. In order to contribute to sustained economic and social growth, cadastral systems play an essential and on-going function. They are used to provide information for various uses in society and the data often have significant legal, social, and economic importance. Therefore, information should be accessible, and the cadastral system should be open to the general public (Fourie and Nino-Fluck, 1999).

Cadastral systems use standard information technology and are spatially enabled rather than spatially powered. This implies, for example, that practically all authoritative data, especially coordinates, are stored and manipulated spatially (for example as numeric or textual data in database tables rather than as spatial objects). A spatial representation (object) is generated and added to the database as new co-ordinates are generated for a point (for example by least square adjustment). In turn, this is used to generate spatial representation of relevant details such as observations, parcels, boundary lines, and so on (Haanen and Sutherland, 2002).

3.3.2 Benefits of Cadastral Systems

The importance of a cadastral system which works well can hardly be overestimated. A well-organised cadastral system acts as backbone of society. Modern reforms of the cadastral system recognize the history of the cadastral system as a key instrument of public services and highlight its fundamental effect on the adoption of the land management concept. In the opinion of Enemark et al. (2014), approximately 2,000 cadastral systems were multipurpose government engines, functioning better when used and incorporating administrative tasks in land tenure, value, use and development, and focused on sustainable land management.

It is for this reason that a huge demand and interest has been placed on developing and monitoring a successful cadastral system within countries. According to Bogaerts and Zevenbergen (2001, p.25), “not only do cadastral boundaries provide for legal protection regarding ownership” but, they also provide a source of revenue for the state. A cadastral system is beneficial in the following ways:

a. It is an important tool in many countries around the world which supports land reforms. The cadastral system establishes hierarchical land-administration structures for governments,

technically ensuring vital space and capital for Western society's economic activities (Harvey, 2006; Österberg, 2013).

b. It provides the capacity to create an effective and equitable system of taxation. Land cannot be taxed unless there is knowledge of the location, size and ownership of the land. In such a land system, all parcels of land can have a real value based tax levied on them (Harvey, 2006).

c. The development of a cadastral system, and especially the systematic production of the cadastral maps, allows a government to decide the amount of state land it possesses. This evidence alone has provided ample reason for some countries to undertake a cadastral survey, such as the *English Domesday Book* in 1085 (The National Archives, 2011).

d. A number of potential users such as state, regional, and local governments, the private sector, and education benefit from the cadastral system. Governments are the source of every land administration and other resources. The cadastral systems will carry out a stream of uniform data for upgrading nationwide maps and statistics for use in the census report. Furthermore, small-scale national maps and themes can be related to more detailed regional and local government databases. Provincial maps may be connected to other comprehensive maps and databases accessible from private companies and local authorities. Even provincial governments can readily access information with local governments (Majid, 2000, Enemark et al., 2014).

e. Private sectors often profit from the cadastral system through activities such as developing standards and legislation, exchanging themes and data sets, and, among others, large-scale maps. Most significantly, in interacting with government authorities, the private sector profits from how the cadastral system can speed up administrative activities and minimise costs.

f. The cadastral system permits greater access to geospatial information by members of the public. Quicker access to documents concerning individual rights, such as planning control, native title, and land title issues, is vital and eventually will change the attitude of the public towards administering programmes of local government.

g. The cadastral system also helps to resolve simple land disputes by simultaneous access to databases for the planning, cadastral, title, and customary land title.

h. Rights and interests are real property benefits that can be traded for monetary compensation, reassigned or generally delegated to another. Rights and interests shall be registered in the records of the land registry. Surveys and legal structures such as the *Public Land Survey System* (PLSS) and also parcel-by-parcel surveys and definitions provide geospatial details essential for the description of rights and interests (FGDC, 2008). Moreover, the application of SDI is evident when Member States exchange themes, data sets and information through a cadastral system (Majid, 2000).

i. The cadastral system guarantees the historical traceability of any data change, since their first cadastral registration, related both to rural parcels and urban units.

The contemporary cadastral system is a move towards the concept of a *Multipurpose Cadastre* (MPC). Pursuant to Kaufman (1998, p.2), the MPC is "a methodologically structured public inventory of data pertaining to all legal land objects in a given area, nation or region, based mostly on demarcation of their borders."

The MPC is an addition to the existing cadastre to include other registers for land details. These registers can contain databases with information on planning and valuation. MPC is intended to fulfil more than its original intent of solely serving the land market. The successful and productive mechanism of a nation's cadastral system is also a vital important for sustainable development. Figure 17 illustrates the benefits of modern cadastral systems.

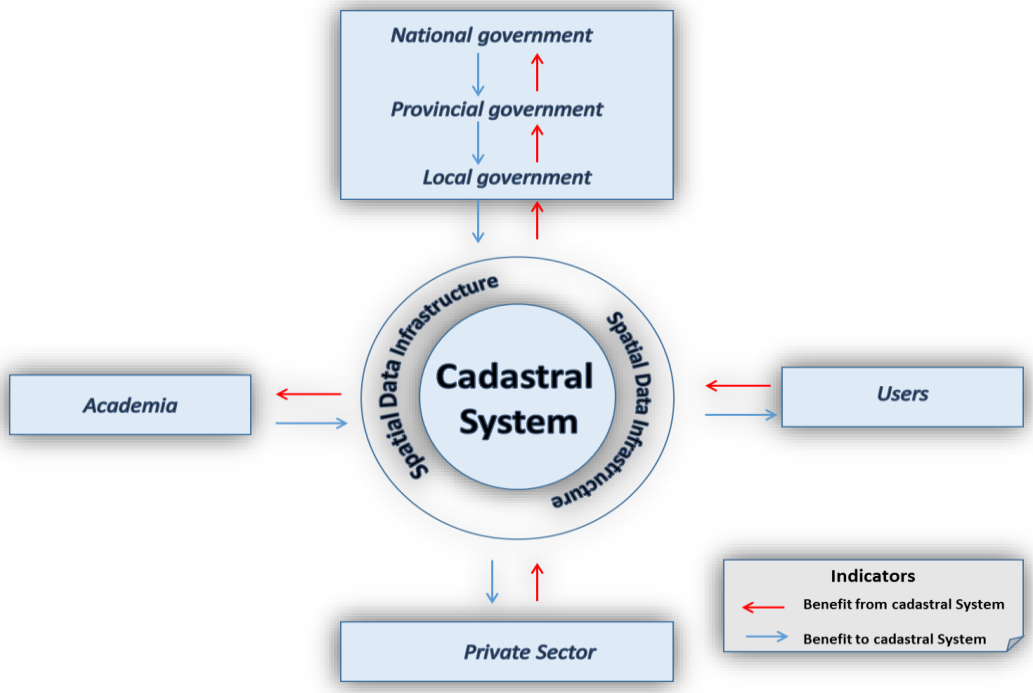


Figure 17: Benefits of modern cadastral systems (Majid, 2000)

3.3.3 Limitations of Cadastral Systems

The cadastral systems implanted in different nations have not lived up to expectations in certain aspects. For instance, it is not easy to access and share cadastral information within and across jurisdictions. There is a lack of popular understanding due to the variations in definitions used in different jurisdictions, and there is a lack of a versatile approach to dealing with non-parcel geospatial representations of ever-changing and current types of land interest (Lemmen et al., 2017).

It is also understood that legal or structured systems do not represent millions of citizens whose tenure is largely social instead of legal, such as freehold rights and registered tenants. Conventional land registration systems, like cadastral systems, and the manner they are currently structured, are unable to provide security of tenure for many low-income groups and adequately address the severity of urban challenges (UN-HABITAT, 2003).

Many developing nations have cadastral extent of below 30 per cent. This implies that in many nations, more than 70 per cent of the land is entirely beyond the land registry. In cities where greater than one billion inhabitants reside in informal settlements without sanitation, clean water, community facilities and tenure protection or poor quality of life, this has created major problems (Lemmen et al., 2017). This has also created food security and rural land management problems for countries (Enemark et al., 2014).

Accordingly, it can be said that modern cadastral systems are in a problematic situation. The dialectics of progress apply mainly to developed countries which face a huge investment in re-engineering their legacy systems to permanently meet the requirements of the modern user, including quicker procedures for land transfer, good access to data, guaranteed reliable data sets, fast dissemination channels, value for money, fitness for use and tailor-made products. However, developing countries still have only a few cadastral data handling institutions which provide access to their data through web-based services (Lemmen and Oosterom, 2001, Lemmen et al., 2017).

3.4 Cadastral Data Standards

3.4.1 Cadastral Standards Outline

Throughout the field of geographical information, standardisation started over 25 years ago. It started with the emergence of the requirement for transferring of data from one system to another in a static perspective. Later, there were requirements for interoperability. The criteria for standards today differ from one profession to another. It is therefore necessary for all the professions involved in the field of geographical information to realise that different standards may be expected at some point (Salgé, 2005).

Several scholars have identified two different principles for standardisation. This is a data-centric approach and a process-centric approach. The specifications can be expected to achieve data portability between systems in the first approach. The method is exemplified by the work of *CEN/TC 287*. This approach tackles the most pressing needs of today and yesterday. Throughout this route, the main elements for standardisation are conceptual models, quality management, metadata, uploading, query and update. Even so, the geospatial community is now contemplating a different approach to standardisation, also termed process-centric (Salgé, 2005).

This approach is the product of a growing interest in information highways. This is an important development because the geospatial community market will continue to lag unless it also adapts to this trend by adopting open operability standards that support distributed data management ideas. *ISO/TC 211* focuses on this approach and even if the goal of completely open systems for GI is discounted as unrealistic and unattainable in the short term, the process-centric concept must remain the longer-term goal (Salgé, 2005).

The standardisation activity has become increasingly essential for surveyors. The implementation of technical and professional standards is one aspect that distinguishes practitioners from others (Hawerk, 2001). Furthermore, the advantages of standardisation have a strong financial importance for a contemporary society. Cadastral data standards are essential for efficient communication, integration and data sharing. In various regions of the globe, cadastral data concepts and standards

have been applied and commonly used to establish robust structures that satisfy the various demands of modern land information and cadastral systems (van Der Molen, 2014; Kaufmann, 2014; Steudler, 2014). The creation of international standards for cadastral data involved the removal of land management problems and the administration of land-related resources.

The main objective of the standards is to provide for the configuration and description of cadastral data that will promote the exchange of data between all organs of state and the private sector. This will safeguard and promote investment in cadastral data across all sectors. Consequently, standards ensure that cadastral data operates in line with other data sets. For instance, in order to decide if a parcel or cadastral information is accessible in a given region, users would need to navigate to that geography and then check that certain basic parcel information and metadata have been made accessible for that area (Kaufmann 2014).

It should be observed that the aim of the cadastral standards is to provide only the minimal details required to facilitate the location of parcel-level information and the identification of the source. These data, along with other acceptable metadata, provide information explaining how and where to obtain the data required to support applications (FGDC, 2008).

3.4.2 United States of America's Cadastral Data Content Standard

The USAs' *Central Data Content Standard* (CDCS), established in the mid-1990s, is a standard for cadastral data. The first version the CDCS, which appeared in 1996, was under the supervision of the *Federal Geographic Data Committee* (FGDC). Revisions occurred in 1999, 2002, 2003, and 2008 (FGDC, 2008). The CDCS describes a standard that provides textual definition of land survey objects, land records, and land ownership information, "promoting the sharing of information across every level of government and the private sector. This guarantees maintaining and improving investments in cadastral data at all levels of government and the private sector." (FGDC 2008, p.4). The CDCS is the source of automating the legal elements of cadastral data contained in the public record.

The FGDC stated goals for the CDCS are as follows:

a. "Providing common definitions to public records of cadastral data to support the successful use, interpretation and automation of land records.
b. To enhance data sharing and include suggested values for the attributes.
c. Eliminating redundancy inside and through these systems to resolve contradictions related to the application of homonyms and synonyms in public land registry systems.
d. To provide guidelines and clarification on common concepts for land records and land survey professionals in order to enhance land records, automation, management and usage.
e. To use interactive participation in standard production to reach out to non-federal organisations and facilitate the widespread implementation of the standard." (FGDC, 2008, p.4).

All levels of government and the private sector envisage using the CDCS. Therefore the CDCS integrates as much as possible with existing standards. The standard incorporates standardisation of cadastral information related entities and objects, including survey measurements, land interest through transactions, general property descriptions, and data on boundary and corner evidence. Some or all of these applications are meant to have standard support (FGDC, 2008).

The standard is not intended to reflect design for implementation (FGDC, 2008). All geospatial metadata specifications for this standard comply with the FGDC's *Content Standard for Digital Geospatial Metadata FGDC-STD-001-1998.* The standard's intended geographic scope is countrywide coverage including all onshore cadastral and marine cadastral information.

The standard describes characteristics or qualities to be found in documents relating to land ownership. It offers suggested domains for several elements, and provides a description of interagency for each element (FGDC, 2008). The interoperability of jurisdictions, activities, and meanings should make cadastral records more standard.

The standard does not limit or filter the built-in details. Geospatial and the topological relationships and spatial features required to construct and maintain a spatial information system are not included in the standard (FGDC, 2008). For some attributes and relationships between attributes, the standard is provided in the form of a logical data model, as input and attributes variables, as well as proposed domain values. The standard presentation is structured as a model of entity-relationship.

The standard provides sufficient information to convert the information from records to a common basis. For example, while automating distances which have any unit of measurement is conceivable, the original units of measurement must be displayed in a legal cadastre. This requirement adds a large amount of attributes to the standard (Lemmen et al., 2015). Among these added attributes, an attempt is made to provide suggested value domains to facilitate potential data transformations and migrations. These suggested domains are not an exhaustive list, and supporting additional or extended domains. The word "suggested domain" does not, however, plan to mean that it is a structured domain list (Lemmen et al., 2015; FGDC, 2008).

The guidelines and requirements for automating cadastral information into the standard partly rely on the details found in the records of land ownership. That is, information that is not accessible cannot be automated but all available information could be automated. Certain guidelines for the standardisation of data are based on data reliability or integrity. One example of data integrity is that you can relate the information to a source document. The relationships between the entities and attributes are protected by another form of data integrity (Lemmen, 2010).

3.4.3 Land Administrative Domain Model

Land administration evolves and improves over time in many countries, the speed of which is always determined by the rate of technological change as well as social dynamics. Many instruments are prepared to assist and improve this development from the standpoint of geospatial, cadastral, and land registry. The *Core Cadastral Domain Model* (CCDM), which is currently termed the *Land Administrative Domain Model* (LADM), has been implemented to include the *Land Administration Domain* (LAD) reference model (ISO, 2012; Lemmen et al. 2015).

It was submitted to the *International Organisation for Standardisation* (ISO) and was approved as an international standard in 2012, like *ISO 19152*, constituting the first adopted international standard in the land administration domain (ISO, 2012; Lemmen et al. 2013, 2015). *Technical Committee* ISO or TC *211, Geographic Information or Geomatics,* prepared specifications for ISO 19152.

LADM is a design process, not a data product configuration (in the case of ISO 19131). A reference LADM representing particular information-linked features of land administration (such as components beyond and beneath the surface of the earth and over water and land) is defined in ISO 19152:2012. LADM provides a formal language for the description of existing systems, based on their similarities and differences. It is a descriptive standard, not a prescriptive one, and can be expanded (Babalola et al., 2015). LADM makes the successful frame of land administration simpler and can act as the cornerstone of any system of land administration LADM is adaptable, commonly used and serves as a key outlet of government worldwide experience in these matters (Lemmen, et al., 2017).

Instead of replacing existing systems, the purpose of LADM is to provide a systematic approach to explaining the systems in order to better understand their similarities and differences. The LADM model is represented in the *Unified Modelling Language* (UML). It also includes land administration terminology that is as seamless as possible to be useful in practice focusing on various foreign frameworks (Babalola et al., 2015). The terminology permits a common definition of various formal and informal practices and procedures in different jurisdictions. This also offers a framework for regional and national profiles and facilitates a consistent mix of information on land administration from different sources (ISO 19152:2012).

Implementing LADM requires that an application scheme be created, such as a country profile. LADM is standardised but subject to expansion. It is very likely that for a particular region or country profile additional characteristics, operators, alliances, and classes would be required. The LADM does not cover the representation of land administration related data, such as address data, taxation data, land use data, land cover data, valuation data, publicly owned network data and archival data (van Oosterom and Lemmen 2003). However, LADM guides how to represent and relate such data to the LADM (Tjia and Coetzee, 2013).

An abstract, conceptual model of four packages linked to parties is presented (people and institutions). It provides specific systems of operations and RRRs (ownership privileges) and geospatial units (parcels and legal space of buildings and service networks). Lastly it also offers spatial sources (surveys) and spatial representations (geometry and topology). The package of parties includes classes that represent details about an entity or association that has a relationship with the land. That may be a party or a party of a group. A group party is several parties forming a distinct body in the land administration sense (van Oosterom and Lemmen, 2003).

By right, restriction, and responsibility, the LADM enables communication between the entity (natural or non-natural) and the object of the land. UML class diagrams specify this. How this UML model can be used in the XML scheme and how the model can be used for real data exchange within the interoperability of the networked society (van Oosterom et al., 2006). Figure 18 provides an overview of the LADM.

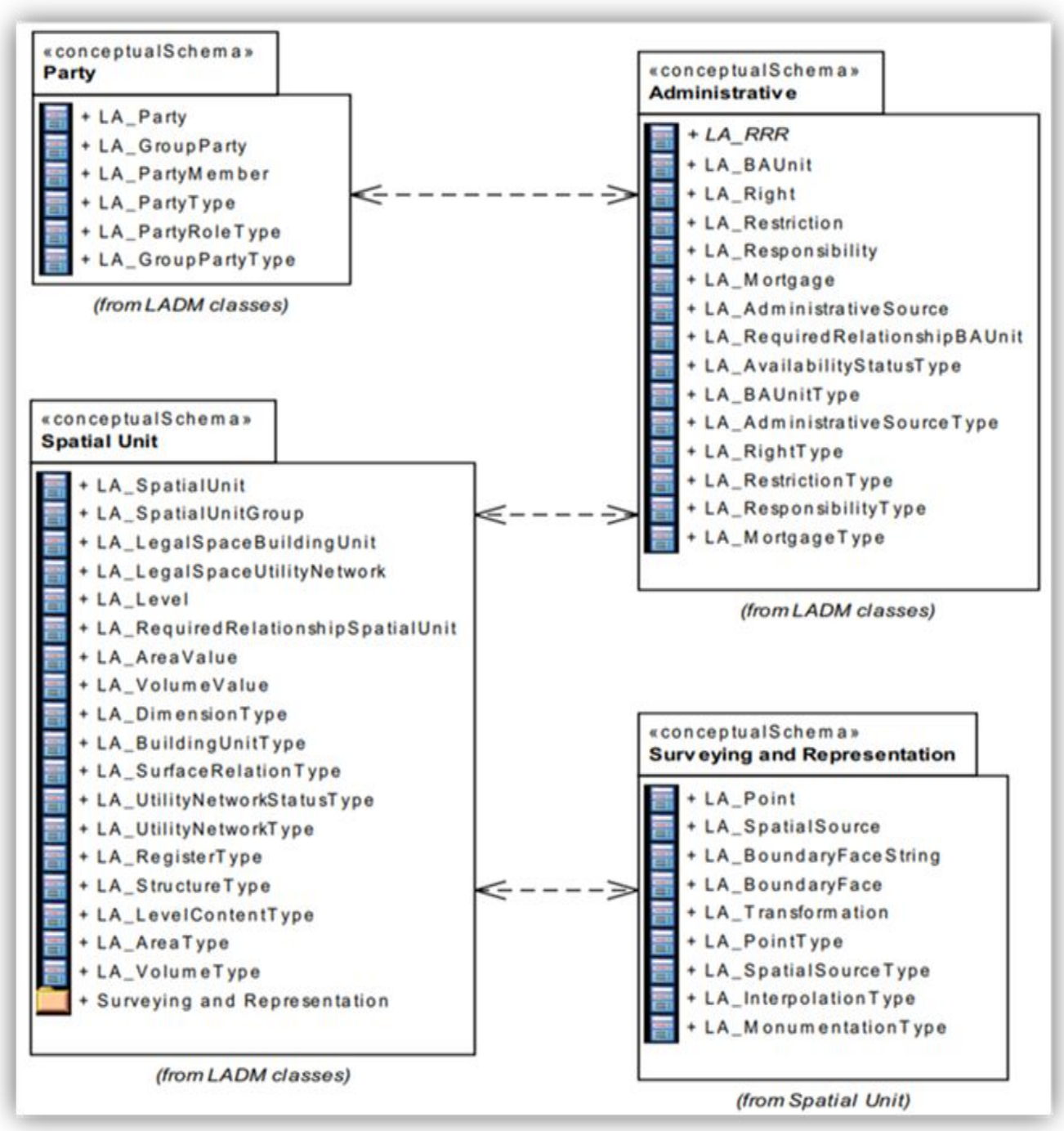


Figure 18: LADM overview (ISO 19152:2012)

The model aims to provide an extensible framework for an effective and efficient cadastral system depends on a model-driven architecture and allows stakeholders to interact, both within one country and between various countries on the basis of the shared ontology implied by the model (Hespanha et al., 2008). The purpose of the model is to promote the sharing of information throughout various government spheres, including the private sector. The CDCS classes and attributes can be arranged into generic class groups (Hespanha et al., 2008). Table 9, presents a distinction between the content of USA cadastral data and LADM.

Table 9: Comparison between the USA CDCS and LADM (Tjia, 2014)

USA Cadastral Data Content Standard	ISO 19152, LADM
Agent	LA Party
Transaction Agent	partyRole (an attribute of LA Party)
Parcel Legal Area Description	LA SpatialUnit area (an attribute of LA_ SpatialUnit)
Record Boundary Corner	LA BoundaryFaceString; LA Point
Rights and Interests	LARRR (LA Right, LA Restriction & LA Responsibility)
Restriction	LA Restriction
Transaction Document	LA AdministrativeSource

3.4.4 Social Tenure Domain Model

This section is pertinent to this research because it examines how the Social Tenure Domain Model (STDM) was created to provide support for the implementation of the concepts of a land rights continuum. It is also important to consider its overall impact on the rural poor's tenure security. This section includes additional literature that is important for better understanding cadastral frameworks, as well as testing the applicability of STDM. According to the United Nations Human Settlements Programme, *UN-Habitat* (2015, p.1) STDM "is a pro-poor, gender responsive and participatory land information system, developed by the *Global Land Tool Network* (GLTN)". Generally speaking, this set of rights cannot be defined relative to a parcel, and new types of spatial units and a domain model called the STDM, have therefore been created to accommodate these social tenures.

This is a pro-poor method of land information management that can be used to help poor people's land systems throughout urban and rural areas, but it can also be connected to the cadastral system so that all information can be processed in a single system (Augustinus and Lemmen 2011, p.1). The model is intended to promote security of tenure for the poor, women, and vulnerable groups, but increasingly is recognised as an important land governance tool. The STDM includes all forms of tenures, traditional and other social tenures, including informal and customary tenures (Augustinus and Lemmen, 2011).

Also the STDM can be connected to the cadastral system to keep all the details on one system. Lemmen (2010) defines STDM as an accessible land information platform that allows documenting all main scenarios of tenure. Information about customary tenure and informal tenure of settlements can be captured and registered via STDM. Lemmen (2010) argues that STDM lets us prove what can be found in terms of on-the-ground tenure as recognised in local communities. Some of the existing STDM tools are participatory boundary survey mapping based on handheld GPS measurements, or drawing boundaries from satellite images. STDM accommodates people-to-land relationships that cannot be registered as part of structured land administration structures (Antonio, 2017). The model can be used to encourage land management and to address the welfare of the poor in urban, rural, and slum areas (Lemmen, 2010). It can also link (convert) the information collected later to the land and cadastral system.

The STDM is under development as an ISO-standard so-called "specialisation" of LADM. The word "specialisation" indicates that there are certain terminology differences; for instance, in STDM, what a "real estate right" is in a formal framework is known to be a "social tenure relationship." Notice that a formal right is often a relation of social tenure, but not all relations of social tenure are formal land rights. Spatial units are, according to the STDM ISO-standard, the areas of land (or water) where

rights and the relationships of social tenure apply (Antonio, 2017). Such areas may be depicted as a document, a single point, a series of unstructured lines, a surface, or even a volume of 3D. This range of representation of spatial units can cover community-based land management systems, or rural, or urban, or other types of land administration, such as marine cadastres and 3D cadastres. Surveys may relate to identifying spatial units on a photograph, image, or topographical map. Sketch maps may be drawn up locally. A map of a sketch can be drawn on a wall and then photographed. Figure 19 depicts the basic classes of STDM: *Party, SocialTenureRelationship*, and *SpatialUnit* (Antonio, 2017).

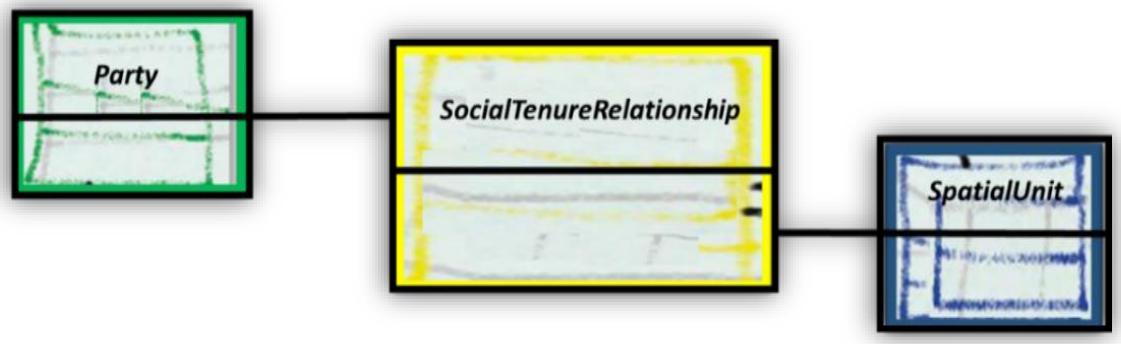


Figure 19 Basic classes of STDM: Party, SocialTenureRelationship and SpatialUnit (Lemmen, 2010)

According to Saers et al. (2015, p.5), the basic classes of STDM consist of "parties (tribes, individuals, villages, cooperatives, organisations, governments), social tenure relationships (people-land relationships that may be formal, informal, customary or even conflictual) and spatial units (representations of reality where social tenure exists that may be described as sketch-based, point-based, line-based or polygon-based)." STDM's versatility is to understand that groups rely on local tradition, heritage, faith, and behaviour. In several ways, the spatial units and relationships of social tenure may appear (Saers et al., 2015). In addition to the formal registration of formal land rights, STDM records can concentrate on findings that lead to the registration of unofficial land-use rights.

The STDM may contribute to sustainable development through the implementation of adaptable, unorthodox land management. This may be an opportunity to strengthen land management systems, and it may begin in community-based mapping processes, supporting land and property rights mapping. Local communities also lack knowledge on land laws and non-administered areas where those people reside. Many organisations have discussed these issues and anthropologists have developed networks such as the 'indigenous mapping network' (Saers et al., 2015). Slum mapping relating to tenure is also a topic of international concern.

The STDM approach will open up new markets for the land industry, and will also provide opportunities to develop new skills and improve management skills. The STDM will allow all people, including the poor, to be protected by some form of land administration system. This will boost the land industry's land management capability, as well as solve potential challenges such as climate change. STDM will lead to poverty reduction, as land rights and weak claims are brought over time into the formal framework (Lemmen, 2010).

3.5 Marine Cadastre

3.5.1 An Overview of Marine Cadastre

This section provides an overview of marine cadastre and identifies the differences and similarities with land cadastre. This section demonstrates that the application of existing land-based cadastral principles is an emerging theme that corresponds with the transition to a situation where there is no distinction between terrestrial and marine SDI. This research is relevant to marine cadastre because it identifies spatial data and legislative infrastructure duplication. Key areas of the land cadastral system framework have been identified for marine cadastre attachment. At the very least, the review seeks to understand why legislative alignment of marine cadastre are required.

The most evident marine cadastral concept is aimed at resolving land and applies to high-water marks (HWM) for countries that share borders with bodies of water such as the ocean. The marine cadastre defines the place and spatial scope of rights, restrictions and responsibilities across the marine environment (Balla and Wouters 2017). The marine cadastre's scope includes (among other things) delineation, classification of legislative material bodies, scientific data (such as geology, hydrology, and biology), and other marine-related information with boundary implications. Table 10, shows some of the definitions for marine cadastre.

Table 10**: **Definitions of marine cadastre

Author	Definitions
Robertson et al. (1999)	A mechanism to allow the boundaries of maritime rights and interests to be registered, spatially administered and physically described in relation to the borders of neighbouring countries or the inherent rights and interests.
Nichols et al. (2000)	Information system that incorporates both the significance and the spatial scope of property rights and ownership interests, the different rights and restrictions of maritime jurisdiction.
Collier et al. (2001)	A tool for defining, managing and administering the limits that together with related RRRs will be legally recognised.
Binns (2004)	A spatial boundary monitoring tool that visualises, defines and implements legally established boundaries and related rights, restrictions and responsibilities in the marine environment.
Zentelis (2011)	It is a registration system and geospatial information of the marine space. This includes overly, inevitable and inherent rights (mainly for use and lease rights), restrictions and responsibilities that are performed on all legitimate (spatial) entities in the sovereign territories of the coastal area.
Stāmure et al. (2017)	A mapping authority and information system for maritime borders and coastal land, covering both the nature and geographical scope of the interests and property rights, the title and the various rights and obligations of the maritime jurisdiction.

Binns et al. (2004) states that the continually changing marine zones regarding the changing land-sea interface complicate a uniform meaning for the marine cadastre. Despite the complexity, several countries have, or are still researching and defining, marine cadastres. The concept of a marine cadastre is in most cases, clear in the country's criteria, based on its past political and marine management activities and on the country's road to economic growth and sustainable development (Binns 2004, p.86).

In response to global implementation, several definitions have emerged that there is a need to improve the management of coastal and marine environments. Designing marine cadastres raises questions about definition and function.

Marine boundaries are mathematically defined, with typically no tangible evidence remaining after the survey (Fowler and Treml, 2001). It is not realistic and for the most part, not feasible or beneficial to demarcate underwater borders in the same way as is practiced on shore. While the boundaries of the ocean are delimited, the multitude of meanings mathematically defining the boundaries is a recognised obstacle to the concept of marine cadastres. This establishes marine borders that occur legally and on paper without any tangible physical comprehension.

Physical demarcation of marine borders can be done using the virtual means provided by modern technical advances (Fowler and Treml, 2001). Stāmure et al. (2017) clarify that data collection did not cause problems during the development of the marine cadastre system. However it has been difficult to integrate and share data resources across various information systems. The summarised information demonstrates that the core definition of the marine cadastre can be examined from a broader perspective:

a. “More reliable information is needed; it ought to be up-to-date, accurate, comprehensive and efficient at the same time.
b. Appropriate data and technology standards, SDIs, supporting the reliability of the respective devices, technologies and software should be developed.
c. Interaction should be developed between stakeholders who facilitate the exchange of information needed for decision making. Collaboration, collaboration and data sharing are examples of such interactions, as is the institutional framework, such as policies and regulations, which in turn, increase the possibility of each stakeholder achieving their own goal.
d. In marine infrastructure casual elements should be considered.” (Stāmure et al., 2017, p.20)

Stāmure et al. (2017) further outline the main reasons for establishing the marine cadastre as:

a. “To ensure the effective use of territorial and internal waters
b. To resolve ownership rights throughout internal and territoria lwaters.
c. To accumulate full textual and spatial cadastral data for land units and buildings in the sea.” (Stāmure et al., 2017, p.20)

The concept of the marine cadastre is still complicated because of challenges such as the discontinuity of land and marine regions, as well as different organisational, technical, and legal challenges. Worldwide, projects in the field of marine cadastre are being researched and introduced to upgrade marine management systems while understanding the integration of land and sea-based spatial data infrastructures. Marine cadastre management is highly reliant on the spatial information system (Collier et al., 2001). The geospatial depictions of marine boundaries are difficult to envisage. However, the marine cadastre, as a component of the marine management system, entails access to geospatial data that is trustworthy and accessible to all stakeholders. The conflicting overlap of international, national, and state borders presents a confusing dilemma (Binns et al., 2004). Figure 20 illustrates the central concept of the marine cadastre.

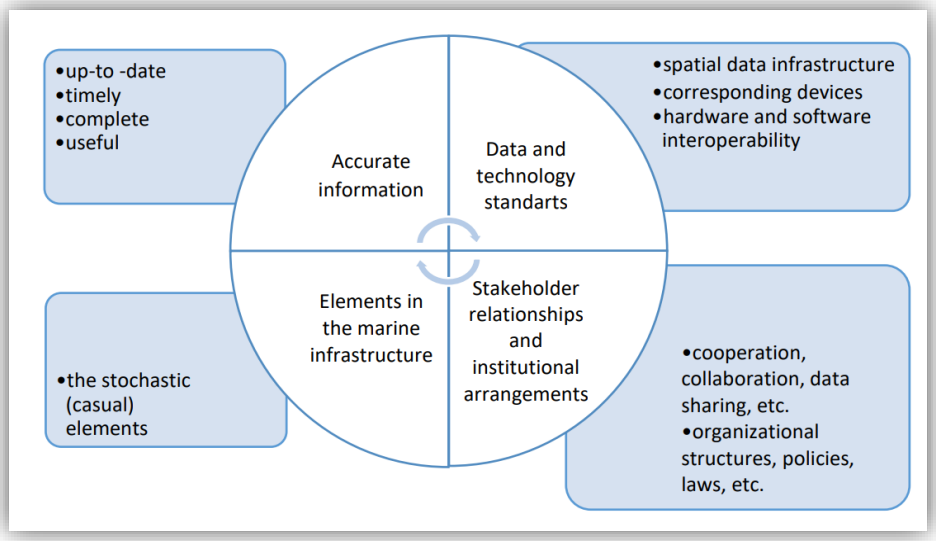


Figure 20: The central concept of the marine cadastre (Sutherland, 2005)

3.5.2 Differences between Land Cadastre and Marine Cadastre

Many of the similarities and variations between the marine cadastre and its corresponding land units are due to the particular characteristics of the marine environment that do not relate to the terrestrial setting, land register and cadastral data. As with land, access, ownership, and use rights are subject to the ocean. The "hunter-gatherer" theory of land tenure suggested by Grant and Williamson (1999) indicates that modern land division and ecological conservation is rooted in the human mind set and is entirely different from the ocean conservation informing mind set. The marine cadastre is developed at the national level, and although it can be informed by international practice, must be tailored to the local context.

Sesli and Uslu (2010) explain that one major difference between land and marine cadastres is that many coastal countries have a mixture of private and state ownership of land. However, in many countries, the ownership of marine space lies solely with the state. This provides opportunities for better governance of the ocean, as a central government institution, while at the same time being a repository of associated state and private sector RRRs. Collier et al. (2001) describes some other differences which highlight difficulties associated with the marine cadastral as opposed to land cadastres as follows:

a. “Tenure in land administration requires the period in which the space is legitimately inhabited or owned. Nevertheless the principle of tenure does not exist at sea because of the multiplicity of concurrent uses and the temporal nature of water.
b. Classical means of boundary demarcation cannot be used offshore.
c. The marine world is 3D and classical 2D simulations are not appropriate.
d. The rights may differ over time, adding a fourth dimension to the spatial data.
e. It is normal for multiple overlapping RRRs to occur in a single location.
f. The baseline to which reference is made to many maritime borders is ambulatory.” (Collier et al., 2001, p10).

In short, spatial planning uses cadastral information about the marine cadastre. Spatial data are used for surveillance at sea. Furthermore in order to complete the concept of the marine cadastre, it is essential to realise the utilities, the cables below the water surface and the mineral deposit sites, both those already discovered and the possible ones, respectively (Balla and Wouters, 2017). The literature referred to the fact that the modern definition of marine cadastral applies not only to the traditional cadastral map but also to the possibilities of spatial visualisation where the cadastral region can be located in the virtual tridimensional (3D) space.

The marine cadastre is a base layer of the *Marine Spatial Data Infrastructure* (MSDI) providing basic maritime boundary information and related rights and obligations that are frequently updated and maintained (Balla and Wouters, 2017). Rajabifard et al. (2007) emphasise the significance of a connection across land and marine environments, rather than the prevalent international pattern of isolation management. It is important to note that the concept of the marine cadastre raises a range of different issues to that of the land cadastre (Balla and Wouters, 2017). Table 11, lists differences and similarities between land and marine cadastres.

Table 11: Comparison of the marine cadastre and the land cadastre (Binns et al., 2004)

Land Cadastre	Marine Cadastre
Differences	
Total ownership rights or exclusive usage rights apply	There are practically no full ownership rights or exclusive use of the marine space.
Ordinary land demarcation strategies refer to the land environment: borders are enclosed and delineated, and there is visible evidence of an offshore boundary.	Ordinary methods for land demarcation cannot be extended to the marine world. Sea borders are delimited, not demarcated, and there is no visible evidence of offshore borders.
The presence of conflicting rights in a single area is rare for the land context.	The existence of multiple (overlapping) rights within a single area is common in the marine environment.
Classic 2D simplifications would be acceptable	The marine world is three-dimensional, but it will not suffice with the classical 2D simplifications.
Rights could never differ with the period of time.	The rights which differ regarding the time scale, adding spatial data to the fourth dimension.
The baseline which is related to many land boundaries is not generalisable.	It is transferable to the baseline referred to by many marine boundaries.
Similarities	
In both cases overlapping human activity occurs.	
Interactions on the coastal zone are mutually intense and require equal management effort by separating RRRs (especially with increasingly invasive marine technologies).	

The most striking and clear indication of this is that there is no actual or apparent boundary demarcation on the seabed. Owing to the vast depth of the ocean and the complexity of the ocean atmosphere, very little has been achieved or can be achieved to map the ocean floor. If the geographical location is to be taken as a fundamental element in the development of the related data sets in the marine environment, a paradigm shift on the part of custodians would be required for many of the data sets that have been established for land tenure or use (Widodo, 2003). Currently, the marine cadastre concept is still evolving and will be unique in terms of its characteristics, stakeholders, technical, legal, and institutional aspects, for a specific jurisdiction.

3.6 South African Cadastral Handling

3.6.1 Historical background of cadastral concepts in South Africa

Because Cape Town was the very first part of South Africa to be inhabited by Europeans, it is unavoidable that the Cape Town was formally the largest contributor to cadastral data and geodesy. The first cadastral survey in the country was concerning a region of land throughout the borders of the *Liesbeek River*. Table 12, shows the highlights of the South African cadastral concept historical timeline. This provides a summary of cadastral concept evolution in South Africa and remind one of the background of South African history.

Table 12: South African Cadastral Concept Historical Timeline (Menzies, 1967)

	Period	Description of highlights
Past	1st one hundred years (1652 to 1752)	• first one hundred years of South African Geodesy or cadastral concepts
	2nd one hundred years (1753 to 1853)	• The British occupation of the Cape in 1806 had also brought about a tightening up of land registration procedures
	3rd one hundred years (1859 to 1959)	• Sir David Gill, the then Astronomer Royal at the Cape, who in 1879 drew up a comprehensive scheme for the proper survey and mapping of South Africa. • Land Survey Act 9 of 1927 was enacted.
Present	4th one hundred years (1961 to Present)	• In 1972 the Trigonometrical Survey Office became part of a wider organisation and together with the Offices of the Surveyors-General was placed under the aegis of the Director-General of Surveys. • The National Control Survey System (NCSS), which is highly accurate and is marked by a network of Trigonometric Stations and Town Survey Marks, covers the entire South Africa. The NCSS has been fixed on the 1984 World Geographic System (WGS) ellipsoid since 1999, with the location of the Hartebeesthoek Radio Astronomy Telescope as the platform's source

a) “In 1488, Bartholomew Diaz de Noveas traveled by a ship well south of the Cape, then shifted east and afterwards to the north, arriving at Mossel Bay, then sailed east into *Algoa Bay* and then onto the *Great Fish River*, midway across Port Elizabeth and East London. Throughout that journey, Diaz installed a symbol that was later discovered by Professor Axelson of the *University of Cape Town* (UCT). He identified Cape Agulhas upon his arrival, as well as the

Cape he called Cabo *Tormentoso* (Cape of Storms). This term was subsequently amended to the label *Cabo de Boa Esperanca*, meaning Cape of Good Hope, by King John of Portugal (Menzies, 1967).

b) In 1497, the shipping lane to India through the Cape was discovered by Vasco da Gama. He then reached *St. Helena Bay* in November 1497, circled Cape Malindi on the eastern coast of Africa, and arrived in India in May 1498. Vasco da Gama labelled this place Natal
c) In 1503, *Table Mountain* was ascended by Antonia de Saldanha in 1503. He was renowned as the first European to climb it.
d) In 1580, Sir Francis Drake sailed throughout the Golden Hind around the Cape
e) In 1652, the initial *British East India Company* ship arrived at *Table Bay*.
f) In 1615, the earliest colonists settled at *Table Bay*, South Africa.
g) In 1652, Jan van Riebeeck set up the earliest European settlement on the southern edge of Africa (Menzies, 1967).
h) In 1657 Peter Potter, the first surveyor to practice in South Africa, arrived from the Netherlands. It was decided to allow settlers to farm for their own benefit. When settlers became free burghers and could own land, diagrams were required to be drawn up by qualified surveyors (Menzies, 1967).
i) In 1751, at the behest of Prince William of Orange, Nicholas Louis de la Caille (French astronomer-geodist) had to list the southern stars with celestial coordinates of right ascension and declination. These data were taken from a house owned by Mijnheer Bestbier in Strand Lane, Cape Town.
j) In 1813, the British establishment passed laws (including the Cradock Proclamation) that no land sale would be allowed until the land had been properly surveyed and registered.
k) In 1845, Natal became a separate district of the Cape Colony, and a Surveyor-General was appointed. While s Surveyor-General was also appointed in the Transvaal and Orange Free State in 1866 and 1876 respectively.
l) In 1910, Natal, Transvaal and Orange Free State territories retained their individual legislation, controlling cadastral surveying until the commencement of the Land Survey Act 9 of 1927.
m) In 1972, the Trigonometrical Survey Office became part of a wider organisation and together with the Offices of the Surveyors-General was placed under the AEGIS of the Director-General of Surveys.
n) In 1980, it became the Chief Directorate of Surveys and Mapping (CD: SM).
o) In 1994, introduction of the land reform project resulted in to a well-revised and secure Land Survey Act No. 37 of 1997.
p) In 1999, the datum referred to as the Hartebeesthoek94 Datum and uses the World Geodetic System 1984 (WGS84) as ellipsoid of reference was implemented nationally.
q) In 2010, Project Vulindlela (or the South African e-Cadastre) was intended to become a digital application designed to automate and maximise the organisation effectiveness of the CSM and Deed's registry offices within the branches of the DALRRD. Unfortunately the project never took off (van Zwieten, 2014).
r) In 2014, the South African marine and mining cadastral initiatives topped the government agenda for attracting new investment in both the maritime and mineral exploration (van Zwieten, 2014).
s) In 2018, the SASDI's committee for spatial information formally recognises the DALRRD as the base data set custodian coordinator and custodian of the cadastral data theme.

3.6.2 The South African Cadastral Administration

In any given country, the legal mandate of cadastral administration usually resides with the organisation (or organisations) responsible for capturing, collecting, maintaining, and dealing with cadastral data. In some countries, cadastral administration is the responsibility of local governments, in others administration is a national endeavour, administered under one or more departments. The roles and responsibilities of cadastral data management in South Africa are driven by national government. In this section various pieces of legislation are explored to understand the legal requirements of South African cadastral administration. The importance of this is that the legislation influences the behaviour and the functions of how cadastral data custodians or organisations as well as other role players administer the data. The literature review examines the South Africa cadastral value chain in terms of data capture, collection, maintenance, and management, and highlights the capacities of the stakeholders to do so.

Various laws dictate what standards, software, or metadata of the cadastral data can be included or excluded in cadastral data composition (FGDC, 2008). The South African *Constitution* places registration of deeds, land survey, and land reform activities as a national government obligation. This covers the major elements of reforming the land, redistribution, restitution and tenure. The *Department of Agriculture, Land Reform and Rural Development* (DALRRD) oversees the land tenure system (security of tenure and registration of rights). The provincial government is also responsible for numerous functional areas related to land administration such as agriculture, environmental affairs, housing, and regional and land development.

Ideally the cadastral system in South Africa is supposed to involve two principal governmental organisations which are the SG and the Deeds Office, with registered professional land surveyors and conveyancers playing crucial roles in the operations of the system. These professionals, compile processes, approve and register title deeds and the diagrams necessary to secure property rights into two independent systems, the deeds registry, and the cadastral information system, respectively. The South African cadastral system is based on the quality of land parcels that are sufficiently well-surveyed, organised, accurate, and managed, for a positive system of land registration (Kitchin and Ovens, 2013).

To date, contemporary surveys had to be centred on the *World Geodetic System* 1984 (WGS84) *South Africa Geodetic Control network Cape Datum*, which offers unchanged levels of accuracy. For beacons of any boundary surveys, the coordinates uniquely marked on the geodetic grid are necessary. Strategically positioned control beacons throughout the country build trust between banks, certain financing agencies, companies, and the wealthy public about the quality, classification, and safe lodging of land records. So few conflicts on borders seldom reach the courts (Kitchin and Ovens, 2013).

This structure needs to be sustained, and at the exact time, it needs to be modified to meet the needs of most South African citizens. In general, soon as the opportunity arises, the system requires to be good enough to accommodate land tenure to be upgraded. The South African cadastral model does not incorporate all other real rights registration and informal or social land tenure structures that fall outside the formal land registration system. Modern approaches are required to be established and implemented to accommodate the registration of all rights for all citizens as envisaged by the continuum of land tenure (Tjia and Coetzee, 2013).

An even worse a significant limitation is that maintaining the new structure is restrictive and expensive. All land parcels must be surveyed to tight specifications, regardless of their scale, quality, or position. Even more, the current South African cadastral system only provides ownership information. This implies that it is important to source information on public restrictions somewhere. Thus, for instance, it is possible to obtain information on zoning and building lines through municipalities, but restitution claims must be directed to the DALRRD. (Kitchin and Ovens, 2013).

The functional areas of the municipality in terms of land management include the planning and management of land use, land and property rates and taxes, as well as the regulation and control of land development within their management areas. Land surveying is carried out through professional land surveyors affiliated with the *South African Geomatics Council* (SAGC) by service providers. Conveyancing is conducted through the utilisation of private conveyancers and notaries.

Lastly, section 211(1) of the South African Constitution recognises the status and role of traditional leadership authorities, who are mainly situated in rural areas, to perform functions associated with land in terms of customary law (Kitchin and Ovens, 2013). The key acts related to these functions are the *Deeds Registries Act* (No. 47 of 1937) and the *Land Survey Act* (No. 8 of 1997).

3.6.1.1 The Deeds Registries Act (No. 47 of 1937)

The *Registrar of Deeds Office* within the DALRRD maintains public land registries through its nine provincial offices. All offices are under the supervision of the *Chief Registrar of Deeds*. The DALRRD is responsible for the registration of real rights in land, and other documents tendered for registration. It also maintains records of all registered rights over land parcels. It also maintains records of all the rights over land parcels registration. The registration data set, for the context of this study, refers to a register of all land parcels and owner information registered at the Deeds Offices throughout the country (DRDLR, 2011).

These data sets are maintained by the deeds offices using the *Deeds Registration System* (DRS). Registration of deeds is conducted by means of the *Deeds Registries Act* and the *Sectional Titles Control Board* is formed under the Act. Deed registration is not only renowned by Africans but also by global jurists as a consistent and precise registry of deeds with security as great as titles, although the mechanism is largely managed manually (Amadi-Echendu, 2016). Table 12, summarises the *Deeds Registries Act.*

Table 13: Summary of the Deeds Registries Act (No. 47 of 1937)

The South African Cadastral System legislative Environment Overview		
The *Deeds Registries Act (No. 47 of 1937)*		
No.	***Items***	***Description***
1	Land registration	Deeds
2	Its services	Nine provincial Deeds Offices; and *The Department of Agriculture, Land Reform and Rural Development* (DALRRD)
3	Its legislation	The *Deeds Registries Act (Act No. 47 of 1937*); and the *Sectional Titles Regulation Board*
4	Deeds registration data set	Ownership Attributes
5	Land registration systems	Not completely incorporated with the cadastral system

The *Deeds Registries Act*, in effectively makes a transfer of every right to land compulsory. It is defined by *Roman-Dutch law*, which was implemented during the colonial period when the transfer of land was required to occur in the presence a judge and preserved reliable and accessible registers recording all the transactions. Registration is inadmissible without an approved diagram of the SG, to ensure the record is accurate (Radloff, 1996). Few people challenge the correctness of the system. A high degree of reliability and safety characterises the entire system. According to the *Deeds Registries Act*, no portion of any piece of land shall be transferred or registered without a diagram.

Land registration is the influential component of the *Deeds Registry* in the modern context and contains 'relevant land transaction documents by considering legal facts, legal ramifications and the size, location and use of land parcels' (Henssen, 1981, p.4). The incorporation of RRRs and land use on the property market encompasses other legislation that spreads across all branches of government. These entail energy and minerals, municipal procedures, taxes, valuations, planning and environmental matters. The spatial representation of legally derived SG diagrams and text documents in the context of deeds by the deeds offices together form the basis for all land development and form part of the value chain in South Africa.

The country's land registration system is not completely incorporated. The SG and the Office of the Registrar of Deeds run their land information systems in silos and are independent of each other. The legal conveyancing chiefly uses a manual process. On the other hand, *the South African Deeds Registration System* (SADRS) complies with land title security through the registration process. This process involves the conveyancers' provision of deeds and documents tendered for registration, implementation, termination, and security of private immovable property rights that include freehold, leasehold, and servitudes.

The SADRS is focused on the management of an electronic registry of real immovable property rights and related restrictions and conditions, whereas the cadastral information system focuses on the capture, processing and storage of land parcel data within the *Cadastral Surveys Management* (CSM) branch of the SG provincial offices (Tjia and Coetzee, 2013).

There is a problem with the lack of incorporation of the two traditional business and database models. In dealing with the present demands, the current models are outdated and inefficient. For example, the DRS branch is said to be under-resourced, making it incapable of catering to the envisaged high influx of requests for land registration from the land reform programme (Riba, 2012). Consequently, there is need to connect the DRS to the cadastral information system to upgrade the land parcel management of all practices of land tenure outstanding in the present system, despite their recognised legal status in the land reform programme.

Once more therefore, there is a need to apply the principles of *Cadastre 2014* which endorse the complete recordation of all land rights, including all the RRRs, in the coming cadastral systems (Kaufmann and Steudler, 1998; Tjia and Coetzee, 2013). Although the office of deeds is compliant, barriers persist in the office of the SG. The most current fee plan was released in the Government Gazette in August 2011, with the estimated price of land transfer being roughly 2.6 percent of the land value. To promote optimum service delivery, the SG and the Deeds Office have jointly published guidelines (Kitchin and Ovens, 2013).

3.6.1.2 South African Land Survey Act (No. 8 of 1997)

The *Land Survey Act (No. 8 of 1997)* is briefly investigated in this subsection because it is the foundation upon which the South African cadastral system is based. The examination of cadastral data in South Africa started in 1834 and comprised the examination of survey diagrams (Simpson and Sweeney, 1973). *The Land Survey Act (No. 9 of 1927*) was passed in 1927 because by then, both the diagrams and survey records were examined. The Act was amended several times and was replaced by the *Land Survey Act (No. 8 of 1997*) which highly regulates the work of members of the survey profession in terms of standards and accuracies.

The *Land Survey Act (No. 8 of 1997)* dictates the responsibilities and the power of the SG towards archiving, keeping, and maintaining the data and the examination thereof. The Act also sets the duties of the land surveyors regarding the submission of new data for examination. The Act is intended to legislate the survey of land in the Republic and to facilitate for related matters. The Act also mandates the CSG to be responsible for cadastral surveys and land-information services.

The CSG is obligated to survey or map all land parcels, or the cadastral data, and to collect relevant information associated with these spatial boundaries that is then stored in the deed's registry by the *Registrar of Deeds*. The land Information service requires the planning, collection, and adjustment of cadastral maps. The fact that the SG Offices maintains full records of all cadastral surveys means that there is practically no risk of overlapping properties and, once registered, no likelihood of conflicting ownership claims. Table 14, summarises the *Land Survey Act (No. 8 of 1997).*

Table 14: Summary of the South African Land Survey Act (No. 8 of 1997)

The South African Cadastral System legislative Environment Overview		
South African Land survey Act (No. 8 of 1997)		
No.	**Item**	**Description**
1	Land Information	Cadastral system
2	Its services	The CSG Offices; and 8 SGs for 9 provincial offices
3	Its legislation	*The Land Survey Act (1997)*
4	Cadastral alphanumeric data set	Land parcels
5	Land information systems	Not completely incorporated with the land registration systems

Both the *Land Survey Act* (1997) and the *Survey Regulations*, called the *Manual of Procedures*, have been instrumental in streamlining the survey-related roles of land surveyors in both the private sector and the government sector. The regulations determine how to execute and organise a cadastral survey and its records. The *Land Survey Act* helps to reduce the area of ambiguity in land boundaries and all boundary surveys have to be conducted under the supervision of a professional land surveyor, according to the Act. The Act also regulates the professional duties of various land surveyor institutes

In the end, "the implementation of the *Land Survey Act* should result in each land parcel being surveyed, each survey linked to the national coordinate system and each land parcel being given unique identifiers and archived at SG offices with survey reports of the field observations and survey methods used by the competent land surveyor" (Hull and Whittal, 2013, p.23). The diagrams map two-dimensional property on the ground and make up the spatial portion of South African cadastral

system. The other components constitute the RRRs integrated into the cadastre by land use planning and property taxation, governed by local authorities and the DRS at the Deeds Office.

3.6.3 South African e-Cadastre

The exploration of South African e-Cadastres in this subsection is intended to identify links between the South African cadastral administration and information systems. The preceding subsections pave the way for the definition of an e-Cadastre in this subsection. This section draws on the overview of South African e-Cadastre also known as project "*Vulindlela"* and strives to the principles of future cadastral systems. It should be noted that just as the term cadastral system extends the term cadastral or cadastre, so the term e-Cadastral covers the political, regulatory, fiscal, technical and social aspects.

The e-Cadastre is an automated system that provides services historically provided by an authoritative cadastral source using automated cadastral data to provide government services to residents, enterprises and other public sector administrations within the context of e-Government (Borzacchiello and Craglia, 2012). Some scholars describe the primary objective of e-cadastre as a form of accelerating the delivery system for land title surveys (van Oosterom, 2018).

Hull and Whittal (2013, p.2) contend that the e-Cadastre is a "electronic, parcel-based land tenure information solution that utilises the functions of institutions in the management of surveys and mapping, land registry, land valuation and land use or development in a form that is generally focused on e-government outcomes relevant to the development of cadastral systems." The e-Cadastre is focused on tried and tested cadastral surveying concepts, but it encourages the use of current and future technology to reap the benefits of the electronic era (Haanen and Sutherland, 2002).

Riba 2012 defines the e-Cadastre as a high-profile electronic system designed to simplify and optimise the organisational efficiency of the CSM and deeds registration divisions of the then *Department of Rural Development and Land Reform* (DRDLR) currently known as the *Department of Agriculture, Land Reform and Rural Development* (DALRRD) by offering a solution that allows for interoperability and service-oriented architecture-based integration with one single view of the scope of the constituency. The e-Cadastre was intended to assist in developing a more accurate reflection of South Africa's cadastre and to facilitate a major reduction in examination and approval time, which will have positive spin-offs for the land development value chain and the economy.

The South African e-Cadastre project is a digital application designed to automate and maximise the organisation effectiveness of the CSM and Deed's registry offices within the branches of the DALRRD. The project addresses two major land issues the security of title, which is the commitment of the deeds registration branch, and the management and maintenance of the cadastral data, which is the obligation of the CSM branch. The latter shall also be in charge of examining and approving sectional title plans, diagrams and general plans (Riba, 2012).

Project *Vulindlela* is designed to assist the DALRRD to provide enhanced management of property and land rights information upon completion. The e-Cadastre solution is envisaged to be implemented at all Deeds Offices and CSM Offices across South Africa, and to enable a range of role players in the land development and property arena to interact with the South African cadastral data. The project aims to achieve an automated, agile, integrated, and optimised solution in the areas of business, data,

applications, technology, and security. When implemented, this solution will benefit the DALRRD and its clients in numerous aspects (van Zwieten, 2014). With an expected increase in the volume of land registrations (about 20-million land parcels or more) arising from the government's land reform measures, the deeds registration branch was found to be under-resourced.

Other challenges were also of significant relevance. There was a need for the DRS to be linked to the cadastral information system for improved efficiency and accuracy of land parcel management of current and evolving forms of land tenure. This need demanded a consolidation of the DRS and CSM's databases which would provide the DALRRD with one unified integrated information system about land parcels and ownership data (van Zwieten, 2014).

At an external stakeholder e-Cadastre workshop hosted by the DALRRD, the CSG, Mmuso Riba, revealed that a strategic decision had been taken by the DALRRD in October 2013 to suspend work on the e-cadastre project (van Zwieten, 2014). This, he explained, was due to challenges being experienced with the back-scanning of data from the SG offices and the development of the e-cadastre project not proceeding as planned.

On 14 March 2014, the then President of South Africa issued a proclamation published in the *Government Gazette* calling on the *Special Investigations Unit* (SIU) to investigate the DALRRD, the *State Information Technology Agency* (SITA), and its service providers, for alleged fraud, corruption and maladministration relating to the e-cadastre project, and the processing of the DRS (van Zwieten, 2014). The *Government Gazette* made explicit reference to the DALRRD's e-cadastre project and e-cadastre system, the DRS, the enterprise architecture product for DALRRD, the regulatory impact assessment and the back-scanning of DALRRD records into microfilm images for the DALRRD database (van Zwieten, 2014).

According to Maqhina (2020), DALRRD Minister Thoko Didiza has reported that inquiries are currently underway for fraudulent activities, corruption and mismanagement related to the e-Cadastre project. The *Chief Surveyor-General* and the *Chief Director of the Cadastral Spatial Information* Board are currently facing legal proceedings. However the two listed DALRRD officials are still employed by the Department in the National Geomatics and Management Services Branch (NGMS).

Minister Thoko Didiza reported that the Chief Surveyor-General had to face legal proceedings on allegations of wrongdoing in the management of the Project Vulindlela. Whereas the Chief Director faces disciplinary action on accusations of discrepancies in the managing of Project Vulindlela. But that these issues have been referred to the General Public Service Sector Bargaining Council (GPSSBC) for review by the arbitrator and have been identified more than three times but have not progressed (Maqhina, 2020).

The Minister also claimed that these officials had been suspended for 38 months, when taxpayers had been coughing their salaries The suspension of the Chief Surveyor-General began in 2017 and is still subject to investigation. The *Chief Director* for cadastral spatial information’s suspension commenced in 2017 and was ended in 2019. The Minister reported that DALRD had compensated R3.9 million to these two high ranking officials throughout their suspension (Maqhina, 2020). Minister Thoko Didiza announced this in response to parliamentary questions from the opposition parties.

Table 15, summaries the review of the literature on the South African e-Cadastre framework, *Project Vulindlela* as well as an overview of the e-Cadastre process, the advantages, challenges and possible outcomes of a fully functional e-Cadastre.

Table 15: South African e-Cadastre system Project Vulindlela (Riba, 2010, 2012; Coetzer, 2013)

South African e-Cadastre System (*Project Vulindlela*)	
Item	**Description**
Overview of e-Cadastre operation	Centrally managed by Cadastral Surveys Management and deeds registration branches of the DALRRD.
	It aimed at addressing the security of title and management and maintenance of cadastral data as well as to incorporate 8 provincial cadastral data sets.
	Integrate *National Geospatial Management Services* (NGMS) and title deeds office system, that is land parcels and land ownership data.
	Supports title deed transactions and maintenance of the functional e-cadastre.
	Incorporating 300 million title deeds documents in TIFF format, scanned.
	Maintain and process 20 million exponential growing land parcels.
	Provide a platform to securely transact and audit properties.
Benefits of e-Cadastre	Improved service delivery.
	Consolidated data sets.
	Customer or business-driven demands based on reduced operational costs.
	Optimisation of resources and improved system maintenance.
Challenges of e-Cadastre	Need to sustain 100 thousand possible daily property transactions.
	Need to facilitate all *NGMS* offices spatial operations in real-time.
	Need to provide spatial data to public, land surveyors, city planners.
	Provide an open spatial data platform for other departments and Municipalities.
	In October 2013, the e-Cadastre project suspended.
	Special Investigations Unit (SIU) investigation on South African e-cadastre underway – hence e-Cadastre is still on hold.
Potential results of e-Cadastre	Consolidated national cadastre.
	SA government has a single spatial repository to perform spatial queries and get monthly feedback.
	Standardised all addresses and coordinates in a consistent format and datum.
	Nationwide association of title deeds documents to land parcels.
	Improved precision thereby making the system more useful to the public and business.
	Manage SA cadastre from a centralised managed platform and improve local economy.

This section has looked at the ideas that contribute to a greater understanding of the South African e-Cadastre. Elements of good governance, prospective cadastral planning principles, and an interpretation of e-government and e-governance have all been incorporated into the proposed working definition of an e-cadastral. The stated aim of this section was to examine a description and status of the South African e-Cadastral based on current applicable literature. Project Vulindlela is intending on developing and implementing an e-cadastre in South Africa, but there is little literature or research to direct global e-cadastral growth and adoption. Furthermore, the definitions of the word ‘e-Cadastre' remains ambiguous (Hull and Whittal, 2013).

3.7 Conclusion

This chapter has addressed the objective stated in section 1.4.2 (1b), to understand the legislative and policy environment for cadastral data. This chapter also explored the concepts that enable a better understanding of the terms cadastral data, cadastre, and cadastral system which are in general use. The international best practice literature was used to review topics such as the cadastral concept, historical perspective on cadastral data, cadastral data standards, cadastral systems, and outlined the benefits and limitations thereof.

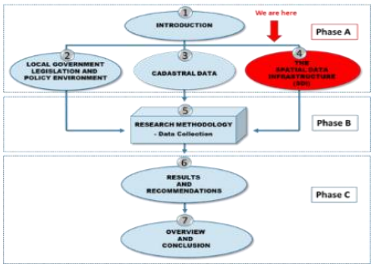
This chapter also outlined the importance that the cadastral system plays in influencing decision making, land development, and how it benefits its stakeholders and society at large. This chapter has shown that the LADM can be applied to standardise cadastral data in South Africa. The chapter explored the legislative and policy environment for cadastral data. Both the Land Survey Act and the Deeds Registration Act are identified as the main legislative driver for cadastral data in the country.

The review of South African cadastral data handling or administration literature at the national sphere of government revealed some of the key benefits of the existing cadastral framework and the cadastral system. For example, the country's cadastral surveying is said to be among the best in the world because it provides accurate delineation of boundaries for the purpose of registering real rights in land, thereby providing secure formal land tenure for registered properties.

Some of the challenges in the South African cadastral framework that impede efficiency in cadastral data maintenance are that the cadastral information management system is not fully integrated with the deeds registration system due to the various business models currently in operation. The literature also revealed that appropriate cadastral frameworks and interrelated activities between cadastral and land tenure system elements fail to ensure effective support of land tenure security. Because of the narrow operational focus on technical excellence in the design and implementation of the existing cadastral information systems across all spheres of government, South Africa's existing cadastral frameworks impede efficiency in cadastral data maintenance.

International and local experience reveals that cadastral frameworks, in particular cadastral systems, have in certain circumstances not effectively improved cadastral data maintenance or realised the objectives underlying their implementation in developing countries. Evidence in the literature suggests that in the main this has been due to a mismatch between the cadastral instruments and processes supplied and existing limited co-ordination and co-operation amongst organs of state, as well as structural factors. Limited usage of 3D cadastral information in the national cadastral system results in sectional title units that are not accurately represented geographically.

CHAPTER 4
THE SPATIAL DATA INFRASTRUCTURE (SDI)



4.1 Chapter Overview

Chapter 2 discussed local government concepts and the context of cadastral data in general was provided in Chapter 3. In order to present a detailed discussion of the Spatial Data Infrastructure (SDI), this chapter draws upon all previous chapters. The chapter identifies and explains the various SDI components, providing literature on SDI coordination and cooperation. The governance of SDI is also a focus of this review. Good SDI governance, cooperation, and coordination are extremely beneficial to government spatial data stakeholders and users. In this chapter, the main objective is to understand the legislative and policy environment for the South African Spatial Data Infrastructure (SASDI). The elucidation of literature regarding SASDI contributes to the understanding of the current situation in which SASDI finds itself in and identifies the SASDI progress and challenges. The focus of SASDI helps to unpack all the possible frameworks within which the SASDI base data set custodians are appointed and governed.

The SASDI custodians for base data sets have been identified, and the process of appointing base data set coordinators and custodians for base datasets is still ongoing. However, in terms of SASDI involvement, there are currently uncertainties regarding the custodianship roles and responsibilities of various government stakeholders for base data sets. As a result, there is no clear cohesion and collaboration among stakeholders. Spatial data from various government spheres could be integrated and harmonised through data sharing, allowing easy access to all organs of states with a vested interest in spatial information. As a result, the rest of the chapter serves as a prelude to answering the study's goal, objectives, and research question.

Furthermore, in the literature there are words that seem to be generally accepted until one attempts to describe the concepts they entail. These include words such as fundamental, base, core, reference data, and other related terms that are often used. There are different perspectives and concepts regarding these terms. Fortunately, they may result in the definition of very similar specifications but there are clear distinctions between them. For this research, the word "base" will be used particularly concerning the SASDI review. The main goal of the following sections is to gain a broad understanding of the situation regarding the role and responsibilities of SDI and SASDI literature. The following sections are an attempt to achieve the goal of this chapter.4.2 Spatial Data Infrastructure (SDI).

4.2 Spatial Data Infrastructure

4.2.1 The Origin and Concept of SDI

This section delves into the SDI origin and SDI as a concept. An overview of how some countries have dealt with the advancement of SDI is explained. The intention is to source lessons from the global experience for discussion, and to draw from those lessons to support arguments in this chapter and the research study. The importance of SDI in this research is to determine how SDI represents the concept of interconnected SDIs, which are designed and implemented to serve various specific applications at the national, provincial, or municipal levels.

To elaborate on the preceding point, the United States of America (USA) example is considered with its outstanding handling of geospatial data for the past three decades. The concept of SDI emerged in the late eighties to the early nineties. Countries such as the USA and Australia, for instance, recognised the need to develop data access relationships for sharing and recycling data, primarily to reduce duplication in spatial data collection. These pioneering relationships became the basis for the development of national SDI concepts. The USA and Australia designed and developed an SDI based on their explicit specifications and precedence (Coetzee, 2008; Maphale and Phalaage, 2012).

For the previous three decades, SDIs have been acknowledged broadly because they facilitate geospatial data sharing and dissemination. A knowledge platform from which to learn and gain experience emanated from status reports of SDI advancements and documentation provided by practitioners' and researchers' experiences with studies of early SDI development. Most work conducted was limited with regards to knowledge of the various dimensions and challenges of SDIs. Ever since these trends began, SDIs and the knowledge bases have grown rapidly. SDI draws expertise from many disciplines, such as geomatics, economics, computer science, surveying, planning, and sociology (Mwungu, 2017). It originated in an era of *information and communication technology* (ICT) revolution which influenced the primitive definition and understanding of SDI (Maphale and Phalaage, 2012). Over the past three decades, engagements on the establishment of infrastructure that is need for accessing and sharing of geospatial data has been underway in various countries.

The European Union (EU), along with numerous European countries, has made notable SDI developments. In 2007, *Infrastructure for Spatial Information in Europe* (INSPIRE) was established through the conglomeration of SDIs of member countries in Europe (Craglia and Campagna, 2009). The trend of developing SDIs at national and regional levels has been followed by the rest of the world. This includes, amongst others, the Australian National SDI and the Asia-Pacific SDI (Rajabifard, 2002). The SDI bandwagon was further boasted by the addition of third world countries, including African regions, at the turn of the century (Makanga and Smit, 2010; Mwange et al., 2016; Guigoz et al., 2017). Since their initial creation, SDIs have evolved throughout various generations. The first generation began during the 1980s and typically adopted a top-down, product-based approach. In those early SDIs, by having a major strategic and operational role, national mapping agencies had a significant impact. The product-based SDI model was based on a data producer and was national mapping agency driven. It focused on data production, database creation, and centralisation. Amongst the first-generation SDIs, data were a significant driver (Rajabifard et al., 2006).

During the year 2000, the advanced ICT capabilities sparked the evolution to second-generation SDIs. The second-generation SDIs shifted the focus from solely connecting the SDI to present and future databases, to the establishment of an infrastructure that would enable the efficient management of access to geospatial information. The product-based development model changed to a more process-based approach (Rajabifard 2002; Rajabifard et al., 2006). This model encouraged SDIs to become decentralised with distributed networks (Rajabifard et al., 2003). Since the user requirements specifications are the key drivers of SDI, the focus of the new models was on the use and application of data.

Significantly, second-generation SDI prioritised the dissemination of data by the creation of a link between data and data users. Making users' part of the SDI component increased the importance of the SDI. Preliminary SDI development was initially the domain of organs of state whose role it was to map and collect small-scale data about their area of jurisdiction or a nation. They contributed both on a strategic and operational role in SDI development, adopting a top-down approach to policy advancements. Previously, unlike national government SDI initiatives, local governments and private sector participation in SDI activities had not been formally established, coordinated, and advanced which resulted in uncoordinated SDI efforts. Since development of policy happened at the national level, both the local government and the private sector were left with little or no role to play in SDI development. Figure 21 illustrates the SDI evolution and ascertains three generations of SDIs (Rajabifard et al., 2006).

	1st generation SDI	2nd generation SDI	3rd generation SDI
Approach	Product-based	Process-based	Uncoordinated decentralized activity
Focus	Data production, database creation and centralizations	Use and application of data, Web services	A problem-oriented virtual world to facilitate decision making
Key driver	Data	Users and their needs	Decision making
Role players			
- National authorities	Strategic and operational		Strategic but less important
- Local authorities	Operational to lesser degree		Operational
- Private sector	Not involved		Operational

Figure 21: SDI evolution (Coetzee, 2008)

The evolution and development of third generation SDI is presently in its infancy in spatially enabled societies (Rajabifard et al., 2003; Coetzee, 2008). There are other data collection, handling, and storage frames, such as *Volunteered Geographical Information* (VGI), which recognises the role of independent collectors of geospatial data (Coleman, 2010). This also includes crowdsourcing, which Goodchild (2007) posits is similar to VGI because it mainly refers to the utilisation of social networks and web technology as a means to generate map products and services (Goodchild, 2007; Crooks et al., 2016).

SDI is an evolving, long-term concept. It usually consists of multiple components and can be developed at different levels moving from local to global level (Budhathoki and Nedović-Budić, 2007).

This means that the specifications for content suitable for an SDI are also evolving. Over the past three decades, the evolving SDI concept has gradually shifted its focus, as can be confirmed by organisations such as the *United Nations Global Geospatial Information Management* (UNGGIM). For example, the transformation can be observed from a focus on data coordination, exchange and sharing, with the emphasis on a top-down approach (meaning from national to local sphere), to a bottom-up approach (meaning from local to national sphere).

It can also be seen to have shifted from a centralised to distributed approach as well as to a more service oriented focus (Williamson et al., 2006; Van Loenen et al., 2009). This has revealed that the roles of the national governments, provincial governments, local governments, and the private sector are evolving. This also highlights the fact that perhaps the role of national governments has diminished both at the strategic and operational levels, even though there is a strong case for a strategic role of national government in SDI through coordination. The tables has turned and the first-generation organisational level of SDI, which was conducted by national governments, has now moved to the level of local government (Coetzee, 2008).

While SDI operations have expanded to the local government level, there is also a trend for greater regional collaboration as can be witnessed through the creation of SDI regional efforts such as the permanent committee on *GIS Infrastructure for Asia and the Pacific*, *INSPIRE* in Europe, and the permanent committee on SDI of the Americas. The *United Nations Economic and Social Council* (UN ECOSOC), states that the full potential of geospatial information and essential technological resources, could be made more useful and accessible to a wider scope of policymakers and users of geospatial data, if regional and international coordination and cooperation in the field can be increased (UN ECOSOC, 2010).

Developing SDIs around the world are designed to ensure increasingly efficient and effective management and use of geospatial data properties. At various levels of government areas, the SDI principle assists in different kinds of decision-making. Literature reveals that role actors from various disciplines and different jurisdictional levels recognise and define the SDI definition differently. For instance, globally, private sector involvement in national SDIs has increased substantially. SDIs are now gradually starting to have a legal mandate in their use, creation, maintenance, and implementation (Masser et al., 2008). The SDI concept is also shifting to support a different business paradigm. SDIs allow the advancement of public or private geospatial information organisational collaborations to provide access to a wider data spectrum and related resources that are beyond the resource ability of an individual organisation. SDIs are seen as infrastructure promotion by connecting geospatial data users with providers on the basis of a shared data exchange or sharing objective (Masser et al., 2008). The SDI concept is presently being aligned with the rapidly growing location-based and cloud-based services such as VGI and crowdsourcing, to mention just a few (Harvey et al., 2012; Goodchild and Li, 2012; Senaratne et al., 2017).

Reasons for implementing SDIs have altered from resource saving and increased productivity, to the more holistic socio-cultural ideal of SDIs serving the interests of societies. Since the mid-1990s, for example, SDIs have emerged as an enabling forum for evidence-based decision-making and policy making applied to the challenges of sustainable development (Scott and Rajabifard, 2017). Their growing importance has improved connectivity and the greater involvement of different public and private stakeholders has made suitable governance vital for effective SDI development and management. This is a challenge, however, owing to the complex, multi-stakeholder, multi-level,

technical and open nature of SDIs. As SDIs play an increasing role in society, more insight is needed into SDI governance (Sjoukema, et al., 2017).

4.2.2 SDI Definitions

"The most frequently accepted description of SDI would be the one defined in the cookbook of the *Global Spatial Data Infrastructure* (GSDI), which states that SDI is a term that describes a range of techniques, regulations, and institutional arrangements that encourage the access and utilisation of geospatial information and applications" (GSDI, 2009, p3). In defining SDI, Nebert (2004) introduces a similar concept, which states that it is the applicable base set of geospatial information policies, technologies, and overall organisational arrangements that help to make geospatial data ready for access. This definition has been expanded by many jurisdictions to include foundation or structure data and standards. The definition of an SDI differs from one nation to another. Some emphasise the development of spatial data, while others the sharing of available data, or the use of prescribed standards (Makanga and Smit, 2010).

Table 16: SDI definitions

No.	Source (reference)	Definition of SDI
1	Maphale and Moreri (2018, p.2)	SDI is a geospatial technology and institutional conglomerate fused with multi-sector professional operation. It can play a leading role in promoting major government, sector and private decision-making avenues if implemented and coordinated properly.
2	Coetzee at al. (2019, p.1)	SDI could be described as the infrastructure, resources, systems and installations necessary for the functioning of society to provide a country, city or region with geospatial data and services.
3	Cooper et al. (2014, p.1)	An SDI is an expanding term in the geospatial data community to facilitate and coordinate the exchange and sharing of geospatial data and resources between stakeholders at different levels.
4	Kumar and Jailia (2018, p.1)	SDI is essentially a medium used for geospatial resources to promote its access, management, reuse, availability and maintenance.
5	Fourie (2016a, p.19)	SDI can be defined as integrating technology, people and policy as a platform for promoting access to data holdings in the public and private sectors.
6	Noucher et al. (2017, p.1)	SDIs are contributors to the "*Digital Earth*" vision, a multi-resolution, 3D representation of the earth that allows huge quantities of geo-referenced data on physical and social environments to be found, visualised and made sense of.
7	Barbero et al. (2019, p.11)	SDI is a complex set of components encompassing the legislation, access networks and data handling facilities (based on the existing technology solutions), standards and human resources needed for the efficient collection, management, access, distribution and usage of geospatial data for a particular jurisdiction or society.
8	Kim (2011, p.8)	SDI is a system for spatial geospatial data, metadata, users and resources (services) that are adaptively integrated to allow effective and scalable use of geospatial data.
9	Vancauwenberghe et al. (2009, p.)	SDI is the means of assembling geospatial data that defines the arrangement and attributes of the earth's characteristics and phenomena.
10	FGDC (1996)	SDI is a framework of policies, standards and procedures that engage with organisations and applications to encourage more effective use, management and development of geospatial data.

Table 16, lists the SDI definitions in line with the ambitions, and goals of geospatial information requirements of the people they assist across the organisational, local, national, regional, and global stages (Kumar and Jailia, 2018). The fact that there is an abundance of SDI definitions is a suggestion that there is not a universal understanding of precisely what SDI involves, which in turn, is embedded in the fact that various different sectors within a particular country may face contrasting needs (Craglia, 2010). Consequently, the incentive for SDI development may differ from one country to another. Furthermore, some of the definitions highlight various components of SDI, while others emphasise the goal of establishing a national SDI. However, the gist of all these definitions of SDI come down to the fact that SDI is the framework of factors, or elements, that are required by a geoinformation community to make effective use of spatial data or information.

In Crompvoets et al. (2004), the SDI is understood as a tool to ensure working conditions in which every role player, such as the users and the producers of geospatial data, may collaborate to cost-effectively make the most of the technology in order to better achieve their intended objectives. These definitions span over the past three decades. They are sourced from various countries hence, the definitions reflect their original focus (such as cultures or religions), and the general perceptions of those location and periods in time. As scholars and practitioners have sought to explain SDI, the meanings did not stop new ones from surfacing.

Generally, the objectives and components of SDI service the ambitions of a certain jurisdiction and thus their political inspirations are witness-able. An SDI primarily hosts geospatial data and their attributes, metadata, data discovery functionality, data display, and evaluates the geospatial data (catalogues and web mapping) and has some means to deliver access to the geospatial data. Additional resources or policy structures are also available to formalise the SDI applications and to include the software to support geospatial data applications (Kumar and Jailia, 2018).

For an SDI to be purposeful, it must also take account the institutional agreements required to organise and manage it on a scale that includes local, regional, and national platforms. The term infrastructure is applied to endorse the idea of a dependable, sustainable environment, analogous to geospatial information utilising a set of standard procedures, etiquettes, and specifications. Thus, an SDI facilitates the conveyance of practically unlimited packages of spatial information. It is necessary to consider the provisions for the dissemination of geospatial data as form of an infrastructure (Longhorn, 2001).

4.2.3 SDI Components

The word “component” is broadly utilised in geoinformatics and other sciences and is used to distinguish between essential parts that form a whole. From an SDI perspective, numerous factors may be considered as components or ingredients of SDI (McLaughlin and Nichols, 1992). These components are' sources of geospatial data, metadata, data networks, technology (dealing with data capture, maintenance, and description), institutional structures, policies, standards, and end-users,' according to Coleman and McLaughlin (1998, p.21).

SDI usually comprises a minimum of five constituent components irrespective of the extent of the location scale. These constituent components include data, end users, policies, standards, and technological resources. They are a significant necessity for the effective collection, usage, access, and management of geospatial data at various administrative levels (Nedovic-Budica et al., 2004).

The SDI components of a particular infrastructure are usually unique, but at the same time, their requirements are largely expected to be interoperable.

The segments of SDI components are greatly interconnected and exhibit a dynamic reciprocal relation that influences the development of complete SDI frameworks (Warnest et al., 2005). Rajabifard (2002) suggests that various categories of components can be formed based on the nature of their experiences with the SDI system. The first category comprises the focal technological components, such as the access networks, policy, and standards. The second category is based on the simple partition between the data and the end users of geospatial information.

Warnest et al. (2005) argue that the fundamental components of SDI can briefly be defined as access network (the technological architecture of the SDI); policies (which facilitate the development and utilisation of the SDI); standards (which address interoperability challenges); data (that provide context and reference information for a jurisdiction); and lastly, the institutional arrangements (which include people and partnerships through formal written agreements, or through more informal negotiations).

Depending on the complexity and extent of their connections within the SDI framework, such components can be identified (Warnest et al., 2005). The SDI components described above originate from Rajabifard's (2002) interactive model. The model describes the nature or functional environment of the SDI. In the view of Rajabifard (2002, p.29), “an integrated SDI cannot consist solely of geospatial data, value-added services and users, but rather addresses other essential interoperability, policy and network issues." Figure 22 illustrates the relationship between the SDI components.

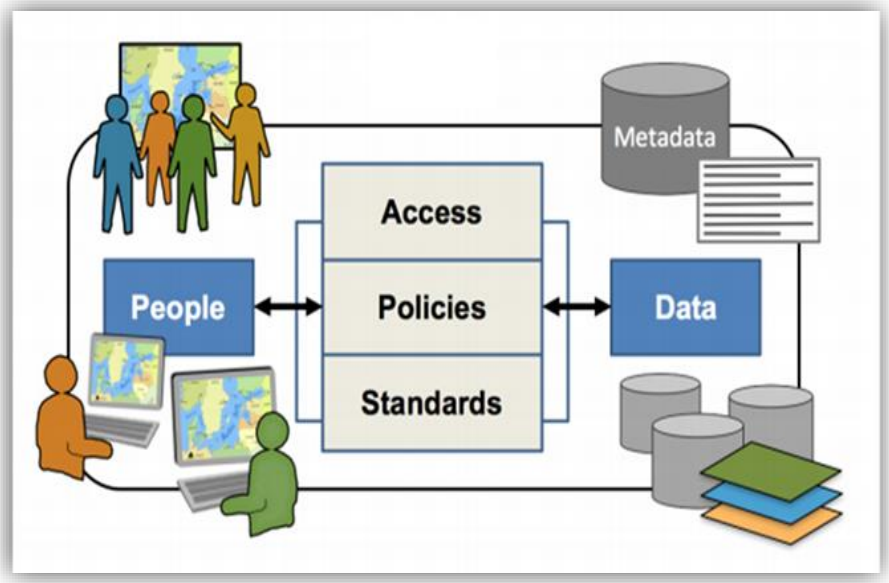


Figure 22: Relationship between SDI components (Rajabifard, 2002)

In contrast to Rajabifard (2000), Cipolloni (2018) emphasises that the SDI is composed of a set of technical and non-technical components that facilitate the sharing of geographic information. Four

main domains related to SDI can be identified as data, metadata, network services and share agreements. Except for the share agreements which are legal requirements and do not provide technical guidelines for the infrastructure, the other domains provide technical specifications on how to build the Infrastructure.

The data component involves different elements related to the data storage system, normally the database software and applications to manage and ingest these, as well as the standardisation, harmonisation and validation processes tools that permit high semantic interoperability, a quality check and integration on data. The metadata component is composed of a software application that assists a system to compile or charge metadata in a standard template and defines the rules of how to fill in the template. The network service component represents the software applications and rules to make data, metadata, and information in the general approach available, accessible, and interoperable in different systems (Cipolloni, 2018).

SDIs primarily comprises of data, hardware and software from a technical perspective. A fully usable SDI, however still requires people's efforts, funding from organisations, governmental policies, requirements for data and software standards, and several others. SDI provides an answers to the challenges of exploration of resources and redundancy of data. It offers a single platform where geospatial data, maps, services, and other digital resources can be searched for (Georgiadou, et al., 2006). SDI enables geospatial data to be generated once and replicated numerous times in various applications from a cost or benefit point of view. More broadly, in an effort to expand the transparency of government operations and to boost citizen engagement, SDI can be recognised as an essential factor in the e-government and open-government movement. Good accessibility to geospatial data also triggers new enterprise development, which may not otherwise be possible (Ralston, 2004).

Presently, substantial effort has been made in several countries to build modern infrastructures of SDI beyond the traditional components of SDIs in order to reinforce the operational essence of SDIs in line with their governments' digital transformation. Examples of these initiatives involve the development of new components, new web-based systems, spatial registries, the harmonisation of geospatial and attribute data through thematic domains, innovative methods such as *Application Programming Interface* (APIs) to render accessible and reusable geospatial data (Barbero et al., 2019).

4.3 Coordination and Cooperation in SDI

4.3.1 Collaboration in SDI

In this section and the next two sections, three dominant aspects to coordination are discussed, namely collaboration, hierarchy, and stakeholders. These three aspects not only assist in understanding the causes of coordination problems, but they also provide insight into the mechanisms through which coordination can be attained. Hierarchy, as a coordination mechanism, refers to authority as the main pattern of interaction. Stakeholder coordination, within the SDI context, is based on geospatial data exchange and collaboration between several actors, this form of coordination depends on cooperation.

The term collaboration is ambiguous but is defined commonly as stakeholders working together towards a shared goal. Tarmidi (2016) describes collaboration as a form of cooperation between role players from various disciplines to solve a problem. While Alshehri (2011) suggests that collaboration is a form of participation whereby stakeholders are involved in planning and working with other stakeholders to solve a problem and achieve a goal. Coordination is also concerned with the necessary procedures, activities and behaviour to ensure that the individual component parts are coordinated to create a working product.

Coordination provides the crucial relation among the governance processes of 'steering' and the 'rowing' activities of individual actors that drive the society in the direction desired (Box, 2013). The role of coordination is crucial in the sense of distributed SDIs and capacities that are under different management of custodians. SDI coordination, however, is considered to be a distinct and very important governance support mechanism (Oxford University Press 2012).

It is also an approach in which each stakeholder cooperates with each other to resolve various issues with the association of a common theme. Furthermore, Alshehri (2011) maintains that it is understandable that collaboration is a process to build common understanding among stakeholders to achieve a common goal. In spatial data sharing, collaboration is envisaged as very significant as it assists to reduce duplication of data, optimises the use of organisational resources, and provides efficient and manageable management (Warnest, et al., 2005; Tarmidi, 2016). Collaboration has many benefits. It aids in transparent decision making, better asset management, reduces duplication of work, and improves speed of information access (Wheeler and Peterson, 2010). In addition, technical competence, absorptive capacity and organisational motivation are all extended by collaboration (Ariffin et al., 2014).

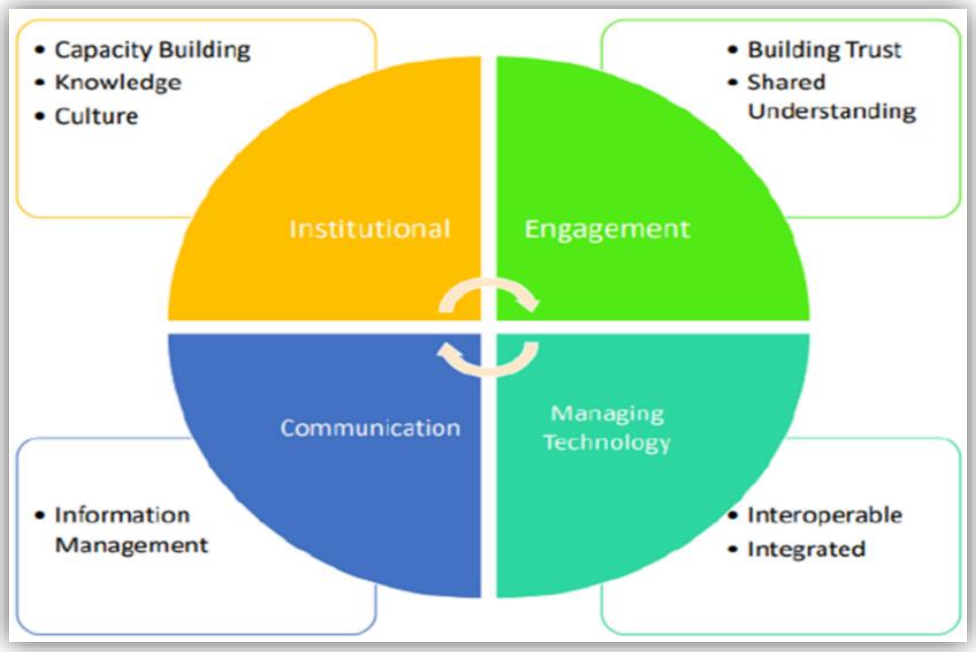


Figure 23: Aspects of collaboration (Rosly, 2018)

Figure 23 depicts the linkages between components of the collaboration process. Interoperable technology is needed for collaboration. In SDI collaboration, initiatives are usually driven or facilitated by spatial data custodians and other stakeholders. Collaborative custodianship is one form of collaboration in SDI. For example, in South Africa, authors such as Coetzee et al. (2019, p1) assert that "collaborative custodianship refers to a framework in which several custodians come together to produce integrated SDI data sets." At all levels of government, the collaborative agreements encourage productivity.

This is to ensure that information can be shared through various mediums. With an interoperable system, decision-making process can be implemented more efficiently and effectively (Paiman and Asmawi, 2015). Considerations in this regard are common technical standards, platforms, software, and applications. Collaboration can create and enhance the process spatial data sharing by emphasising the network between organisations.

In spatial data sharing, organisational and institutional aspects are very important as they involve the management of technology. Collaboration between institutions in terms of effective engagement, communication, and technology are essential to reduce data duplication between local, state, and federal organisations. Beneficial outcomes of collaboration include better *Return of Investment* (ROI), improved inter-organisational relationships, increased organisational efficiency, data related benefits, compatibility, organisational effectiveness, and overall improvements in satisfaction (Saligoe-Simmel, 2019).

Collaboration has been identified as critical for the development of SDIs and should be prioritised at all levels of government and across many sectors. Any cooperation between stakeholders related to geospatial information improves the national SDI implementation. At its best, SDI allow cross-border and multi-agency cooperation to resolve the most significant social and environmental challenges, including natural and man-made disasters (Saligoe-Simmel, 2019).

Today, SDIs are rapidly evolving. Together, the internet and cloud computing are transforming the way organisations manage data and collaborate. Web geospatial data processing is significantly easier to use, deploy, and integrate into an SDI ecosystem than traditional systems For example, all forms of geospatial information are handled by portals, comprising of data and services, maps, analytical models, workflows, applications, and even access and data security. Organisations are connected and collaborate through a network of portals. Data service APIs enables users to bring together data dynamically from distributed systems into a host of applications (Saligoe-Simmel, 2019).

Lack of coordination between different spatial data producers and users is often considered as a critical barrier to the development of an SDI. In the public sector, coordination has always been very problematic because of the fragmentation of the sector into several organisations. These organisations all have their own specific tasks and competences, which make it difficult for them to align their policies (Rosly, 2018).

Consequently, government programmes sometimes overlap or duplicate each other. In other instances, the absence of coordination has led to major gaps in legislation and policy (Saligoe-Simmel, 2019). Collaboration in the public sector is important to enhance data sharing between different spatial data producers and users particularly with regards to geospatial data. It should also integrate land based and marine based stakeholders (Rosly, 2018).

4.3.2 SDI Hierarchies

From an SDI background, the term “hierarchy” is referred to as a composition of a tree-shaped structure that branches or divides into smaller sub-systems (Rajabifard et al., 2003). Subdivision can transpire recursively so long as it makes sense to subdivide. Hierarchies are normally characterised by hierarchical roles, which produce various hierarchy types. For example, in SDI, higher level global SDIs can be divided into regional SDIs which consist of one or more lower level local SDIs. Rajabifard et al. (2003) argue that the hierarchies of the SDI are formed at different local, state, national, provincial and global levels through the interconnected SDIs. Two perspectives on the essence of SDIs lead to a deeper understanding of the SDI hierarchy (Rajabifard, 2002).

The *umbrella view* considers SDIs from a broad perspective encompassing all the different hierarchical levels. It exhibits the top-down approach. In contrast, the *building block view* states that any level of an SDI serves as a building block that supports geospatial data required by higher levels within the SDI hierarchy. It thus entails a bottom-up approach. These two views of SDI hierarchies establish the conditions by which decision-making and sourcing of geospatial data of various themes, from across different SDI hierarchical levels can be made (Rajabifard et al., 2003). SDI initiatives such as standard and legislative developments are largely based on the *umbrella view* of SDI, whereas the *building block view* is considered preferable for gathering and generating base data sets.

As previously discussed, SDIs operate on various levels ranging from the institutional, local, state, national, and ultimately to the global scale. Every component of these levels focuses on various extents of geospatial data scale, organisational structures, and related matters. Within the SDI hierarchy, the national level SDI is the most influential and provides support in establishing and linking all the other lower levels (Rajabifard, et al., 2003; Alexiadou and Rajabifard, 2006). As a consequence of its central role in the hierarchy, the national SDI produces a detailed representation or profile of the country and contributes to enhancing national economy and security and improving environmental and natural resource management. Accordingly, the national SDI is a critical sustainable development platform.

A SDI hierarchy model that includes SDIs at different political-administrative levels has been developed (Chan and Williamson, 1999; Rajabifard, et al., 2000). A corporate *Geographic Information Systems* (GIS) is used in the model as an SDI at the business-base hierarchy level (Chan and Williamson, 1999). Increasing the SDI at or above local level is mainly formulated through the incorporation of spatial data sets which were initially established for use in businesses operating at, or below, that level. Aggregation function is the most important method for building a hierarchy. Explicit classes are aggregated as they share one unique attribute or property. This is because various SDI measures will merge to establish the next higher hierarchy at a certain political or administrative level.

"This dynamism is due to the apparent complexity between two SDI hierarchy levels and within one SDI level and the relationships between all SDI hierarchy models" (Rajabifard, 2002, p.7). By splitting SDI initiatives to distinct levels, SDI hierarchy models aim to minimise such complexity. One way to evaluate and map these relationships in the sense of an SDI hierarchy may be to assess the impact and relationships of each component at each SDI level on the same component at a different level. Thus, trends of direct and indirect possible impacts and relationships between them can be observed across each of the components considered (Rajabifard et al., 2000).

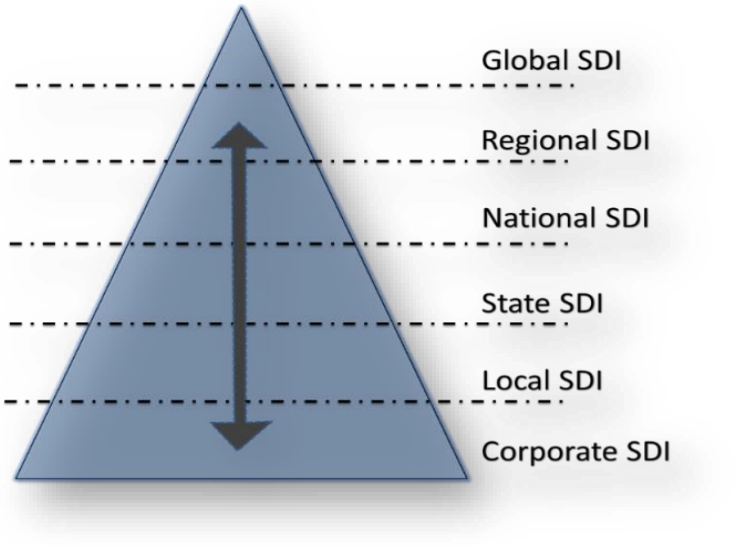


Figure 24: SDI Hierarchy Model made up of inter-connected SDIs (Rajabifard, 2002)

Figure 24 demonstrates SDI Hierarchy Model made up of inter-connected SDIs. Across multiple stages of SDIs, relationships are dynamic. From the SDI hierarchy perspective, SDI initiatives in this study refer to global SDI, regional SDI, national SDI, local SDI and corporate SDI. According to Zhang (2003), hierarchies of SDI can be represented in two ways vertically and horizontally. Vertical representation implies inter-SDI hierarchical levels. Horizontal representation implies intra-SDI hierarchical levels. Developing any SDI is a matter of their associated cooperation, coordination and partnerships with other jurisdiction (Rajabifard et al., 2000).

Global SDI (GSDI) is an international SDI representing the coordination of nations and organisations and promotes the establishment of SDI throughout the world. It also assists to foster legislation, policies, and processes in order to harmonise geospatial data exchange and usage. GSDI enlightens and creates awareness regarding SDI benefits inside and outside international boundaries of policy makers, decision-makers and involved nations.

Regional SDI focus on SDI issues at a regional scale. It usually involves collaboration between several regional organisations and groups. Such collaborations work together to address important cultural, social and environmental challenges and topics (Rajabifard et. al., 2000). The primary aim of this partnership is to coordinate economic activity in such a way that regional and national benefits are maximised. Geospatial information at a regional scale offers the ground for informed decision making of a particular continent or region.

The national SDI is intended to help manage a country's applications of geospatial data, with the aim of avoiding wasteful duplication of effort and to enable effective and economical facilitation of a nation's resources (Kim, 2011). The national SDI has a stronger influence than other levels within the general SDI hierarchy, as well as an important function in establishing and coordinating SDIs at other levels. This implies that the national level has a significant effect on the higher and lower levels of SDI hierarchies. A national SDI's position in an SDI hierarchy reveals a peculiarity not present at other SDI Hierarchy levels (Rajabifard et. al., 2000).

The state SDI level may use base geospatial data sets from other hierarchical levels for their applications. A state SDI has a direct impact on other hierarchical levels of SDIs in terms of technical standards and its role is significant in influencing the decisions of the upper levels on strategies and standards. Sate levels of an SDI hierarchy are similar to the functional level of a local structure (Cetl, 2012).

Local SDIs facilitate the establishment and support of data sharing and access at the local level (Asseng et al., 2018). Local SDIs cover spatial data issues at the local administrative level, including municipalities and cities. Local SDIs are envisaged as the ideal starting point for most SDI initiatives. Spatial data sets at the local level are the most detailed and have the largest scale, which makes them the most expensive to capture, collect, update, administer, and distribute (Cetl, 2012).

4.3.3 SDI Stakeholders

SDI stakeholders are the individuals or groups with an interest in SDI's initiatives to deliver their intended outcomes and to improve product viability. Stakeholders either influence or are affected by SDIs (Hjelmager et. al., 2008). The *International Cartographic Association* (ICA) model developed by Hjelmager et al. (2008), includes six types of stakeholders in an SDI, namely policy maker, producer, provider, broker, value-added reseller, and end user (Cooper et al., 2019).

The ICA model is a conceptual model and is usually used to describe stakeholders in an academic SDI. In this model, stakeholders are considered as individuals or as organisations (Coetzee et al., 2018). The literature, however, contains a variety of other categorisations for SDI stakeholders. According to Cooper et al. (2019), a stakeholder in an SDI setting might be considered an actor who can have either an active or inactive association with any activities or components of an SDI. Individuals and organisations can play multiple roles, so it is more appropriate to categorise stakeholders by role rather than individually or per group. Table 17, describes types of stakeholders in the ICA model.

Table 17: Types of stakeholders in the ICA Model (Hjelmager et al., 2008)

No.	SDI Stakeholders	Depiction
1	Policy maker	Sets an SDI policy as prescribed by all its stakeholders.
2	Producer	SDI producers generate geospatial data or related services.
3	Provider	Offers users with geospatial data or related services across all SDI levels.
4	Broker	Brings together users and providers of geospatial data, and helps negotiate contracts between the involved stakeholders.
5	Value-added reseller	Adds to or improves certain features of an existing product or package of products, and avails it as a new complete package.
6	End-user	Any interested party in the activities of SDI. The user who supports or applies SDI products and services.

The jurisdiction of public sector stakeholders, for example, includes a variety of different categories (Vandenbroucke et al., 2009). Coetzee et al. (2017) describe the relationship between an SDI and its stakeholders as mutual, implying that the SDI both impacts and is affected by its stakeholders. Stakeholders define the scope and policies to meet the purpose of an SDI; they implement an SDI based on that scope and policies, and they make use of products and/or services as intended for the SDI (Hjelmager et al., 2008).

Table 18: Stakeholder typologies for SDIs (Coetzee et al., 2018)

Source	Typologies
Harvey and Tulloch, 2006	Data provider, data producer, data distributor, data coordinator, data user, data sharing collaborator.
Harvey and Tulloch, 2006	Local and agencies, federal and regional agencies, private companies, and utilities.
Vandenbroucke et al., 2009	The federal, municipal, provincial, and regional authorities. Inter-municipal organisations, entities of mixed public and private status.
Béjar et al., 2012	Custodian, operational and governing body, contact, promoter and funder, member, end-user, and educator contributor.
Rautenbach et al., 2012	decision makers, CSI members;, funders, and policy makers; base data sets custodians; producers of non-base data sets; producers of SASDI services; services providers; consumers and end users of SASDI services.
Coetzee and Smit, 2015	Data producers (for example, municipalities, scientists on a project), funders, collaborators (for example, researchers on a project), reviewers (of data before publication), users (for example, planners at municipalities, policy makers, decision makers, citizens), advisors (for example, advisory board members), trainers, communicators (for example, public relations, media).
Welle Donker and Van Loenen, 2016	Enablers, developers, aggregators, suppliers, and enrichers.
INSPIRE, 2018	INSPIRE committee, national contact points, INSPIRE coordination team, *Spatial Data Interest Communities* (SDIC), INSPIRE maintenance and implementation group, *Legally Mandated Organisations* (LMO).
Marine Spatial Data Infrastructure Working Group, 2018	National mapping agencies and public sector stakeholders at the administrative, standards experts; private sector and survey departments; policy and political level; users; *International Hydrographic Organisation* (IHO) working groups and committees; regional or national SDI initiatives; GSDI; other data providers; marine/maritime organisations.

Table 18, shows the stakeholder typologies for SDIs. The categorisation of SDI stakeholders in this research serves the purpose of identifying the relevant stakeholders in the literature review to gain an understanding of which category the researcher is dealing with. For this study, stakeholders were classified as data users, data providers, or facilitators, of the national data set, based on their interest in the data set.

4.4 SDI Governance and Policy Environment

4.4.1 SDI Governance

The section begins with a brief description of SDI governance and offers an overview of the reasons why the term governance applied to SDI has emerged. The other aim of this section is to explain the role that policies play in fostering the growth and implementation of SDIs. The significance of connecting SDI efforts to the policy objectives in the territory is highlighted. A range of modern cultural policy issues related to SDI are addressed and descriptions of policies with a focus on operational policies are presented to tackle those topics A number of current SDI-related policy issues are addressed and examples of policies are presented, focusing on operational policies (Box, 2013).

SDI governance refers to an underlying and enabling decision-making and implementation strategy that involves institutional frameworks, functions, policies, procedures and processes that enable shared objectives to be accomplished through collective decision-making and concerted action. The purpose of the governance and legal framework is to define obligations and to control the day-to-day operation of such services including the use of data in order to promote access to data through services in ways which do not lead to violation of rights and do not eventually lead to liability (Box, 2013).

The recent developments in the SDI governance concept reflect the evolving nature of SDI, which in addition, is motivated by significant changes in the political and technological conditions wherein SDI takes place (Box, 2013). The transition from centralized organisation structure to distributed and shared networks has followed SDI's shifting attention from data provider desires to data consumer interests, acknowledged as the transition from product to process model (Masser, 2005; Box, 2013).

In some cases, SDI became originally motivated by the business requirements of public mapping and surveying activities and concentrated on them. This reality has been expressed by concurrent coordination frameworks and organisational structures. The current organisational structures are still not necessarily inherently the most effective tools for supporting SDI, as these programmes have changed and reoriented over the last couple of years (Masser et al 2008).

As a crucial factor, Box (2013) refers to leadership in SDI results For instance, Kok and van Loenen (2005) utilized leadership as being one of the institutional methods for evaluating the competence of the SDI. Bellafiore et al (2008) suggest that although SDI leadership is important to SDI's achievement, it is the epitome of good practice in management. A central component of the vision of good governance and stakeholder dedication is leadership (Masser, 2005). Confidence is connected to leadership and is vital to safeguarding the duties of representatives of collection action. A key aspect of successful governance is the formation and maintenance of organizational confidence in governance procedures and credibility in the main department (Harvey, 2003).

Methods of SDI governance have evolved mainly from initiatives of geospatial coordination. The terms governance and coordination are used interchangeably and it's worth making a clear distinction between them. The aim of governance is to include a mechanism of mutual decision-making to guide a shared initiative. Leadership, whether through a formal or consensual mandate, is a crucial dimension of governance as it provides an integral guiding mechanism and ultimate ownership for a combined effort. In order to allow them to work efficiently together, coordination is synonymous with 'coordination of the different components of a complex body or activity' (Box, 2013).

SDI governance is known to be hierarchical, with various facets of SDI under different governance structures and overlapping them in many instances. In the field of standards, perhaps this is best illustrated, as SDI development is focused on many standards for technology and content. For example, stakeholders involved in the development and distribution within an SDI of a specific geospatial information resource may well be regulated by a variety of specific institutional, legislative and domain standards frameworks relating to information content, design, semantics, and delivery formats, all of which have separate governance structures (Box, 2013).

There is considerable variability in the conceptualisation theory and practical implementation of SDIs, although SDI and governance are disputed, with interconnected social and technological aspects,

dynamic, changing, subjective, and multi-faceted definitions. While insufficient literature on the conceptual or functional aspects of SDI governance is available, the implemented SDI includes indirect and direct governance expressions. Information is accessible in a variety of ways about how governance is conceptualised and implemented in practice, with individual information and expectations and documentation relating to specific programmes being the main sources (Box, 2013).

4.4.2 SDI policy environment

The policy approach aims to direct and facilitate the development of services, as well as to guide both users of geospatial data and providers of geospatial data in order to achieve the best possible overall outcome of SDI use. Even within territory in which they are applied, SDI policies are tightly associated with the overall regulatory structure. SDI correlates remarkably well with open government policy priorities (Bill, 2017).

In order to develop creative and useful products and applications that maximise the significance of the original data, a strong emphasis is put on encouraging public access to government-held data. In 2015, for example, the *United Nations* (UN) unanimously adopted the *Sustainable Development Goals*, which include a pledge by all countries to "ensure public access to information." By the end of 2016, 109 of the 193 United Nations Member States had adopted constitutional provisions for public access to information (Bill, 2017).

A data policy creates an atmosphere that encourages organisations, on a legal basis, to contribute to easy access to the data sets of the country. The *Africa Action Plan on Global Geospatial Information Management* (2016) is a descriptive data strategy at the *UN-Global Geospatial Information Management* (UN-GGIM). It forms the basis of a legal structure in the SDI context, defining some basic data-specific principles to be followed by individuals and organisations when generating, processing, transforming, disseminating and using data. Geospatial data, social and economic data, policy data, and so on could be the data in this case.

Even though a comparison can be made between data policy and information policy, it should be acknowledged that during the SDI process, a piece of information can be seen as an input to a further process and thereby become an input data for that process during the SDI process. As a result, it is also difficult to distinguish between data and information and to separate information policy specifically from data policy in certain cases. Some of the problems in the policy system are addressed by the legal framework and some only function as guidance (UN-GGIM: Africa Action Plan, 2016).

A variety of factors that function varies in various national or regional contexts, several of which are in the stage of continuous change, are driving the development of geospatial data policies (Longley et al., 2005). For example, policies that can be related to SDI efforts or that affect SDIs entail technological innovation and development, rapid change in user expectations, collaborative approaches to horizontal governance, increased citizen engagement, free or fee-based availability of data, reduction of regulatory and administrative burdens, effects of government reform, and reduction of duplication of data. While they interrelate, in the first place, the main components of geospatial data policy and their 'drivers' are better seen separately. However, compared to other advantages that are distinct, individual policies may be supported. On the basis of economic theory, there is also some support (and vice versa) for the distribution of government geospatial data at marginal cost (Longley et al., 2005).

The key prominent areas in which these attentions have been concentrated are the "base or core" or, most significantly, the "framework" data. The explanations for this are self-evident because they are the data used most often and are necessary for the use of other data sets. Without them, the use of GIS is highly limited. That said, many other parties' principles and activities that collect and use data also have an input effect on these key collectors and suppliers of data. In considering them as a whole, there is also a great deal of merit. For nations or for the sub-sets of the nation state for which their jurisdiction applies, governments or combinations of them establish policies. With the exception of the policies of private organisations that are articulated by strategic objectives and goals, major government policies are typically made operational or often strategic by promulgating laws or regulations (UN-GGIM: Africa Action Plan, 2016).

It should be recognised that geospatial data policymaking takes many different forms worldwide, especially in relation to the nature of the nation-state. For example, as stated in the Soviet Union before 1989, a major gap used to exist between the centrally driven models and that in some democratically organised societies. At both strategic and operational levels, SDI policy development work may be required. SDI strategic policies resolve high-level concerns and set targets (e.g. ensuring compliance with certain standards and procedures) for organisations (Longley et al., 2005).

Strategic policies serve to create a hierarchical framework within which the SDI initiative is developed and assist to foster the involvement of stakeholders in infrastructure growth and usage. Therefore, SDI geospatial data policies can be referred to as strategic or operational instruments that help facilitate the development or use of an SDI. These policies provide instructions on how to connect and use the infrastructure to provide access to its data resources, and they are also important to address user needs (Longley et al., 2005).

4.4.3 SDI Operational policies

SDI operational policies address geospatial data lifecycle problems, according to Arthurs and Giff (2013), and help facilitate access to and usage of geospatial information (for example, guidelines and manuals for data collection, management, dissemination and use). Documentary evidence of best practises in the implementation of SDI policy has become more common and open to organisations implementing SDI, so work on policy formulation can be feasible with internal resources. Conversely, conducting background studies, consulting stakeholders, and adapting good international practices to the local context may also be relevant for external experts (Arthurs and Giff, 2013).

Operational policies often include guidelines, best practices, guidelines, procedures and manuals (such as acquisition, maintenance, dissemination, and use) that address geospatial knowledge lifecycle issues. Operational policies are crucial to overcoming data sharing obstacles and facilitating the secure and effective interoperable exchange of location-based information, making it easier to deal with issues like access to data, accuracy, ownership and integrity. This definition applies to all SDIs and, in slightly modified versions, can be used for various types of SDIs, from local to regional to global. Shared governance and policies are important orthogonal components of an SDI (OGC, 2016).

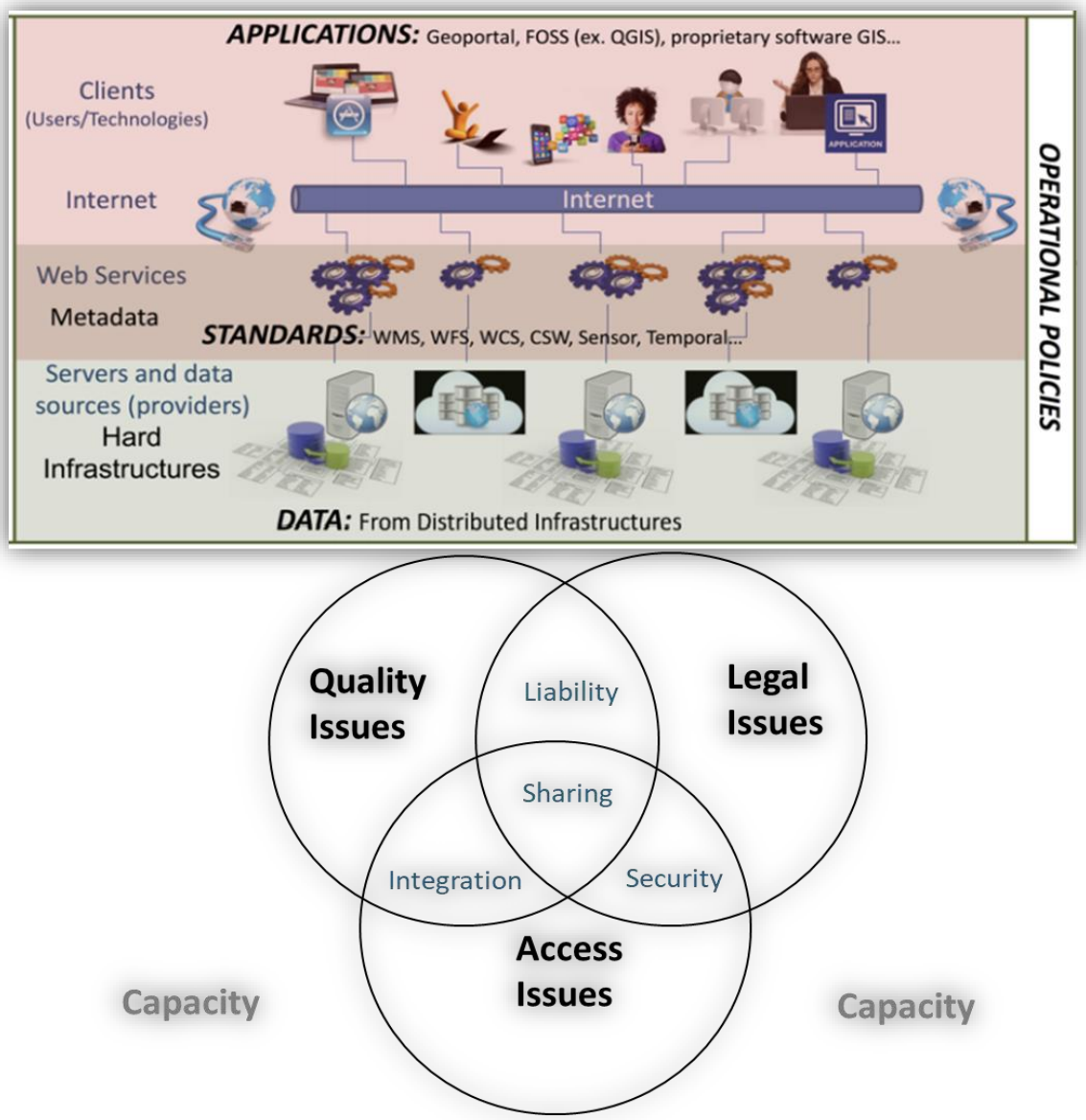


Figure 25: The aspects of an SDI and it operational policies (Open Geospatial Consortium, 2016)

Figure 25 displays the components of an SDI and its operational policies, according to the Open Geospatial Consortium (OGC). It shows a range of possible organisational policy considerations within the context of SDI growth. In the issues observed, there are many commonalities and linkages. They can be divided into three wide fields, namely quality issues, legal issues and access issues. This generally means that at the intersections between these regions the issues occur (Open Geospatial Consortium, 2016).

First, at national level, the SDI policy is introduced, and then the dependent provincial and local governments harmonise their policies with national policies. The result is usually centralised spatial data management and practice sharing across vertical jurisdictions, enabling national-level policy to

facilitate coherent SDI initiatives and encourage interoperability across all levels of government. Reality, however, demonstrates a contrasting picture (Smith, et al. 2009).

Local levels may develop and innovate more rapidly than national levels and may not reproduce or compare representations of the national SDI design (Smith, et al. 2009). In the first section of this chapter, various aspects of SDI that are relevant to this dissertation were addressed. However, concepts, elements, coordination, hierarchies, stakeholders and governance are used to explain the different aspects of the root of SDI. Any of these various aspects of SDI will be used in the last section of this chapter to address the South African national SDI in the following chapter.

4.5 The South African National SDI

4.5.1 Spatial Data Infrastructure Act (No. 54 of 2003)

The review of the South African literature regarding the SDI legislation and policies provides an excellent basis that will support further aspects and eventual results of this study. In this chapter, any reference to data custodians also applies to base data set custodians (BDSCs) and other custodians. The facts that are presented in this chapter show broad consensus regarding South African national SDI governance, but more importantly demonstrate that it promotes access, sharing, collaborative partnerships and exchange of geospatial data. Therefore, efforts to strengthen the *Spatial Data Infrastructure Act* (No. 54 of 2003) (SDI Act) must follow a holistic programme that considers concerns associated with data, coordination, collaboration, standards, technologies, and most significantly, the constituents, in a meaningful way.

The SDI Act is the recognition of the significance of geospatial data as a strategic asset to support decision-making to attain the national development goals of South Africa. The Act governs the collection, management, maintenance, incorporation, dissemination, and use of geospatial information, and refers to the state bodies that keep spatial information as data vendors and spatial information users. The SDI Act aims not only to avoid conflicting and duplication of spatial data capture and collection, but also to provide for regulations, guidelines, and recommendations to promote the exchange of geospatial information, in order to publish metadata and to prevent wasteful expenditure (SDI Act, 2003).

The SDI Act provides for the creation of the CSI and SASDI. The SDI Act also provides for the *SDI Regulations (2017)*, the draft SASDI compliance guidelines, as well as the *Pricing Policy for Spatial Information Products (2015) and Services* and the *Base Data Set Custodianship Policy* (2015*)* which were approved by the Minister. The SDI Act was publicised in 2003 and signed into law at the beginning of 2004, but only started to become functional in 2010. Sections 1 to 11; 13; and 19 to 22, of the SDI Act came into operation in 2006. In April 2015, sections 12 and 14-18 of the SDI Act were promulgated. Today, the SDI Act has come into full operation and makes it perfectly clear that no individual is responsible for everything done in accordance with the law in the exercise or performance or purported exercise or performance of any authority in support of the SDI Act. Figure 27 illustrates the components of the SDI Act.

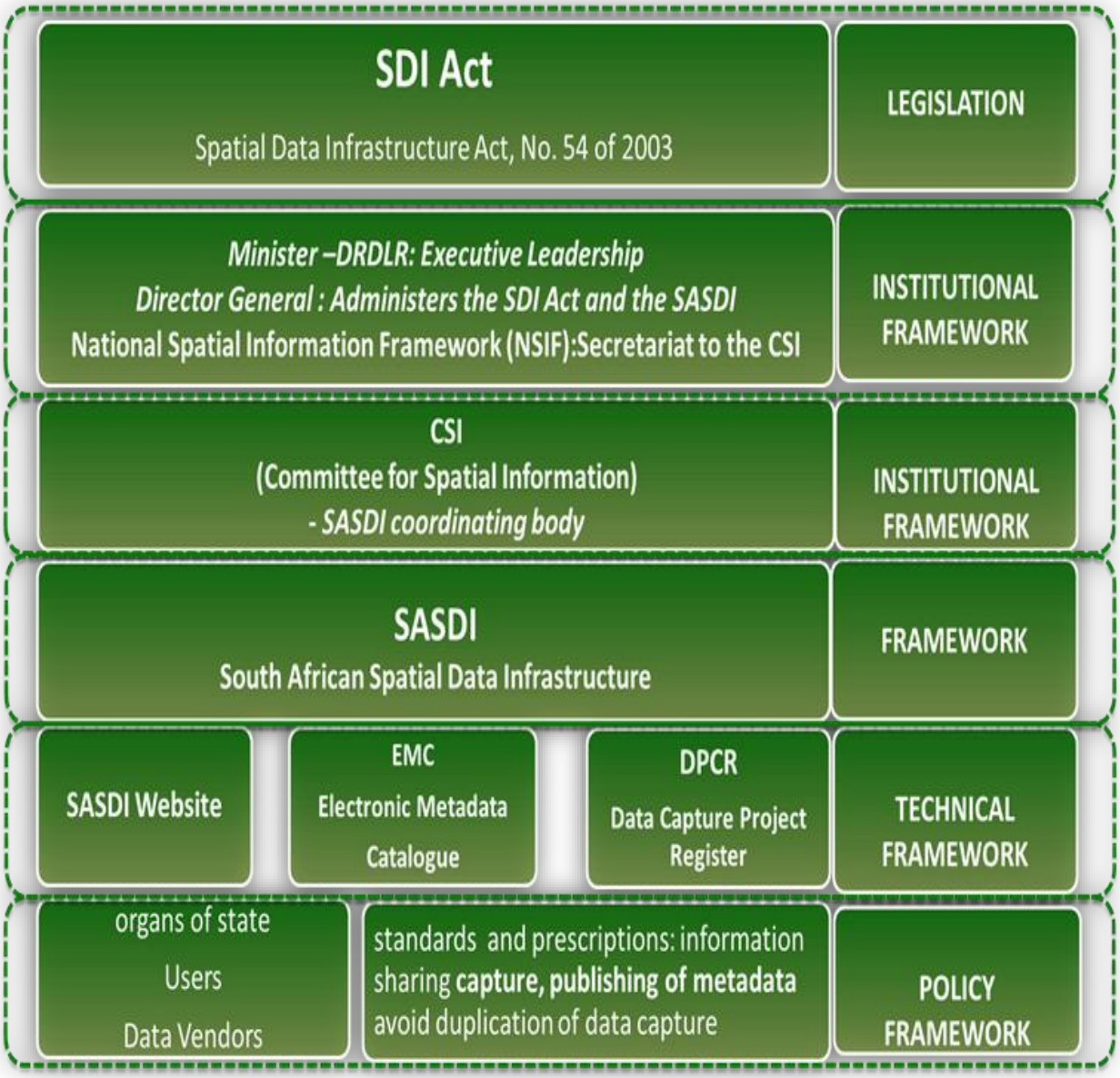


Figure 26: The components of the SDI Act (*Fourie, 2015a*)

The SDI Act (2003) was promulgated by parliament, through the South African Constitution. The Act reinforces the ideal of encouraging state institutions designated as data custodians to share geospatial information and to assist each other in achieving organised and up to date geospatial data sets. It offers impetus to the democratic right to access state-owned information and information kept by other persons. The Promotion of Access to Information Act (commonly known as PAIA) (No. 2 of 2000) “give credence to this privilege and defines appropriate steps to reduce the financial and administrative strain on the government. With the PAIA in place, it is necessary to make sure that the right of access to information applies also to geospatial information” (PAIA, 2000 p.2).

Growth of South Africa as a country is particularly reliant on an efficient national SDI. Decision-making cannot be centred on intuition or insinuation; it has to be based on evidence. The SDI Act provides

guidelines on laws providing for the processing of large quantities of geospatial knowledge that can be collected for use in spatial analyses. It defines framework data sets as those information themes which data custodians have captured or collected. The definition of SDIs by legislation offers a stable foundation for the creation and growth of national and local SDIs, as the legislation guarantees and protects the rights and functions of different stakeholders (Fourie, 2015a).

4.5.2 South African Spatial Data Infrastructure

The *South African Spatial Data Infrastructure* (SASDI) is relevant to this research because it provides literature on how SASDI promote the use and sharing of spatial information and an understanding on how it allows for coordination and cooperation amongst all stakeholders regarding access to spatial information. SASDI is established by section 3 of the *Spatial Data Infrastructure Act* (No. 54, 2003).

It is integral to the successful implementation of the SDI Act. According to section 3 of the SDI Act (2003, p4), “the national, technical, institutional and policy structure for facilitating the collection, administration, management, integration, distribution and use of geospatial information in South Africa is known as SASDI”. The SASDI is the national SDI (NSDI), an initiative of the South African government. The term "national" indicates that SASDI is meant to be used by the national geo-information (GI) community and that all public organisations should implement an SDI function to perform (Fourie 2015a, p. 20).

The components of SASDI consist of the institutional framework, technical framework, and the policy framework. Such components and their different segments are closely intertwined; therefore, one weak component may negatively impact the current operation of the SASDI (Alford, 2009). The SASDI components serve as the central pillar for establishing consistency and structure in the documentation of day-to-day spatial data application areas, as well as the development of network infrastructures to facilitate the exchange of spatial data. They include technical standards, access networks, policies, fundamental data sets and services, institutional arrangements, and people (Maphale and Moreri, 2018).

The SASDI is built on the concept of a hierarchical, interdisciplinary SDI encompassing the involvement of stakeholders from across all levels of government. According to Siebritz and Fourie (2015), such decentralised SDIs should, therefore, be transferred to the NSDI. This would ensure that organs of state are responsible for developing their own spatial data models in accordance with their organisational needs and in accordance with the appropriate spatial data standards. In general, the SASDI aims at managing and supplying geospatial data, encouraging geospatial data sharing and access, and avoiding duplication in data capture and collection. Table 19 lists the objectives of the SASDI.

Table 19: Objectives of the SASDI (SDI Act 2003, p4)

Objective (a)	Capturing spatial information through cooperation between public organisations;
Objective (b)	Promoting efficient spatial information management and maintenance;
Objective (c)	Promoting the use of spatial information and its sharing;
Objective (d)	Facilitate stakeholder coordination and cooperation;
Objective (e)	Eliminate duplication of data capture;
Objective (f)	Encourage widespread accessibility to spatial information; and
Objective (g)	Protect the state's copyright on activities related to spatial information.

A concerted aspect of managing and collecting spatial information is inspired mostly by its cost-effectiveness and because of the need to guarantee that information from multiple perspectives can be quickly and concretely integrated (Fourie, 2016a). The SASDI's functional achievement depends entirely on the partnerships of stakeholders, and the SASDI is the platform to enable sharing of the country's geospatial data. Numerous organisations, particularly government departments, have already made substantial improvements in collecting geospatial data.

However, at present, various SASDI role players need support and assistance with capacity building. This should improve their knowledge and understanding of the relevant national data access standards, guidelines, and policies. It will also ensure the development of the SDI necessary for promoting economic growth as well as social and environmental interests. Also essential for implementing an effective and efficient SASDI within South Africa, is legislation to regulate the exchange of geospatial data (Kay, 2018). The available literature suggests that successful implementation of an NSDI, such as the SASDI, will take many years.

4.5.3 SASDI Origin and Milestones

In South Africa, the need for an NSDI was initiated when governmental departments recognised their inability to produce and maintain high quality spatial data (Cooper, 2016). There was a need to integrate data from different organisations to improve resource management. In the mid-1980s, the *Coordinating Committee for the National Land Information System* (CCNLIS) shared government-wide experiences of digital geospatial data in South Africa (Cooper, 2006).The *National Programme for Remote Sensing* (NPRS) and CCNLIS were accountable for the South African *National Exchange Standard* (NES), published in 1987 (Clarke, 2011; Cooper, 1993).

CCNLIS also coordinated geospatial data related activities such as collection and sharing of aerial photography in government departments, with the aim of minimising duplication and to advance sharing of geospatial data at various scales (Cooper, 1993). CCNLIS became the underlying foundation that led to the creation of the national SDI in South Africa. Subsequently, the demands for a framework for effective governance and access to geospatial data were recognised and there was a further need for a government-wide unit with resources to take CCNLIS forward (Cooper, et al., 2014).

Several government departments' databases were fully integrated in 1997 and the directorate called the *National Spatial Information Framework* (NSIF) was established in the then *Department of Land Affairs.* The rationale behind the establishment of this directorate was "the creation of a technical and policy framework to allow unhindered access to, and the use of, spatial data for efficient and productive governance, planning and decision-making across all tiers of government" (Cooper et al., 2014, p.70).

The provisions of the SDI Act make it clear that all powers exercised and functions conducted under the Act must be exercised and performed in a way that does not infringe on copyright and gives substance to the values enshrined in the PAIA. In 2000, the PAIA was passed. It gives effect to this right and explicitly states appropriate initiatives to minimise the administrative and financial burden on the state (PAIA, 2000). With such an act in place, it was necessary to make sure that the right of access to information was rightfully aligned with geospatial information. Since then, apart from

passing the SDI Act into law in 2003, and the preparation of draft regulations to support the Act, SDI Act initiatives have slowed down (PAIA, 2000).

Figure 27: The milestones in the South African SDI (Sinvula et al., 2017)

Figure 27 illustrates the SASDI milestones achieved between the periods 1987 to 2019. From 2003 to 2016, there was very little further development to the SASDI, and a new approach was sought (Siebritz, 2014). Throughout that period, several national SDI activities continued to operate. For

example the publication of the South African metadata profile proceeded in 2005 (SANS, 2005), while the signing of a multi-government license for SPOT 5 imagery also occurred (Harvey et al., 2012), and the publication of the South African address standard was undertaken (SANS, 2008). The CSI was finally appointed in 2010 under the SDI Act and, in 2016, it was reappointed for the second period of a three year term. Since then, the CSI has identified and appointed the SASDI base data sets, base data set coordinators and custodians, and also finalised regulations in 2016.

The SASDI also conducted the first audit for base data custodianship within the *Department of Agriculture, Land Reform and Rural Development* (DALRRD), and developed the code of conduct for the CSI in 2017 (NSIF Newsletter, 2018). The establishment of the draft proposal to form the *South African Geospatial Information Management Strategy* (SAGIMS) was instigated through the CSI. The plan is now in the draft process and it is foreseen that geospatial data and information management will be outlined in line with the growth priorities of South Africa (Sinvula et al., 2017).

The creation of the *Marine Spatial Data Infrastructure* (MSDI) was integrated into the CSI work plan for the 2016-2019 period at the initial meeting of the second term of the CSI. The introduction of MSDI provides opportunities for a supportive environment in terms of the national government initiatives such as the implementation of the *Oceans and Coast Information Management System* (O&C IMS) and *Operation Phakisa* (Fourie, 2016b) in order to resolve the policy and operational specifications for data.

The establishment of the O&C IMS and the introduction of Operation Phakisa underlined the need for policy frameworks to create a supporting spatial data governance framework in order to enable such national initiatives. These projects, as described in the *National Development Plan* (NDP), would contribute to South Africa's national goals of economic growth and sustainable development.

At the global scale, the SASDI aims to react and contribute to the UN-GGIM's efforts through the *Africa Regional Committee* (UN-GGIM Africa, 2015). UN-GGIM Africa (2015) raised a fundamental point concerning the African region, namely that it seeks to increase the amount of information and knowledge tools and services built at all SDI levels, to enhance the accessibility and usage of geospatial development information in the African national SDI.

The UN-GGIM study focused on national geospatial information management by supporting legislative and policy-oriented approaches for the advancement of SDIs. A significant feature of UN-GGIM Africa is that South Africa has been integrated into the *National Geospatial Information* (NGI) Committee and is responsible for co-chairing with Ethiopia and Burkina Faso (Fourie, 2016b). The vision of the SASDI echoes the sentiments outlined in the NDP of supporting national outcomes.

The NDP aims to eradicate inequality and reduce disparities in South Africa by 2030. Providing easy access to current, high quality geospatial data are vital to satisfying the NDP objectives. The *National Planning Commission* (NPC) through the instruction by the President of South Africa was tasked to develop and implement the *NDP 2030* vision, in order to address the objectives of the NDP by utilising geospatial information. The following section deals with the SASDI components, with an emphasis on the inherent institutional, technical and policy frameworks.

4.6 SASDI Components

4.6.1 SASDI Institutional Framework

An institutional framework describes the coordination and cooperation of organisations involved in the establishment and maintenance of a national SDI (Ezigbalike et al., 2000). The SASDI institutional framework comprises the following bodies the Minister in charge of the DALRRD who provides executive leadership; the Director-General who administers the SDI Act and the SASDI; the CSI, the coordinating body of the SASDI; and NSIF, the secretariat of the CSI. The coordinating body is usually accountable for the drafting and execution of policies as well as the implementation of the SDI Act. An overview of the roles and responsibilities of the four SASDI coordinating bodies or institutions is given in this sub-section.

The 'institutional framework' is all about who' performs what and the allocation of 'governance' (Feeney et al., 2002). It is primarily through the institutional processes or the 'how of the institutional system that the advantages of cooperation have been illustrated. In South Africa, institutional frameworks play a critical role in providing the basic components for the SASDI institutional framework and resolving the various layers of the decision-making mechanism (Feeney et al., 2002).

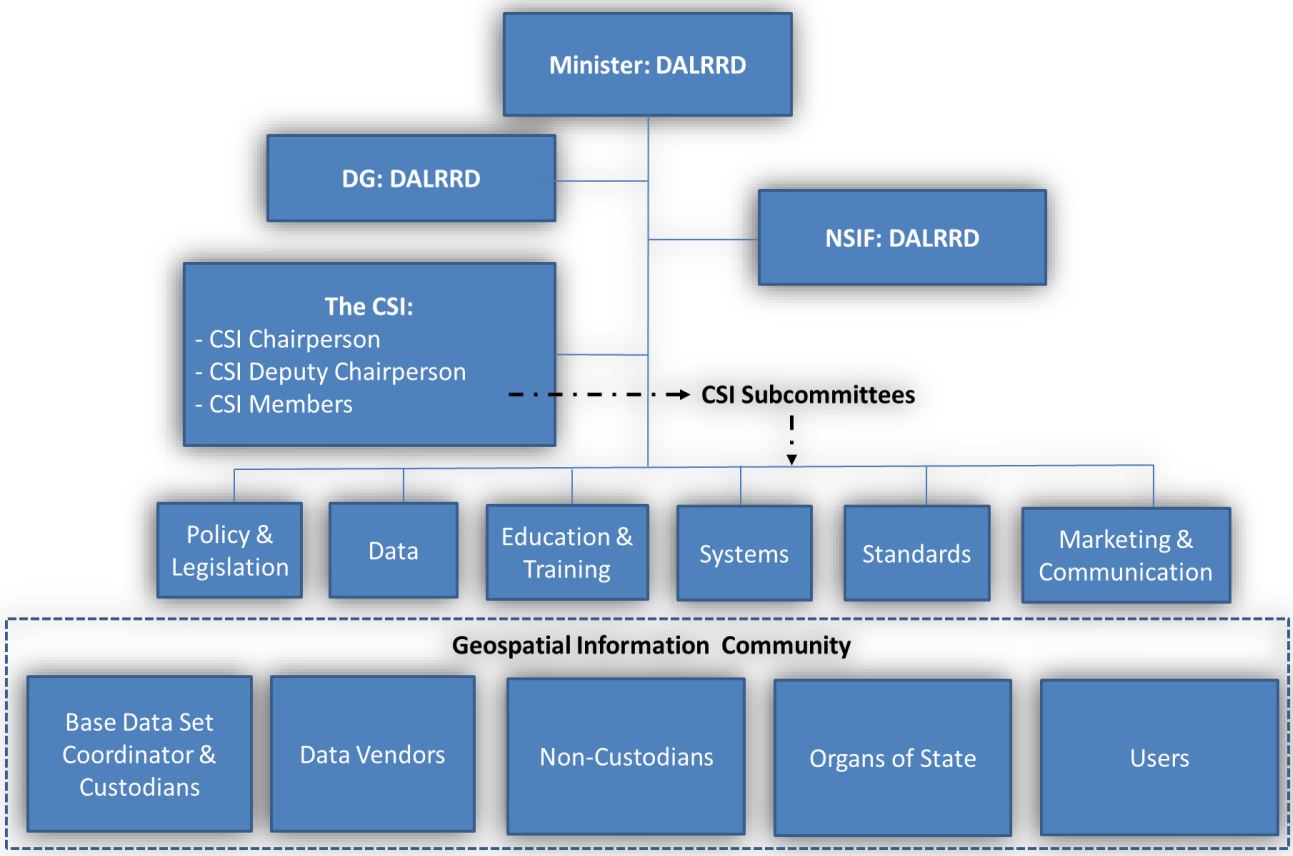


Figure 28: Overview of SASDI stakeholders (SASDI website, 2019)

Figure 28 provides an overview of the SASDI stakeholders. Acquisition and processing of geospatial data is typically carried out by a variety of organisations in South Africa across all levels (national, provincial and local governments). The institutional framework of SASDI is guided by the legislative and policies as well as administrative arrangements for the development, maintenance, access and implementation of standards and data sets. This is because institutional frameworks cannot be progressively viable without a clear geospatial information legislation and policies (Fourie, 2015a). The SASDI Institutional framework could be more effective if are supported and facilitated by the office of the presidency. A good SASDI framework represents effective governance and effective custodianship of public information in an ever-changing and dynamic global environment.

SASDI stakeholder may refer to any person, group, or organisation that is subject to the SDI Act, is involved in activities related to geospatial information, or has a legitimate interest in, or concern with, the CSI and SASDI. SASDI stakeholders include data custodians and non-custodians who are described as stakeholders not identified as a data custodian, for a specific data set. Organs of state, referred to as public bodies, are national, provincial, or municipal departments, constitutional institutions, public or state-owned entities, government, and business enterprises. Data vendors are spatial data distributors, agents, or service providers from the private sector, when performing a public function on behalf of a data custodian or organ of state. Geospatial data users refer to members of the public, spatial data users, and members of the geospatial community (Fourie, 2016a). According to the SDI Act the following are the main role players of the SASDI institutional framework:

4.6.1.1 Minister of DALRRD (Executive Leadership)

Executive Leadership gives credibility and promotes the required financial investment for the continuous of SASDI (SASDI Website, 2019). It also has a role to play in ensuring that parliament gives priority to the SASDI approach to the management of geospatial information. Based on the government's internal structure, the Minister of DALRRD is the minister responsible for the main development sector in which geospatial information, surveying and mapping, and remote sensing, are a service sector, or sub-sector of, for example, environment, mining, or defence. The ministry in charge of the SDI may be the office of the Prime Minister, or that of the President, and its role is to provide greater support at the policy level. In South Africa, according to the SDI Act, the minister of the DALRRD provides executive leadership and political support for the Act and to financially help the industry's unique action agendas (SDI Act, 2003).

The powers of the minister are described in section 4 of the SDI Act. To name a few, the minister may recommend standards and interventions relating to the exchange and integration of spatial information that will be published in the *Government Gazette*, decide spatial information costs, grant immunity from payment, create an electronic metadata catalogue, and decide remuneration for CSI members who are not government officials. It is also the Minister's duty to make regulations and has the right to bypass any CSI decision (SDI Act, 2003).

4.6.1.2 Director-General of DALRRD

The Director General (DG) of DALRRD (SDI Act 2003, section 3(3)) administers the SDI Act and the SASDI. In this research, the DG is referred to as the head of the national government in charge of its departments or agencies in general (SDI Act, 2003). The DG may be delegated all responsibilities of the CSI and SASDI by the minister. The Director-General helps maintain political interoperability in the sense of SASDI. Gómez et al. (2019) describes political interoperability as a form of collaboration

and cooperation across all organs of state and international level to identify regulatory structures and policies that ensure and promote the efficient and productive exchange of geospatial information and data.

The DG usually represents the executive leadership at the CSI meetings and receives advice from the CSI. Parliament is responsible for the SASDI statute, and DALRRD is responsible for the oversight and decision-making through the DG (SDI Act, 2003). The DG in control must ensure that the SASDI framework is comprehended and endorsed within the spheres of government and parliament (political advocacy), that the administrative requirements for its development and operation are met (administrative advocacy), and that the government provides the necessary financial resources and helps mobilise external resources (financial advocacy and provision).In general the DG offers strong political leadership that is needed to lead participatory approaches and reforms in accordance with the goal of deriving long-term benefits for good SASDI governance.

4.6.1.3 Committee for Spatial Information

The SDI Act (2003) mandates the CSI amongst other things, to advice the Minister, the DG, and other organs of state, on matters regarding the capture, management, integration, distribution, and utilisation of geospatial information. The CSI is a statutory body established in terms of section 5 of the SDI Act. The CSI reports to the minister of DALRRD and must hold at least four meetings a year. The primary purpose of the CSI is to coordinate the implementation of the SASDI and to represent the interest of the GI community in general. The committee can advise the Minister, or any other organ of state, on matters relating to geospatial information, as well as to appoint and monitor base data set coordinators and custodians (SDI Act, 2003).

In terms of SDI Act, (2003) the committee must encourage, foster and safeguard an atmosphere for efficient spatial information collection, management, dissemination, and usage. It must also track and acquire information on the functionality of the SASDI, and support the functioning of any structure or measure established under the SDI Act. The committee will print, distribute, sell, fund and administer any material related to spatial information that is written. It must, within three months of the end of each financial year, submit a report to the Minister specifying the activities of the CSI and its sub-committees and any recommendations made by the Committee to enhance its functioning or the activities of the SASDI. According to the Act (SDI Act, 2003, section 5), the CSI consists of the following members appointed by the minister:

a. One person to represent the Minister.
b. Two people from DALRRD.
c. One person from each government department.
d. One person from each provincial government.
e. Two people (one from an urban municipality and one from a rural municipality).
f. One person from the GITO Council.
g. One person who teaches GIS.
h. One person who represents the professional bodies.
i. Between 1 - 4 persons from state agencies.
j. Each base data set custodian.

The Minister of the Department of Agriculture, Land Reform and Rural Development (DALRRD) usually invites interested parties to nominate suitable eligible persons who are prepared to serve as members of the CSI under the SDI Act, in compliance with the provisions of section 5(3) of the SDI Act (2003) for service at CSI. Nominated individuals are not to be excluded under section 8 of the SDI Act (2003). All nominated persons are required to declare compliance with the criteria laid down in *SDI Regulations* 11(b) (2017). The Minister will take affirmative action steps as referred to in section 15(1) of the *Employment Equity Act* , 1998 (Act No.55 of 1998), including requirements found in the *SDI Regulations* (2017), into consideration when nominating the committee members.

The appointed members of the CSI are expected to guide strategically the development and implementation of the SASDI and resolve spatial information issues, while ensuring that the maximum gain is obtained from government investments in geospatial information (SDI Act, 2003). For a duration of 3 years from the date of appointment, which shall be published in the Government Gazette, the designated members of the committee shall remain in office. The chairperson and vice-chairperson of the CSI are key players and their responsibilities include:

1. to ensure that the CSI meets the requirements of the SDI Act and its regulations;
2. secure funding for the CSI, its activities, and the SASDI;
3. assist data custodians with securing funding (for example lobbying the relevant ministers through the departmental channels); and
4. liaising with key stakeholders, and promoting the CSI and the SASDI.

The original CSI laid a solid foundation in terms of defining the policy framework and institutional arrangement (Chauke, 2018). The first meeting of the CSI was held on June 2010, however, poor attendance by some of the members resulted in the meeting not forming a quorum and almost paralysed in decision-making powers. Nevertheless, the CSI continued to make noticeable strides towards the implementation of its duties. The CSI has established its own project schedule and has set up six subcommittees on policy and legislation, data, standards, systems, education and training, and communications and marketing.

The *Policy and Legislation* subcommittee, as mandated by the SDI Act, is delegated the duties which includes to facilitate the implementation of the Act, and to draft and review legislation, policies and guidelines adopted in order to promote the effective and efficient implementation of the SASDI. This subcommittee's vision is to improve the quality of life for all South Africans through executing its duties in managing the spatial information required to promote economic development whilst protecting the natural environment (SASDI website, 2019).

The *Education and Training* subcommittee is mandated with the responsibility of determining the educational and training needs of the various stakeholders to achieve the objectives of SASDI. Additionally, it has to develop an overall framework to address training needs and to promote research in the field of SDI. "The subcommittee aims to facilitate the institutionalisation of the SASDI by developing practical means whereby institutions can implement the SASDI policies and technical systems enabling them to comply with the requirements of the legal framework" (SASDI website, 2019).

The *Systems* subcommittee is mandated to develop and implement systems to improve access to, and availability of, relevant spatial information. This subcommittee's vision is to develop the SASDI website, CSI portal, EMC, and DCPR and to ensure an integrated systems environment that caters for the requirement of users, custodians, and central operations in support of CSI and SASDI (SASDI

website, 2019). Ultimately, this subcommittee aims to ensure an integrated spatial data environment along the lines of *Clearinghouse* in the US and *INSPIRE* in Europe.

The mandate of the *Standards* subcommittee is to develop, promote, and implement geospatial data set standards to ensure the interoperability of systems. To achieve this, the subcommittee has to identify the standards that are needed for the SASDI to succeed, for instance in terms of data integrity, attribute information, ontologies, data models, unique identifiers, software interfaces, online services, network services, encoding and portrayal. Additionally, the subcommittee has to ensure an integrated systems environment that caters for requirements of users, custodians, and central operations in support of the CSI and SASDI. This should ensure encapsulation of metadata requirements in an integrated manner (SASDI website, 2019).

In line with section 6 of the SDI Act, the *Marketing and Communications subcommittee* was created to publicise and build awareness of CSI initiatives and the importance of geospatial information for effective governance, planning and decision making. The subcommittee's vision for the SASDI is that "South African geo-referenced data, products and services are made available and are accessible to all users" (SASDI website, 2019).

The *Data subcommittee* was created to work out and perform data-related tasks in order to carry out the CSI's data functions. The Data Subcommittee's vision is to discuss the accessibility and usability of well-maintained spatial data sets that will help and improve South Africa's growth planning, sustainable land use management, service delivery, and the quality of life of its citizens.

The *data* subcommittee was established to execute duties such as "to identify the criteria for core spatial data sets and base data set custodians and coordinators; to identify and appoint base data sets custodians; to manage and maintain the data capture project register; to identify spatial data gaps; to assist with data deficiency process mapping if required; and to compile a report for the criteria to identify base data sets, base data set coordinators, and base data set custodians specific to the coastal and marine sphere" (SASDI website, 2019).

Collaboration with related sub-committees to facilitate the implementation of standards and policies for data collection, distribution, and management (data classifications, data models, data structures, feature types, feature attribute types, unique identifiers, and so on), as well as for spatial data reliability. Increasing data custodian interaction by consolidating and making available a schedule of activities for each base data set. The schedule shows who is doing what and why, including facilitation of activity integration, preparations, budgets, and facilitation of joint meetings (SASDI website, 2019).

The data subcommittee, in collaboration with the *Development Bank of Southern Africa* (DBSA), saw the significance of conducting a study to identify the initial set of 10 base data sets' themes and their custodians in order to take the development of the SASDI forward (Schwabe and Govender, 2012). The research was carried out in three stages: literature review, interview, and stakeholder involvement. Before the study report was finalised, four consultation sessions were held in four provinces to obtain feedback and comments from the user community. Future research by the data subcommittee may adjust the criteria and identification of base geospatial data sets and data custodians. Table 20, on the following page, lists the CSI subcommittees' mandates and activities.

Table 20: The six CSI subcommittees' mandate and activities (SASDI website, 2019)

Subcommittees	Mandate			Activities
	SDI ACT	SASDI Regulations	SASDI Policies	
Policy and Legislation	*Section 3:*	*Regulation 18:* The CSI may prepare policies, manuals and guidelines	• *Section 7.4* of the Pricing Policy, and • *Section 7.5* of the Base Data Set Custodianship Policy	• Develop /draft SASDI Legislation, policies, and compliance guidelines. • Systematic monitoring and review of the effectiveness of Legislation, regulations policies and guidelines. • Draft the South African Geospatial Information Management Strategy (SAGIMS).
Data	*Section 6(2)*	*Regulations 5, 6,7 ,8, 9, and 10* are all applicable to this subcommittee	Base Data Set Custodianship Policy: • *Section 6* • *Section 7* • *Section 8*	• Draft a criterion for base data sets for the SASDI Coastal and Marine. • Monitor base data set coordinator governance, shared custodianship and base data set governance agreements • Define processes and procedures to implement shared custodianship for base data sets. • Develop and implement a metadata audit report mechanism and spatial Data Gap Analysis report- Form F
Education and Training	Section 3	*Regulation 2 and 4:* Capacitating Custodians on the capturing and publishing of metadata	• *Section 6.3.1 (q):* of the Base Data Set Custodianship Policy	• Advanced metadata course design. • Training on advanced metadata course and prepare research agenda (document) and development of custom-made educational material
System	*Section 3*	*Regulations 2, 3, 4,5,8, and 9*	• *Section 6.3.1 (q):* of the Base Data set Custodianship Policy	• Deploy SASDI EMC (on SAEON). • Deploy SASDI Website • Develop a Standards Portal • Deploy DCPR and enhance current capabilities, including online (Forms D, E1&2, F)
Standards	*Section 11*	*Regulations 2, 3, 4,5,8, and 9*	• *Section 6.3.1 (q):* of the Base Data set Custodianship Policy	• Standards site license and procurement of standards: metadata standards, Part 1 (SANS 1878-1, ISO 19115-1 & ISO 19115-3) • Identify and gazette standards
Communication and Marketing	*Section 6 (2) (e)*	*Regulations 17:* Records of proceedings of the CSI	• *Section 6.1.2 (a):* of the Base Data set Custodianship Policy	• Develop and implement Marketing and Communication Strategy • Prepare CSI Branding Guideline including templates

For the purposes of Section 10 of the SDI Act of 2003, the CSI subcommittee refers to subcommittees such as the data subcommittee formed by the CSI. The SASDI CSI subcommittees are composed of members of government organisations and SASDI recognised stakeholder communities who share similar values in multiple kinds of geospatial data. The members of the CSI range from GISc technical experts to GISc managers and are named by their organisations to serve their interests in the CSI. The CSI approved the following base data sets namely the administrative boundaries, imagery, roads, social statistics, land use, land cover, hydrology, cadastral data, geodesy, and conservation areas. Table 19 lists the appointed and pending appointments of base data set custodians and coordinators, as well as their respective base data set themes, according to the decisions made by the CSI and its supporting subcommittees (CSI, 2020).

Table 21: List of appointed base data set custodians and coordinators (CSI, 2020)

No.	Theme	Coordinator	Data sets	Custodians	Data Access Link / Contact Person
1.	**Administrative Boundaries**				
1.1.	**Administrative boundaries 1**	Department of Agriculture, Land Reform and Rural Development (DALRRD)	High Water Marks	*Not yet finalised*	
			Low Water Marks	*Not yet finalised*	
			National and International Boundaries	*Not yet finalised*	
			Provincial Boundaries	*Not yet finalised*	
1.2.	**Administrative boundaries 2**	South African Municipal Demarcation Board (MDB)	Wards	MDB	http://dataportal-mdb-sa.opendata.arcgis.com
			Local Municipalities	MDB	http://dataportal-mdb-sa.opendata.arcgis.com
			District Municipalities	MDB	http://dataportal-mdb-sa.opendata.arcgis.com
			Magisterial Districts	Department of Justice and Constitutional Development	https://www.justice.gov.za/maps/maps.html
			Traditional Council Areas	Department of Traditional Affairs	Email: wilsonm@cogta.gov.za
2.	**Imagery**				
2.1.	**Aerial Imagery**	DALRRD	0.25m to 5m GSD aerial imagery	Chief Directorate: National Geospatial Information (NGI)	Sales@drdlr.gov.za http://cdngiportal.co.za/cdngiportal/
2.2.	**Satellite Imagery**	South African National Space Agency (SANSA)	Satellite Imagery	*Not yet finalised*	Email: customers-eo@sansa.org.za http://catalougue.sa.sa.org.za
3.	**Cadastral data**	DALRRD	Land Parcels	Provincial Offices of the Surveyor-Generals	http://csg.dla.gov.za/
			Ownership records	Provincial Offices of the Registrars of Deeds	http://www.deeds.gov.za/ITSODeedsWebB/deedsweb/welcome.jsp
4.	**Conservation**	Department of Environmental Affairs, Fisheries and Forestry	Conservation Areas	*Not yet finalised*	https://egis.environment.gov.za/
		Department of Environmental Affairs, Fisheries and Forestry	Protected Areas	*Not yet finalised*	
5.	**Geodesy**	DALRRD	Trigonometrical Stations	Chief Directorate: Information	Sales@drdlr.gov.za http://cdngiportal.co.za/cdngiportal/
			Town Survey Mark		
			Trigonometrical Beacon		
			TSM Scheme		

			TrigNet		
			Benchmark		
6.	**Hydrology**				
6.1.	**Hydrology**	Department of Human Settlements, Water and Sanitation (DHSWS)	Drainage Regions	DHSWS	http://www.dwa.gov.za/iwqs/gis_data/
			Rivers	DHSWS and CD: NGI	http://www.dwa.gov.za/iwqs/gis_data/
			Water Management Areas	DHSWS	http://www.dwa.gov.za/iwqs/gis_data/
6.2.	**Wetlands**	SANBI	Wetlands		http://bgis.sanbi.org
7.	**Land Cover**	DALRRD	South Africa National Land Cover	Department of Environmental Affairs, Forestry and Fisheries	https://egis.environment.gov.za/
8.	**Land Use**	DALRRD	*Not yet finalised*		

In reference to Table 21:

1. Theme 1 is *Administrative Boundaries*. This theme has been divided into two sub-themes: *Administrative Boundary 1* (registration divisions, international, national, provincial, and maritime) and *Administrative Boundary 2* (municipal, magisterial, and voting). The appointed base data set coordinator for *Administrative Boundary 1* is the DALRRD, while the custodians are not yet finalised. The South African MDB was appointed base data set coordinator for *Administrative Boundary 2* and was also appointed as base data set custodians.
2. Theme 2 is *Imagery*. The theme comprises of aerial imagery (0.25m to 5m GSD aerial imagery) and satellite imagery. DALRRD: NGI was appointed base data set coordinator and custodian for aerial imagery. While SANSA was appointed base data set coordinator for satellite imagery, the appointment of satellite imagery custodians has not yet been finalised.
3. Theme 3 is *Cadastral data* which comprises the following cadastral data sets: land parcels and ownership records (see section 3.5.1). The DALRRD's *Chief Surveyor General* (CSG) was appointed base data set coordinator for cadastre. The *Provincial Offices of the Surveyor-General* and the *Provincial Offices of the Registrars of Deeds* were appointed base data set custodians for the land parcels and ownership records, respectively.
4. Theme 4 is *Conservation* and consists of conservation areas and protected areas.
5. Theme 5 is *Geodesy* which comprises of the following data sets: trigonometrical stations, town survey mark, trigonometrical beacon, TSM scheme, TrigNet and benchmark.
6. Theme 6 is *Hydrology* which is divided into hydrology and wetlands. They consist of the following data sets: drainage regions, rivers, water management areas, and wetlands.
7. Themes 7 is *Land cover*, and as data sets it is referred to as the South Africa national land cover.

4.6.1.4 National Spatial Information Framework

The *National Spatial Information Framework* (NSIF) directorate is established within the branch of the *National Geomatics Management Services* (NGMS) under the DALRRD. The NSIF supports the advancement and implementation of the SASDI. The core clients of the NSIF are organs of the state (all three spheres of Government) including users of spatial information. Emphasis has been placed on the establishment of national policies and regulations under which SDI operations are to be implemented (Smit et al., 2009). This top-down approach is an integral part of higher government levels because they are responsible for creating and maintaining the legislative framework within which lower government levels function. The NSIF is primarily involved in every aspect of establishing policies and regulations to promote the good governance of the country's SDI operations. It is also concerned with the first and second stages of national SDI creation that are mainly metadata and process oriented. At this level of government, SDI initiatives are limited to a top-down policy setting approach and to some degree of adherence through compliance guidelines (SASDI website, 2019).

The NSIF core functions are to assist in the facilitation of the administration and implementation of the provisions of the SDI Act. Other functions include, amongst others, facilitating policy, regulations, and standards development for SASDI; ensuring and supporting compliance with the SDI Act by the geo-spatial information community; providing technical platforms for SASDI and geo-spatial information integration services, and the provision of secretarial and administrative support for the CSI. The NSIF is also tasked with the duty to establish, maintain, and provide a national spatial data infrastructure. The NSIF has succeeded in guiding the enactment of the SDI Act. SASDI was introduced and promoted by the NSIF through the establishment of a legal framework for collaboration, sharing, management and dissemination of geospatial data among stakeholders and the creation of SASDI technical tools. The SDI reached early development, however, the operation and activities of the NSIF dropped significantly and the SASDI faded (Thabethe, 2008; Smit et al., 2009).

4.6.2 Technical Framework

The technological foundation for an SDI allows access and exchange of geospatial resources to become interoperable (Nebert, 2004). A growing amount of information is deemed vital for day-to-day decision making in contemporary society and a significant portion of this information is generally attributed to "location" in the sense of the earth's position. As more online information encompasses some geographical meaning, it has also become increasingly difficult to identify, coordinate, and access it. Furthermore, the capacity to discover and access geospatial data resources for use in visualisation, planning, and supporting decision making, is a requirement to support local, regional , national, and international societies.

The SASDI technical framework comprises four SASDI technical tools, namely the SASDI Website, the CSI portal, the DCPR, and the EMC (SASDI website, 2019). Noticeably, the authoritative sources of primary geospatial data sets, or data custodians, have the capacity and ability to exchange or provide users with their geospatial data. Data custodians in South Africa play an important role in the efficient usage of geospatial data and in how geospatial data can be utilised to make informed choices for better public sector governance (Kay, 2018). The technical framework is discussed in detail as follows.

4.6.2.1 SASDI Website

The main goal of the SASDI website is to promote the, usability, availability and accessibility of geospatial information through the use and sharing of geospatial information. The SASDI website is also envisaged to provide an environment that allows for co-ordination and co-operation amongst all stakeholders regarding online access to spatial information. The website was developed by the *Office of the Chief Information Officer* (OCIO) and is intended to integrate all the technical tools, namely the DCPR, CSI portal, and SASDI, into one document repository as well as the standard portal, which makes provision for ISO, SANS, FDGC, and others.

The preliminary phases of the website development have been implemented. The website is now in production and can be accessed on www.sasdi.gov.sa (Chauke, 2018). These websites' fundamental goal is to serve as a comprehensive catalogue service with provisions for access to spatial data and to browse graphics. In addition, programmes allow individual organisations, consortia, and geographically established communities to join together and promote their online digital spatial data. SASDI improves the exploration and accessibility of spatial data by providing a central access point for data set information publishing and discovering, using standard data descriptions (SASDI website, 2019).

4.6.2.2 SASDI Electronic Metadata Catalogue

The DALRRD, through the NSIF Directorate, has an agreement with the *National Research Foundation* (NRF) to devise an SASDI metadata portal as an electronic metadata catalogue (EMC) within the *South African Environmental Observation Network* (SAEON) system. This is referred to as the SASDI EMC, or in short, the EMC (SASDI website, 2019). Base data set custodians (BDSCs) are required to capture and maintain metadata of their data holdings for publishing on this system (Hugo, 2015a). The SASDI EMC portal offers the facility for BDSCs to capture and publish metadata in a secure environment. The portal also enables spatial data users to search and discover spatial data availability, by providing access to all metadata published on the system, and including metadata contributed via the SASDI portal as well as other contributing SAEON nodes.

BDSCs can also host their data sets in their infrastructure, or other infrastructure of choice, and provide details of access to such data sets in the metadata published in the EMC. Details of access could be a URL to a site for downloading or viewing the data set or contact details for acquiring the data set. Access to the data must be aligned to the license conditions which must be adhered to. Where a BDSC does not have the infrastructure to store or archive their data sets, they may apply to SAEON to archive their data set(s) with the SAEON data portal. SAEON may agree to archive such data provided they sign a data provider agreement. Such an agreement falls outside the scope of the SASDI EMC (Hugo, 2015b).

Section 12 of the SDI Act stipulates that BDSCs have to capture and maintain metadata for just about any spatial information they possess. Further, BDSCs must make their metadata available for inclusion in the electronic metadata catalogue of the relevant department in the prescribed manner. The “prescribed manner” referred to in section 5 of the SDI Act is applied through the implementation of the SASDI EMC. The onus is on data custodians to ensure that they capture and maintain their metadata on the SASDI EMC. All metadata is publicly accessible, to allow potential users to locate data sets of interest to them.

This portal, and any action emanating from the use of this portal, is subject to the provisions of the legislative and regulatory framework. To ensure that the EMC serves both spatial data producers and users optimally, two levels of governance have been established the *Project Steering Committee* (PSC) for oversight and strategic management, and the *Technical Liaison Committee* (TLC) for technical coordination.

The PSC comprises representatives from the NSIF, the SAEON, the OCIO, the CSI and two custodian organisations to represent the user community. The TLC has a similar composition but includes three custodian representatives. The committees are instituted for the period corresponding to the agreement between DALRRD and the NRF. The TLC provide priorities for implementation, and assists with URS verification, acceptance testing, and sign-off. The TLC also provides feedback to the PSC on the progress (Chauke, 2018).

4.6.2.3 Data Capture Project Register

Section 12(3) of the *SDI Regulations* (2016) of the SDI Act calls for the publication of project specifications for the purpose of collecting or capturing geospatial data on the *Data Capture Project Register* (DCPR) and for the CSI to be informed of such specifications. The CSI aims to investigate and make recommendations on whether the intended capture of data constitutes overlap or duplication of capture and whether collaboration with the public body may be possible to streamline the capture or collection of data (Motswenyane, 2016). The *SDI Regulations* establishes the DCPR as a tool to register all spatial data capture or collection projects before being undertaken.

As stated in section 3(e) of the SDI Act, a DCPR is developed as one of the SASDI technical tools and incorporated into the SASDI website. The DCPR facilitates the registration of projects intended to collect spatial data. The purpose of the DCPR is to ensure efficient South African spatial data collection by allowing anyone to register the intention to capture spatial data; optimising the process and costs of gathering spatial data, by coordinating the efforts, and ensuring that knowledge of the existence of custodians' spatial data repositories is shared widely; to attain the reduction in duplication of collection and capture efforts for South African spatial data, and provide easy online spatial data project registration (SDI regulations, 2016).

The DCPR is a benefit for the spatial data collectors, capturers, and users, and provides a platform to register projects intending to collect data (Fourie, 2015a; Motswenyane, 2016). The DCPR applicable to both custodians and non-custodians deals only with the EMC metadata that is based on existing data sets. It does not apply to already existing tangible products, but to planned activities. Once captured, preparatory metadata for the intended product can be easily imported into the metadata platform (Motswenyane, 2016). The DCPR's, therefore, deal with the preliminary metadata phase of the broader planning and metadata catalogue development. The proposed regulations already make provision for the following DCPR forms:

a. Form E1: Request approval from CSI to capture spatial data.
b. Form E2: Inform CSI of the intention to capture spatial data.
c. Form D: Report regarding an error or perceived deficiency in the quality of spatial information.
d. Form F: Submission of spatial data requirements.

4.6.3 Policy Framework

The required legislative structure and strategies for the establishment of SASDI have been formulated in South Africa. The South African legislation governing the exchange of geospatial data is also key to the execution of efficient and productive SASDI (Kay, 2018). The policy framework is an agreement that outlines a set of rules and regulations or objectives that could be used in the negotiation or decision-making process to support a more comprehensive set of principles, or to guide the constant maintenance of the policies of the organisation. As stated previously, all sections of the SDI Act were promulgated in May 2015. Under the guidance of the CSI, the SASDI delivered the *base data set custodianship policy* and the *pricing policy for spatial information products and services.*

These were published in the form of a notice in the government *Gazette* of February 2015. The gazetted policies focus on providing management processes and procedures that are needed to incorporate standardised and well-maintained data into SASDI reforms. The SDI Act Regulations (2016), have been published for comment and finalised and gazetted, while the SASDI compliance guidelines document is still in the drafting phase (Kay, 2018). The SASDI policy framework plays a role in shaping the roles and responsibilities of the BDSCs and to resolve the diverse creation of spatial data across different levels of government and organisations. Figure 29 illustrates the SASDI policy framework as outlined by Fourie (2018).

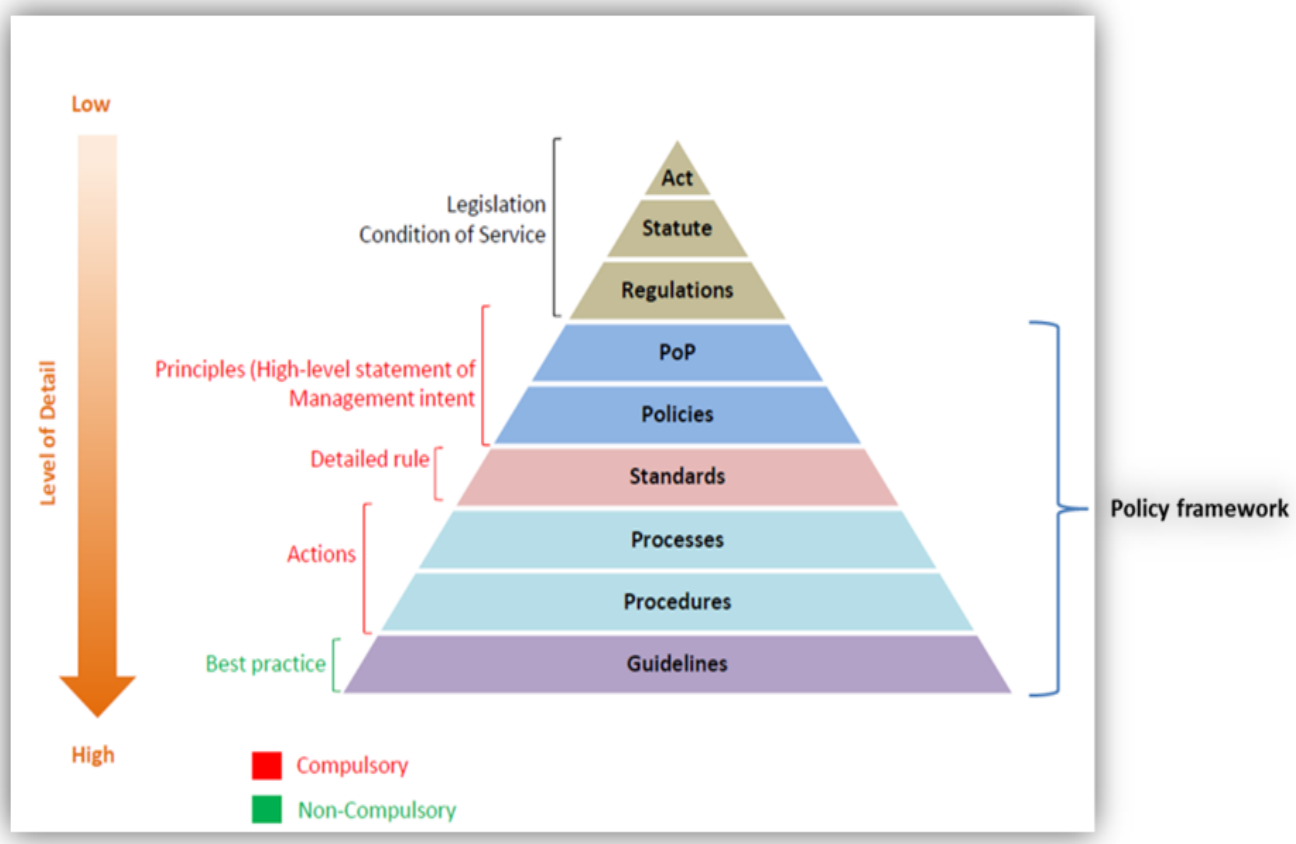


Figure 29: SASDI policy framework (Fourie, 2018)

4.6.3.1 The Base Data Set Custodianship Policy

The *Base Data Set Custodianship Policy (2015)* was published for implementation in 2015. It applies to organs of state and data vendors to the state, also referred to as non-custodians. The main objective of the *Base Data Set Custodianship Policy* is to demonstrate the criteria for identifying and appointing Base Data Set Custodians (BDSCs) in order to encourage the sharing of data, and to foster collaborative partnerships between BDSCs and other entities or organisations.

The policy also ensures access to, and availability of, the relevant base data sets, describes the rights of BDSCs in terms of the *SDI Act* and other relevant legislation and policies, and defines the responsibilities of the data user with respect to the BDSC (Base Data Set Custodianship Policy, 2015). Section 6.1.7 of the *Base Data Set Custodianship Policy* provides data quality requirements for BDSCs. The following points define the quality requirements:

a. "For the reason for which it was captured, the BDSC would ensure that the base data set is correct and up-to-date regarding the determined user needs. If there are possible errors, the extent of possibility of its correctness must be made available.
b. The BDSC can make sure that there is no ambiguity in the base data set or spatial information.
c. The BDSC will guarantee that the accuracy and resolution of its base data sets and other geospatial data satisfies the requirements of its target audience.
d. BDSCs with particular base data sets may confirm that updates to the base data set are sent to the custodians of the derived data sets.
e. The BDSCs of the derived data sets must guarantee that their data sets are derived from the most current base data sets."

The *Base Data Set Custodianship Policy* provides the rights, roles, and responsibilities of all organisations concomitant with the base data set value chain. The policy frames the responsibility of a custodian, data vendor, and the data users. This approach educates the users to entrust the base data sets into their daily operational undertakings, but also provides for a feedback mechanism to custodians.

4.6.3.2 Policy Pricing of Spatial Information Products and Services

The objective of the *Policy on the Pricing of Spatial Information Products and Services* of 2015, is to make sure that informed decisions are taken on the pricing of spatial information in the public sector and that the implementation of the pricing policy is consistent. If properly implemented, this policy will result in sustained, fully compliant, and interoperable data sets (Fourie, 2015a). The failure to compensate must not be seen as an obstacle to the denial of access to public services by a user or a group of users.

The policy must guarantee effective and universal access. It comprises of all geospatial information offered by organs of state and encompasses any data custodians of spatial information and other government organisations offering goods and services for spatial information, either as primary or secondary data vendors. This policy "conforms with geospatial information products and services which are typically accessible to the organisation and which are also referred to as value-added products and services by the organisation to the client for special needs" (*Policy for Pricing of Spatial Information Products and Services,* 2015, p. 2)

The objectives of the *Policy for Pricing of Spatial Information Products and Services* (2015, p. 2), are to "promote openness in the public sector by eliminating the costing of information as an obstacle; enable availability to spatial information products and services on the basis of cost effectiveness; promote continuity in the government sector in the pricing of spatial information products and services; promote the *Batho Pele* concept of offering value for money to user groups; and promote economic growth".

4.7 SASDI Custodianship

4.7.1 Data Custodianship

According to the SDI Act (2003, p.3), "a data custodian refers to a state organisation or independent contractor or entity involved in the exercising of public authority or the operation of a public function that collects, controls, manages, integrates, distributes or uses geospatial information". Custodianship is not necessarily synonymous with the ownership of the data or the copyright of the data. The public function is often a legislative authority. Even so, this description is very substantial and can be adapted to any organisation that captures spatial information. This definition is contentious and does not differentiate between base data sets derived from other data.

An organ of state designated as the custodian of a particular data set is considered the authoritative source for that data set. This means that the custodian of the base data set is the designated body or individual responsible for the creation or management of that data set and shall have the right to determine the conditions under which such data may be used or disclosed (SASDI, 2019). The SDI Act (2003, p.3) defines a base data set as "the spatial information themes that a data custodian has captured or collected".

Data custodians do not need the permission of the CSI to capture spatial data that falls under their custodianship, by justifying their authority, but must inform the CSI of their intention to capture such geospatial data. This requirement has been implemented to enable the CSI to record and provide access to preliminary metadata for data sets intended for capture, as well as to monitor the progress of data capture projects and compliance with SASDI objectives (Base Data Set Custodianship Policy, 2015).

For the purpose of implementing SASDI, any stakeholder not identified by the CSI, as the custodian of the base data set for the specified base data sets, or as the custodian of any other spatial data set, shall be considered as a non-custodian. In addition, any data custodian attempting to collect any collection of spatial data that does not fall within the limits of their custodianship shall be treated as a non-custodian for such set of data. It is mandatory for non-custodians wishing to capture spatial data to seek the permission of the CSI to capture such spatial data.

This requirement has been introduced to allow the CSI to decide the reason for and, where appropriate, to authorise the intended non-custodial data capture. This will also allow the CSI to provide guidance to applicants on the objectives of SASDI, to record and track the progress of applications and/or appeals, to provide access to preliminary metadata for data sets intended for capture, and to monitor the progress of approved data capture projects (SASDI, 2019).

The BDSCs are identified by the CSI in terms of data custodian appointment criteria. During the 2011-2012 financial year, the CSI data subcommittee, authorised research and stakeholder surveys to be carried out to determine the criteria for the identification of South Africa's base spatial data sets and responsible custodians (Schwabe and Govender, 2012). On 1 October 2012, the results were workshopped, consolidated, and presented at a CSI meeting. Table 22, on the following page lists the SASDI custodianship recommendations that were adopted.

Table 22: SASDI custodianship recommendations (Schwabe and Govender, 2012)

SASDI Custodianship Recommendations Adopted	
Recommendations	**Description**
Recommendation 3	Criteria for identifying base data set custodians: - Mandated responsibility (compulsory). - Enough capacity, resources, and infrastructure to be custodian (conditional). - Requested by the CSI (compulsory).

The Constitution of South Africa (1996) sets out the fundamental values and principles of cooperative government and intergovernmental relations that embraces coordination, collaboration and cooperation between state institutions. The CSI adopted the base data set coordinator and the custodian governance model in pursuit of improving optimal cooperation between base data set coordinators and custodians. The model describes the different functions of coordinators and custodians in setting up and maintaining the base data set.

The predominant hierarchical institutional structures of political and bureaucratic components of governance are an important factor affecting the architecture of the SASDI custodian reference model, as SASDI is driven by the state, which still control the majority of geospatial information resources and remains the key SDI engine. This is certainly relevant when one acknowledges the well-defined geographical reach of jurisdictions and the related extent of the priorities and obligations of government institutions residing within these jurisdictions for geospatial information. Thus, it can be inferred from the above that SASDI custodianship relationships are hierarchical arrangements (SASDI, 2019).

SASDI custodian reference is undertaken “to capture and state requirements and domain information so that stakeholders may understand and agree on them” to support the design of a large complex system. Once an organ of state has decided to take responsibility for the custodianship of a specific base data set, the department or organization would be liable and accountable for the custodianship.

The different custodianship roles and responsibilities within the organ of state would also need to be clearly identified and defined, and then officially assigned to the most suitable unit or functional entity. The custodian reference model is applicable to the management of all geospatial data sets whether they are base or non-base data sets (SASDI, 2019).

Collaboration through partnership and teamwork is fortified without stirring the coordinator into a superior role or undermining the role of the contributing custodians, thus base data set governance is at the heart of the base data set custodianship and custodian governance model. As the CSI is determined to ensure complete implementation of this model, more work still need to be done to address challenges (Fourie, 2016b). Figure 30 provides a high-level overview of the approved base data set custodianship model approved by the CSI.

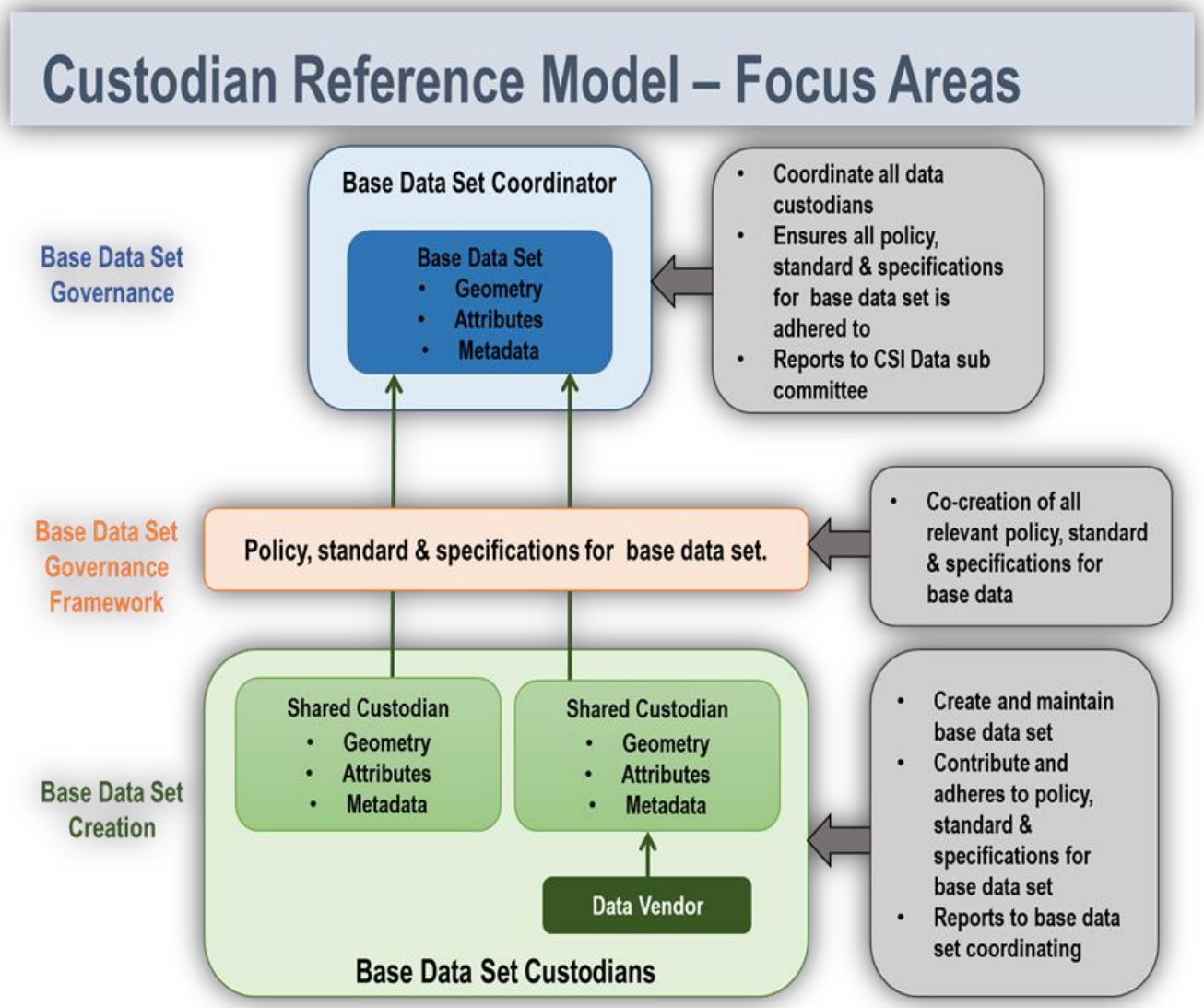


Figure 30: BDSC and the Custodian Governance Model (Fourie 2018)

The concept of coordination and collaboration through agreements between contributions from the relevant custodians is presented as a sustainable model for data management. The significance of institutionalising data governance was endorsed by custodians accordingly as stated by Fourie (2016b). According to Coetzee et al. (2019, p. 5), "The concept of collaborative custodianship and co-ordination of custodianship will be the only approach to deliver a well-managed data set to all the users.

4.7.2 Shared Base Data Set Custodianship

The concept of dual or shared custodianship is defined by the custodianship policy as circumstances in which more than one organisation is appointed as a custodian of a single base data set (Base Data Set Custodianship Policy, 2015). For instance, an individual organisation or agency, or even a functional unit, may be the designated custodian for the geospatial data and another designated for the attribute data function.

According to du Preez (2019) it is possible to have over one organ of state as a data custodian for the same spatial entity or feature, where applicable. In these cases, all data custodians will agree to the policies, requirements and specifications for the base data set and adhere to them. The categories of collaboration for base data set custodianship are as follows:

a. In terms of spatial and attribute data sets collaboration. The *Base Data Set Custodianship Policy* (2015) states that circumstances in which an organisation or type of custodian is referred to as the *base spatial data custodian,* means that they are responsible for the spatial component (geometry) under their authority, and another organisation, called the *base attribute data custodian*, is the custodian of the attributes information. Each data custodian is accountable for their component in the same data set. Figure 31 illustrates the SASDI spatial and attribute data collaboration concept as depicted by du Preez (2019).

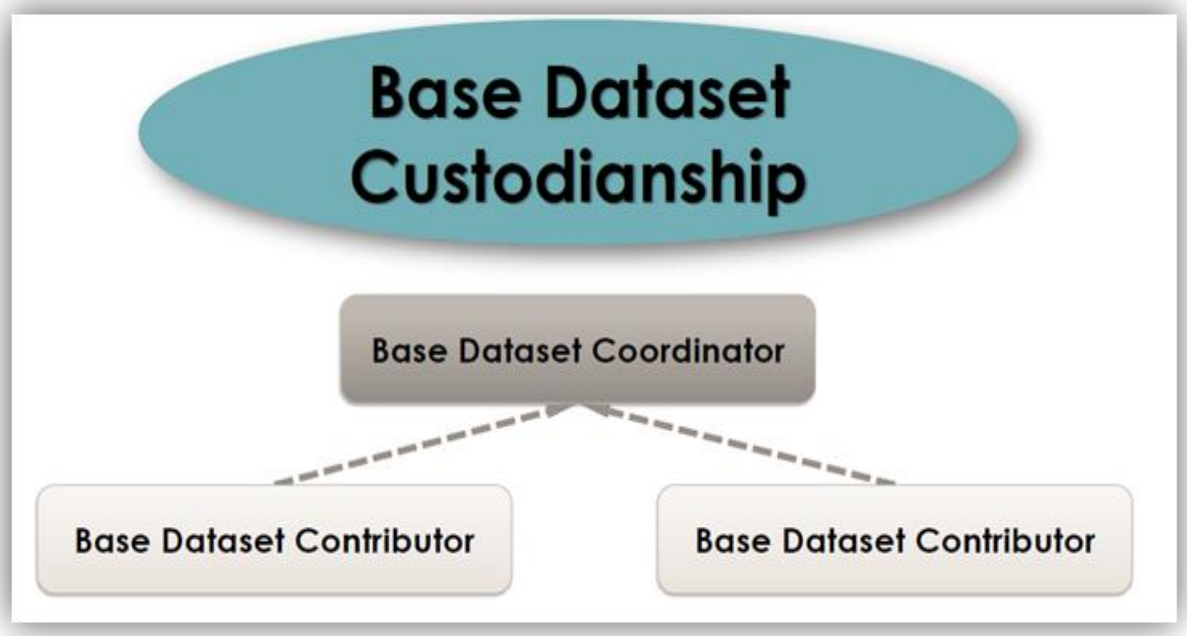


Figure 31: SASDI Spatial and Attribute Data Collaboration Concept (du Preez, 2019)

b. *Regional Data Collaboration.* According to the *Base Data Set Custodianship Policy*, this happens when national data sets are generated by consolidating several regional or lower-order data sets. Under these conditions, several organisations are capturing different data sets, each for the same spatial object or feature type, but with separate geographical dimensions (Base Data Set Custodianship Policy, 2015).

In order to merge such data sets, each participating custodian must guarantee the interoperability of its data sets by entering into an agreement and complying with the same standards and data collection criteria. Each contributing custodian takes responsibility for the quality of the data set within their area of jurisdiction In relation to regional cooperation, spatial-attribute custodianship collaboration is subject to the same terms and conditions (Base Data Set Custodianship Policy, 2015; du Preez, 2019).

Figure 33 illustrates an example of regional data collaboration. In this case, the regional data collaboration ensures that each province is listed as a data contributor to the aggregation of all provincial data sets into national or higher data sets. Regional data collaboration may also take place at the provincial level when provincial data sets are created through the consolidation of a number of local municipal data sets (du Preez, 2019).

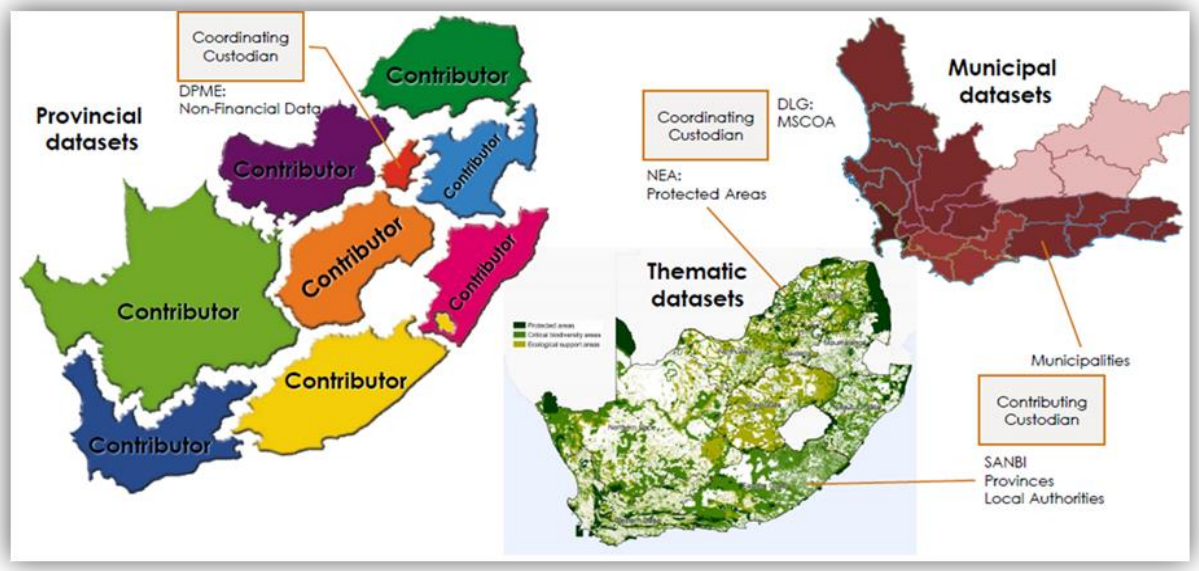


Figure 32 An example of regional data collaboration (du Preez, 2019)

In a country, a regional data collaboration SDI enables efficient, flexible, and shared usage of geospatial data sets and thus assists service delivery and community development. According to Kalliola et al. (2019, p.74), “SDIs can be manifested or developed in multiple domains within a specific country, ranging from the organisational to the local and national.” In different countries, SDI advancement has concentrated primarily on national needs, which are mainly associated to government data policies and practices.

In certain areas, the top-down approach is supplemented by local or regional structures which may have formed in direct response to the appropriate situations of their operating regions. For this purpose, they help to research how demand-based, organisational SDIs, with their specific community implications, can completely change (Kalliola et al., 2019).

The concept of the base data set coordinator has been established to promote and improve the governance of the base data sets. The function of a base data set coordinator has been developed to boost the governance of the base data set. The coordinator is accountable for ensuring that the BDSCs produce base data sets that adhere with all policies, specifications and requirements. The other function of the base data set coordinator is to ensure that the custodians of base data attribute build base data sets that comply with all specified policies, standards and specifications. Figure 33 shows the SASDI shared custodianship model (Fourie, 2017).

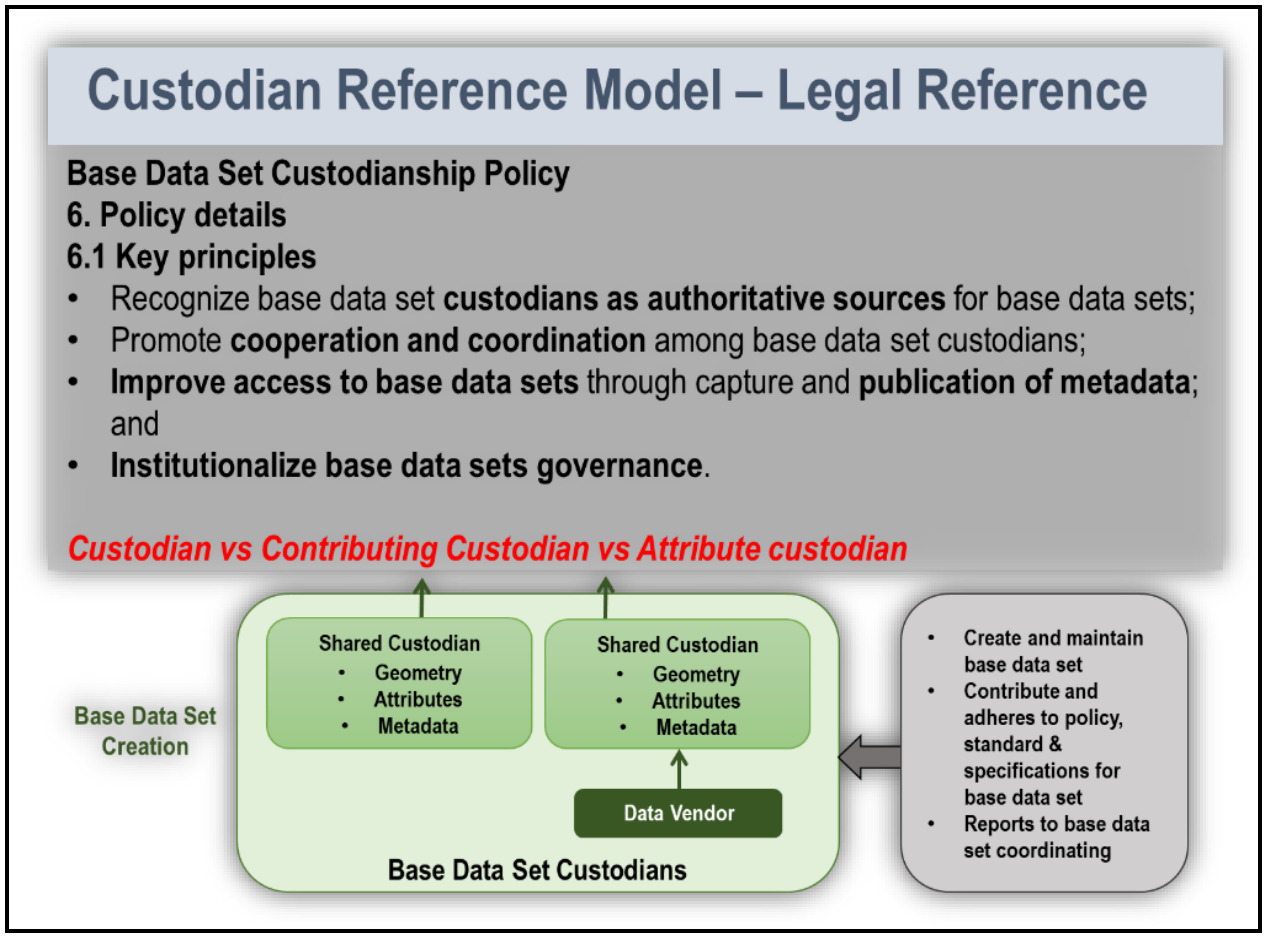


Figure 33: SASDI Shared Custodianship Model (Fourie, 2018)

The task of the coordinator of the base data set was established to facilitate the governance of the base data set between public sector organisations. The base data set coordinator is accountable for safeguarding the base spatial data custodian(s) and base attribute data custodians in order to develop base data sets that comply with all policies, standards and specifications which are commonly used in the country. The coordinator of the base data set is also responsible for maintaining the consistency of data and the synchronisation of the base data sets, for the same spatial object or feature type, but with adjacent geographical coverage, derived from various custodians (SASDI Website, 2019).

The other reason of the establishment of a base data set coordinator is to enable a set of principles for the responsible management of critical regional resources and commits all appointed data custodians across all organs of state to cooperate in the implementation of the SASDI. The government's approach on sharing geospatial data is dependent on the effective functioning concept of the shared base data set custodianship (Base Data Set Custodianship Policy, 2015). The following are the types of base data set custodianship:

i. The *Base Data Set Coordinator* is responsible for integrating and coordinating all aspects of the base data set. Regional data sets can, where possible, be integrated into national coverage data sets. Then the coordinator reports to the CSI Data Subcommittee on all the base data set activities.

ii. The *Base Spatial Data Custodian* is accountable for the base data set's spatial component (or the geometry). The custodian must work closely with the custodian of the base attribute data and report to the base data set coordinator on all base data set activities.

iii. The *Base Attribute Data Custodian* is responsible for the base data set's descriptive component (also known as the attributes). They must work together with the custodian of the base spatial data and report to the base data set coordinator on all base data set activities (Base Data Set Custodianship Policy, 2015).

The concept of custodianship for base data sets is at the centre of information management as it provides accountability and transparency for data and acknowledges authoritative sources that provide users a degree of consistency and assurance. The collaborative approach of the base data set coordinators and the BDSCs in managing the base data as shared custodians, or contributing custodians in a partnership with national, provincial, and local government, enables the integration of data for the benefit of the entire country in the form of a nationally consolidated data set (Base Data Set Custodianship Policy, 2015).

4.7.3 Custodianship Roles and Responsibilities

The roles and responsibility for developing and maintaining a geospatial base data set usually reside with an organ of state identified as a data custodian. It is crucial to recognise the custodianship of the base data set in a country, together with a few critical parameters associated with data type and data access practices (SASDI, 2019). Accordingly, data custodians must take steps to ensure reliable and effective protection against the loss of geospatial information under their custodianship or against any unauthorised or inappropriate access, alteration or disclosure of such geospatial information (Base Data Set Custodianship Policy, 2015).

The legislation, a cabinet or departmental plan, or a proposal to satisfy a particular service, administrative, or industry need defines the compulsory accountability for government organisations. Mandatory responsibility provide for capacity, infrastructure and resources, and thus lack of accountability does not necessitate grounds for pardoning custodial responsibilities, unless specifically granted by the Minister based on section 20 of the SDI Act (2003, section 1(c)).

In general, issues of data custodianship roles and responsibilities can become complex if not properly understood because they are based on defined criteria. The full potential of data custodians' roles as drivers of economic growth and development through geospatial information, can only be achieved if data are available to the user base in familiar formats, with access to public decision-makers and leaders in the civil and private sectors (Schwabe and Govender, 2012).

The roles and responsibilities of base data custodians include an authoritative source who are identified by the CSI in terms of the criteria for data custodians, cooperation and coordination, access, data quality, shared data custodianship, base data governance, rights and user responsibility. Table 23, summarises the SASDI base data set custodians' roles and responsibilities descriptions as follows:

Table 23: SASDI BDSC roles and responsibilities (Base Data Set Custodianship Policy, 2015)

	SASDI BDSC roles and responsibilities	
	Role/responsibility	**Description**
1	Authoritative Source	As an authoritative source for data sets, custodians must keep such data sets up to date through a maintenance plan (Sec. 6.1.1).
2	Cooperation and Coordination	Data custodians shall: • Enable sustainable and productive use of services through a commitment to collaborate with each other in the sharing of geospatial information; • increase access to and enhance dissemination of geospatial data; • throughout all government realms, prevent duplication of data capture and cost; engage users when deciding data capture and maintenance needs; • validate and describe spatial data in their custodianship; • responsible for the integrity of unmodified geospatial information provided on their behalf by a data vendor (Sec. 6.1.2 and 6.2.1)
3	Access	Data custodians shall: • metadata capture for their data holdings; • disclosure or rendering data accessible to the public on demand, unless prohibited under the Public Access to Information Act (PAIA); • to maintain confidentiality of individuals through the relevant legislation; • capturing their own metadata in the EMC and provide or distribute geospatial data in accordance with related metadata (section 6.1.3 and 6.2.2).
4	Data Quality	• Data custodians should guarantee that the quality and resolution of their data meets specified users requirements; ensuring that their data are reliable, up-to-date and free of uncertainty in compliance with specified standards; include in the data set metadata, quality statements on the integrity and accuracy of the data (section 6.2.4).
5	Shared Data Custodianship	• In situations where custodianship is shared, the base data set coordinator and base attribute data custodians should collaborate and agree on policies and specifications (section 6.1.4).
6	Base Data Governance	• Where custodianship is shared, a base data coordinator must be appointed to ensure compatibility and integration of multiple data sets for consolidation into a base data set (section 6.1.5).
7	Rights	• In the context of the *Pricing Policy for Spatial Information Products and Services* Data Custodians are eligible to charge for the geospatial data they produce (section 6.2.5).
8	User Responsibility	• In geospatial data sets, users must report deficiencies found (section 17 of the SDI Act).
9	Standards and Prescriptions	• Data custodians and vendors should comply with the standards and specifications laid down by the Minister pursuant to (Sections 11.(1)(a) and (3))
10	Data Capture Project Register (DCPR)	• Data custodians and non-custodians should register or ask approval to capture geospatial data initiatives on the DCPR (Section 6.1.3(d)).
11	Distribution and Pricing of Products and Services	• Data custodians are authorized to invoice for their geospatial information or data sets accounted for in accordance with the Policy on Pricing of Spatial Information Products and Services (2015)
12	Security, Licensing and Copyright	• Data custodians must take reasonable steps to adapt security precautions to prevent loss, unauthorised access, alteration or disclosure of personal information; Section 6.1.3(e).
13	Monitoring and Evaluation	• At the request of the Committee (as may be referred to the NSIF), data custodians should include any documentary proof submitted within a fair period of time for the purpose of enforcement monitoring (Section 8.2).

4.8 SASDI Standards, Metadata, and SASDI Challenges

4.8.1 SASDI Metadata

The SDI Act (2003, p.3) defines metadata as "a description of the content, quality, condition and other characteristics of spatial information". Metadata in general is typically described as data, or simply data information. Metadata is viewed as a means of data description, consistency, state, authorship, and any other attributes of spatial data (Nogueras-Iso et al., 2004; Alford, 2009). Metadata defines the 'who, what, where, where, why, and how' tools for geospatial data interpretation and handling.

Metadata offers functions such as “maintenance, to preserve the geospatial resource investment of an organisation; distribution, to provide customers, vendors, data catalogues or clearing houses with information about the resources of an organisation; and providing users with the information required to interpret and process data from external sources” (Fourie 2015a, p.22). The presence of meaningful metadata and its resources within the SDI requires an improvement in the sharing of geospatial data and access among the data community.

Limbach et al. (2004) posit that metadata documentation enables all stakeholders to gain better understanding pertaining to each other’s data sets, thus leading to efficiency in spatial data utilisation. In addition, Duval (2001) indicates that metadata promotes data security, as users can retrieve digital content by accurately identifying descriptive data. Metadata may also promote collaboration with spatially-related organisations, as metadata offers information to other outlets involved with data exchange, such as clearing houses (Pierkot et al., 2006). In the context of SASDI, metadata serves for four main roles namely:

a. For the purpose of discovery or availability (information needed to decide which data sets exist for a specific subject or geographical scope, as well as aspects such as title and geographical scope).
b. Fitness for use (information required to decide if a data set meets the specified requirements, such as constraints, quality, extent or resolution).
c. Accessibility, referring to information needed to acquire a data set from the distributor or owner (elements such as resource site or URL, and contact details).
d. Data transfer, refers to information required to process and interpreting a data set, obtained through transfer from an external source or for data aggregation (elements such as methodology and spatial reference system).

Section 12(1) and (2) of the SDI Act (2003, p. 12) states that “a custodian of data should capture and manage metadata for any geospatial information held by it and see into it that such metadata is readily available to the users". Furthermore, Section 14(3) specifies that, along with the spatial data or information, a data custodian or a data provider providing spatial information must therefore provide the necessary metadata. In order to comply entirely with the SDI Act, data custodians are expected to publish their metadata and collect metadata for their data holdings; to offer access to their data holdings by rendering metadata available to users in the organisation's information manual including any data sets disseminated; and to ensure that their metadata are made available for publication in the EMC (SDI Act, 2003).

Metadata defines the scope of the spatial data information thoroughly. Consequently, the user can easily understand what the data entails without spending time worrying about the information that is missing or needed. The SASDI metadata focuses on the core metadata elements specified and their mandatory, conditional and optional requirements. It consists of a reference list of metadata fields, intended to compare metadata fields or elements for a range of standards. This work has yet to be completed and presented for approval by the CSI. However, this does not prevent data custodians or contributors from recording the essence of metadata for their data holdings from the outset.

Metadata can be used to minimise the data burden, as the product content could be used to discover and obtain data resources. Including keywords, time, contacts, type of data, and attributes, metadata will then guide users of spatial data into choosing how best to use the data (Nebert, 2004). Metadata gives both the geographic resources and the accountable organisation. Consequently, metadata is valuable for marketing. Metadata may allow end users to obtain data information without having to conduct data originator inquiries (Hunter et al., 2003). When properly captured, metadata is relevant and is available for discovery. If appropriate metadata information has been added to existing resources or data sets, users may choose a data set that is suitable for use within the necessary geographic extent for a given subject and purpose.

Metadata also includes the information required to access or obtain the data set, and to direct its transition and integration with other relevant data sets. It enables accessibility to, and usage of, geospatial data for all by ensuring that metadata is captured, current, widely available, and usable in an online information catalogue. Metadata can support organisations which produce data in numerous forms. According to Deng (2002), some spatial data professionals use metadata for the evaluation and organisation of the data underlying it.

Wayne (2005) similarly notes that an increasing number of spatial applications and analysts rely on metadata to assimilate and view data. Metadata also contributes to data protection activities by arranging, identifying, preserving, and upgrading data tools (Batcheller, 2008). Many organisations believe that the component metadata file (XML) of the data collection, even if it is unfinished, is ample evidence that they have fulfilled their duty to comply with the *SDI Act*. When an XML file is opened, it is very difficult to find incomplete documentation. This results in the metadata lacking essential details which robs users of the right to select an accurate data set that is most suitable for their particular needs. It then becomes necessary to analyse the data set itself in order to assess its fitness for use.

4.8.2 SASDI Standards for Metadata

Metadata is generally captured according to an explicit set of standards and prescriptions. These standards are intended to address the needs of user communities in order to describe definite types of resources. They describe the metadata schema including the metadata sections, entities, and elements (Eagleson and Escobar, 2003). This is the prescribed form of capturing and representing metadata using standards. FGDC (1998, p.5) describes standards for metadata as “formal guidelines or procedures that permit proficient and informed usage and administration of geospatial data sets”. Standardised content of attribute information allows ingenious utilisation of big data by organisations through their information infrastructures (Campbell, 2008).

In addition, the exchange of data within an entity and between organisations, involves the implementation of universal standards based on a strong consensus (Jacoby et al., 2002). The *Open Geospatial Consortium* (OGC), however, makes it clear that implementing standards alone is not an

approach which is entirely sustainable. Therefore, an organisation's task can include choosing suitable or customisation standards that can be easily adopted by spatial data stakeholders (OGC, 2018).

The *International Organisation for Standards* (ISO) has a subcommittee at international level responsible for developing geographic information standards (TC 211). The ISO subcommittee, established in 1993, includes numerous members from both developed and developing countries (Nebert, 2004). The working group discusses standards that could be implemented to an SDI at different levels (Crompvoets et al., 2018). Two international standards for metadata are *ISO 19115-1:2014 – Geographic Information – Metadata – Part 1: Fundamentals*; and *ISO 19139: 2007 – Geographic Information – Metadata – XML schema implementation*. Other internationally renowned metadata standards include *Dublin Core*, comprising only 15 metadata elements for defining a wide range of resources; and the *FGDC standard - FGDC-STD-001-1998,* also referred to as the *Content Standard for Digital Geospatial Metadata* (CSDGM). Standards are needed for reference and data models, data quality, data transfers and metadata.

The protocol relevant for the listed standards includes CS/W, HTTP and FTP. A country or a community of practice sometimes adapts a metadata standard to meet its unique needs. A number of metadata standards are available, despite their primary variations including the areas of application they cover, their width, their depth (the amount of information they cater for) and their encoding (Cooper, 2016). This is known as a profile for metadata. *SANS 1878-1: 2005* is a *South African National Standard* (SANS), entitled *"South African spatial metadata standard, Part 1: Core metadata profile*". This standard is a profile of the *ISO 19115* standard adapted to describe the schema required in South Africa for geographical information and services. There is also a *SANS 1878-2: 2010* standard entitled *"Geographic information – Metadata – Part 2: Extensions for imagery and gridded data"* (Cooper, 2016). Figure 34 illustrates the SASDI compatible metadata standards and protocols.

STANDARDS	PROTOCOL		
	CS/W	HTTP	FTP
Dublin Core		Yes	Yes
ISO 19115 ...	Yes	Yes	Yes
FGDC	Yes	Yes	Yes
SANS 1878	Yes	Yes	Yes
EML		Yes	Yes
DataCite		Yes	Yes
ArcCatalog		Yes	Yes
DDI		In Process	In Process
Darwin Core			

Figure 34: SASDI applicable metadata standards and protocols (Hugo, 2015a)

The standards are the most important aspect of the SASDI, and they are one of the main success factors required to achieve the SDI Act goals. The principal source for geospatial data and services standards is the related ISO *Technical Committee*, ISO/TC 211, *Geographic Information/Geomatics*, for which the local mirror committee of the *South African Bureau of Standards* (SABS) is SABS/TC 211, *Geographic Information*. The CSI data as well as the standards subcommittees are working on

the identification of main metadata elements and the mandatory, conditional and optional obligations associated with them. Although the names can vary in different metadata specifications, Figure 35 demonstrates the common metadata sections, entities, and elements that have been adapted. The blue text indicates the minimal metadata needed to represent most spatial data sets or resources hence no image and gridded data extensions are included. The mandatory (M), conditional (C) and optional (O) obligations indicated should only be considered as guidelines, as they are yet to be finalised (Fourie, 2015a).

❖ ***Identification or Citation** (what, by whom, why):*
- Title (M)
- Resource online URL (C)
- Subject (M)
- Publication/reference date (M)

★ ***Author/Responsible party** (who to contact):*
– Author/creator responsible party/individual (M)
– Publisher responsible organisation (M)
– Address (O)
– Position/role (O)
– Contact details (O)

★ ***Associated party/co-author(s):***
– Contributor individual (C)
– Contributor organisation (C)
– Address (O)
– Position/role (O)
– Contact details (O)

- Topic category, keywords (M)
- Abstract/description (M)

❖ ***Usage, restrictions, constraints** (for whom, for what):*
- License and user rights (M)
- Provenance/lineage statement (M)

❖ ***Methodology** (how):*
- Main step(s) (O)
- Detailed documentation/description (O)
- Instrumentation (O).

❖ ***Technical parameters** (what):*
- Language (M)
- Character set (M)
- Scale/resolution (M)
- Distribution format(s) (M)
- Format version (C)
- Data/spatial representation type(M)
- Spatial reference system (M) and Projection (C)
- Data Quality (M)
- Maintenance (m)

❖ ***Data dictionary/schema (what):***
- Object type/name (M)
- Attribute name(s) (O)
- Definition, valid values (O)
- Column/field name(s) (O)
- Value type (O)
- Dictionary URL or schema (O)

❖ ***Coverage/dimensions of the data** (where, when):*

★ ***Spatial coverages - provide at least one:***
– Geographic identifier/location/name (M)
– **Geographic Reference:**
– Latitude (C); Longitude (C)
– **Bounding coordinates:**
– North (M); South (M); West (M); East (M)

★ ***Vertical Extent:***
– Minimum (C);
– Maximum (C);
– Unit of measure (C);
– Datum (C)

★ ***Temporal extent/coverage***
– Begin date (M)
– End date (M)

★ ***Physical measurement/observation coverage:***
– Quantity (O)
– Unit (O)

★ ***Taxonomic coverage:***
– Rank(s) (C)
– Value(s) (C)

❖ ***Metadata elements:***

★ ***Online resource:***
– Metadata online URL (C)
– Protocol (C)
– Name (C)
– Description (C)

★ ***Metadata standard:***
– Metadata standard name (C);
– Version (C)
– Language (M)
– Character set (M)

- Metadata file identifier (M)
- Metadata creation date/time stamp (M)
- Maintenance (m)

★ ***Custodian (metadata):***
– Metadata contact/individual (M)
– Organisation (M)
– Address (O)
– Position/role (O)
– Contact details (O)

Key: ❖ Section, • element ★ Entity, – element

Figure 35: Generic metadata elements adapted from "Metadata Fields Comparison" (Fourie, 2015a)

The SASDI and SABS have recently developed a cooperative and collaborative framework on the development and implementation of geospatial information standards also known as geographic information standards. This co-operation further aims to identify ways in which strategies can be effectively implemented through synergistic activities and common actions, in a way that is viable for both organisations and respects the common commitment to develop and make standards available to data custodians (Fourie, 2015b; SASDI website, 2019). The cooperation will seek to support and guide the implementation of the programme activities of the CSI to encourage the use of standards for good management of spatial information for decision making and thus support economic development. The regulations made under the SDI Act require the CSI to define applicable national and international spatial information standards, including any standards determined by the SABS, at least annually. The CSI must prepare of a list of all identified standards or any amendment of standards which must be communicated to all data custodians and all data vendors by publication in the *Gazette*.

4.8.3 Summary of SASDI Challenges

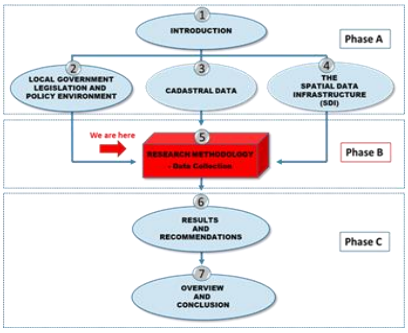
In summary, literature has shown that in South Africa, data custodians have a good understanding of the SDI Act and the functioning of the CSI and are acquainted with the CSI's operations (Kay, 2018). Even though this is the platform from which data custodians may adhere with their SDI Act responsibilities, geospatial data sharing in South Africa has some challenges. There are capacity and capability limitations on the side of the data custodians and the users. The lack of buy-in from the political and senior management level for implementing SASDI. The majority of SASDI data custodians partially comply with the requirements of the SDI Act in terms of geospatial data sharing and custodianship compliance guidelines (Laldaparsad, 2014). One of the main implementation challenges in South Africa is the minimal amount of funding available. Another major challenge is the multiple dynamics among stakeholders. All in all, SASDI is not at a mature stage.

Coetzee (2018) classifies the factors that lead to SASDI collaborative custodianship challenges as political, technological, economic, social, environmental, and legislative. Politically, problems like organisational priorities and silos are obstacles that can hamper collaborative custodianship development. Economically, the lack of resources to promote cooperation and the financial implications of effectively implementing policies are constraining. Socially, ignorance of other stakeholder's data, unwillingness to share, and apathy are reasons to be apprehensive about collaboration. Technologically, the problems relate to non-standardised agreements, and lack of universal data specifications (Coetzee, 2018). Legislatively, the challenges are endless. These involve confusion about requirements to collect precise thematic data due to contradictory laws on geospatial statistics, such as the SDI Act and the *Statistics Act* (No. 6 of 1999). Originally, the SASDI framework did not define a hierarchical system, but the latest plans are for an infrastructure capable of serving the local or metropolitan, regional, and national government systems faithfully (Mwange et al. 2016).

4.9 Conclusion

This chapter discussed the nature and concept of spatial data infrastructures based on SDI initiatives world-wide. The chapter has shed light on the understanding of SDI and established the importance of SDI as a crucial mechanism in spatial information management decision making processes. The chapter has also outlined a spatial hierarchy relationship among the different types of SDIs. It has uncovered how the use of SDI has helped in the efficient and effective management of spatial information. The legislative and policy environment for or the CSI and SASDI were outlined and discussed. Currently, in South Africa, numerous challenges are preventing the SASDI from operating at full capacity. The literature review shows that there is still a lot of work to be done in order for the SASDI to serve the needs of all spatial data users and stakeholders in South Africa. Despite limited geospatial data management capacity, the use and value of spatial data in decision-making to achieve South Africa's development goals is growing and should not be underestimated. The chapter has revealed that custodians for base data sets are required to meet the demand for accurate and timely spatial data. This will increase the momentum for establishing the SASDI as a long-term framework for facilitating the capture, management, maintenance, integration, distribution, and use of spatial data. South Africa's SDI frameworks impede the efficiency of spatial information maintenance, such as cadastral data, due to a lack of political buy-in, inappropriate placement of the NSIF, and a lack of metadata and stakeholder participation.

CHAPTER 5
RESEARCH METHODOLOGY



5.1 Chapter Overview

The preceding three chapters have laid a theoretical ground on which this chapter is built. This chapter focuses on the various research methods applied to gather and investigate the information that is essential to address the research objectives. The research data in this study was sourced through a systematic review of literature, desktop survey, questionnaires, interviews, and non-participation observations at SASDI workshops. Primary, secondary, tertiary, and grey literature sources were used to conduct the literature review. This study consists of an interaction between theoretical practicalities and practical proof. While the results of the empirical investigation informed the refinement of the research questions, methodology and theory, the empirical study was moulded by the theoretical basis of the study. The process which informed how the research data were collected, collated, and analysed in this study is presented in the form of a research flowchart and the research matrix. The chapter concludes by addressing the various ethical considerations that needed to be adhered to whilst conducting the research.

5.2 Research Methods

5.2.1 Types of Research

In various disciplines, researchers frequently use qualitative and quantitative research methods and approaches for their studies. Accordingly, in planning a research project, a researcher needs to recognise whether they will employ a qualitative or a quantitative research type. The research methods required for this study were predominantly qualitative in nature and adopted an explanatory, qualitative empirical approach. The approach implemented to obtain and gather the data from key participants was literature review, semi-structured questionnaires, interviews, and observation. This approach aligned well with what is advocated in an interpretive qualitative research.

As indicated by Flick (2014), qualitative research is any type of research that produces findings not attained by statistical procedures or different methods for evaluation. A qualitative research is a research pertaining to lived encounters and sentiments about organisational functioning. Qualitative methods are suitable for answering most of the "why" questions that researchers have when they develop their projects. Given (2008) argues that quantitative research depends on the capacity to foresee what must be estimated or measured in advance. He further maintains that quantitative approaches are appropriate for examining what occurred and experiments can be used to test interventions. Table 24, lists characteristics and differences of qualitative and quantitative research.

Table 24: Characteristics and differences of qualitative and quantitative research (Creswell, 2014)

Type of research	Definition	Instruments	Data	Characteristics
Qualitative	"a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell 2014, p. 4)	Questionnaires Interviews Focus groups Unstructured observation Engagement with stakeholders Recording behaviour Case study	Interview data Observation data Document data Audio-visual data Text based Text and image analysis Themes, patterns interpretation	Natural setting Holistic Multiple methods Inductive data analysis Interpretative Narrative description Small sample Unstructured and free form Researcher as key instrument
Quantitative	"the means for testing objective theories by examining the relationship among variables which in turn can be measured so that numbered data can be analysed using statistical procedures" (Creswell 2014, p. 4; Austin and Sutton 2014, p. 436).	Experiments Cohort studies Clinical trials Case-control study Structured questionnaires Test hypotheses or specific question Measure and test Statistical techniques	Measurable data Numerical data Statistical data	Structured response categories provided Researcher not involved Results are objective Large samples

5.2.2 Qualitative Research

As listed in Table *24,* Creswell (2014) defines qualitative research as a method for investigating and understanding the significance that individuals or people attribute to a social challenge. Eyisi (2016) argues that qualitative research is portrayed by methodologies that accept the subject's point of view as focal. This approach also pays significant attention to detailed observation to produce a 'rich' and 'deep' description. The "natural setting" described in Table 24 simply implies that the researcher collects data where the participants experience the issue under study.

Multiple methods in a qualitative research typically mean multiple sources of data collected from various methods. Inductive data analysis of patterns, categories, and themes are built from the ground up. Data analysis is an on-going process. Interpretation means making sense of the data while trying

to set aside personal experiences from the research. Some of the weaknesses of qualitative research are that it can be time consuming, may have no clear strategy for data analysis because of multiple approaches and, the interpretation of data may be subjective (Creswell, 2014). Nevertheless, the utilisation of a qualitative research method in this study made the focus of obtaining data through open-ended and conversional communication much quicker and easier and assisted in investigation and interpretation of the data collected in order to realise both the research objectives and aim. The nature of this research approach also assisted in restricting the research to reasonable timeframes and in avoiding research exhaustion as the scholar did not have to return to the same participants repeatedly.

5.2.3 Quantitative Research

In Table 24, Creswell (2014) further defines quantitative research as a method for testing target speculations by analysing the relationship among factors or variables. Quantitative research designs accentuate objectivity in estimating and depicting phenomena (Austin and Sutton, 2014). As such, the research design augments objectivity by using numbers, statistics, structure, and control. An important sub-classification of quantitative design is experimental and non-experimental. The instruments used in this type of research include amongst other experiments, cohort studies, clinical trials, case-control study, structured questionnaires, test hypotheses or specific question, measure and test, statistical techniques, and mathematical techniques.

5.3 Research Design

Burkholder et al. (2019) suggest that a research design is the overall arrangement for the assortment, estimation and investigation of data. Typically, a research design will portray the motivation behind the purpose of the study and sorts of inquiries being tended to, the methods to be utilised for gathering information, ways to deal with choosing tests and how information will be investigated. The research design in this section is articulated for the purpose of conducting professional scientific research and forms the basis of the entire research dissertation.

5.3.1 Research Matrix

According to Klopper et al. (2007), a research matrix is an instrument envisioned to help a researcher to sort out the data in their research investigation into a reasonable research study. The reason for using a research matrix is to create order out of disarray and to provide a standard structure of creating order. It provides space for everything, which allows you to concentrate on the information itself. Klopper et al. (2007) argue that a research matrix can be portrayed as a sort of conceptual framework in table or grid format, comprising of a rectangular cluster of symbols that are orchestrated in rows and columns to shape a representative set which, when utilised all together, empowers a scientist to make decisions about non-evident connections that exist between sections on the table (Klopper et al., 2007). The matrix in this research encapsulates the research design or what the researcher intended to do in the investigation of the research questions and highlights the flexibility that can be achieved in its use. It also further depicts the three objectives of this study namely, the legislative and policy environment for local government, cadastral data and SASDI. Each row of the research matrix shows a research objective and sub-objectives where applicable, matching the research question and sub-questions where applicable. Table 25, illustrates the research matrix of this dissertation.

Table 25: The Research Matrix

No.	Research Objectives		Research Question & Sub-research Questions		Method of Data Collection	Approach to answer Research Questions
1	legislative and policy environment for:	**1.1 local government *(particularly South African local government)***	To what extent can municipalities be considered to have a custodianship role for cadastre within the South African Spatial Data Infrastructure?	What is the role of the three spheres of government in S.A. and what is the mandate of local government?	Literature review Desktop research Other sources: books, journal articles etc.	Definitions & context of Local government. Related work: Local government worldwide. Local government in South Africa: legislative and policy review.
		cadastral data *(particularly South African cadastral data)*		How cadastral data should be captured, collected, maintained and managed throughout the cadastral value chain in South Africa, and the capacities of the role players to do so?		Cadastre & cadastral data definitions Cadastral data stakeholders Cadastral data worldwide South African Cadastral context
		SDI *(particularly SASDI)*		What is CSI, SASDI, and who are the stakeholders? What are their roles & responsibilities?		What is SDI ? SDI stakeholders? SDI international perspective SASDI context, Definition and Collaborative custodianship
2	**To analyse the current roles of metropolitan municipalities, the CSG and Provincial SGs in handling cadastral data.**		Do municipalities have any legal mandate regarding cadastral data?		Questionnaires Structured interviews Observational research Organisational-reports Newsletters	Questionnaires & Structured interviews directed to relevant respondents namely the three Gauteng metropolitan municipalities, Gauteng provincial surveyors general & Chief Surveyor General.
			Do municipalities capture their own data? How is cadastral data captured, collected, maintained and managed throughout the cadastral value chain in municipalities ?			
			Do municipalities consider themselves as custodians?			Understanding of functional units of the respondents, including policy and legislative environment.
3	**Based on the results, recommend how municipalities can contribute to custodianship roles and responsibilities in the SASDI, and make conclusions.**		Why municipalities do not have any custodianship roles and responsibilities for SASDI?		Review the legislation and policies for local government in particular from a South African context. Cadastral data review with focus on the South Africa. SDI and SASDI review (particularly SASDI governance framework).	Description of legislation and policy environment in the South African local government. Present Cadastral data and systems as well as the e-Cadastre in South Africa. Description of reasons why metropolitan municipalities Why municipalities do not have any custodianship roles and responsibilities for SASDI. Make recommendations Draw conclusions based on the results.

The approach applied to answer the research questions was basically the steps that were taken when answering the research question. For example, the first part of the research matrix shows that a literature review and other research instruments were used to assemble or gather the important information that empowered the respondent to respond to the research question. The research matrix concludes with a column which indicates the conclusions that were drawn based on the research findings and results, and the relevant recommendations.

5.3.2 Research Flowchart

According to Vu-Ngoc (2018), a flowchart is a diagrammatic portrayal that outlines the succession of activities to be executed to get the answer for an issue to accomplish the research objectives. A well drafted flow diagram is useful for readers to follow the sequence of the research process and line out any discrepancies. A flowchart is a diagram displaying activities and schedules in a complicated research study or system. It also acts as a map to get the reader from the beginning of a query until the completion of a final understanding. A flowchart offers a wonderful technique for putting order to word phrases, clusters and developing validity (Matyus, 2016).

Flowcharts can be used for all sorts of data collection. They help organise thoughts and also lay out the required data in the process of data capture or collection. There are numerous types of flowcharts that are often used to present results or organise research. Matyus (2016) lists some of the most commonly used flowcharts as follows:

1. Basic flowchart: is a simple visual depiction of step-by-step methods or activities, with shapes and arrows demonstrating the direction of progression.
2. The swimlane flowchart: it illustrations how separate entities in a process develop and interact. For instance, this flowchart may display how sales and operations in certain institutions run concurrently and when they eventually cross paths.
3. A workflow flowchart: demonstrations the functionality and interactions of objects in a particular business or process. It can also be used by researchers or scholars to identify problems or successes within a process.
4. A data flowchart: is applied to display the establishment and interactions of the system and external data.

In this study the choice of the research flowchart used is a workflow flowchart. This study describes a workflow flowchart as a visual representation of a research workflow, commonly completed through a flowchart. It utilises standardised structure to describe the meticulous phases required to finish a process. A flowchart that is shown or used in this study depicts the process undertaken to realise the results.

Figure 36 is an illustration of the research flowchart for this study and it helps the readers to follow the sequence of the research methodology to provide guidance in the use of the research instrument. The research is divided into three research instruments namely literature review, questionnaires and interviews, and the observations. The literature review was used to review the legislative and policy environment for local government, to review the legislative and policy environment for cadastral data, and to review the legislative and policy environment for SASDI.

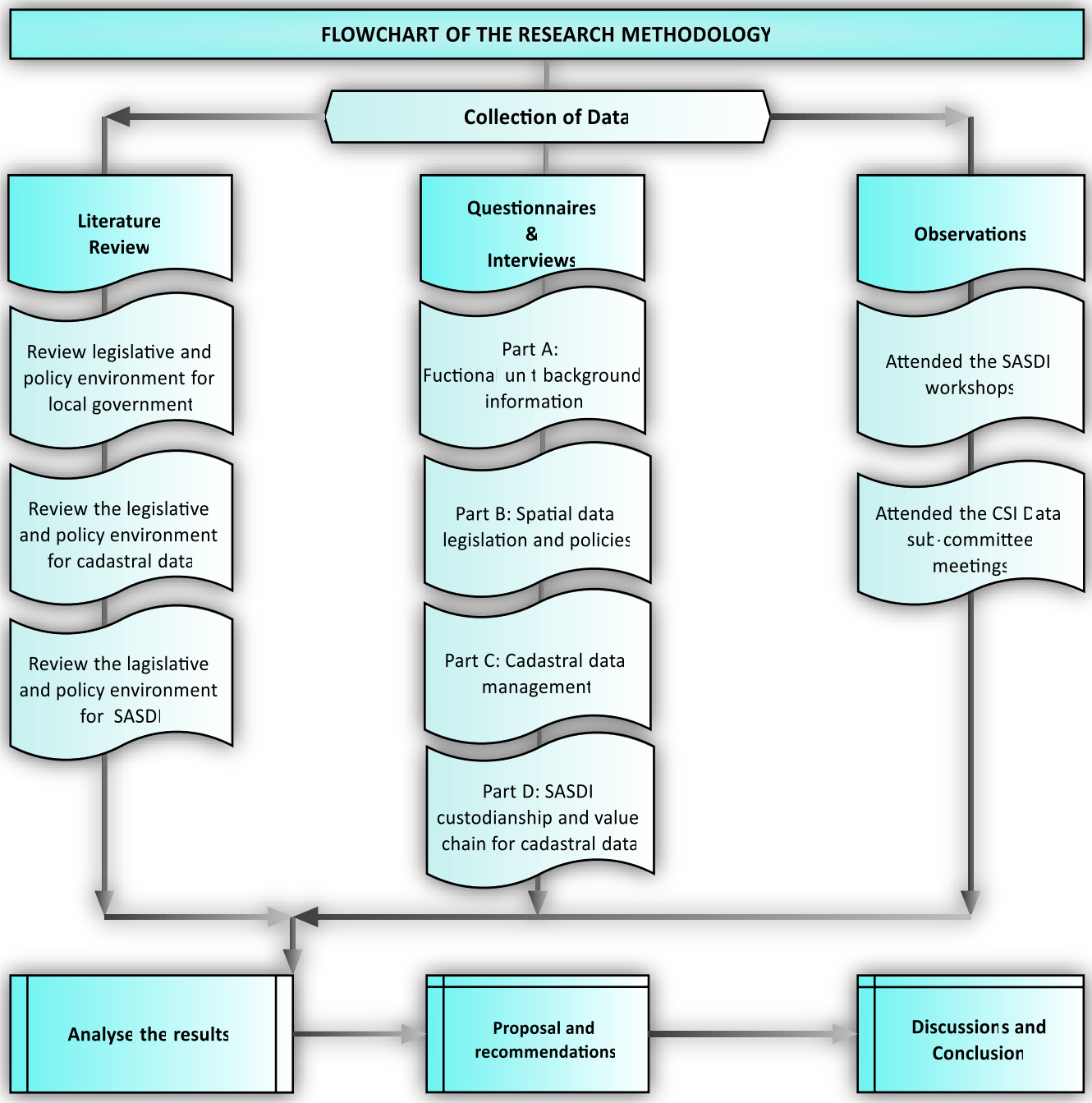


Figure 36: The research flowchart

The questionnaires and interviews were divided into part A, to gather the functional background information of the respondent; part B, to gather information pertaining to spatial data legislation and policies; part C, to get information regarding cadastral data management from the respondents; and part D to gather information about SASDI custodianship and value chain for cadastral data. The observations were conducted at the SASDI workshop and the CSI Data Subcommittee meetings.

5.4 Study Area

This research study is conducted within the context of the South African local government, SASDI, and uses the South African cadastral data from the selected participants, namely the three Gauteng metropolitan municipalities; the Gauteng provincial office of the SG and the CSG. Figure 37 shows the study area of this research study comprising of the three Gauteng metropolitan municipalities, namely the City of Johannesburg, City of Tshwane, and the City of Ekurhuleni.

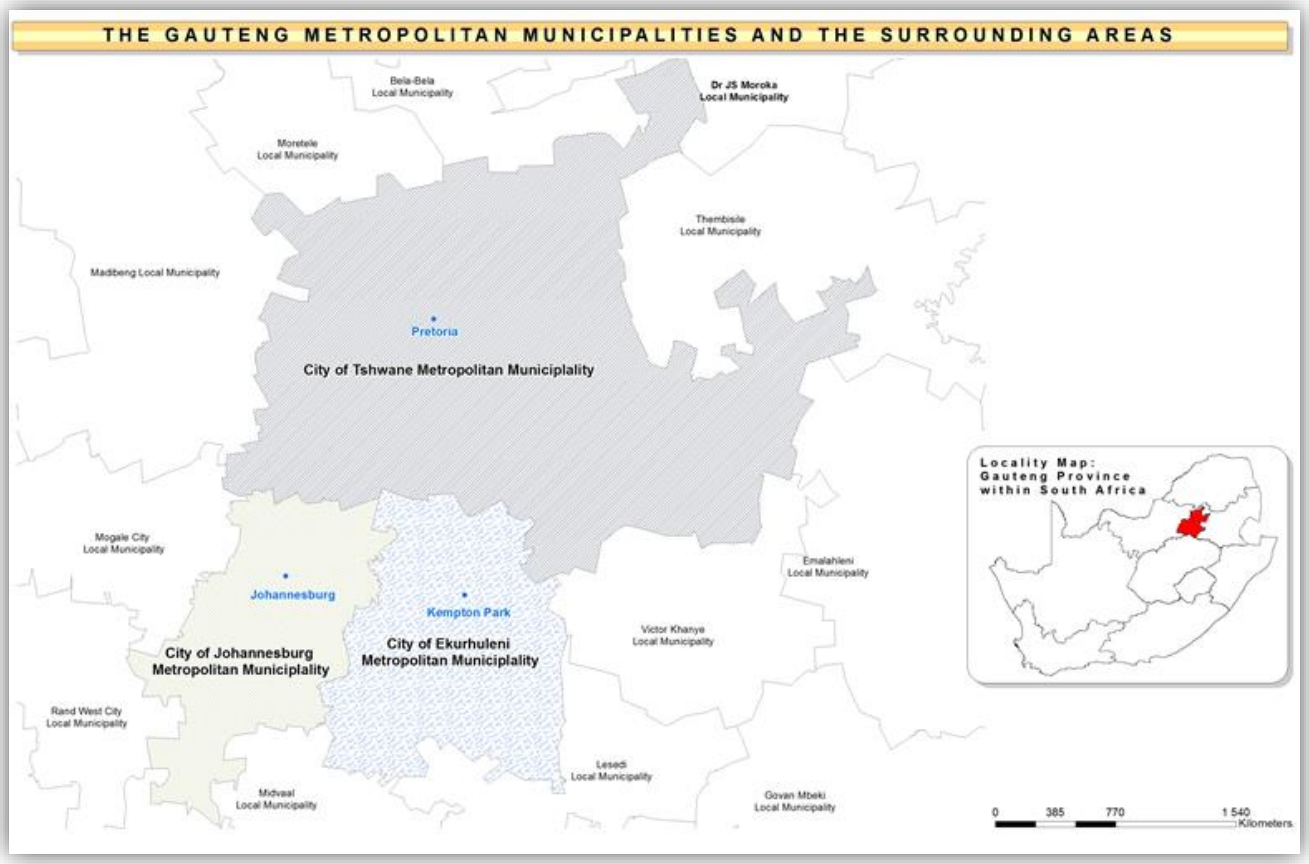


Figure 37: Map of the study area

The provincial office of the SG and the CSG were selected as areas of study because they have been officially appointed as data custodians and custodian coordinators for cadastral data theme in South Africa. The Gauteng metropolitan municipalities were chosen as a study area because they are involved in terms of SASDI activities and play a critical role in land administration and cadastral mapping. The same metropolitan municipalities are in charge of keeping cadastral documents under their control up to date. In the province and South Africa, these metropolitan municipalities are at the forefront of land reform, spatial transformation, and land governance and management. The reason of this research to focus on Gauteng metropolitan municipalities was because Gauteng is the smallest (18 810 square metres), wealthiest, and most populous (per square metre) province in South Africa (Census 2011). The selected areas of Tshwane, Johannesburg and Ekurhuleni metropolitan municipalities, provincial office of the SG and CSG were, therefore, considered to have been appropriate in order to achieve the objectives of this study. Table 26, lists the demographic information of the three metropolitan municipalities.

Table 26: Demographic data of the three Gauteng metropolitan municipalities (Census, 2011)

Municipal name	Population size	Population density	Area	Households	Households Density
City of Tshwane Metropolitan Municipality	2,921,488 (463.89 per km²)	460/km2 (1,200/sq. mi)	6,297.83 km²	911,536	144.74 per km²
City of Johannesburg Metropolitan Municipality	4,434,827 (2,695.97 per km²)	2,700/km2 (7,000/sq. mi)	1,644.98 km²	1,434,856	872.26 per km²
City of Ekurhuleni Metropolitan Municipality	3,178,470 (1,609.10 per km²)	1,600/km2 (4,200/sq. mi)	1,975.31 km²	1,015,465	514.08 per km²

5.5 Research Instruments

The research instruments refer to the type of tools used to collect data such as questionnaires, focus groups, document review or literature review, interviews, and observations. The research aim and objectives of this study were achieved through the utilisation of the research exploration instruments illustrated in Table 27.

Table 27: Research instruments descriptions

No.	Name of Instruments	Type	Period	Target
1	Extended literature review	Qualitative	During data collection	- Legislation and policy review. - Review the management process of cadastral data. - SDI review.
2	Questionnaires	Qualitative	During data collection	- Cadastral data capture and management. - SDI readiness.
3	In-person interviews	Qualitative	During data collection	- Follow up unanswered questionnaires. - Organisational background and mandate. - Base data set custodianship
4	Observation	Qualitative	Pre-data collection and during data collection	- SDI and SASDI. - Attend SASDI workshops and meetings to obtain contextual information. - Stay aware of the present patterns and advancements pertaining to SDI, SASDI and cadastral data.

Table 27 also shows the period during which data were collected and concludes with the target column which describes the type of data that were reviewed. During this study an extended literature review, interviews, questionnaires, and observational research were conducted in order to gather the necessary data that was used to answer the research questions and research aim. The research instruments identified in Table 27 are unpacked and explained in the section that follows.

5.5.1 Extended Literature Review

This study sought to obtain the information to inform recommendations on the custodianship roles and responsibilities of metropolitan municipalities regarding cadastral data within the context of SASDI. For this purpose, a broad and appropriate literature review was conducted in an endeavour to deliver the theoretical basis for this research project. The literature review delivered scientific justifications for the research questions of this study.

Review of the literature provided a theoretical background for subsequent research and developed the breadth of research on the topic of interest. Literature review is largely alluded to as the "theoretical framework," or "research background". An extensive literature review, according to Mondal and Mondal (2018), ought to be orderly to guarantee an explicit methodological approach, unambiguous in clarifying the measures by which it is guided, far reaching in its extent of including all pertinent material, and thus reproducible by other scholars who might follow a similar methodology when reviewing a certain topic.

Mondal and Mondal (2018) argue that literature review is having a knowledge relating to the general state of the literature by sourcing, outlining, and combining obtainable literature regarding the researcher's subject of intrigue. This study, in accordance with Mondal and Mondal's (2018) proclamations, utilised obtainable literature to comprehend the legislative and policy environment for local government, cadastral data and SASDI. This allowed the researcher to thoroughly investigate the legal framework that governs how the Gauteng metropolitan municipalities' CSG and SG office currently contribute to cadastral data in the country.

The literature review was conducted predominantly by referring to primary, secondary, and tertiary literature and grey literature which were obtained through the internet, common data bases and sourced from libraries. The main topics addressed during the literature synthesis were on different spheres of government, the South African local government legislation and policy, cadastral data, and spatial data infrastructure.

Using an extended literature review was necessary to properly evaluate and investigate research findings that other scholars have reported on the topics. Doing this, strengthened the rationale for conducting this research. The internet was used extensively as a source of general information in this study and in order to understand the legislative and policy environment for local government that defines the roles of the three spheres of government in South Africa.

Reanalysis of results and findings from various scholars was conducted. Table 28 lists the literature review data collection and analysis processes that were applied during the phase of literature assortment. The stages were as follows:

Table 28: Literature review data collection and analysis process

Research instruments	Stages in the data collection process	Phases of Data Collection and analysis
Phase 1: Literature review (Qualitative)	*Stage 1*	formulating the research question and objective(s)
	Stage 2	searching the extant literature
	Stage 3	screening for inclusion
	Stage 4	assessing the quality of primary studies
	Stage 5	extracting data
	Stage 6	analysing data

Stage 2: *Searching the extant literature*. Searching the literature and making decisions about the suitability of material to be considered in the review was conducted in this stage. The literature review was divided into three chapters, namely local government, cadastral data, and spatial data infrastructure. This made the search for literature much easier.

Stage 3: *Screening for inclusion*. The evaluation of the applicability of the material identified in the preceding step was conducted in this stage. All the identified literature related to local government, cadastral data and spatial data infrastructure were screened. Table 29, illustrates a set of predetermined rules which provided the basis for including or excluding certain studies. According to Carter (2018), inclusion and exclusion criteria set the boundaries for the systematic review.

Table 29: Pre-determined rules for including and excluding certain studies (Carter, 2018)

Predetermined rules for including or excluding certain studies				
Type of resources	**Primary Literature**	**Secondary Literature**	**Tertiary Literature**	**Gray literature**
Authors	Researchers/ scholars	Researchers/ scholars	Professionals	Professionals
Content	Original research results in journals, dissertations, conference proceedings, correspondence, scholarly journal articles (research based)	Review articles, systematic reviews	Textbooks, encyclopaedias, handbooks	Letters, memorandums, faxes, reports, flyers, templates, newsletters, brochures, product lists, budgets, financial documents, policy documents, forms News, general interest article, pop culture, sports, etc.
Sources	Always cited (footnotes, bibliographies)	Always cited (footnotes, bibliographies)	Sometimes cited	Not cited Sometimes cited
Published	Peer-reviewed journal	Peer-reviewed journal	Sometimes reviewed	Not and Sometimes reviewed
Period	Less than 5 years* seminal studies included (older than 5 years)	Less than 5 years* seminal studies included (older than 5 years)	More than 5 years	More than 5 years

Stage 4: *Assessing the quality of primary studies*. In addition to screening material for inclusion, the scientific quality of the selected studies needed to be assessed. Reliable and valid quality assessment of primary studies was undertaken. Evaluation of the documents relating to local government, cadastral data and spatial data infrastructure was conducted and the outcomes resulted in the usage of acceptable primary studies.

Stage 5: *Extracting data*. This stage involves gathering or extracting applicable information from each primary, secondary, tertiary, and grey literature study. The extracted information was that which addressed the research aim and objectives.

Stage 6: *Analysing and synthesising data*. As a final step, the researcher collated, summarised, aggregated, organised, and compared the evidence extracted from the included studies. The extracted data was presented or drafted in a meaningful way to provide a new contribution to the extant literature.

5.5.2 Questionnaire

Hofstee (2006) describes a questionnaire as a research instrument comprising of a progression of inquiries to collect data from respondents. In reviewing Silva et al. (2014) and Barry (2016) noted they emphasise that a questionnaire enables responses to be accumulated from the respondents moderately rapidly and cost effectively. Barry (2016) maintains that a questionnaire is likely to produce less in-depth responses and prevents the researcher from probing responses further. A semi-structured questionnaire (refer to Annexure A) was compiled and utilised to obtain relevant data from identified key cadastral data custodians and perspective custodians.

The questionnaire approach was appropriate for this study because it was intended to take stock of the current status of the SASDI custodial roles and responsibilities in terms of cadastral data in a metropolitan municipality. A draft questionnaire was prepared by the researcher and discussed with the researcher's three supervisors. All the changes suggested by the supervisors were implemented.

The questions within the questionnaires were typed and prepared in English, and they were prepared as a semi-structured protocol using open-ended questions which were intended to permit the respondents to describe or answer in their own words. Using the three metropolitan municipalities as the study participants, the research was able to investigate the role of metropolitan municipalities in the value chain for cadastral data in South Africa and to make recommendations on their roles and on the custodianship of cadastral data.

The cover page of the questionnaire comprised an introductory statement pertaining to the brief motive for undertaking the study, the participant consent form, the collection of brief background information on the respondent's functional unit, and their signature. The rest of the questionnaire was divided into four parts A, B, C and D (refer to Annexure A for a complete questionnaire with consent form).

Elaborating on Table 30, Part A of the questionnaire contained four questions and introductory information as well the consent form. All questions were based on the organisation's functional unit relevant to this study. Two questions where multiple choices, closed-ended, questions and the

respondents were asked to tick the right option. The other two questions were open-ended, and respondents were asked for their opinions and comments without suggesting a pre-set list of answers. In Part B, all four questions were open-ended, and respondents were asked for their opinions and comments without suggesting a pre-set list of answers. Table 30, shows the questionnaire format used in this study.

Table 30: The questionnaire format

Sections or Parts	Description of content
Research introduction and Consent Form	This part included the research consent form and provided a brief background to and purpose of the study.
Part A: **Functional unit background information**	The intention of this part of the questionnaire was to gather information and gain insight pertaining to the mandate of the relevant functional unit of the organisation, the duties they perform with respect to cadastral data and spatial information in general, and where they source their spatial data.
Part B: **Spatial data legislation and policies**	In this part, questions on the Land *Survey Act No. 8 of 1997*, SASDI and legislation and policies affecting cadastral data were contained.
Part C: **Cadastral data management**	This part contains questions related to cadastral data management such as definitions of terminologies, cadastral data capturing, collection and dissemination, the use of cadastral data, format of the data kept, the scale of the data set, and the GIS or data set standards that are used by each organisation involved in this research.
Part D: **Custodianship and value chain for cadastral data**	The last part of this questionnaire was mainly based on questions related to spatial data related collaborative agreements/contracts, data custodianship responsibilities, metadata, SASDI, and internal error reporting processes and procedures, data set specific question (completed for cadastral data set) and additional questions.

Part C of the questionnaire consisted of a total of 15 questions of which, all were open-ended questions with the exception for one question which respondents were allowed an option to tick a box or elaborate. Part D consisted of nine sub-sections which were also subdivided further into smaller parts. This brought the number of questions in this part to 30. The questions were mostly closed-ended with a few open-ended. All open-ended questions had a remark section to allow respondents to make additional remarks if necessary.

Identical questionnaires were distributed to the *Corporate Geo-Informatics* (CGIS) office based at the City of Johannesburg Metropolitan Municipality; the CGIS office based at the City of Tshwane Metropolitan Municipality; City Planning Department: Geo-informatics office based at the city of Ekurhuleni Metropolitan Municipality; and the CSG office and the Gauteng SG office, both administered under the DALRRD.

All the partaking organisations were represented at either the national, provincial, or local sphere of government in South Africa. For the purpose of this research, the participation protocol was that one manager and one technical expert from each participating organisation was included in the study, where possible. Managers were preferred for the knowledge they possess on the legislation and policies regarding cadastral data management, land administration and geoinformatics, while

technical experts were preferred for their technical expertise on cadastral data management, land administration and geoinformatics.

5.5.3 Interviews

Interviews are a staple method used in qualitative research. The interview, as a research method, is a noteworthy information gathering procedure involving verbal communication between the researcher and the participant (Creswell, 2014). Interviews are commonly used in exploratory and descriptive studies. There is a range of approaches to interviewing. However, for the aim of this study, unstructured interviews were applied; meaning that the participant responses were not limited to answering direct questions (Sanders, 2018).

For the purpose of this study, an interview approach was appropriate because it assisted to explain, better understand, and explore cadastral data and spatial data infrastructure opinions and experiences. Since the interview questions for this study were open-ended questions, it made this instrument more appropriate. It also enabled the researcher to collect in-depth information. The purpose of the semi-structured interviews was to assist the researcher with follow-up questions on incomplete questionnaires and to briefly assess how municipalities currently fulfil their role for cadastral data within SASDI by discussing the following:

a. Institutional arrangements (functional unit).
b. Overview of organisation's spatial data legislation and policies.
c. Cadastral data management (cadastral systems, for example, cadastral data).
d. Value chain for cadastral data (stakeholders).
e. Implementation of Spatial Data Infrastructure within an organisation or functional unit (custodianship).
f. Any other relevant issues pertaining to cadastre in the organisation.
g. Respondent may submit additional materials, for example, presentations or any documentation on cadastral data.

All participants were sent e-mails regarding the interview. The e-mail clearly stated the reasons for the interview, with a list of questions to be asked (all questions were based on the unanswered questions of the questionnaire) even though the interviews were unstructured. Sending the interview questions to the participants in advance was premeditated to make it easy for the respondents to answer.

Each interview session lasted no longer than one hour. All the interviews were a face-to-face interaction with the participants and were held at the offices of all individual eight respondents or officials. The request for an organisation to participate by making available a manager and a technical expert from their organisation was made through an email. A request for participation letter was sent to all organisations that were part of this study prior to data collection, and participants were asked to sign and email back the letters. Only technical experts participated in the interviews and no manager was part of the interviews.

The managers gave the same reason that they have delegated officials with relevant knowledge and experience, hence they did not participate. Since these were follow up question that were not completed on the questionnaire that was circulated in advance, some managers gave inputs into the

question that the researcher sent out. This strategy permitted the researcher to deliberate on the topic and the dynamics of the interview. Table 31, lists the semi-structured interviews that were conducted with five participating organisations. The name of the organisation and functional unit visited, the date, duration of the meeting, and location where the meeting was held.

Table 31: The list of conducted interviews

Organisation	Functional unit	When	Duration	Location
CoJ	CGIS	02 August 2019	1hr	158 Civic Boulevard
CoT	Cooperate: GIS	23 July 2019	1hr	CoT Metro Building
CoE	City Planning Department	24 July 2019	1hr	Markem Building, Kempton Rd
CSG	Cadastral Spatial Information	12 August 2019	1hr	Deeds Office
Gauteng SG	Gauteng SG	12 August 2019	1hr	CSG Office

5.5.4 Observational Research

Malhotra et al. (2017, p.292) describe observational research as “a method which includes recording the personal conduct standards of individuals, items, and occasions in an efficient way to obtain information about the phenomenon of intrigue”. The observer does not question or communicate with the people being observed. Driscoll (2011) argues that observations can be conducted on any subject matter, and the type of observations the researcher conducts rely upon the research question. Given (2008, p.522) argues that observational research “is considered as fundamental to good qualitative research. Observation can be used to collect various sorts of behavioural or interactional data”. The collection of observational data ranges from open-ended (a search for pattern) to closed and coded (a search for pattern confirmation).

Kawulich (2005, p.1) also submits that an observational research is “a deliberate depiction of occasions, practices, and rarities, in some random setting chosen for a research. The researcher’s role can range throughout this process.” To investigate how Gauteng metropolitan municipalities, CSG and the SG office currently contribute to cadastral data, the observation tool was chosen in order to supplement the other research methods of the study. The researcher conducted non-participatory observations through systematically recording observations and by adopting a naturalistic approach at the two SASDI workshops and *CSI Subcommittee* meetings.

By comparing and synthesizing the observed information with information gathered from the review, questionnaires and interviews, this provided a holistic investigation and interpretation of the research questions. SASDI cadastral data workshop was held on 29 May 2018 in Pretoria. The participants were the CSG delegates, provincial SG representatives, Gauteng local municipalities’ representatives and *CSI Data Subcommittee* members. Each participant was requested to prepare a presentation covering the theme cadastral data.

5.6 Limitations and Assumptions

The primary limitation of this study was its scale. The scope of this study is wider, but the sample size was limited to only three metropolitan municipalities and the DALRRD. These three Gauteng metropolitan municipalities are a limitation to the study because the data collection in each municipality was confined to a few respondents or organisations. Data collection was a challenge because each metropolitan municipality has its own internal policies. This led to a number of unique challenges and set them apart from each other, which creates complexities when comparing or analysing data collected from each metropolitan's internal policies. For instance one question not applicable to all municipalities. Only the City of Johannesburg has provided account of its policy relating internal spatial information management. Other municipalities either did not have such internal policies or, like Tshwane, were in the process of formulating one. Another limitation was that only the Gauteng provincial SG office was selected out of eight provincial SG offices in the country. The CSG offices represent the national sphere of government. Permission to source relevant information about the study area, like processes of cadastral data management at local government, was granted because this information is freely available at any organ of state.

5.7 Ethical Considerations

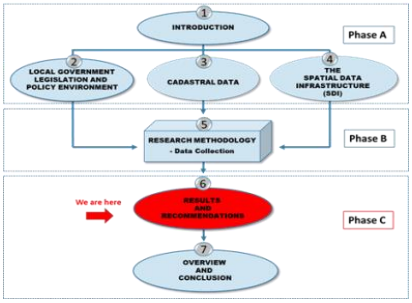
An accurate citation of used sources in the research, particularly in the literature review, was applied according to the relevant referencing methods, to acknowledge the sources. The researcher completed an ethics application to the *University of Pretoria's Department of Geography, Geoinformatics and Meteorology Ethics Committee* for approval before starting with the process of data collection. The University's Ethics application is very significant because it protects the institution and the researcher from possible legal implications resulting from the research. Refer to the attached Ethics Permission Letter (Reference number: 180000087) from the *Ethics Committee* of the *Faculty of Natural and Agricultural Sciences* in Appendix B.

The researcher told the participants from the three Gauteng metropolitan municipalities and the DALRRD, of the purpose, nature, data collection methods, and extent of the research prior to commencement. Further, the researcher explained to the participants their typical roles as perspective data custodians or coordinating base data set custodians in writing via email and letters where applicable. Cadastral data custodians and non-custodians were informed about ethical issues concerning informed consent and uninformed consent and they signed the consent form (Refer to Annexure A for a consent form as part of the questionnaire). It was made clear to the participants that the research was only for academic purpose and their participation in it was voluntary.

5.8 Conclusion

In this chapter the research methods that were applied were presented and explained. A brief synopsis of how the information and data was obtained and analysed was provided in the form of a matrix. A research flowchart was provided in order to illustrate the sequence of actions that were executed to achieve the research objectives. The chapter indicated that the research conducted was predominantly qualitative. The information gathered from the key respondents was through empirical qualitative research methods, by means of literature review, questionnaires, semi-structured interviews, and participant observations of a workshop and meeting.

CHAPTER 6
RESULTS AND RECOMMENDATIONS



6.1 Chapter Overview

This chapter sets out the results of the literature review, questionnaire, interviews, and observational research, as described in the previous chapter. The bulk of the research results emanated from key respondent interviews and the questionnaire, as well as from the literature review. The research study endeavoured to address three main objectives, namely to understand the legislative and policy environment for local government, cadastral data and the South African Spatial Data Infrastructure (SASDI); to investigate how metropolitan municipalities, the Chief Surveyor General (CSG) and the Gauteng Provincial Surveyor General (SG) office currently consider their roles for cadastral data management; and to propose how municipalities can contribute towards the custodianship role and responsibilities in the SASDI.

In order to move forward, the shortcomings of the cadastral data and the SASDI need to be identified and addressed. These challenges and concerns were raised by the interviewed respondents. The research results that were established in the study are elaborated on and presented in the following order firstly, the literature review, followed by results from the questionnaire and interview, and finally the observation results. The results of the literature review were extracted from Chapters 2, 3 and 4.

6.2 The Results

6.2.1 Literature Review Results

This component of the research was mostly restricted to a desktop review of existing literature. Results are presented under the following headings: legislative and policy environment for local government; legislative and policy environment for cadastral data; and legislative and policy environment for the SASDI. The general literature review of available research on the legislative and policy environment local government, cadastral data and SDI or SASDI from a theoretical perspective and previous studies were examined. A review of these topics from a South African point of view is presented as follows:

6.2.1.1 The South African Legislative and Policy Environment for Local Government

A review of the existing research work on local government offered a very useful insight in terms of understanding the legislative and policy environment. The salient results of the research on the *South African Constitution* are noted. Table 32, provides an outline of the legislative and policy environment for local government:

Table 32 Results: South African Legislative and Policy Environment for Local Government

Results
a) The 1996 Constitution of the Republic of South Africa is fundamental to the economic, social and spatial development of the country and to the reform of its legal system. Amid the country's well-known past, one of the strongest themes in the Constitution is access to land and shelter. The Constitution recognises that the distinctive, interdependent and interrelated spheres of government are national, provincial and local.
b) Under Chapter 2 of the Constitution, the Bill of Rights provides that 'property' (which encompasses but is not restricted to land): • The State must take appropriate legislative and other actions, within its existing resources, to promote conditions that allow people to have access to land on an equal basis.
c) Land is alluded to as a class of property in sections of the Constitution.
d) The fundamental right to access to information kept by the State and others, this is fostered by the *Promotion of Access to Information Act* No. 2 of 2000 (PAIA), which compels the State to make unclassified information accessible to the public.
e) The municipalities separately execute their constitutional mandate in an efficient, effective and sustainable way. In its clearest meaning, municipal autonomy is represented in Schedule 4B and Schedule 5B of the Constitution in the distribution of powers and functions, with legal personality given to municipalities by the *Municipal Systems Act*.
f) The local government sphere comprises of 257 municipalities. The municipalities deal with growing local economies and providing infrastructure and service delivery. In the context of land administration municipalities are mandated to conduct duties such as land and property rates and taxes and regulate and control land development within their area of jurisdiction. All major municipalities are empowered to develop and manage municipal valuation rolls that are used to provide the rates assessment for properties within their administrative areas.
g) Traditional authorities established in certain rural areas have a role associated with land in terms of customary law. Section 211(1) of the Constitution acknowledges the position and role of traditional leadership in accordance with customary law. The *Municipal Structures Act* also allows traditional authorities to engage in the implementation of the *Integrated Development Plan* (IDP) policy.Today, in South Africa, there is a constitutionally pluralistic structure in which common law and customary law systems work in tandem and are of equal standing. However there is no individualised documentation of community land rights as the register is restricted to actions that only extend to 'formal' lands.
h) In South Africa, the local government *Municipal Property Rate Act No 6 of 2004* (MPRA) is the central law for the control of property valuations.
i) Municipalities are expected to determine the rate policy that is subject to the public consultation process under Section 4 of the *Municipal Systems Act* and the *Municipal Finance Management Act*.
j) The objective of the *Intergovernmental Relations Framework Act* (No. 13 of 2005) is to achieve coherent governance and to promote cooperative governance, and to ensure effective provision of services, effective monitoring of the implementation of policy and legislation, and the realisation of national priorities in the three areas of government.

Results
k) Section 3(3) of the *Municipal Systems Act* on co-operative governance allows unified local governments to establish common approaches as a separate sphere of government for local government; promote collaboration, mutual assistance and resource sharing between municipalities; find solutions to local government problems in general; and encourage compliance with co-operative principles. This is a mandate that is broad and generic. It is not clear who will assist and track local government enforcement in implementing programs and initiatives for this reason.

6.2.1.2 The South African Legislative and Policy Environment for Cadastral Data

This sub-section summarises the results from previous literature on cadastral data. The results describe the legislative and policy environment for cadastral data, the cadastre system, cadastral stakeholders, cadastral data standards, and cadastral data progress and challenges. Table 33, lists the results for the legislative and policy environment for cadastral data.

Table 33 Results: South African legislative and policy environment for cadastral data.

Results
a) The review of the literature found that different pieces of legislation have a direct or indirect effect on the capture, management and distribution of cadastral data. Acts, laws, procedures, guidelines, ordinances, and instructions are included. The results indicated that South African law is rooted in a variety of land ownership modes and partial land rights, both individual and collective. The basis for cadastral data are defined by these pieces of legislation. In South Africa, they set out the basis for the cadastral concept. In addition to a plethora of domestic legislation, South Africa has ratified or is a signatory to numerous international conventions. This helps South Africa regulate the use of cadastral data locally, while at the same time conforming to internationally accepted standards.
b) In conjunction with the *Land Survey Act* (No 8 of 1997), the Office of the Chief Surveyor General is responsible for maintaining cadastral data and for approving all diagrams necessary for the purposes of land registration. On 11 April 1997, the Land Survey Act 8 of 1997 began and intended to regulate the survey of land in the Republic. The appointment, powers, roles and responsibilities of the Chief-Surveyor-General, the Surveyor-General and the Chief Director are laid down in Sections 2 to 3A and 5 to 6. After the adoption of the final Constitution of 1996, the Land Survey Act was promulgated. There should be no apparent inconsistency between the provisions of this Land Survey Act and the Constitution in this context, as may arise in cases of pre-constitutional legislation. In reality, in particular, the Land Survey Act adheres to the values enshrined in the Bill of Rights of the Constitution, especially section 9. This Act is versatile enough to appeal to many forms of cadastral reform.
c) The Deeds Registry is responsible for the registration of all titles and changes made to them from time to time, as provided by the Deeds Registries Act (No 47 of 1937) and related regulations. However, the functions of the Deeds Registry have not been studied in depth because they fall beyond the scope of this research. Under different functional units, the Deeds Registries Office and the Cadastral Office operate separately. These offices, which come under the national DALRRD and consist of CSG, SG offices and provincial registry of deeds, are all responsible for land registration and land registry surveys. Currently, the cadastral information system and deed systems are not integrated, and they need to be integrated in order to improve the efficiency and accuracy of land information management in South Africa (a complicated issue, but the links between the systems seem to be difficult). The South African cadastral survey, nevertheless, is considered as one of the best on a global scale, as it provides accurate boundary delineation in order to register real land rights.

Results
d) Cadastral data exists under a cadastral framework funded by the government, managed, financed, and maintained by the government. The cadastral data and land record systems of South Africa are of outstanding quality. This is because the cadastral definition is founded on principles of good governance, including an open, transparent property rights registry. South Africa's land registry is centred on a cadastral system under which a diagram registered with the Surveyor General's office describes each portion of the land. Two subsystems form the cadastral system the land registration and cadastral surveys. The cadastral system comprises of two major governmental bodies, the *Provincial Surveyor General Office* and *Deeds Office*.
e) The on-going issue of individual property rights on customary land and that in most instances this land is not surveyed (no formally documented parcel boundaries exist) or formally registered ownership. The powers of traditional leaders over land allocation and on-going security of tenure are difficult, somewhat sensitive and on-going debates.
f) The challenges exist in aspects where mandate overlaps, lack of implementation clarification, and the challenges of government capacity to be enforced (at all levels, but especially municipal). The government structures that make accessible data on cadastral data and deeds are unstable and tend to be increasingly becoming out-dated in the way they make information available.

6.2.1.3 Legislative and Policy Environment for the SASDI

This sub-section presents the findings of Chapter 4 of the SASDI literature review. The results have recognised that SASDI discourses are well explored in literature and that their accomplishments are expressed alongside constraints in most cases. Table 34, lists the results of the legislative and policy environment literature review for SASDI as follows:

Table 34: Legislative and policy environment of the SASDI

Results
a) The SDI Act, No. 54 of 2003 (section 16) reflects the concept of cooperative government and intergovernmental relations as laid down in the Constitution by promoting state organs designated as data custodians to share spatial information in terms of collaborative agreements and to assist each of them in achieving coordinated spatial data set updates. This Act also provides the framework for cooperation that makes it easier for South Africa to collect, maintain, access and use geospatial data. This involves gathering and publishing metadata as well as describing requirements and prescriptions for the sharing of geospatial information.
b) The SASDI is crucial to the SDI Act's effective implementation. The SASDI's definition and objectives are outlined in section 5.5.2 of this dissertation.
c) The SASDI is based on the idea of a hierarchical collaborative SDI, which involves participation from all levels of government by stakeholders. This means that state bodies are responsible for developing their own spatial data models in accordance with their organisational requirements and in accordance with the defined standards for geospatial data.
d) The technical, institutional and policy components of SASDI are listed as follows: • Three key components form the technical framework: the SASDI website, the Electronic Metadata Catalogue (EMC) and the Data Capture Project Register (DCPR). • The institutional framework covers the following: the DALRRD Minister and Director-General, the Spatial Information Committee (CSI) and the National Spatial Information Framework

Results

- Policy framework consists of the *Base Data Set Custodianship policy*, *Pricing of Spatial Information Services*, SASDI *Regulation* and the *Compliancy Guidelines.* These policies provides for the SASDI framework in order to establish a well maintained authoritative data set.

e) The Base Data Set Custodianship policy provides for the CSI to appoint custodians of the base data set and to keep them responsible for the geospatial data they are entrusted with, and also specifies the duties and obligations of base data set custodians. The policy specifically supports the notion of collaborative custodianship as it facilitates cooperative partnerships between custodians of the base data set and other individuals or organisations in order to ensure access to the relevant base data sets. The three conditions for appointing a custodian are set out as follows:
   i. mandatory mandated responsibility
   ii. To generate and maintain such a data set, the organisation should have sufficient capability, resources and infrastructure, however this criteria is optional.
   iii. Recommended to be a data custodian by the CSI, this is a mandatory condition.

f) Under section 12 of the SDI Act, data custodians are responsible for capturing and maintaining their metadata and must make their metadata accessible to the DALRRD for inclusion in the EMC in the manner prescribed.

g) The framework for SASDI is intended to support the national outcomes set out in the National Development Plan (NDP).

h) The SASDI problems identified are mainly legislative, institutional, political and economic. They are listed briefly as follows:
   i. Legislatively, a strategy document or plan is absent from SASDI. Lack of compliance by the established and designated data custodians in terms of metadata capture and publication on the EMC. Current failure for existing custodians to comply with legislation, privacy and confidentiality issues; and problems related to the Personal Information Protection Act (No. 4 of 2013), all impede the functioning of the SASDI.
   ii. Institutionally, current geospatial information systems mainly represent their own customers, regardless of the needs of other potential users (organisational priorities and silos, followed by perceived individual objectives). Communication is related to hierarchy and control in most organs of state. Maturity is questionable concerning transparency, ownership, and shared responsibility. There is a lack of clearly defined functions, responsibilities and duties regarding collaboration.
   iii. Politically, limited or no buy-in from politicians and senior management in government.
   iv. In economic terms, the lack of funding to cover collaboration and the cost implications of implementing practical measures are inhibiting. Staff hosting, maintenance, and up skilling across the three spheres of government, particularly in smaller state bodies, may be untenable, particularly in an uncompromising environment.

6.2.2 Questionnaire and Interview Results

Data was collected from participating organisations by means of a questionnaire on the roles and responsibilities of custodianship of cadastral data in the context of SASDI, and five interviews were conducted with officials of the participating organisation, the interviews were intended as a follow-up query on unanswered questions from the questionnaire. Tables and summary methods are used to represent raw data, including the results of the questionnaire and the answers to interviews. The theme of each question and the answer given are presented in a tabular format from Part A, Part B, to Part C. Responses are presented in paragraphs due to the nature of the questions in Part D.

6.2.2.1 Part A: Business Mandate Supported Functional Unit

This subsection of the questionnaire was intended to investigate how different functions within an organisation are performed and controlled by different parts of the business. The data collected from Part A assisted with the establishment of the reasons for separating business operations into functional areas which is to allow each to operate within its area of expertise, thus building efficiency and effectiveness across the organisation as a whole. Table 35, lists the results of the business mandate supported functional unit as follows:

Table 35: Business Mandate Supported Functional Unit

Responses from the three Gauteng metropolitan municipalities, the CSG and the SG	
Question key phrase	**Response**
1. Mandate of functional unit	Metropolitan municipalities responses: The business mandates at the metropolitan municipalities included amongst others to make geospatial information available for the municipalities and its clients. This includes the capturing, management and processing of relevant property information in different configurations (that is services and products) as needed. Providing GIS support to metropolitan city planning and development to ensure all data are captured and managed and provide intelligent data analysis of the various forms of data to allow for management to make informed decisions for future developments and investments.
	The CSG mandate includes: a. Consolidating the national cadastral data and publishing them quarterly on their website for clients to access nationally through *ArcGIS Viewer*. b. Overseeing the spatial cadastral databases at all the provincial SG offices around the country. c. Coordinating the activities at all the SG offices nationwide in terms of data quality and assurance and software license renewals. d. Facilitating the process of replicating all the SG *Oracle* databases at the CSG Office to create a database backup and to use such database to run all quality control assurance queries. e. Data coordinator for all the SG offices. The Gauteng SG office functions to maintain cadastral spatial information and cadastral information services; provide cadastral advisory and research services; provide national geo-spatial information services; ensure accurate cadastral surveys and maintain a complete data set of all cadastral information and provide service delivery coordination services.
2. Spatial information activities (Functional)	The functional unit activities that the metropolitans, the CSG and SG perform, with respect to spatial information, are data collection, collation, interpretation and analysis, integrity, quality, metadata, dissemination of data, planning, decision support, policy, and reporting.
3. Spatial information activities (Organisation)	The organisational activities that the metropolitans, the CSG and SG perform with respect to spatial information are data collection and collation, interpretation and analysis, data integrity and quality, metadata, data capture and dissemination, planning, decision and policy support, and reporting.

Responses from the three Gauteng metropolitan municipalities, the CSG and the SG	
Question key phrase	**Response**
4. Spatial data sets sourced from other organisations	The metropolitan municipalities indicated the spatial data and the name of the organisation(s) from where they source, it and what they use the data set for, as follows: • Gauteng cadastral and servitude data sourced from the SG for the purpose of supplementing metropolitan municipality's base data set. • SG approved township layout data (CAD format) sourced from the different land surveyors and used for the purpose of updating the approved and proclaimed townships to metropolitan municipalities base data set. • Points of interest sourced from the service provider (*AfriGIS*), used for the purpose of mapping and viewing on online maps. • *Census 2011* sourced from *Stats South Africa* used for the purpose of mapping, analysis and viewing online maps. • Ward demarcations sourced from the Demarcation Board used for the purpose of mapping and viewing on online maps. • SG diagrams and plans sourced from the SG for the purpose of cadastral data maintenance and updating. Weekly deeds files sourced from the *Registrar of Deeds* for the purpose of ownership (title deeds/registration) maintenance. The CSG and SG indicated the spatial data and the name of the organisation(s) from where they source data, and for what the data set is used, as follows: • Ortho-photo imagery, sourced from the *Chief Directorate: National Geo-*Informatics (NGI) for the purpose of orientation. • Transport data, sourced from the *Department of Transport* for the purpose of orientation. Water data, or hydrological data, sourced from the *Department of Water Affairs* for the purpose of orientation.

6.2.2.2 Part B: Geospatial Data Legislation and Policies

Part B presented data on supporting geospatial data legislation and policies of Metropolitan Municipalities, CSG and the provincial SG Office, as well as on how they influence the use of cadastral data. This showed how the legal and policy system assists the participating organisations in the management of cadastral data. The results of the geospatial data legislative and policies investigation are presented in Table 36, as follows:

Table 36: Spatial Data Legislation and Policies

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
5. How does the *Land Survey Act* (No. 8 of 1997) affect your work?	The CSG and SG mandates specified in the *Land Survey Act* specify that municipalities work according to the Act and adhere to the rules and regulations of the Act. It empowers SGs to ensure an integrated and comprehensive land administration. According to metropolitan municipalities, the Act affects their work through the town survey marks maintenance. The

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
	cadastral data are maintained only according to SG approved diagrams and plans. However, one metropolitan stated that it has no specific impact. The municipality receives approved SG diagrams from the SG's office and captures accordingly.
6. What is the contribution of cadastral data towards the SASDI?	All the metropolitan municipalities alluded that they recognise cadastral data as a base data set of national importance. It is important when its metadata is on the SASDI electronic metadata catalogue (EMC). The importance and usage of the cadastral database for urban planners, property valuators, and engineers, is paramount to perform their duties and make informed decisions. Spatial and network analysis also uses cadastral base data to develop communities and improve service delivery.
	The contribution of both the SG and CSG's cadastral data towards the SASDI is that as the authoritative source of cadastral data, they are two of the key stakeholders of the SASDI since they were appointed as base data set coordinators, and cadastral data are one of the base data sets for the SASDI. They contribute their metadata to the SASDI. Various other legislation or policies affect cadastral data within these offices through the prescribed standards, processes, and procedures of cadastral data set capture, management and dissemination.
7. How do other legislation or policies affect cadastral data use in your organisation?	In metropolitan municipalities, generally, spatial information policies provide a guide to standards for the GIS units within the relevant area of jurisdiction. The *Base Data Set Custodianship Policy* defines and identifies municipalities as contributing custodians. The *Pricing of Spatial Information Products and Services Policy* provide guidelines on pricing of the municipality's cadastre. Only one GIS policy affects cadastral data use in some municipalities. Cadastral data use is affected by the *Deeds Act* with respect to land ownership and *mSCOA* (*MFMA Circular No. 80 Municipal Finance Management Act* (No. 56 of 2003)) with regards to standard functionality requirements of the municipality billing system (integration via unique ID key i.e. *LIS* key). The CSG and SG stated that cadastral data are some of the base data sets for the SASDI. It plays an important role in the overall base data set in the country. It indirectly ensures the promotion of sustainable development. It affects the standards of cadastral data capture.

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
8. Which legal and policy framework administers cadastral data within your organisation?	The responses from the metropolitan municipalities pertaining to the legal and policy framework that administers cadastral data mentioned: • compliance with *ISO 9001* (QMS) relating to work procedures; • components of the MAYCO approved GIS Strategy addresses certain geospatial database administration responsibilities; • *mSCOA* addresses the need for cadastral data for the property value chain (integration via a unique ID key i.e. *LIS* key); • *SDI Act* and its policies; and • *Spatial Information* policy and security policy. The CSG listed the following legal and policy frameworks namely: The *Deeds Registries Act* (No. 47 of 1937); land administration policy; and the *Land Survey Act* and its regulations.

6.2.2.3 Part C: Cadastral Data Management

The purpose of Part C of the questionnaire was to take stock of the data on how the three Gauteng metropolitan municipalities, the CSG and SG maintain and manage the cadastral data the collect or capture. Table 37, lists the results of how the participating organisations conduct cadastral data management as follows:

Table 37: Cadastral Data Management

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
9. What is your understanding of the cadastre and cadastral data?	The understanding of cadastre and cadastral data by metropolitan municipalities is that cadastre is a database or delineation of property boundaries as a legal registry, such as stand boundaries, township boundaries and farm boundaries, as well as roads and possibly street addresses. The metropolitan also stated that cadastre is a legal or public register of land tenure indicating the position, dimensions, extent, value and real rights to land, and that cadastre is a record of an area including location, boundaries, value and ownership of the land. They defined the cadastral data as a system of legally establishing the position, dimension, and extent of land boundaries for purposes of creating land parcels suitable for ownership or recording real rights to land. The CSG and SG's understanding of cadastre and cadastral data is that cadastre is cadastral data combine with ownership information, and cadastral data are about property boundaries. It is processed data in respect of fixed property boundaries. The information is used to administer the land in the country and for sustainable development.
10. & 11. Do you capture your own	All participating metropolitan municipalities confirmed that they do capture their cadastral data when it is necessary, based on the SG approved diagrams or plans and "status" based on deed records e.g. "registered". The metropolitan municipalities

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
cadastral data and how often do you update the cadastral data?	stated that they update the cadastral data on a daily basis and updating data is a continuous process. As soon as changes (SG approvals) come through, the updating commences. The CSG do not capture their own data but source it from the provincial SG offices, while SGs capture their own cadastral data using private professional land surveyors to capture it on their behalf.
12. How are cadastral data sets managed within your Functional unit?	The general response from the participating metropolitan municipalities was that it is a unit's role and privilege to manage the cadastral data through the database administration functionality. However, one metropolitan municipality stated that cadastral data sets are managed by a sub-section called *Land Information System Management* (LIS) within the section: *Corporate Geo-Information Management*. The CSG and SG Gauteng's responses were that the management of cadastral data is conducted by the unit called *Spatial Information* that updates farms and farm portion boundaries daily, including their descriptions. It receives the latest cadastral information from land surveyors, upon approval, management of cadastral data sets commences. Each SG office manages its own data. At the CSG, data are collated and disseminated to users.
13. Do you source your cadastral data from the Survey General office?	The participating metropolitan municipalities concurred that they source cadastral data from the SG. In most cases they source their cadastral data via websites or electronically online. Only SG diagram images are sourced through electronic downloads and ordering of specific approved cadastral diagrams or plans. They usually receive a list of all new approved diagrams at the end of every month. They then download these diagrams from the CSG website or via a customised *Request for Information* (RFI) tool. They also request specific diagrams as and when required from the SG. CSG source cadastral data from the SG offices. The question is not applicable to the SG, though they source their cadastral data using private professional land surveyors to capture it on their behalf.
14. Do you provide your cadastral data to the Surveyor General office?	The Gauteng metropolitan municipalities confirmed that they do offer updated cadastral data to the SG offices when requested by the SG offices and normally the cadastral data are not taken up by SG office. The question is not applicable to both the CSG and the SG.
15. What are the uses of cadastral data in your functional unit?	The participating metropolitan municipalities stated numerous uses of cadastral data in their respective functional units. The answers varied: cadastral data are the foundational data set of the base-map on the *Intranet and Internet GIS Viewers*; it is essential to various levels of integration; it is a reference to maintain services data sets; it is useful for geospatial analysis and reporting (including mapping); and it is the starting point of the property value chain. The metropolitan municipalities also use it for validating billing records to assist with financial impact, value of property, including assisting with decision making within the city, correcting allocation of points of interest, heritage buildings, validating ownership

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
	vs. stand parcels and so on. It is also used for revenue enhancement, development facilitation, service delivery boundary disputes and zoning scheme databases. SG and CSG are the custodians of cadastral data, therefore, they supply cadastral information to various stakeholders and facilitate the regulation of cadastral surveys in order to support land and economic development with special emphasis on land tenure reform.
16. Do you have the authority to update the cadastral data?	The metropolitan municipalities agreed that they have the authority to update cadastral data in their care. They are mandated through the *Municipal Rates Act* (No.6 of 2004*); Municipal Systems Act* (No.32 of 2000); *Municipal Financial Management Act* (No.56 of 2003), and the *Spatial Planning and Land Use Management Act*. In one metropolitan municipality, the mandate is usually with the sub-section: *Land Information System Management (LISM)*, but also governed by *mSCOA* (Financial Systems) and AG requirements. Both the CSG and SG office are mandated to update the cadastral data through the *Land Survey Act* (Act No. 8 of 1997).
17. What would trigger an update of the cadastral data?	Answers from the participating metropolitan municipalities included the following reasons: • Through section 38 and 101 certificates legislated by the *Town Planning Ordinance*. • When transferring the property ownership from deeds downloads and exception report from finance for geographical information system (GIS) match. • Provincial gazette notice of proclamation. • Daily cadastral data capture via automated downloads of approved SG diagram images. • Change of ownership, consolidation, rezoning of property, subdivision of property and so on. • Information received from the SG's office that needs to be captured or updated on SDE. CSG and SG stated that new township and property establishments are the main trigger for updating cadastral data.
18. and 19. What formats are used to store and distribute all the cadastral data sets?	The metropolitan municipalities store their cadastral data in various formats, ranging from the shape file using *Esri South Africa* software, *ArcGIS SDE* and *MSSQL Spatial*, spatial relational database (Geodatabase), and *Enterprise GIS* database in ST geometry type. The same metropolitan municipalities distribute their cadastral data in various formats ranging from digital dxf, pdf, excel and hardcopy maps, digital data distributed in *ArcGIS* file geodatabase (.gdb), shape (.shp) and web map services (municipality base map), *ArcGIS Desktop Enterprise* (LAN service), *ArcGIS Online* mapping service (Public), *File* geodatabase, *Microsoft Access* geodatabase, and export to various image formats such as: pdf Tiff etc. and CAD formats .drg .dwg .dxf and .cex.

Responses from the three Gauteng metropolitan municipalities, the CSG and SG	
Question key phrase	**Response**
	CSG and SG data sets are stored in the Oracle Spatial Database and data are extracted to shape file format for users. They disseminate cadastral data in hard copies and digital images, and extracts of spatial data in dxf and shapefile format.
20. Briefly describe your cadastral system.	Metropolitan municipalities' cadastral data handling system comprises all SGO approved land parcels (townships, erven, farms, farm portions, agricultural holdings), sectional schemes, servitudes, leases, proclamations and so on). It also comprises an attribute indicating if the real right is registered at the Deeds Office. Title deed numbers of registered properties are also included in the cadastral attributes. The CSG and SG described their cadastral system as the combination of the survey of the parcels and the recording of the ownership and rights pertaining thereto.
21., 22., and 23. What is your understanding of LADM, STDM and ISO 19150?	The participating metropolitan municipalities said they were not familiar with the terms LADM, STDM, and ISO 19152. One metropolitan municipality described LADM as a data model that facilitates fast, efficient land administration. Based on the land administration standards, ISO 19152 facilitates cadastre exchange. They described STDM as a refinement of LADM, which includes pro-poor security of tenure (informal and formal rights). Person to social tenure relationship to spatial unit ISO 19152:2012, defines a reference LADM covering basic components of land.

6.2.2.4 Part D: Custodianship and Value Chain

Part D of the questionnaire provides a summary of the results on the custodianship and value chain of geospatial information or cadastral data.

Question 24: Describe your collaborative agreements/contracts with other organisations (e.g. organs of state, service providers, agents etc.)

Metropolitan municipalities' responses: Those without any collaborative agreements in place agreed that consideration should be given to improving collaboration in areas of mutual interest, reducing duplication of data capture, improving data exchange, and reducing costs through the optimisation of resources. The one metropolitan who has collaborative agreements in place stated that the data exchange agreements are signed as and when required. They currently have collaborative agreements with *IEC, StatsSA,* and *SG* (organs of state) and *Enterprise* license agreements with various service providers or data vendors namely *AfriGIS, The Knowledge Factory, HERE Data*, and *TELKOM*.

The respondents from the CSG and SG offices stated that they have not set up any collaborative agreements between themselves and other organs of state or other stakeholders. Although organs of state and stakeholders source or collect data from the CSG and SG, there is no formal agreement that they are aware of with external data providers. They also agreed that this should be considered to improve collaboration in areas of mutual interest, reduce duplication of data capture, improve data exchange, and reduce costs through the optimisation of resources.

Question 25 (i, ii, and iii): Do you have any data maintenance plans in place and data integrity plans?

Note: Data custodianship responsibilities questions and answers are combined (from questions 25 (i, ii, iii) and 26 (iv, vii), 27 (a – s), as stated in the questionnaire). Question 26 (iv - vii) is focused on cadastral data, question 27 (a – s) is based on metadata.

The metropolitan municipalities' data are maintained at the operational level as far as possible. In most cases, municipal data are updated for every census. Formal maintenance plans have been drawn up by some of the metropolitans who participated in the study. Amongst the maintenance plans mentioned were the standard operating procedure(s) for cadastral maintenance between the GIS units such as *City Parks, Joburg Roads, PikitUp, Disaster Management,* and *Transportation*.

The general response was that the data integrity is determined by the methods of capture and is geared for their mandated purpose. Metropolitan municipalities, including the SG and CSG, handle errors as they are reported in an informal process. Data are verified before being added to the SDE and metadata must be attached and correctly geo-referenced. Updates and maintenance are aligned to secure data from the SG (SG diagrams or plans) and the Deeds Office. Geometry checks and other quality assurance procedures are conducted as well as backups and DR plan(s). The job description for the Manager, Spatial Information, was described in this regard.

In cases where there is not a formal error reporting system, respondents indicated that it was mainly because errors would be extremely difficult to pick up due to the specialist nature of data captured and lack of resources and expertise. Data integrity is geared to the organisation's data capture mandate and does not take broad GIS user needs into consideration. With limited capacity, organisations follow a mandate-focused approach to data capture.

Question 26 (iv, vii): Data accessibility, distribution, and consolidation at national level (cadastral data)

The currency of data sets varied according to the type of data and method of capture. The data sets are distributed and supplied through online mapping service, all and any data transfer and storage facilities, hard-drive, DVD, USB, hard copy maps, and distributed via media, email, or *Drop-box*. All respondents considered that their data are made accessible at a no cost, in accordance with the approved SASDI pricing policy and the *Cost of Fulfilling User Request* (COFUR) is applicable were necessary. The ability to integrate own with other data sets depends on format and geo-referencing, and can be integrated via 26-digit code, or any common attribute.

The unique ID key (LIS key) is essential for data set integration (for example zoning, property management, valuation system, and so on). Other departments or stakeholders utilise their data as the base data set therefore data are integrated, for example, the SG. The metropolitan municipalities do not consider themselves as base data custodians and almost all their data sets captured are derived. Data consolidation at national level is a function of the base data set coordinator where applicable and updated data sets do not always cover all areas.

Question 27 (a – s): Metadata captured and/or published standards and format, metadata comprehensive and meaningful? (Metadata)

The respondents confirmed that they capture metadata and it is compulsory for all organs of states' GIS data layers to have metadata. Some of the respondents admitted that their metadata is not in accordance with the required standards specified according to the SASDI EMC. The inspection of metadata supplied through geospatial data by some participants (in a shapefile's XML format) the default metadata is edited to include pertinent data and organisational information in certain key fields. The capturing of metadata takes place on an ad hoc basis and consists mainly of the software's default metadata files. Although some efforts are made to capture comprehensive metadata for core data sets, that is the exception rather than the rule. With a shortage of skilled GIS personnel, data capture is regarded as more important than the tedious rounding off, of metadata capture.

With the exception of one municipality, all respondents confirmed that they do publish their metadata on the EMC. When questioned, the reason for the municipality not publishing their metadata was that they were still busy compiling complete metadata for their data set. Metadata records should conform to the current South African and international SDI standards and prescriptions to promote interoperability. The minimum number of metadata elements specified for spatial information held by the respondents should conform at least to the minimum core metadata elements specified in *SANS 1878 part 1* and *ISO 19115 part 1*.

Additional metadata elements also may be specified in accordance with those regulations. The metadata formats varied according to organisation, ranging from hardcopy document, *Esri North American* – xml, *Esri Catalogue* and *ArcGIS Translator*. The *CSI Standards Subcommittee* (2018) was tasked to investigate, inter alia, metadata standards and fields of capture. This must be formally concluded so that the NSIF can provide organs of state with formal guidelines regarding the capture of metadata. This needs to be prioritised, as standardised metadata are essential to facilitate data set search and discovery. An issue regarding the appointment of custodians is that access to data has been indirectly affected, in the sense that stakeholders who are not officially named as custodians do not feel obliged to provide their metadata.

Question (t): Are you affiliated with the South African Geomatics Council (SAGC) or the SASDI? (Additional question which are optional).

All respondents are registered with the South African Geomatics Council (SAGC) and some of the respondents are not affiliated with the SASDI, but they have reported being aware of the SASDI.

Question (u): Concerns raised by respondents

The respondents highlighted the issues of mistakes on approved SG diagrams/plans not being addressed by the SG or the responsible land surveyor; missing SG diagram images on SG office system; the SG website being down too often, restricting access to SG diagrams and plans; and inadequate experienced Geographical Information Science (GISc) operational staff capacity to maintain cadastral data. From the interviews and questionnaire responses, it may be concluded that there is uncertainty about the relationship between state-owned enterprises and government departments in matters relating to data ownership, pricing, and custodianship. There is some expectation from these, and possibly other, government departments that the CSI should mediate in

such matters. The value of cadastral data is often underestimated. Cadastral data should be granted higher status and regarded as an asset, so that a greater cut of the budget can be directed towards building geospatial data management capacity to facilitate the capture, management, maintenance, integration, distribution and use of spatial information.

6.2.3 Observational Results

A non-participant observation was used for investigating the extent to which municipalities can be considered to have a custodianship role for cadastral data within the SASDI. Various presentations were conducted and all cadastral data stakeholders presented their version of the definition of the theme cadastral data. In most cases organisations defined cadastral data according to way the handle cadastral data in their daily operations. The municipalities described cadastral data as “a legal or public register of land tenure indicating the position, dimensions, extent, value and real rights to land.” The list of data sets under the theme cadastral data was described as follows: land parcels and ownership records the authoritative source of these data sets were identified as the provincial offices of the SG and provincial offices of the *Registrars of Deeds* respectively.

It was agreed that there is a need to list “contributing” data custodians responsible for capturing or maintaining each data set contributing to the theme cadastral data. The CSG and provincial offices of the SG were requested to draft the list of contributing data custodians for cadastral data with the help of metropolitan municipalities. All municipalities referred to the same key legislation when listing the applicable municipal legislation and indicated that the administration of cadastral data is grounded into the guiding principle from the *Municipal Property Rates Act (No.6 of 2004)* and other local government laws as well as the custodianship policy (section 4.5.2.3 of *Base Data Set Custodianship Policy*).

The observation revealed the current situation regarding the cadastral data administration at the national level which is that the CSG is the base data set coordinator, while spatial cadastral data are captured in the regional or provincial SG offices. These duties are aligned with both the *Land Surveyor Act* of 1997 and the *SDI Act* 54 of 2003. However their main functions include amongst others to promote and manage all survey and service related matters. They also responsible for examining, approving, and maintaining cadastral documents. These documents includes the diagrams, general plans, sectional title plans, beacon agreements, servitude plans and the survey records. The cadastral data maintenance processes were presented and they ensure that a complete, current, accurate, and accessible electronic data set of relative positions of all land rights is maintained.

The municipal representatives expressed the concern concerning the funding and structural location of the SASDI that are based within the DALRRD. The DALRRD is a custodian for several data sets. This makes DALRRD a referee and a player, thus creating conflict of interest. Recommendations were made that the most appropriate placement of spatial coordination function within government should be considered. Through observation there were few calls for the NSIF functions to be place at the presidency. Limited capacity and resource was another point of concern that is frequently raised by the cadastral stakeholders. The demand for accurate and timely spatial data can only be properly met if custodians are appointed for base spatial data sets. As a sustainable structure to promote the collection, management, preservation, integration, distribution and use of spatial information, this will drive the momentum to develop the SASDI.

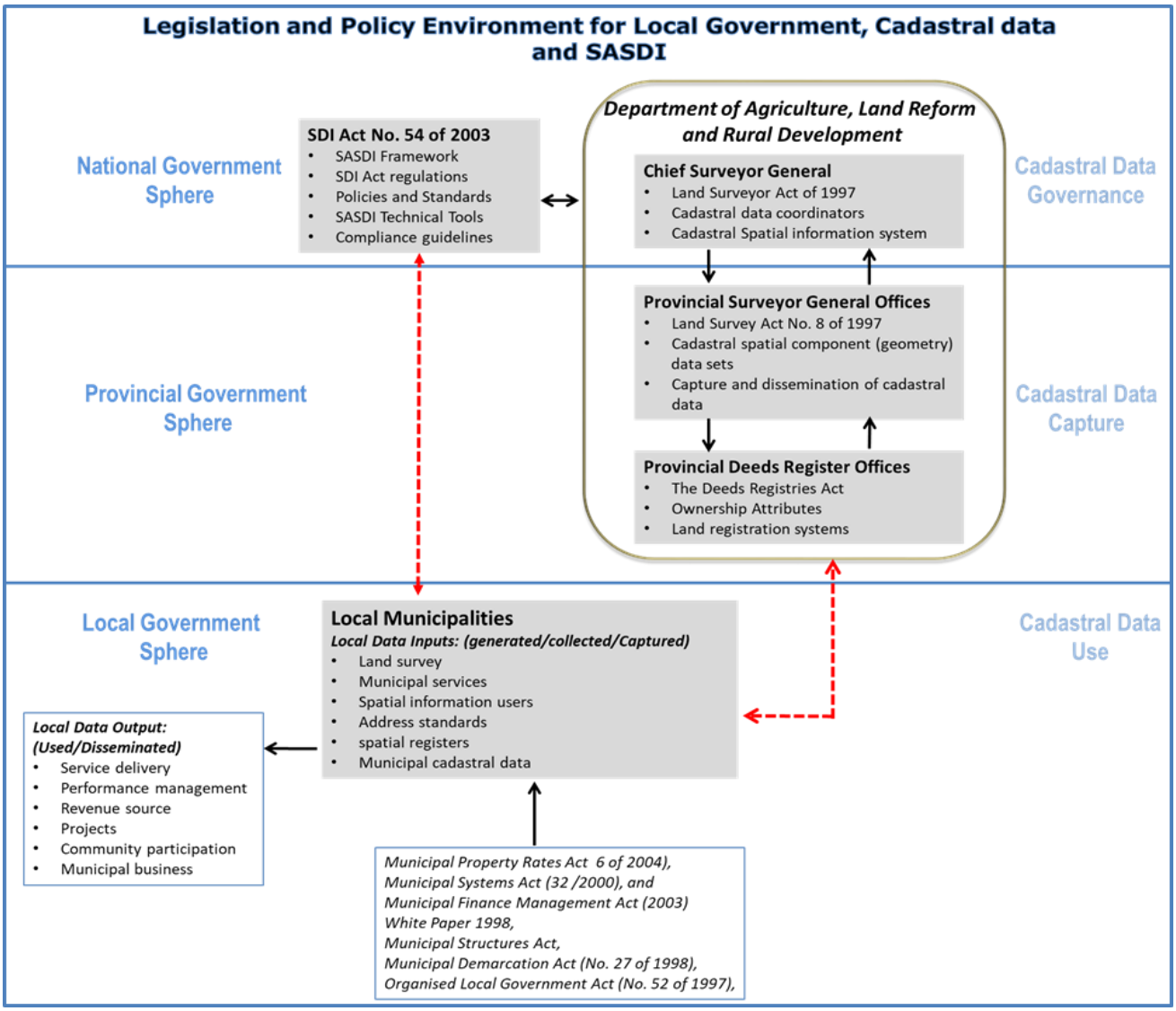


Figure 38: Legislation and Policy Environment for Local Government, Cadastral data and SASDI

Figure 38 illustrates the picture of the legislative and policy environment for the local government, cadastral data and SASDI. The red dotted lines represent the areas where this dissertation identified misalignment and lack of coordination in the context of cadastral data management. It is divided into the national, provincial and local spheres. At the national level the DALRRD comprises of the CSG which is responsible ensuring the integrity of surveyed real rights and to supply, maintain and provide access to cadastral data to the user throughout the country. The 8 provincial SG offices are responsible for land registration and cadastral surveying at a provincial level. The key legislation that governs the Surveyor General's responsibilities are the administration of the *Land Survey Act (Act 8 of 1997)* and the *Sectional Titles Act* (Act 95 of 1986).

All the participating organs of state illustrated their SASDI preparedness and readiness. A requirement was identified to highlight the legal environment in which the cadastral data are administered. Challenges that were observed include no formal agreement with other contributing custodian or

external data providers, a split cadastral system (not integrated) with the land registration system, The concern raised by some provincial offices of the SG is that metropolitan municipalities cannot be appointed or seen as authoritative source for cadastral data because their legal mandate is far-fetched.

Challenges identified by the three Gauteng metropolitan municipalities includes lack of data sharing among organs of state, duplication of efforts in terms of data capture, lack of user data requirements, failure to use acceptable standards. While the cadastral data specific challenges include spatial boundary errors, property description errors, missing properties, multiple layers, gaps and overlaps as well as insufficient attributes. Another main concern was that the CSG website is frequently down, thereby making SG cadastral data inaccessible. It was shown that these challenges can be address only if they can list all cadastral data custodians, develop guideline of the roles and responsibilities of custodians, to create a communication model and recognised metropolitan municipalities as cadastral data custodians. Although Metropolitan municipalities were not recognised as data custodians at this workshop, the results show that they have a legal mandate to be custodians and have sufficient capacity, resources and infrastructure.

6.3 Discussion

The literature review revealed that the public sector in South Africa is guided by a broad range of legislation and policies that the sector should comply to, and that such legislation and policies must be balanced against the statutory requirements as to how organisations should execute their functions. The analysis also revealed that a high-profile *Bill of Rights* is the foundation of the Constitution of South Africa. The Constitution is based on the principles of cooperative governance and inter-governmental relations, which foster coordination, collaboration and cooperation between organs of state.

The findings of the literature review have shown that municipalities are considered have custodian roles and responsibilities for cadastral data within the SASDI. The present situation is that the roles and responsibilities of South Africa's cadastral data are driven by the national government. The *Deeds Registries Act* (No. 47 of 1937) and the *Land Survey Act* (No. 8 of 1997) are the backbone of the cadastral data theme's legislative setting. The SG and the Deeds offices are the base data set custodians for land parcels and ownership records respectively, while the CSG is the custodian coordinator for the cadastral data theme. This means that the South African Constitution puts the functions and obligations for the registration of deeds, land surveys and land reform activities under the authority of the national government, including the essential aspects of land reform, redistribution, restitution and tenure. The DALRRD supervises the land tenure system (security of tenure and registration of rights).

In terms of cadastral data handling, within their respective jurisdictional boundaries, the metropolitan municipalities are empowered to perform land and property valuation within the structure defined by statute. All major municipalities are authorised to establish and administer municipal valuation rolls that are used to establish rate assessments for properties across their administrative areas according to the *Municipal Property Rates Act* of 2004. This guarantees that municipalities remain economically

viable and sustainable. As far as the Act is concerned, it is important to create and maintain a registry of all property rights from which the valuation roll is periodically collected and revised.

In their internal databases and land information systems, metropolitan municipalities run their property data separately and differently. This method of managing the operation of cadastral data makes it difficult to manage and exchange property data through their internal departments and contributes to data disputes and misinterpretations. This has a disruptive influence on service delivery as well. Municipalities use various methods and procedures for the management of cadastral data. The SG office approves the development survey plans, while the registered land ownership information is collected from the office of deeds. The geospatial data divisions of municipalities assess the property value. The components of rates and taxes capture the change of ownership from the ownership data of the deeds. Revenues from land tax rates and service fees are obtained by their revenue divisions.

In short, this demonstrates that the country's property valuation and taxation activities rely on the formal system of land registration. These functions rely on reliable, up-to-date and timely land parcels and ownership data. This means that successful and collaborative management of land knowledge is important. However this has proved to be a daunting task, especially in an environment where organisations operate in silos and certain organs of state are involved in the maintenance and supply of certain land information. This can be further complicated by the CSG website, which sometimes experiences occasional downtimes, as well as the lack of collaborative data agreements and a lack of data interoperability that guarantees seamless data incorporation.

There are a large number of stakeholders from many industries, working at many levels (national to local) that are part of the South African land administration domain. They often communicate successfully within this 'population' of stakeholders. At other times, they remain very distant from each other. This results in the often-repeated assertion that South African cadastral data stakeholders appear to work in 'silos.' The management and maintenance of cadastral data by various organs of state with different mandates causes gaps in data and possible data conflicts. As a consequence, there is a lack of transparency in communication and collaboration between stakeholders.

The review of the literature on land administration in South Africa at national level highlighted some of the main benefits of the existing cadastral and registry systems. For example, the South African cadastral survey is described as one of the best surveys in the world, as it provides an accurate definition of boundaries for the purposes of registering real rights in land, thereby providing formal land tenure for registered properties. One of the shortfalls of the cadastral system is that the cadastral information management system is not completely integrated with the deed registration system due to the various business models currently in operation.

The e-Cadastre was envisaged as a workaround for the convergence of the two systems, but its development has been halted. However this creates an opportunity to introduce the LADM extensible reference schema in order to update and improve existing models to become functional and competitive at a lower cost. Data sharing between SG and municipalities can be made simpler by implementing an online shared concept, such as interactive cloud mapping within the field of land administration.

In South Africa, the SDI Act (No. 54 of 2003) sets out the legislative and policy environment for SASDI. It also offers an integral basis for collaboration, making it easier for geospatial data to be obtained, managed, accessed and used. This includes collecting and publishing metadata, as well as defining the criteria and requirements for sharing geospatial information. SASDI encourages organs of state designated as data custodians to share geospatial information in the sense of collaborative agreements and to enable each of them to achieve coordinated updates of spatial data sets. SASDI is based on the concept of a hierarchical collaborative SDI requiring the involvement of stakeholders from all levels of government. This means that organs of state are responsible for designing their own geospatial data models in compliance with their organisational requirements and the standards set for geospatial data.

Nevertheless, observations made at the workshop demonstrate that many of the base data sets used in land administration are regulated by the government under particular arrangements and as set out in the SDI Act, 54 of 2003. However, local authorities currently appear uncertain about their roles and responsibilities in SASDI, all of which are attributed to lack of awareness and misaligned legislation and policies across all government departments. Furthermore, the result raises arguments that the SASDI is not at a mature stage, although SASDI is currently seen as fully fledged.

This is because of the legislative, institutional, political and economic challenges it faces. The legislative issues relate to the present culture of SASDI enforcement with the lack of a culture of benefit or meaning. SASDI legislation does not recognise parties who comply with or demonstrate good practice or reward them. Politically, SASDI has constrained political participation, resulting in a lack of accountability, coordination and cooperation. Dual or shared custodianship responsibility is very questionable. Institutionally, difficulties involve incidences where each department undertakes its own mandate, attempts to set up its own database and information system, and pursues its own needs and priorities without considering how the other organisation is affected.

Organisational goals and silos, followed by apparent individual goals, objectives and "ulterior motives" are challenges that may hinder progress in terms of collaborative custodianship. In economic terms, the lack of resources to promote cooperation and the cost consequences of introducing realistic initiatives are inhibiting. Hosting, maintaining and developing staff skills across the three levels of government, especially in smaller organs of state, may be unaffordable, particularly in an austere atmosphere. The results of the questionnaire offered a summary of the current roles of metropolitan municipalities, CSG and provincial SGs in the handling of cadastral data.

The results showed that metropolitan municipalities fulfil the legal mandate needed to be part of the custodians of the cadastral data. The handling of cadastral data by metropolitan municipalities requires a multidisciplinary approach to developing integrated systems that use geospatially referenced information. Building these systems is focused on the concepts of surveying, mapping, remote sensing, cartography, *geographic information systems* (GIS) and management information systems as science and business expertise applicable to application areas.

These metropolitan municipalities perform their cadastral surveys through the use of Land Surveyors. Municipalities also have a dedicated GIS functional unit, which is involved in carrying out activities related to providing GIS support to urban planning and growth to ensure that all planning information

is collected and controlled, and to provide an intelligent data analysis of various types of data to allow management to make informed decisions on potential developments and investments in their jurisdictions.

The results of the interviews indicated that municipalities are required to store, administer and maintain records of all parcels of land under their jurisdiction. All properties are correctly captured through the land information system. The land information system supports the entire life cycle of property or cadastral data as it starts and finishes at the *Deeds* and *the Surveyor-General Offices*. However the billing of property takes place on a monthly basis, which results in municipalities using and updating cadastral data on a daily basis.

The information system that collects land-related data is an invaluable tool for local government in terms of revenue administration and management. Operational and administrative roles of local authorities also include information on land. There are two main sources of cadastral data used by metropolitan municipalities. The municipalities obtain an extract from the Deeds and the SG Offices on a weekly basis. If there is a transfer of ownership, the appropriate property data are collected and the screening process is conducted. If any contradictions are detected, they are usually referred back to the respective source.

The exploration of custodianship roles and responsibilities for cadastral data in the scope of SASDI has been shown to be complicated, particularly because of the scale, scope and development of data and information in the field of land administration. The research revealed some challenges such as the difficulties of linking the cadastral information and registries systems) and the on-going concern around individual land rights on customary land and that this land is in most cases not surveyed (for instance, results suggest that there is a lack of formally recorded parcel boundaries) nor is ownership formally documented. However the state-run platforms that make available cadastral data are stable and available, but seem to be slowly aging in the way they make data accessible. The following section provides more detailed and tailored recommendations in the quest to provide solution to the challenges highlighted in this dissertation.

6.4 Recommendations

In relation to the findings, several essential recommendations from the research are discussed. These recommendations apply not only to municipalities, but also to all organs of state with a vested interest in SASDI and geospatial data. Recommendations on controversial subjects are also provided in order to help move forward in the areas of roles and responsibilities of municipalities for cadastral data within SASDI. Some of the following recommendations are based on previous research and have not yet been implemented. They are also perceived along the basis of the particular restrictions related to the current subject of research and the overall trends in SASDI discourses. These have been categorised in tables which comprises of justifications, goals and actions. Measures to address the current challenges facing metropolitan municipalities with respect to cadastral data custodianship and administration should be put in place. In the short-term, these recommendations are realistic or attainable, particularly the one with technical implication need to be developed in support SASDI and municipalities. In the medium-term, they are also appropriate. In a long-term some are being tackled. Amongst others, these measures should include:

6.4.1 Recommendation 1:

Appoint metropolitan municipalities as custodians contributing to the cadastral data theme. For example, while retaining the lead custodial role and overall responsibility, the custodian coordinator and the base data set custodian could enter into an agreement with other contributing custodians to assume the derivative responsibility for specific data set components.

Recommendation 1: Justification, Action and Goal

No.	Reason	Description
1	Justification	• Municipalities are mandated with the responsibility of operating and maintaining a land information systems (*Municipal Property Rates Act No. 6 of 2004*). • Metropolitan municipalities are the main consumers of cadastral data or land or property data sets, such as land valuation or land tax data. A non-expert perception is that property data forms a good attribute data for the cadastral data theme. • Results have shown that metropolitan municipalities can be referred to as 'de facto' custodians because they already manage cadastral data to a reasonable degree in keeping with the base data set custodianship policy and SASDI guidelines.
2	Action	• The appointment of metropolitan municipalities need to be officially ratified by the CSI once they have been identified as contributing custodians for cadastral data. • In instances where data are captured at provincial or municipal level and these data can be consolidated into national data sets, an organ of state should be designated as the coordinating custodian for such data sets. • The coordinating custodian will be responsible to compile data capture standards and guidelines, as well as a data set maintenance plan. • A collaborative agreement may be drawn up between the coordinating custodian and contributing custodians.
3	Goal	• This will support a range of national cadastral initiatives undertaken by the national government that rely on the ability to access, integrate and evaluate data from contributing custodians of data at the level of local government. • This will boost users' ability to access and incorporate cadastral information from various organisations generating it. • Contributing custodians, in collaboration with the national, provincial and local governments, enable data to be integrated for the good of the country in the form of a nationally consolidated data set.

6.4.2 Recommendation 2:

Define the mechanism and processes for handling or managing the partnerships between the custodian coordinator, base data set custodian and contributing custodians. This, however does not aim to replicate the current and ongoing operation, procedures and work plans of the data custodian. As part of their usual course of business, these data custodians utilise cadastral and land related activities. The Base *Data set Custodianship Policy* (2015), outlines the roles and responsibilities of data custodians as to how geospatial data should be handled in a coordinated manner on behalf of the country or the public.

Recommendation 2: Justification, Action and Goal

No.	Reason	Description
1	Justification	• In terms of the method and procedures of handling the arrangement between the custodian coordinator, the base data set custodian and the contributing custodians, the current laws and policies do not provide inclusive guidelines. • In most cases, data administrators at the local sphere of government are not sure of their legal mandate for cadastral data, particularly in cases of shared custodianship. • In matters related to data ownership, pricing, and data custodianship, there are uncertainties concerning the roles and responsibilities of most organs of state for SASDI participation, and unresolved ambiguities related to the relationship between organs of state. However if the protocols for managing the relationship between the data custodians are established, it will make it much simpler for the CSI to appoint additional data custodian.
2	Action	• Draw up an inclusive guideline document on the process and procedures of managing the relationship between the data custodians. Or data governance guidelines. • Develop organisational maturity matrix to be used to assess the coherence of the data custodianship obligations.
3	Goal	• Well defined measurable, progressive custodianship roles and responsibilities. • These processes and procedures will assist with clarifying cadastral data theme external factors and challenges that are unique among amongst these data custodians. • This ensures consistent standardisation, vertical alignment, and appropriate harmonisation of data.

6.4.3 Recommendation 3:

The property data sets, such as the land valuation or land tax data should to be catered for under the SASDI cadastral data theme, and its relationship with land parcels and ownership data should be correctly modelled in order to be properly included in the cadastral data theme.

Recommendation 3: Justification, Action and Goal

No.	Reason	Description
1	Justification	• Metropolitan municipalities undergo rapid urbanisation and rely on high-quality land-related data to mitigate the consequences of urbanisation effectively. • The relationship can be 'many to many' and there is a clear link between land property data, land parcels and ownership data sets.
2	Action	• The link between the property, land parcels and ownership data sets should be correctly modelled and be aligned with the SASDI custodian reference model. • Include the property attribute data under the cadastral data theme.
3	Goal	• To ensure a consistent supply of current state-wide property information to increase the number of users of cadastral data especially in the general businesses. • Improved cadastral data theme structure. • Accomplish a complete cadastral data value chain at a nationwide scale. • Together, these aspects will form the foundations for the interoperability of the base data sets and the healthy growth of the SASDI.

6.4.4 Recommendation 4:

Remove obstacles to metadata capture on the SASDI-EMC. Not all metadata is created automatically and the documentation sections themselves must be captured manually by custodians or contributors.

Recommendation 4: Justification, action and Goal

No.	Reason	Description
1	Justification	• It is the responsibility of data custodians to capture and publish metadata. • In terms of how metadata is captured, GIS software methods varies, this creates challenges of capturing metadata on the EMC. • Organizations or organs of state need to capture metadata for their data holdings to conform entirely to the metadata provisions of the SDI Act. This could be considered as a violation of the PAIA Act to withhold relevant metadata information. • There is currently lack of enough metadata uploaded on the EMC. • An issue regarding the appointment of custodians is that access to data has been indirectly affected, in the sense that stakeholders who are not officially named as custodians do not feel obliged to provide their metadata.
2	Action	• Define clear core metadata elements and their associated mandatory, conditional and optional obligations. • Implementation of metadata management plan to specify metadata standard/profile(s) to be used. • A metadata manager could be appointed to compile templates and metadata capture guidelines, ensure that the capturing of metadata is built into business processes. • Create software conversion tool. The ArcGIS software does not have look-up lists (schema) so guidance needs to be drafted to assist ArcGIS users in what must be entered in each field (to make sure that the look up values are standardised). • NSIF, should compile guidelines for capturing metadata in ArcGIS for aligning the harvesting, this requires advising which schema to use and what values should be entered for each field. • EMC contributor capacity building. Engage with metadata contributors to clarify metadata contribution methodology. • An approach to increasing the extent of the contribution of metadata on SASDI EMC by non-custodians and other data contributors needs to be formalised in order to increase access to data for use by all. • Securing a permanent platform for the EMC or develop the EMC internally within the DALRRD.
3	Goal	• Geospatial data will be discoverable for all available data sets. • Meaningful metadata optimises the search and discovery of appropriate data. • Metadata gives legitimacy both to geospatial tools and to the responsible entity. Therefore, metadata is compatible with branding. • The SASDI must be centred on the responsible custodianship and meaningful metadata capture. To contribute to the attainment of socio-economic growth, this would greatly improve access, exchange and use of authoritative and suitable geospatial information to encourage decision-making.

6.4.5 Recommendation 5:

Encourage or promote collaborative custodianship by identifying and analysing solutions offered through cloud mapping. By employing collaborative cloud mapping platforms, at every possible opportunity, to model solution options, decision makers will soon grasp the difference that spatial data can make in optimising their decision-making.

Recommendation 5: Justification, Action and Goal

No.	Reason	Description
1	Justification	• The current situation is that cadastral data is available but largely inaccessible because of ineffective data sharing platforms. For example CSG makes its cadastral data available through the website, which often experiences intermittent downtimes. • Government agencies need to collaborate with each other at various levels, however their policies and procedures can be incompatible, such as categorising geospatial data separately (for instance land valuation or taxes, land parcels or ownership data), operating with varying geospatial measures, or by using different standards of quality or metadata, or different structures. • There is a great opportunity for cooperation on an actual provision of Section 37 of the Public Service Regulations (DPSA, 2016), which specifies that a list of service delivery locations must be released annually by every organs of state.
2	Action	• Introduce online mapping tools that allows collaborative cloud mapping. • A pilot partnership initiative could be formalized and adopted among key role players who already know each other and also operate closely to guarantee that there is a centralised repository of service delivery locations per organ of state managed using a standard and efficient method. • Developed a business plan for development and marketing of the land information system-cloud innovation.
3	Goal	• Through resource sharing and free hosting options, benefits can be achieved. At the local scale, municipalities may collect data through cloud services without adequate funds for their own GIS divisions. • Small and medium-sized local authorities with minimal expertise and finances can be assisted through collaborative cloud mapping to perform geospatial research required for their planning, service delivery, administration and governance. • The cloud offers secure, quick and massive storage of geospatial data sets and related services for an SDI, such as those being built in South Africa, even without custodians needing to worry about efficiency of their own online services. • Collaborative cloud mapping enables omnipresent, reliable, on-demand, optimized and tailor-made mapping of resources shared between different organizations operating on a particular initiative, such as an SDI. • A well designed land information system-cloud cloud web service. • ISO standard on LADM, and the power of cloud computing to overcome some of the limitations of implementing costly local systems.

6.4.6 Recommendation 6:

The existing legislation and policies do not provide comprehensive guidance in terms of the distribution dissemination of geospatial information to users. The current content of the existing agreements are decided solely by the custodian of the geospatial information and do not necessarily align with what other custodians and stakeholders are doing.

Recommendation 6: Justification, Action and Goal

No.	Reason	Description
1	Justification	• The Act and the Custodianship Policy concentrate on the relationship between custodian and vendor but are silent on the relationship between custodian and member of the public or private sector. • Currently, it appears to be the custodian's assumed, but possibly not legal, responsibility to draw up a 'standard' Agreement with users from the private sector in order to 'protect' the data integrity, intellectual property or copyright. This ultimately means that there is no consensus amongst the many custodians of geospatial data, only inconsistency. • As the worldwide use of geospatial data changes with advancing technology in the spatial in-formation space so the demand upon custodians of geospatial data also changes. Users now wish to do more with the data than was anticipated at the time the SDI Act was legislated, for example, creating web-services for geospatial data on the Internet using mobile technology, etc. The demand has extended to 'developers' licenses and 'distribution' licenses.
2	Action	• It is recommended that the SASDI through the CSI: - take note of the identified lack of comprehensive guidance in current legislation and related Policies and Regulations; - Action the design of a *Standardised Agreement* between the data custodian or vendor and user (member of the public and private sector) for the distribution and dissemination of geospatial information, specifying terms and conditions, and what may or may not be done with the data supplied; - Approve the standardised agreement for implementation. • Organs of state, at all levels, should also compile some form of geospatial information agreement setting out conditions and restrictions to using their geospatial data. • Draw up a guideline document on the distribution dissemination of geospatial information to users
3	Goal	• Developed guideline document that gives direction to how the State's geospatial data are to be protected, or treated by users from the private sector. • Such a document could form the basis of a template of a *License Agreement* template that custodians from all spheres of government could utilise. • Approved and implemented '*Standardised Spatial Information Agreement*' between the data custodian or vendor and user

6.4.7 Recommendation 7:

The CSI is recommended to set up funding models for SASDI across all levels of government. The lack of funding to support SASDI activities and the cost implications of practically putting measures in place are inhibiting. SASDI developments are impeded by the shortage of financial resources. Thus outside funding needs to be sought. It does however, take tremendous commitment to attract donors in investing in geospatial data.

Recommendation 7: Justification, Action and Goal

No.	Reason	Description
1	Justification	• There is a current lack of SASDI funding support across all levels of government. • The absence of support for an effective collaborative SASDI through funding and the cost repercussions of practically putting measures in place are constraining. • Hosting, retaining, and up-skilling workers across the three spheres of government, particularly in smaller state bodies, may be impractical especially in an uncompromising environment.
2	Action	The CSI should design funding models for the advancement and implementation of SASDI at the national and local levels, respectively. Through the following remedies: - Economic Regulation - Monetary incentives or deterrents - Government – private sector partnerships
3	Goal	• To establish sustainable SASDI framework across all levels of government. • To classify SASDI as part of the capital infrastructure of generating goods for public. • To guarantee that financial savings.

6.4.8 Recommendation 8:

Standardise cadastral data based on a model: LADM, and if informal tenure is introduced, standardise the data based on STDM

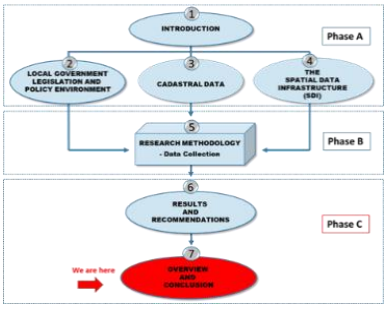
Recommendation 8: Justification, Action and Goal

No.	Reason	Description
1	Justification	• Metropolitan municipalities will use the LADM to update their project and create an advanced property database model that meets global requirements. • Incorporating informal tenure is also needed for the regularisation of informal settlements in municipalities. As a result, it is recommended that STDM
2	Action	• More studies on the use of LADM in South African land administration South African metropolitan municipalities' data models should be refined to adhere to LADM conformance level one.
3	Goal	• Promote diversity to the exchange of cadastral information between various stakeholders and jurisdictions. Improve interoperability between cadastral and land registration systems, thereby improving information exchange at home and abroad

6.5 Conclusion

This chapter presented the results of the comprehensive literature review on the legislative and policy environment for local government, cadastral data and SASDI. The results of data collected through the questionnaires, interviews and workshop observations were provided. These assisted to analyse the current roles of metropolitan municipalities, the CSG and provincial SGs in handling cadastral data. The discussions of the results were presented. The chapter concluded with a comprehensive list of recommendations. This fulfilled the dissertation's objective of providing recommendations. The results outlined in this chapter support the need for metropolitan municipalities to be designated as contributing custodians of cadastral data. The focus of this section or discussion is on local government, however further research could focus more on SASDI context.

CHAPTER 7
OVERVIEW AND CONCLUSION



7.1 Chapter Overview

An overview of the research and conclusion is given in this last chapter. A retrospective view of the main outcomes and an outlook for the future studies are both presented in this chapter of the dissertation. In support of the research question, the overall research dissertation explored the aims and objectives. A theoretical basis for the research was established in the preceding chapters of this dissertation.

7.2 Overview of the Research

In the context of the *South African Spatial Data Infrastructure* (SASDI), this dissertation has devoted considerable attention to exploring custodianship roles and responsibilities for cadastral data. This included a review of the local government's legislative and policy environment for cadastral data, and the SASDI. Only the legislation and policy documents relevant to the aim of this research dissertation were examined in order to determine if they identified any cadastral data or geospatial data mandate. As already mentioned in chapter 1 the aim of this research was to make recommendations on the custodianship roles and responsibilities of municipalities for cadastral data within the SASDI. A comprehensive list of recommendations were provided see section 6.4 in chapter 6.

The facts presented in the previous chapter show broad consensus regarding legislative and policy environment but more importantly promote good cadastral data governance through access, sharing, collaboration, partnerships, cooperation and exchange between data custodians. The full potential of cadastral data as a driver of economic growth and development can only be realised if all cadastral data role players are formally recognised by the SASDI. Efforts to appoint all cadastral data stakeholders must therefore adopt an integrated approach, one which meaningfully addresses issues related to cadastral data custodianship, communications, partnerships, standards, technology, and most importantly all stakeholders. As already mentioned in chapter 1 (section 1.6), this dissertation was divided into three phases namely Phase A, Phase B, and Phase C. A brief summary of the different phases of this dissertation is presented in order to give conclusion remarks, ensues:

Phase A: This phase comprises of the introduction chapter and the literature review chapters. Chapter 1 has encapsulated an overview of the dissertation. It provided the background to the study. It also encompasses the context of the study which is based on the custodianship roles and responsibilities of organs of state for cadastral data within the SASDI.

In addition, the literature review on the legislative and policy framework for local government, cadastral data and SDI respectively was presented in Chapter 2, 3 and 4. In addition, the desktop study of different meanings and characteristics of local government, cadastral data and SDI was also unpacked in these chapters. The review of international literature regarding local government, cadastral data and SDI provide an excellent basis that support further aspects of the results of this dissertation. All the legislative and policy documents relevant to this study were explored. More specifically, the focus was to see what these documents stated about the cadastral data mandate of municipalities and the DALRRD as well as to establish if they promote coordination and cooperation across different the spheres of government with the context of SASDI.

Phase B: this phase solely provided the chapter 5. In this chapter the research methodology and the various research methods applied to gather and investigate the information that is essential to address the research objectives were described. The chapter discussed the types of research, research design, research instruments of the study and it illustrated the study area, it concluded by outlining the research limitations and assumptions as well as the ethical considerations.

The qualitative research collected data in order to investigate the role of metropolitan municipalities in the value chain for cadastral data in South Africa and to make recommendations on their roles and on the custodianship of cadastral data, using the *City of Tshwane (CoT)*, *City of Johannesburg (CoJ)*, *City of Ekurhuleni* (CoE) Metropolitan Municipalities, the Chief Surveyor General and the Gauteng Provincial Surveyor-General Office as examples. Both the research matrix and flowchart illustrated that information and data collected through research instruments was collated and used to draw conclusions based on the results and make recommendations.

Phase C: this is presented two final chapters 6 and 7. Chapter 6 presented the results of the dissertation. The reality is that municipalities maintain and manage the cadastral data for their jurisdictions, they mainly source their cadastral data with the relevant Surveyor General (SG) and in some instances they capture their own cadastral data, but their contribution is often done in isolation. This result in data differences and potential data conflicts and the envisaged concept of co-ordination and co-operation between the municipalities and the DALRRD is hampered. However the recommendation were provided as a possible solution, see section 6.4.

In Chapter 7 here the research overview and conclusion of the work conducted in this dissertation are briefly presented. Finally, by drawing from the results and recommendations presented in the previous chapter, future research is presented.

7.3 Research Objectives Overview

The research objectives are listed in Table 44, together with the chapters in which they were fulfilled. To understand the legislative and policy environment for local government, cadastral data and the SASDI. Objective 1 of this research consists of Objectives 1.1; 1.2; and 1.3 in combination, as set out in Table 38. These objectives were examined individually. Those results are therefore summarised as follows:

Table 38: Research objectives with their fulfilment chapters

No.	Study objective		Fulfilment chapter/s
1.	To understand the legislative and policy environment for :	1.1. Local government (particularly South African local government)	Chapter 2
		1.2. Cadastral data (particularly South African cadastral data)	Chapter 3
		1.3. SASDI (particularly SASDI)	Chapter 4
2.	To analyse the current roles of metropolitan municipalities, the CSG and Provincial SGs in handling cadastral data.		Chapter 5
3.	Based on the results, recommend how municipalities can contribute to custodianship roles and responsibilities in the SASDI, and make conclusions.		Chapter 6 and Chapter 7

7.3.1 Objective 1:

To Understand the Legislative and Policy Environment for:

7.3.1.1 (Objective 1.1): Local Government - particularly South African local government

In recognition of *Objective 1.1*, Chapter 2 considered the legislative and policy environment for local government. Overall, it is clear that the *Municipal Property Rates Act* (No. 6 of 2004) requires all major municipalities to create and administer municipal valuation rolls used to determine property rates within their areas of jurisdiction (see section 2.3.3.5). In summary the South African local government is governed by a wide range of legislation and policies that the sector should adhere to, such as the *Municipal Systems Act* (No. 32 of 2000), the *Municipal Structures Act* (No 117 of 1998), the *Spatial Data Infrastructure Act* (No. 54 of 2003), the *Promotion of Access to Information Act* (No. 2 of 2000) and the *Municipal Property Rates Act* (No 6 of 2004).

There are inconsistencies and overlaps within the institutional arrangements of the local level of government. In the existing legislative and policy provisions, there are different interpretations at the operational level which result in ambiguous coordination and cooperation between organs of state. At the municipal level, there are various and varied sources of legislation that are not constitutionally related to national government legislation and policies, resulting in ambiguities and heterogeneities in land administration and land development. Therefore, the advancement of local government development may require constitutional changes from time to time. The conclusion is that the review therefore satisfies Objective 1.1.

7.3.1.2 (Objective 1.2): Cadastral Data – from a South African context

The review presented in Chapter 3 was tailored to understand the legislative and policy environment for cadastral data in the Republic of South Africa. The results have illustrated that the *Land Survey Act* regulates the surveying of land in South Africa. All land rights issues are treated at the national level and are essentially mandated by the *Land Survey Act* to the CSG. A valuable 'snapshot' of the state of cadastral data has been provided by the analysis of the legislative and policy framework for cadastral data within the South African context. The apparent strengths and shortcomings of existing legislation and policies have been revealed, identifying areas of sophistication and areas that require focus.

In addition, research has shown that problems related to cadastral data legislation and policies vary across national, regional and local levels, leading to uncertainties about cadastral data management coordination and cooperation, resulting in data gaps and possible data conflicts. In certain cases, due to the obstacles created by the different pieces of legislation and regulations, cadastral data are available but largely inaccessible. Other problems include having no option for the recording of legal land rights, and the lack of coordination between the establishment of the cadastral system and customary land rights holders.

The government, however, is aware of the deficiencies in South Africa's cadastral data within the legislative and policy environment and there is evidence that it is seeking to resolve them in a variety of ways. Renewed demands for land administration reform and information systems from different government sectors are giving energy to this much-needed initiative. Another on-going project is the step towards developing an upgraded and faster *Cadastral Information System*. The findings from this dissertation are important for these process. Objective 1.2 has thus been satisfied.

7.3.1.3 (Objective 1.3): SASDI - particularly SASDI

Objective 1.3 was intended to understand the legislative and policy environment for the SASDI. It can be inferred in general that the SDI Act shapes the legislation and policy environment of the SASDI. The SDI Act defines a data custodian as a state entity or as an independent contractor or individual engaged in the exercise of public authority that gathers, stores, maintains, incorporates, distributes or uses geospatial information.

Therefore, the focus was on organs of state that are legally responsible for providing geospatial data, sufficient capacity, resources and infrastructure for the development and maintenance of such geospatial data and are named to be data custodians by the CSI. The custodians of these data sets also form part of the CSI and its subcommittees.

There are a myriad of problems. These include confusion regarding mandates to collect relevant thematic data due to contradictory laws such as the *SDI Act, Municipal Property Rates Act* and *Land Survey Act*. Other limitations include the absence of formal collaborative arrangements or sharing mechanisms, the current failure of established custodians to comply with legislation, issues of privacy and confidentiality, intellectual property rights issues, and the lack of a national SDI strategy many years after the Act was ratified. There is still a definite need to raise awareness of SDI and the value of providing SASDI with meaningful metadata.

The promotion of SDI awareness is not limited to custodians; in reality, in order to reinforce political and financial support for the national SDI, it should start at the highest level of governance. Only when every stakeholder is actively fulfilling their position can the SASDI fulfil its mission. The on-going drive towards specifically defining custodianship of the base data sets by CSI is a definite change in the SASDI. These results, therefore, satisfied Objective 1.3.

7.3.2 Objective 2:

To analyse the current roles of metropolitan municipalities, the CSG, and SGs in handling cadastral data.

As it can be noted from the review, metropolitan municipalities play a crucial level in handling cadastral data and other geospatial data in the country. Therefore, with the development of inter-organisational geospatial data sharing, municipalities tend to become hubs of the SASDI. The current role of metropolitan municipalities in handling cadastral data is quite complex and has grown historically. By law cadastral data on geometry and attributed of parcels are captured by the provincial SG and Deeds offices, from there they are provided to municipalities.

From the point of view of municipalities, however, a large number of operations are set aside in order to comply with the cadastral data handling standards, on the one hand in order to comply with national legislation, and on the other hand on a voluntary basis, so the data can be used immediately for other internal information processes and services. The functions and operations of the metropolitan municipalities rely on cadastral data, not only collecting it, but also capturing it when appropriate.

Although the metropolitan municipalities were clear about their own mandate for geospatial data, they were uncertain about serving on behalf of the entire organisation as custodians, especially with regard to cadastral data that they are not mandated to capture themselves. Nevertheless the findings of this study has shown that the metropolitan municipalities can be referred to as 'de facto' custodians since they handle cadastral data to a fair degree in compliance with the custodianship policy.

For the cadastral data theme, the CSG are the official custodian coordinators. Both the SG and Deeds provincial offices are officially acknowledged as custodians of the base data set for cadastral data (which involves a shared custodianship of geometry and attributes data, respectively). Overall, the South African cadastral survey is regarded not only by African countries but also by global jurists as highly accurate and effective. Integrated cadastral and deed systems could further increase the efficiency of the national cadastral system.

This is not to say that, as often implied, all cadastral-related information systems can or should be combined, but that greater communication and interconnection, cooperation and interoperability between systems and greater sharing of the underlying cadastral data driving the systems should be achieved. These developments could be an advantage for the country's legislative and policy environment. The current situation with regard to cadastral data is that stakeholders access this data set mainly and at some cost from the private sector. Objective 2 has therefore also been satisfied.

7.3.3 Objective 3:

Based on the results, recommend how municipalities can contribute to custodianship roles and responsibilities in the SASDI, and make conclusions

The overall exploration of the roles and responsibilities of metropolitan municipalities in terms of geospatial data stakeholders makes them SASDI hubs. The study revealed that legislation requires municipalities to have SASDI roles and responsibilities, and has shed new light on their role in the country's entire cadastral data value. In essence, it is therefore recommended that local SDIs be formalised because, on the one hand, SDI implementation at the local level is closely linked to and can meet many basic needs of people and public administration by providing enormous quantities of basic geospatial data.

On the other hand, careful local-level SDI design and implementation is a necessary prerequisite for the establishment of a functioning SASDI at both higher and local levels. Taking into account the appointment of metropolitan municipalities as contributing custodians for a theme such as cadastral data would enable local SDI bricks to be seamlessly incorporated into an overall SASDI. Despite the importance of local government geospatial data and the contribution of local SDIs to the use and accessibility of geospatial data in a country, researchers noted that in many countries there is limited research on local SDIs and therefore limited knowledge and understanding of local SDIs.

The proposed formation of detailed processes and procedures of custodianship for data sets within government can provide solution to municipalities and other organs of state that formerly operated on explicit data sets and now fall outside of the appointed custodian’s organisation. This can also aid in terms of historic overlap and inconsistency of geospatial data mandates and management circumstances, since various stakeholders seek to maintain the same geospatial data without any specific agreements or cooperation with other stakeholders. It is therefore recommended that sophisticated governance mechanisms set up at the local government level to coordinate the management of geospatial data and to link it to provincial or national data sets.

It also requires public agencies and their data suppliers to consider geospatial data as relevant information and to apply sound information management standards and good practice when it comes to geospatial data. The designated base data set coordinators and custodians could lead the way in South Africa by demonstrating how the collection and management of geospatial data can be properly organised.

The SASDI should shift beyond a 'stick approach' to a profit or value-driven 'carrot approach.' The SASDI legislation and policy environment should reward parties who comply with or demonstrate good practice. The National Treasury Department should issue supporting guidelines, such as no funding for geospatial data collection without the approval of the CSI. Metadata specifications should also be implemented at the level of the object, while quality, standards and best practice processes should be advocated. Therefore, Objective 3 has been satisfied.

7.4 Conclusion

A review of the international literature as well as South African legislation and policy documents was done. The research was able to provide a set of recommendations than can be used to decide whether metropolitan municipalities can be appointed as the data custodian for cadastral data. In concluding, it is important to reflect back at the objectives set out in the chapter 1 to carry out this research. This research study provided an exposition of the nature of legislative and policy for local government, cadastral data and SASDI. The study also analysed the current roles of metropolitan municipalities, the CSG and Provincial SGs in handling cadastral data.

7.5 Future Research

These future research proposals and recommendations outlined in section 6.4. They are not inherently exhaustive, but serve as a reference to particular approaches and research that may be specifically drawn from this study. There are many explicit initiatives and potential studies that could be carried out in the context of intergovernmental relations, cooperative governance, cadastral data management and SASDI, which are described as follows:

- Further studies on coordination and cooperation between national and local institutions can expand the understanding of enhanced cross-governmental collaboration and contribute to research that can provide a solution to breaking down of organisational silos through harnessing technology and other innovations.

- Additional studies on the significance of collaborative agreements are necessary to improve collaboration in areas of mutual interest, reduce duplication of data capture, improve data exchange, and reduce costs through the optimisation of resources.

- In-depth studies of the cadastral data value chain. No in-depth studies on the cadastral data value chain in South Africa have ever been conducted, thus future studies are needed to further explore the cadastral data value chain in South Africa. This would help build a complete inventory pertaining to role players inside and outside the circle of the cadastral data.

- Studies to explore the applicability of LADM and STDM to areas beyond the formal tenure and cadastral system, such as rural areas and informal settlements are recommended.

- It is further recommended that additional theory of the creation and implementation of integrated cadastral systems be investigated and matched with customary land rights holders' experiences. This would speed up the implementation of land reform in rural and traditional areas.

In terms of SASDI there are relevant interrelated strategies or future studies that can be carried out in SASDI as follows:

- Actualising the BDSC and the Custodian Governance Model as shown in Figure 32 to measure perspective views of those associated with SDI based on quantitative approaches at all levels of government in the country, especially at the local level.

- Further research is required on how property data sets can be catered for under the SASDI cadastral data theme, such as land valuation or land tax data.

- Research on how to employ collaborative cloud mapping as a platform for SASDI's concept of a hierarchical collaborative SDI.

- Conduct feasibility studies on how SASDI can set up fundraising programmes.

- Conduct further research to explain the complexities of the EMC system and formats of SASDI metadata fields. Additionally studies of understanding the intricacies associated with the hierarchical collaborative SASDI, which requires stakeholder participation from all levels of government.

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ANNEXURE A

QUESTIONNAIRE

EXPLORING CUSTODIANSHIP ROLES AND RESPONSIBILITIES FOR CADASTRAL DATA IN THE CONTEXT OF THE SOUTH AFRICAN SPATIAL DATA INFRASTRUCTURE

This questionnaire is intended to take stock of the current status of the SASDI role and responsibilities in terms of cadastral data in a local municipality. The information collected will be used for part of the MSc research of Sam Motswenyane, using the City of Tshwane, City of Johannesburg, City of Ekurhuleni Metropolitan Municipalities, the Chief Surveyor General and the Gauteng Provincial Surveyor-General Office as examples, to investigate the role of metropolitan municipalities in the value chain for cadastral data in South Africa and to make recommendations on their roles and on the custodianship of cadastral data. The results of this questionnaire will be collated and used to draw conclusions based on the findings and make recommendations.

Please submit the completed questionnaire and any attachments in electronic format to Mr. Sam Motswenyane (E-mail: sam.motswenyane@drdlr.gov.za/Contact: 012 312 9627) by ***31 October 2019*** *at the latest. You may also submit additional material e.g. Presentations or any documentation on cadastral data.*

CONSENT FORM:

1. I read and understood what the study is about and its purpose and importance.
2. I confirm and understand that I am a voluntary participant in this study.
3. I recognise at any point that I am free to withdraw from being a part of the survey.
4. I acknowledge that the data and content created will only be used for the purposes of research.
5. I comprehend that the information I provide will be treated as being entirely confidential.
6. I consent to take part in this research study and to permit the information gathered in this questionnaire to be used for the research reasons outlined above.

Yes ☐ - I consent ; No ☐ - I DO NOT consent

Respondent (Management)	**Respondent (Technical)**
Name:	Name:
Surname:	Surname:
Signature:	Signature:

BACKGROUND INFORMATION	
Designation:	
Functional Unit:	
Email:	
Date:	

PART A: FUNCTIONAL UNIT

Q1. What is the mandate of your Functional Unit?
(You may provide relevant documentation or a URL/web address where this information may be obtained)

Comment:

Q2. What activities does your Functional unit perform with respect to cadastral data? (Tick all that may apply.)

Data collection		Data capture	
Data collation		Dissemination	
Data archiving		Data vendor	
Data interpretation and analysis		Planning	
Data integrity		Decision support	
Data quality		Policy	
Metadata		Reporting	

Other (please specify):

Q3. What activities does your Organisation perform with respect to spatial information? (Tick all that may apply.)

Data collection		Data capture	
Data collation		Dissemination	
Data archiving		Data vendor	
Data interpretation and analysis		Planning	
Data integrity		Decision support	
Data quality		Policy	
Metadata		Reporting	

Other (please specify):

Q4. If you source spatial data from other organisations, please indicate the spatial data and the name of the organisation(s) from where you source it and what do you use the data set for? (List the data set(s) below)

PART B: GEOSPATIAL DATA LEGISLATION and POLICIES ***- Tick Yes or No, where it may apply***

Q5. The Land Survey Act No. 8 of 1997 imposes control over how cadastral survey and its records should be perfomed and prepared. How does this Act affect your work?

Please elaborate:

Q6. What is the contribution of cadastral data towards South African Spatial Data Infrastructure (SASDI)?

Please elaborate:

Q7. How do other legislation or policies affect cadastral data within your organisation in general?

Please elaborate:

Q8. Do you have any legal and policy framework that administers cadastral data within your organisation?

Please elaborate:

Name of Data set	From where	For what purpose

PART C: CADASTRAL DATA MANAGEMENT

Q9. What is your understanding of the Cadastre and Cadastral data?

Please elaborate:

Q10. Do you capture your own cadastral data?

Please elaborate:

Q11. How often do you update the cadastral data?

Please elaborate:
Q12. How are Cadastral data sets managed within your Functional unit?
Please elaborate:
Q13. Do you source your cadastral data from the Survey General Office?
Please elaborate:
Q14. Do you provide your cadastral data to the Provincial Surveyor-General Office?
Please elaborate:
Q15. What are the uses of cadastral data in your functional unit?
Please elaborate:
Q16. Do you have the authority to update the cadastral data?
Please elaborate:
Q17. ***What would trigger the update of the cadastral data?***
Please elaborate:
Q18. ***What are the formats used to store all of the cadastral data sets in your area of jurisdiction?***
Please elaborate:

Q19. Do you distribute the cadastral data? (If yes, in what format? E.g. Maps (hard copies) or Shapefiles)
Please elaborate:
Q20. The primary role of the South African Cadastral System is to establish (delineate and document) rights of ownership. Precise delineation of ownership rights has facilitated the creation of a Cadastral Information System, which forms the basis for land valuation; land taxation, growth planning, demarcation of local authorities and land administration. Briefly describe your cadastral system.
Please elaborate:
Q21. What is your understanding of Land Administration Domain Model (LADM)?
Please elaborate:
Q22. What is your understanding of Social Tenure Domain Model (STDM)? **Yes ☐ No ☐**
Please elaborate:
Q23. What is your understanding of ISO 19150? (ISO/TS 19150-1:2012 defines the framework for semantic interoperability of geographic information. This framework defines a high-level model of the components required to handle semantics in the ISO geographic information standards with the use of ontologies.)

PART D: CUSTODIANSHIP and VALUE CHAIN FOR CADASTRAL DATA

SPATIAL DATA RELATED Collaborative Agreements/Contracts	
Q24. Describe your collaborative agreements/contracts with other organisations (e.g. organs of state, service providers, Agents etc.)	
With other organs of state	*Remarks:*

SPATIAL DATA RELATED Collaborative Agreements/Contracts	
Q24. Describe your collaborative agreements/contracts with other organisations (e.g. organs of state, service providers, Agents etc.)	
With data vendors (Service Provider)	*Remarks:*
With data distributors	*Remarks:*

Data Custodianship Responsibilities	
i. Do you have any data maintenance plans in place?	*Remarks:*
Cadastral data:	
ii. How do you ensure data Integrity of your data sets?	*Remarks:*
iii. Is your data made accessible at a cost?	*Remarks:*
iv. Do you make your data accessible on the internet?	*Remarks:*
v. What other ways do you make your data sets accessible (e.g. electronic (CD/other))	*Remarks:*

Data Custodianship Responsibilities	
vi. Ability to integrate own with other data sets?	*Remarks:*
vii. Are your data sets nationally consolidated where possible	*Remarks:*
Metadata	
a. Do you capture metadata?	*Remarks:*
b. Is your metadata published?	*Remarks:*
c. Do you publish your metadata on a metadata catalogue (e.g. Electronic Metadata Catalogue - EMC)?	*Remarks:*
d. What are the metadata standards used?	*Remarks:*
e. What metadata Format(s) do you use?	*Remarks:*
f. Is your metadata comprehensive and meaningful?	*Remarks:*
Error Reporting:	
g. Do you receive error reports on data sets?	*Remarks:*
h. Do you keep reports of such errors?	*Remarks:*

Data Custodianship Responsibilities	
Processes and Procedures in place	
i. Do you have processes and procedures for data capture?	*Remarks:*
j. Do you have processes and procedures for data validation?	*Remarks:*
k. Do you have processes and procedures for data maintenance?	*Remarks:*
l. Do you have processes and procedures for data management?	*Remarks:*
m. Do you have processes and procedures for data archiving and documentation?	*Remarks:*
n. Do you conduct user consultation workshops?	*Remarks:*
Additional Remarks:	

Data set specific (To be completed for cadastral data set)	
Collection/Capture Cycle:	
o. Longevity of collection/capture cycle mandated (Once off, annual, end date)	
p. Frequency (How often to expect an updated data set or subset)	

GIS Standards/Policy - *Tick Yes or No*	
q. Do you comply with GIS standards?	*Remarks:*
r. Are GIS related standards/policies developed within your organisation?	*Remarks:*

GIS Standards/Policy - *Tick Yes or No*	
s. Do your organisation/functional unit have a representation on GIS standards bodies?	*Remarks:*
Gaps* Identified for implementation {*Gaps* could incude: Spatial data content; Definitions/Feature classes; Mapping/Visualisation; Symbols; Data Transfer protocols; Data Exchange formats; Data Quality; Metadata; Spatial Referencing*}	*Remarks:*

Additional question	
t. Are you affiliated with the South African Geomatics Council or the South African Spatial Data Infrastructure (e.g. Committee for Spatial Information member)	
u. Do you have any other problems or issues pertaining to Cadastral data?	

ANNEXURE B

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Ethics Committee

E-mail: ethics.nas@up.ac.za

ETHICS SUBMISSION: LETTER OF APPROVAL

Mr MS Motswenyane
Department of Geography Geoinformatics and Meteorology
Faculty of Natural and Agricultural Science
University of Pretoria

Reference number: 180000087
Project title: The South African Spatial Data Infrastructure framework roles and responsibilities in terms of Cadastral data in municipalities

Dear Mr MS Motswenyane,

We are pleased to inform you that your submission conforms to the requirements of the Faculty of Natural and Agricultural Sciences Ethics committee.

Note that you are required to submit annual progress reports (no later than two months after the anniversary of this approval) until the project is completed. Completion will be when the data has been analysed and documented in a postgraduate student's thesis or dissertation, or in a paper or a report for publication. The progress report document is accessible on the NAS faculty's website: Research/Ethics Committee.

If you wish to submit an amendment to the application, you can also obtain the amendment form on the NAS faculty's website: Research/Ethics Committee.

The digital archiving of data is a requirement of the University of Pretoria. The data should be accessible in the event of an enquiry or further analysis of the data.

Yours sincerely,

Chairperson: NAS Ethics Committee