A BIG DATA FRAMEWORK TO IMPROVE GOVERNMENT SERVICE DELIVERY IN SOUTH AFRICA

by

KHAYALETHU NUNU

199111243

Thesis Submitted in fulfilment of the requirement for the degree

MASTER OF TECHNOLOGY: INFORMATION TECHNOLOGY

IN THE FACULTY OF INFORMATICS AND DESIGN

AT THE CAPE PENINSULA UNIVERSITY OF TECHNOLOGY

Supervisor: Prof. Tiko Iyamu

Date Submitted (October 2019)

DECLARATION

I, **Khayalethu Nunu**, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not been previously submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

23 October 2019

Signed **Date**

ABSTRACT

Governments across the globe, including South Africa, have a duty and obligation to offer effective and efficient services to the citizens. Due to government shortcomings, South Africa has experienced an increase in service delivery protests due to lack of adequate delivery services to the citizens. However, the emergence of ICT has provided a vehicle for government to improve on their efficiency and effectiveness in service delivery. One of the prominent technology concepts that has grabbed the attention and interest from academic, private and public sectors is big data. The government of South Africa is also interested in exploring the concept of big data based on the premise that it presents benefits that improves service delivery.

The aim of the study was to gain better understanding of the factors that can influence the use of big data in a government enterprise. Based on the understanding of the factors, a conceptual framework is developed, purposely to guide the use of big data in order to improve service delivery to the citizens of South Africa. In achieving this aim, the Case Study approach was employed, and a government department was selected for the study. The qualitative methods and interpretivist approach were followed. The semi-structured interview technique and document analysis were used in the collection of data. A sociotechnical theory, structuration was used to underpin the study. This means that the theory was used as a lens to guide data analysis. These methods, approaches and techniques were considered most appropriate in gaining a deeper understanding of how a government department stores, manages, and uses big data for service delivery.

In the analysis, the duality of structure from the perspective of structuration theory was employed to focus on the roles, responsibilities and actions of agents, and how rules were applied in the use of big data for service delivery. From the analysis, it was found there are five main factors that critically influence the use of big data for service delivery, namely: Organisational Requirements, Readiness Assessment, Continuous Assessment, Compatibility, and Big data as a service. Based on these factors, a framework, Big Data Framework for Serviced Delivery (BDFS) was developed. The framework, BDFS can be used to guide the application of big data for service delivery in government departments.

ACKNOWLEDGEMENTS

I wish to thank the following people for the contributions they made in this journey:

- God for the providence, wisdom and grace he bestowed on me. I could never achieve anything without Him, whatever I do will always be for the glory of you.
- My parents for their prayers and unwavering support.
- Professor Tiko Iyamu for sticking with me throughout this journey. Your guidance, patience, wisdom and commitment has made it possible for me to complete my work. You have given me ultimatums, tongue lashings but all of that was to make sure I finish my work. I will forever be indebted to you. May the Lord bless you abundantly and grant you more wisdom.
- My Cape Town family, Sithembele Mkosi, Bulelwa Kotelo and kids, Mbali, Siba and Lukhanyo for all the support. Often times I would come home very late and you continued to encourage and support me to complete my research.
- Noluyolo Magazi for your moral support, encouragements, and general conversations about my research and life at large. When I thought of giving up and feeling down you always found a way of lifting me up and showing me the bigger picture.
- Asanda Wele for your financial and moral support. You were also studying but found it in you to contribute to my studies. Anga uThixo angakwandisela akusikelele ngakumbi.
- Frances Koester for all your support and encouragement through this journey. You always checked how I was doing with my research and that kept me going.
- Zukiswa Kanise for all your support, you had your own stresses about your work but still found it in you to support and encourage me.
- Wandisa Nyikana even though we've known each other recently, you've been of great assistance to me. Thank you also for being an extra ear for all the feedback I got from the forum regarding my work.
- My colleagues at the Department of Rural Development and Land Reform including Raoul Duesimi, Anthony Arendse, Mr. Bastile, Tobani Mtintsilana, Noluthando Tshetu for all the support and encouragements during this time.
- Lastly but not least, all my colleagues at the research forum. Your advices, critiques, knowledge sharing, and support were invaluable to me. I will forever be grateful, and I hope the friendships and acquaintances will continue way past the research forum.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

1.1 INTRODUCTION

Government's duty towards its citizens can be summarized as one where it creates a suitable environment for economic development and meet the basic needs of the people which include water, electricity, law and order, and healthcare among others (Pasquini et al., 2013). This is done with the economic reality of scarcity of resources. In the South African context, 27.7% of the population is unemployed thus reducing the revenue government would collect from taxes (Statistics South Africa, 2017). It is from these taxes that government funds its' programs and service delivery duties. Regardless, government has a duty to provide basic services to its' citizens.

In the last five years, challenges of service delivery continue to increase in many developing countries, particularly in the Africa continent (Rakodi, 2016). What is even more interesting is that many government officials and representatives cannot explain the influencing or underpinning factors that causes the challenges. For example, South Africa is struggling to adequately address the issue of the slow pace in the provision of affordable housing to accommodate low income households, yet the pace of housing delivery is characterized by poor coordination between the arms of government (Ganiyu et al., 2017).

The services that government of many countries provide are influenced by various factors, which are of both technical and non-technical nature (Iyamu, 2017). These factors are also considered as resources in that they are used to enable and at the same time constrain the services that government provides to the society. Some of these resources include technology, data sets, process, and humans. According to Ruhode (2016), the emergence of information communication and technology (ICT) has made it easier for governments to improve on their efficiency and effectiveness in service delivery.

In many countries including South Africa, government departments and agencies, such as health, land reform and social development, increasingly rely on big data to provide services to her citizens. This is primarily due to the characteristics of big data, which include its unusually large data sets (volume), the speed at which data is produced or grows (velocity), and consist of a wide range of data types which include structured and unstructured data, and from numerous sources (variety) (Amankwah-Amoah, 2015). Increasingly there is more interest and attention towards big data from both academic, consulting and organizations perspectives, due to its necessity and significant (Carillo, 2017). There are different variations to the definition of big data such as additional four Vs which are validity, veracity, value, and visibility (ibid). For the purposes of this

study we will restrict our discourse to the common framework which defines big data as high-volume, high-velocity and or high-variety information assets that require new forms of processing to enable enhanced decision-making, insight discovery and process optimization (Gandomi & Haider, 2015)

The ability to analyse diverse data sources and new data types presents government with more potential rewards, opening up possibilities of innovation and creation of totally new economic opportunities (Bhat & Quadri, 2015). The speed at which government can be able to analyse and make decision out of these large and diverse data sets is at the core of embracing and implementing big data technologies. This provides government the ability to improve decision-making and enhance efficiency and effectiveness in service delivery.

In taking advantage of big data, businesses have relied on it for marketing decisions and executing marketing campaigns, as a result, marketing and advertising is tailored to trends observed from the data sources (Hofacker et al., 2016). A study conducted in the United States of America found that companies that adopted a data driven decision making, achieved gains that were higher than other factors could explain (Lohr, 2012). This goes to show the opportunities presented by big data and the benefits of those who embrace and exploit those opportunities.

Being awoken to the benefits and possibilities of big data, in a recent GTECH conference the deputy minister of Telecommunications and Postal Services, Hlengiwe Mkhize was quoted saying, "*We have been constantly reminded that government holds and has access to an ever-increasing wealth of data, including spatial and location data, as well as the data accumulated by citizens on a daily basis. Our premise is that data must be used to improve service delivery to our people*" (Mkhize, 2015). This captures the essence of government's duty towards its' citizens and the role that big data can play in government's endeavours to improve efficiency and effectiveness it the work of government.

1.2 PROBLEM STATEMENT

As in many countries, citizens of South Africa continue to request for more and improved services from the government. However, the services citizens receive do not seem to be improving in many communities of the country. This is respective of the fact that some of the authorities have enough rich data that can be used to engineer better services. For example, there were 173 major service delivery protests in South Africa in 2016 (Municipal IQ, 2017). As a result of the continued poor service delivery, many communities are dissatisfied and have become aggressive in their responses, leading to vandalism of infrastructures, facilities and economic destruction. This challenge is across the different spheres of the South African government. The challenge of not

being able to make use of the available data sets to improve services could be attributed to some facts, such as: (I) lack of know-how about the voluminous data, and its diversity; (ii) demystification of the voluminous data at different levels of velocity for decision-making; and (iii) implication and use of the data, for various purpose in an attempt to improve service delivery. If these problems are not addressed, social-economic challenges will continue to be affected. Also, it has negative implications for social imbalance in the country.

1.3 BACKGROUND TO RESEARCH

The National Development Plan 2030, points to the challenges that many South Africans encounter on a daily basis which are accessing electricity, safe water, sanitation and transportation (National Planning Commission, 2011). These challenges have resulted in an increase in the number of protests due to dissatisfaction with government service delivery (Akinboade et al., 2012). Some of the main reasons for the service delivery protests include lack of or poor service delivery of water, sanitation, electricity, refuse removal, and housing (ibid). Some of these challenges can be traced back to the apartheid era where racial segregation meant inadequate services to the black areas. An example is the recent protests regarding sanitation in Cape Town, South Africa, where citizens resorted to dumping human waste at the Cape Town International Airport and Western Cape Government Legislature buildings (Mcfarlane & Silver, 2016).

The world is currently in the 4th Industrial Revolution which is based on Cyber physical systems that combine communications, IT, data, and physical elements and integrating several core technologies. Amongst those technologies is big data. Big data enables decision makers to measure and know more about their business, which knowledge can be used and translated for improved decision-making and performance (Mcafee & Brynjolfsson, 2012). Three attributes comprehensively define big data, namely data volume, variety and velocity (Hashem et al., 2015). Whilst no one aspect of big data is more important than the other, the ability to analyse diverse data sources and new data types has more potential rewards.

The South African government departments holds huge datasets, but at which rate they are processed and analysed is a mystery. However, these large datasets must be processed and analysed for effective decision-making and for improving service delivery to the citizens. Thus, government departments are well-positioned to become more efficient and more productive by implementing big data technologies in their strategy. In this context, IT, big data, and process are resources, within which rules are required to guide their usefulness and manageability for efficient

and effective services. In this context, IT, big data and process are resources, within which rules are required to guide their usefulness and manageability for efficient and effective services.

1.4 AIM AND RESEARCH OBJECTIVES

The aim and objectives of the research are presented in the section as follows:

1.4.1 AIM OF RESEARCH

The aim of this study was to develop a conceptual framework through which big data can be used to improve service, which the Government Professional Geo-Spatial Services (GPGS) provides to the citizens, such as geospatial services.

1.4.2 RESEARCH OBJECTIVES

Based on the aim of the study as stated above, the objectives were as follows:

i. To investigate how big data within GPGS is stored, managed, and used for service delivery.
ii. To examine and understand how big data influence the services that GPGS provide to South African citizens.

1.5 RESEARCH QUESTIONS

This section covers the main and sub research questions as follows:

1.5.1 MAIN RESEARCH QUESTION

What are the factors that can influence the development of a conceptual framework through which big data can be used to improve service delivery by GPGS?

1.5.2 RESEARCH SUB-QUESTIONS

i. How are big data stored, managed, and used for service delivery by GPGS in South Africa?
ii. What are the factors that influence how big data is stored, managed, and used for service delivery by GPGS in South Africa?

1.6 LITERATURE REVIEW

The areas of focus in the review of literature include Information Communication and Technology, government service delivery and Big Data. Review of literature were also conducted on the theory, structuration theory that underpin the study.

1.6.1 INFORMATION COMMUNICATION AND TECHNOLOGY

Information Communication and Technology (ICT) has been recognized as having the ability to help government improve governance and service delivery through technology (Smith & Teicher, 2006). It should be noted that the implementation of ICT in an organization is not only about the infrastructure and software, it also affects the processes thereof. This in turn is closely related to the impact ICT will have on the customers of that particular organization (Gatautis, 2008). In the case of government this will be the citizens who will attest to the positive impact ICT has on the government's ability to render services efficiently and effectively.

Through ICT governments have been able to render services to its' citizens effectively and in a more economical way. It improves the interaction between various stakeholders – service providers, private sector and citizens (Gatautis, 2008). Furthermore, ICT has been associated with helping government render better public services, increased transparency and accountability (Roman & Miller, 2013).

In a study done in the UK regarding the use of ICT in teaching, the researchers found that ICT increases students' attention and participation, time-saving and through the use of technology teachers have been found to be more motivated (Uluyol & Sahin, 2016).

Use of ICT enables governments to improve service delivery, provide services more efficiently at a faster pace and at lower costs. ICT has also been shown to speed up decision-making, improves internal processing times thus improving management of legislation and enforcement of policies (Matei & Savulescu, 2014). ICT is increasingly used in the political field in attempt to maximize public participation in democratic processes with the aim of winning electoral support. This has been done through the use of social media platforms like Facebook or twitter (Sæbø et al., 2014).

1.6.2 GOVERNMENT SERVICE DELIVERY

One of the main duties of local government in South Africa is the provision of sustainable and effective services to citizens as directed by the constitution which includes the provision of water, sanitation, electricity, health services and housing amongst other services (Statistics South Africa, 2016).

The local government sphere of government ought to excel, but do not, in providing services to the public based on its constitutional mandate and as the closest of the government spheres to the people (Koma, 2010). This problem can be associated to the historical politics of the country. The apartheid era in South Africa created huge inequalities which were based mainly on racial divides, this was achieved by not providing adequate housing, health service and electrification amongst other services (Alexander, 2010). It is when elected officials fail to live up their promises of improving the lives of the people through service delivery that those who feel aggrieved engage in protest action (ibid).

This in turn may lead to protest action or strikes which has become a key instrument used by the citizens to voice their displeasure with government or labour disputes, at times with deadly consequences as seen in Marikana area of South Africa, where about thirty-four people were killed (Webster, 2017).

The use of ICT and data sets opens up many possibilities, which the government can explore to improve service delivery to the citizens (Anom & Rashid, 2010). How these possibilities have been explored remain a challenge in many departments and agencies within the South African government. Also, the use of ICT has increased and improved access to information on government platforms which in turn shapes the citizens' perception of government performance and attitude towards government service delivery (Porumbescu, 2017).

1.6.3 BIG DATA

The term big data, today is defined by technology that can process huge volumes of data at much higher speeds than before (Yang, 2013). Three distinct features that big data is identified with are volume, variety, and velocity (Hansen & Porter, 2017). Volume refers to the size or magnitude of the data which are multiple terabytes and petabytes (Gandomi & Haider, 2015). Variety refers to the different data sources from which data is collected, ranging from sensors, social networks, or smartphones (Hashem et al., 2015). Velocity refers to the speed at which data can be processed (Assunção et al., 2015).

Whilst the characterization of big data is around volume, variety and velocity, value is gained from its ability to enhance and speed up the decision-making and enables decision makers to make intelligent decisions (Hilbert, 2016).

Organizations in the retail sector that have employed big data in their organizations have seen a significant increase of up to 15 to 20% in their return on investment (Fosso Wamba et al., 2015).

It has also been found that employing big data analytics increases the productivity and competitiveness of organizations in both the private and public sector (ibid).

There has been realization around the world that the private sector dominates and has benefitted from the use of big data. Government has also begun to derive benefit and insight from big data as it assists in decision-making in real-time (Kim et al., 2014). It is worth noting that the public sector has been identified as one of the sectors that has collected and stored huge amounts of data and big data could be employed to enhance decision making and used to improve service delivery (Ali et al., 2016).

Countries in Asia have taken steps on implementing big data to address their various needs. In China, for example, traffic data is made available through public websites and GPS software developers use it to provide users with real-time data assisting road users on optimal routes to use and which routes to avoid due to congestion (Yang, 2013). In Singapore, big data is used to manage the security threats through the Risk Assessment and Horizon Scanning (RAHS) and Japan is using it to address tsunami and earthquake related issues (Ali et al., 2016).

In the healthcare sector big data has enabled healthcare ministry to obtain insights and address the issue of quality and escalating healthcare costs (Groves et al., 2013). The issue of big data having an impact on costs is further echoed by (Collins, 2016) who notes that big data may allow monitoring of consumer behaviour in the healthcare system and determine accurately and timeously how they spend their healthcare insurance.

Technology-savvy organizations have begun utilizing big data strategically to refine their processes, create new business opportunities or income streams, and create more value for their customers (Frizzo-Barker et al., 2016). Whilst the reliance on data for decision-making is not new, it is the nature of data available that has changed and with it comes the complexity it the management and analysis thereof (Daniel, 2015).

As discussed above, IT, big data, and process are resources, which can also be seen as agents that are capable of making a difference in transforming service delivery into a better space. However, the transformation requires rules in order to guide the usefulness and manageability of the resources and agents for improved service delivery through efficient and effective. Thus, the structuration theory is required as a lens to underpin this study, in that the theory focuses on agents, resources and rules, and how they are used to produce and reproduce activities within a social system such as government departments.

1.6.4 STRUCTURATION THEORY

Structuration is a social theory that focuses on the interaction of the social structures and the agents (Iyamu, 2017). Agents and structure are the two core paradigms of Structuration Theory (ST) (Twum-Darko & Iyamu, 2015). Structure is described as the resources and guidelines or rules which influence and play a role in the production of social practice (Twum-Darko, 2014). Agent is any conduit that can act, be it a human actor or technology (ibid). ST focuses on the process of production and reproduction of structure to form an institutionalized structure or practice (Amizan Omar et al., 2016).

Social structure comprise of rules and resources which influence the production and reproduction of social system (Yates, 1997). Agents refers to the human agents, technology who operate within the structure (Letseka & Iyamu, 2011). This interaction between structure and agents is known as the duality of structure. Duality of structure affirms the notion that human actions are not only a product of skills and knowledge, but also the creation and recreation of structure which enables or confines these actions (Ma, 2010). Structure and agency are mutually constitutive in that social structure is reproduced by human action at the same time structure enables and constrains human action (Veenstra et al., 2014).

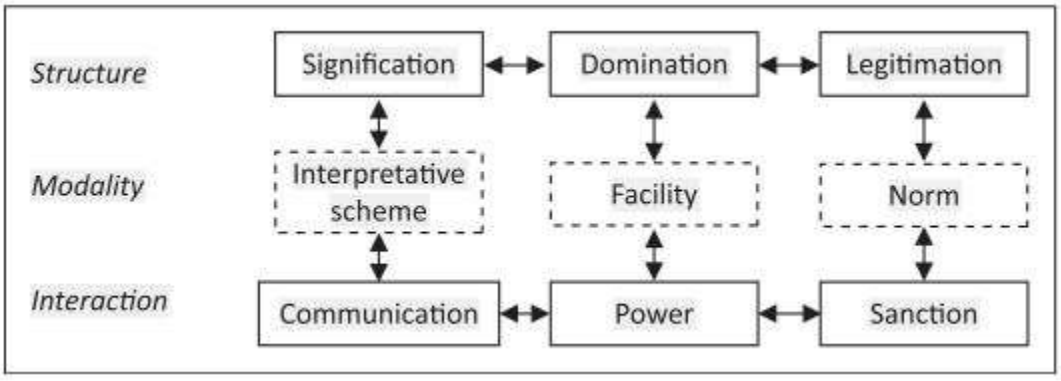

FIGURE 1: DUALITY OF STRUCTURE (IYAMU, 2017)

As shown in Figure 1, the duality of structure concept consists of three dimensions, which are structure, modality, and interaction.

The first dimension signification, produces meanings through organized semantics, e.g. language, this is how a phenomenon is interpreted or understood (Lamsal, 2012). Domination involves monitoring, control and coordination of organizational activities (Daryaei & Mahdavi, 2015). The last dimension legitimation is the application or enactment of norms, values and standards as a way of holding each other accountable (Puron-Cid, 2013).

People use modalities to draw on structures when they perform actions (Mokosch et al., 2015). Interpretative schemes refer to knowledge acquired through signification and determines how the agent communicates their actions (Amizan Omar et al., 2016). Facility refers to the knowledge acquired from the domination process and is reflected by the show of power by the actor (ibid). Through legitimation, norms determine a relevant sanction borne out of human interaction or behaviour (Rose & Scheepers, 2001).

ST emerges as an important tool for planning and interpreting data (Pozzebon & Pinsonneault, 2005). The selection of structuration theory is informed by the objectives of this study from which keywords were extracted that determine the theory that will guide our data analysis. The objectives of this study seek to understand how big data can be used to improve service delivery in South Africa. Essentially this means we must look at the structure of the organization and determine or explain how the structure dictates the use of big data to improve service delivery.

1.7 RESEARCH DESIGN AND METHODOLOGY

Based on the objectives of this study as stated in section 4, the design and methodology for the research were selected. This includes the philosophical assumption, approach, methods, and techniques that will be employed in the study.

1.7.1 PHILOSOPHICAL ASSUMPTIONS

There are two main philosophical assumptions in information systems and technology (IS/IT) studies, which include ontology and epistemology. Ontology is considered to be the study of being and the nature of reality (Fletcher, 2017). While epistemology is generally seen as a philosophy that is concerned with how we come to understand what we know and what informs our knowledge (Assalahi, 2015). Thus, epistemology defines what we mean when we say we know something or what more can be known about a subject (Mack, 2010).

Ontology and epistemology are not mutually exclusive as ontological assumptions give rise to epistemological approaches which then informs the methodological considerations of the researcher (Yazan, 2015). Epistemological assumptions give rise to interpretivism paradigm from which qualitative researchers mostly work from (Graff, 2014). Interpretivism works from the assumption that there are many realities and researchers seek to understand the participants' point of view (ibid). Furthermore, interpretivism is premised on the notion that the researcher encounters the world already interpreted and his task is to discover and understand peoples' meanings and perspectives of a phenomenon (Walliman, 2011).

In the context of this research, ontologically, what we do know are, government have accumulated big data over the years, and service delivery have remained poor. Epistemologically, what can be known is how the big data can be used in order to provide a guide through which service delivery can be improved. Thus, the epistemology was followed, within which a stance was employed in the study.

1.7.2 RESEARCH APPROACH

Similar to the philosophical assumption, there are two main approaches, inductive and deductive. Inductive approach is linked with qualitative studies, wherein the researcher both describes and interprets a phenomenon they have observed within its particular context (Liu & Zhang, 2015). Deductive approach seeks to test theories often through the application of pre-existing or pre-developed propositions to a phenomenon (Rahman, 2015).

Inductive approach is considered useful in constructing a conceptual and theoretical framework from an observed phenomenon (Stol et al., 2016). This study followed an inductive approach, seeking to understand and learn more about the phenomenon of big data in the government of South Africa, how it is managed and can be used to improve service delivery.

1.7.3 QUALITATIVE RESEARCH METHODS

The qualitative and quantitative methods are commonly used in IS/IT studies (Mkhomazi & Iyamu, 2013). Although a combination of both, which is called mixed method can also be applied (Halcomb & Hickman, 2015). Qualitative research is an approach that focuses on how people perceive and interpret a phenomena based on their experiences and the environment they live in (Holloway & Galvin, 2017). The qualitative research method is more preferable if deeper knowledge is required about an issue from which little is known (Algozzine & Hancock, 2016). This research method also is more concerned with the quality of social meanings and people's subjective take on a phenomenon (Percy et al., 2015). Its goal is to look and understand people's attitudes, opinions, beliefs, and their experiences in the environment they live in (ibid).

Quantitative methods are numerically oriented and require precise measurements of constructs (Murshed & Zhang, 2016). Whilst in qualitative method the quality and integrity of the process has to be safeguarded, in quantitative research, the quality of the raw data is much more important (McCusker & Gunaydin, 2015).

In the context of this study that aimed to develop a framework through which big data can be used to improve service delivery within the government of South Africa, the qualitative research method was found to be the most appropriate in conducting this study.

1.7.4 RESEARCH DESIGN

Research design is the conceptual structure within which research is conducted, constituting the blueprint for the collection and analysis of data (Kothari, 2004). Research design provides an outline for the research thereby facilitating smooth implementation of the various research operations (ibid). Research design shows how all the major parts of the research work together in addressing the research questions (Trochim, 2002).

This study employed a case study research design. Case study is one of the most frequently used qualitative research methodologies (Yazan, 2015). It is considered a robust research method as it allows the researcher to investigate a phenomenon within its real-life context using multiple sources of evidence (Zainal, 2007). Through a case study, a researcher gains in-depth knowledge and understanding of situations and the meanings attached by those involved (Algozzine & Hancock, 2016).

Case study is considered ideal when a holistic and in-depth investigation is needed. It is designed to bring out the details from the viewpoint of the participants by using multiple sources of data (Tellis, 1997). Using a pseudonym, an organisation known as Government Professional Geo-Spatial Services (GPGS) was used as a case in this study. The department was identified for the following reasons:

- GPGS deals with issues related to land through, amongst other things, land reform, development, and restitution, which are of huge national interest and have invited intense and often heated debates amongst different interest groups. The land issue is an important topic in the political discourse of the country
- GPGS provides services such as geospatial and cadastral services, which are important for supporting sustainable land development.
- There is prima facie evidence of government not being able to deal adequately address with the land issue, which has resulted in only a small percentage of land to be transferred or redistributed to majority of the citizens who were deprived or dispossessed of their land. This has in turn lead to continued service delivery protests and unrests.
- The dissatisfaction with issues related to land reform and restitution has also seen citizens approaching courts to force government to address its failures in dealing adequately with complaints related to land reform and restitution.

1.7.5 DATA COLLECTION

The three most common techniques of collecting data within the qualitative methods are observation, interviews and documentation (Mack et al., 2005). Over the years, the interview has become the main data collection technique that is closely associated with qualitative research (Englander, 2012). The method is described as “conversation with a purpose” (Ritchie & Lewis, 2003). The semi-structured interview and documentation techniques were employed to collect qualitative data for this study.

1.7.5.1 INTERVIEWS

The use of interviews as a data collection method “*begins with the assumption that the participants’ perspectives are meaningful, knowable and can be made explicit*” (Fretchling, et al, 2002:50). Interviews allow for personal contact and allows the interviewer to acquire detailed and in-depth information about the participants’ experiences and views on a particular matter (Dikko, 2016). The purpose of an interview is to get the participants’ view or perspective of a phenomenon and to understand the rational that informs that perspective (Cassell & Symon, 2004).

Interviews can be categorized into structured, unstructured, and semi-structured interviews (Segal et al., 2006). The semi-structured interview is suitable for probing the interviewees, explore their understanding and perception of the phenomenon (Louise Barriball & While, 1994). Semi-structured interviews also give the flexibility for follow-ups and to seek clarifications on answers given during the interview process (Kallio et al., 2016). Thus, the semi-structured interview technique was employed to collect qualitative data for this study. However, there was existing material not covered using the interview technique. As a result, documentation was added as a technique.

1.7.5.2 DOCUMENTATION

Documentation captures information that cannot be subjected to interviews and other data collection methods and holds key data. It is an essential source of knowledge and learning about an organization (Navidi et al., 2017). In documentation can be found hidden knowledge implicitly related to other key information within the organization (Loh et al., 2001). Documentation further gives the researcher deeper insights and context or rationale for decisions taken within an organization (Warwick et al., 2009). Based on these, the documentation technique was used complementary with the semi-structured interview technique.

1.7.6 DATA ANALYSIS

Data analysis is a process of moving from the collected data into manageable components in an endeavour to gain understanding and/or interpretation of the people or the phenomenon being investigated (Ma, 2015). It allows the researcher to make sense of the collected data from the participants' point of view, noting and identifying patterns, categories, themes, and regularities (Male, 2016). The process of data analysis effectively commences at the same time as data collection (ibid).

Structuration theory was used as a lens to guide the data analysis as follows:

- Through the interaction of human agency and the three dimensions of the duality of structure which are *structure*, *modality*, and *interaction*.
- The role played by the agents (human and non-human) in the structure and how they influence, either positively or negatively the use of big data in the government department.

1.8 ETHICAL CONSIDERATION

The study was conducted within the rules that govern research in the Cape Peninsula University of Technology. The ethical clearance letter was obtained from the Faculty of Informatics and Design as well as the consent letter to grant permission to collect data will be sent to prospective participants. The letter informed the participants about the goals and objectives of the study. Before the start of the interview, permission to record the session was sought from the participants, as well as informing them of their right to withdraw or raise any objections to the use of their information at any time. Furthermore, all participants' data was treated with confidentiality and their identity will be anonymous.

1.9 SIGNIFICANCE OF THE STUDY

From ICT perspective, the study sought to provide a big data framework which can be used to guide how a South African government department provides services. The framework can be replicated across government departments and agencies, making it even more significant. Whilst big data is more used and exploited in the private sector, the study provided a framework for government use of big data technology.

1.10 DELINEATION OF THE STUDY

This study was limited to government departments since the study dealt with using big data to improve government service delivery. Due to budgetary constraints and limited resources, the study was conducted in Western Cape Province, South Africa.

1.11 CONTRIBUTION OF THE STUDY

This study was intended to contribute to both government and academic domains. To the government, it provided insight and guidance on how government can use big data to improving service delivery to its' citizens, from practical and methodological perspectives. To the academic, the study contributed from both theoretical and methodological aspects. Theoretical, the study added to the existing literature in the areas of government service delivery, big data, and structuration theory. Methodologically, the study contributed, primarily on how structuration theory was used to guide the analysis of government big data for improved service delivery.

1.12 STRUCTURE OF THE THESIS

The study was structured into six chapters. This section presents the structure of the study as follows:

Chapter one – this chapter introduced the entire study, from the first to the last chapters.

Chapter two – review of literature related to the study will be presented in this chapter.

Chapter three – this chapter discussed the research methodology that was employed in the study.

Chapter four – the overview of the case that was used in the study was covered in this chapter.

Chapter five – the analysis of the data was presented in this chapter.

Chapter six – finally, the conclusion about the study was drawn in this chapter.

1.13 CONCLUSION

This study sought to show the challenges posed by governments failure to provide adequate services to its citizens. Emergence of ICT has brought effective and efficient platforms for realizing the government mandate. One such technology is Big Data which is characterized by volume, veracity, and velocity. The study followed a qualitative method in its endeavour to answer the given research questions. The research design adopted is case study which selected a government department based on the criteria given above.

The main areas of discussion included ICT, Government Service Delivery, Big Data, and Structuration Theory which was used as a lens for data analysis. The study followed epistemological philosophical assumptions in an inductive approach.

Qualitative data was collected through semi-structured interviews and documentation techniques. What was achieved at the end of this study is a conceptual framework for big data that can be used by the government of South Africa.

CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

Literature review is considered as an important part of any academic studies (Ho, 2016). It helps to provide argument and justification about the phenomena being studied. Thus, this review focused on the aim of this study, which was to develop a conceptual framework through which big data can be used to improve South African government service delivery in the area of geospatial.

This chapter presents a review of existing works that are related to this study. The key areas of the study within which the review was carried out include Information and Communication Technology (ICT), Big Data and Big Geospatial Data of Government. A review was also conducted on the theory, Structuration theory that was used to underpin the study. This includes the relationship between the theory and information systems studies.

2.2 INFORMATION AND COMMUNICATION TECHNOLOGY

Information and Communication Technology (ICT) has many definitions and descriptions owing to its broad nature and scope of coverage. According to Sarkar (2012), ICT refers to a collection of technologies and resources which are used for communication purposes. Wart et al. (2017:528) refer to ICT as "information and communication systems that provide broad functionalities such as office automation, and technological tools used by individuals to communicate". Jin and Cho (2015) view ICT as a conduit or enabler that has revolutionized production, logistics, processes, and decision making. As an enabler, ICT is critical for governments to transform and enhance their roles, improve services, and increase public value (Carayannis & Hanna, 2016).

ICT artefacts are used to enable and support business processes and activities including government services (Dahiya & Mathew, 2018). However, ICT artefacts can, at the same time constrain processes and services (Busch, 2017). For example, its deployment in the public sector has enabled better interaction and relationships between government, citizens and businesses resulting in more convenient, transparent and cost-effective delivery of services (Ruhode, 2016). As a result, many governments in Sub-Saharan Africa have embraced and integrated ICT into their key activities to enhance effectiveness and efficiency in the delivery of services to the citizens (Verkijika & De Wet, 2018b).

Some of the positives that ICT has brought in the public sector is the strengthening of good governance which is evidenced in the areas such as accountability, transparency, responsiveness, efficiency and effectiveness, in the delivery of services (Nulhusna et al., 2017; Ruhode, 2016). This includes digitalisation of government services. The use of ICT to improve services and performance of other government activities in the public sector is widely referred to as electronic government (Mpinganjira, 2015). Concerns have been raised regarding the majority of ICT implementations not meeting or delivering on the expectations of stakeholders especially in South African municipalities (Mawela et al., 2016). Maramura and Thakhathi (2016) argue that whilst e-government in South Africa is competing with other social issues such as housing and, access to healthcare, there is a misalignment between processes, people and technology which would create a favourable environment for ICT implementations resulting in many of them not being successful.

2.2.1 People, Process, and Technology

The successful implementation of ICT projects requires a strategic combination and integrated approach between three critical components people, process, and technology (Rahimi, 2017). The interactions between people, technology and organizational processes as shown on Figure 2, are critical to whether these projects are a success or failure (Jeffries et al., 2017).

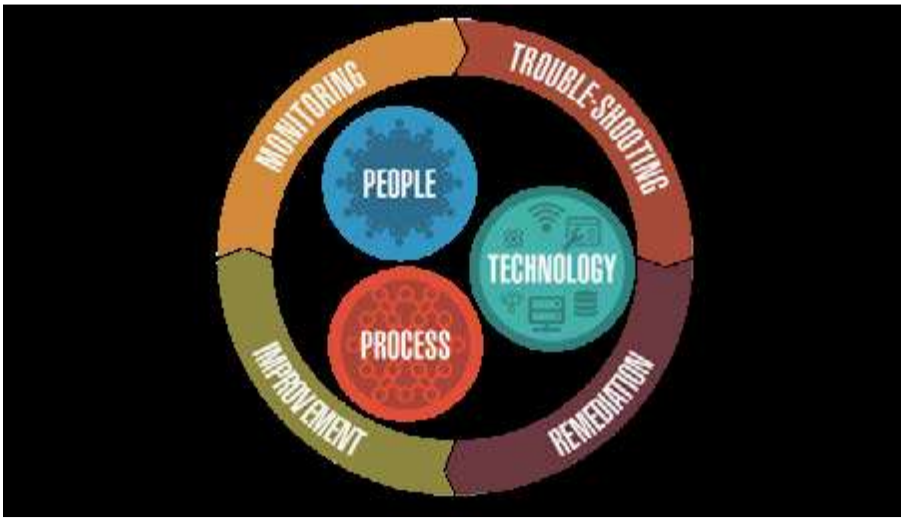

FIGURE 2: CRITICAL COMPONENTS TO ICT SUCCESS/FAILURE (COTENESCU, 2016)

Technology

Technology is credited with promoting governance which manifests in transparency and festering trust between government and citizens (Yimer, 2014). Through ICT, interaction and communication between the citizens and the government is enabled via ICT platforms such as websites, email, and social media (ibid). Apart from enabling government to render better services, technology has also enabled government to decrease corruption and increase transparency (Ramli, 2017).

Whilst technology has brought improvements to people's lives, technology has forced people to change their behaviour and lives to fit and reflect the constraints brought about by technology (Miranda et al., 2015). Technology incorporates procedures, processes and/or standards that can enable or constrain people and processes, thereby shaping consequent actions of people and business processes (Jeffries et al., 2017). For example, web-based platforms are now available to facilitate access and processing of geospatial data thus providing new opportunities for delivery of services in the area of geospatial data (Wagemann et al., 2018).

Technology has also been viewed as a silver bullet, where the effects of technology become exaggerated at the expense of neglecting the importance of people and process (Rose et al., 2015). This is as a result of not fully comprehending the role technology and the conditions under which it can be implemented (ibid). Etoundi et al. (2016) caution that whilst technology can address many issues, it cannot succeed if used improperly or in isolation to other factors such as people and processes.

Furthermore, it is reiterated by Cotenescu (2016:394) that technology is not a silver bullet to solve all problems but rather a "*blend of technology, people and processes*" needs to be created in an organization to achieve success in the implementation of technology. It has been rightly argued that technology is necessary however, is not the only factor that contributes to the success of IT implementation (Rahimi, 2017). In other instances the problem is not the deployment of technology but how it was deployed, what input did the people who will use the technology have and were business processes regarded (Mawela et al., 2016).

People

The proliferation of technology has necessitated people to engage with it as it has affected their lives and at some instances forced lifestyle changes (Soomro et al., 2017). The success of any IT implementation lies in people accepting and/or embracing the changes brought about by new technology (Rahimi, 2017). A negative perception of the user about a technological solution in

an organization may lead to failure of the project implementation (Azmi Omar et al., 2016). Hence, human resources become a vital component in technological deployments to ensure proper deployment and utilization of technology in an environment where it is deployed (Bhat et al., 2018).

As highlighted by Waller and Genius (2015) lack of qualified personnel, problem with leaders and management support, and resistance to change are directly responsible for some of the failures in technology. An apparent tension exists between technology and people in that increased use of technology through automation renders labour redundant and also results in declining wages (Acemoglu & Restrepo, 2016). There are also concerns among the citizens relating to privacy and security when it comes to use of e-government services (Abu-shanab, 2017).

Whilst it has been shown that policy uncertainty is a major barrier to adoption and use of e-government services, social factors such as culture, literacy, and access to resources are among the factors that significantly influence people's use of e-government services (Gichuki et al., 2017). This point is echoed by Gascó et al. (2018) who argue that the social factors such as social attitude, norms and culture, play a vital role in determining the use of technology. For example, in South Africa, most of e-government project failures have been caused by lack of user acceptance due to vast number of reasons including government adopting a top-down approach (Kassongo et al., 2018).

Process

The growth in technological use to access public services by the citizens challenges governments across the globe to continually transform and reinvent their processes so as to provide efficient and effective services through the use of ICT (Sá et al., 2016). Sound business processes and proper alignment between process and technology are foundational to government rendering efficient and effective services to its citizens (Carayannis & Hanna, 2016). Gil-garcia et al. (2018:633) argue that "*it is hard to imagine any government function or governance process that does not involve extensive use of information and technology*".

The use of technology are largely facilitated through enactment of policies and processes constraining people to use e-government services (Stefanovic et al., 2016). Lack of common ICT standards and processes, and the culture of government departments operating in silos constrain and impedes effective delivery of services (Hughes & Smart, 2012). The failure to follow due processes, such as public consultations and stakeholder engagements in the implementation of e-government services can significantly derail and cause failure of such implementation as was

the case with the South Africa Gauteng Freeway Improvement Project otherwise known as e-tolls (Mawela et al., 2016). The failure of government to allow for proper public participation as per government policy, led to a revolt against the system and significantly impacted citizen trust and brought to the fore the ability of stakeholders to influence success or failure of e-government service implementation (ibid).

2.2.2 Electronic Government

Electronic government (e-government) refers to the use of ICT in the provision of information and government services in the public sector with the aim of better, efficient, and improved service delivery and achieving social inclusion and transparency in governance (Deng et al., 2018; Batara et al., 2017). Ali et al. (2018) further define e-government as a process through which government departments and entities use ICT to advance business development and service delivery.

The definition is broadened by Waller and Genius (2015:482) by referring to e-government as, "*use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that have the ability to transform relations with citizens, businesses, and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information or more efficient government management*". Therefore, e-government is critical for the provision and access to government services while at the same time instrumental in assisting government achieve efficiency and transparency in the provision of services (Furuholt & Sæbø, 2018).

As a concept, e-government evolved from the domain of e-business where organizations interacted and collaborated electronically with customers, suppliers and partners through the internet and related technologies (Nath & Kanjilal, 2018). Governments across the globe began to adopt and employ e-government initiatives by leveraging the potential of ICT with the aim of transforming government services for the better (Dahiya & Mathew, 2018). This is evidenced by the fact that all 193 United Nations member states have adopted e-government to improve efficiency and effectiveness in the provision of services (Batara et al., 2017). South Africa is regarded as one of the leading countries in the adoption and implementation of e-government in sub-Saharan Africa (Verkijika & De Wet, 2018a; Gichuki et al., 2017).

Government websites have been an e-government tool at the forefront of facilitating interaction between governments and citizens, allowing for dissemination of information and have been credited with enhancing administrative efficiency and transparency of government processes and

services (Verkijika & De Wet, 2018b). Whilst most governments implement e-government to improve service delivery, Nath and Kanjilal (2018) posit that effective delivery of services requires integration of process and information systems between government departments and its entities. Rose et al. (2015) highlight this point as one that contributes to challenges in the implementation of e-government initiatives, that of competing interests between government agencies and departments coupled with political environment and the complex decision-making processes.

Whilst there have been notable successes with ICT and e-government initiatives, there are a wide variety of challenges that governments are faced with in the implementation and management of these initiatives (Waller & Genius, 2015). These challenges, which undermine, and stall successful implementation of e-Government initiatives include infrastructure, structural and resource problems (ibid). For example in Zimbabwe, whilst government has embraced the concept of e-government, they have however not paid attention to the policies framework that will enable the implementation of e-government thus not realising the benefits brought by e-government such as exploitation of the voluminous and variety of data held by the various government departments and entities (Masuku et al., 2017).

2.3 BIG DATA

The development and rapid growth of ICT has resulted in a dramatic surge in the generation, storage and processing of data leading to the advent of Big Data (Fredriksson et al., 2017). The evolution of big data has brought with it a variety of definitions (Frizzo-Barker et al., 2016). Hofacker et al. (2016) define big data by its distinctive characteristics: volume, velocity, and variety, the 3V's. Volume refers to the size or magnitude of the data which are multiple terabytes and petabytes (Gandomi & Haider, 2015). It is estimated that by the year 2020 the world will generate over 40 zettabytes of data with over 90% being unstructured data (Sivarajah et al., 2017). Variety refers to the different data sources from which data is collected, ranging from sensors, social networks, or smartphones (Hashem et al., 2015). Velocity refers to the speed at which data can be processed (Assunção et al., 2015). A fourth characteristic, value, has been suggested by Ali et al. (2016), which is the process of gaining more insight from the large datasets wherein organizations gain or realize economic value and increased competitiveness. Mauro et al. (2016:131) proposed a new definition and defining big data as, "*Information assets characterized by such High Volume, Velocity and Variety to require specific Technology and Analytical Methods for its transformation into Value*."

Big data is available in various forms such as structured or unstructured data with over 80% of all data generated by various organizations comprising of unstructured data such as voice, text, videos, images, geospatial data or a combination of any of these formats (Kanika et al., 2018). Structured data which constitutes about 5% of all data, consists of tabular data found in spreadsheets or relational databases (Mishra et al., 2017). Textual data held by organizations may consist of emails, corporate documents such as policy documents, social network feeds and blogs (Gandomi & Haider, 2015). Video data is mainly sourced from closed circuit television cameras and videos shared on social media (ibid). Image data may consist of pictures from social media, those found in the health care sector such as magnetic resonance imaging (MRI) scans, computed tomography (CT) scans, radiograph films (Raghupathi & Raghupathi, 2014). Geospatial data consists of location-based data sourced from devices such as mobile phones, GPS and remote sensors (Hilbert, 2016).

For organizations to gain useful insights from big data, it needs to be refined, cleaned, and structured and this process can be achieved through analysis of the data (Al-htaybat & Alberti-alhtaybat, 2017). Private companies have been leading in the use of big data and mostly use it to gain competitive advantage and profit making, however, the public sector's goal in utilizing big data is gaining efficiency and effectiveness in the delivery of services to its' citizens (Kim et al., 2014). For example, retail companies have used big data to better understand their customers and their spending patterns and buying decisions whilst financial institutions use big data to analyse markets and predict investment performance (Klievink et al., 2017).

Whilst governments have started to use big data there are challenges that need to be addressed for gaining maximum value from big data. These include systems operating in silos such as enormous amount of data in legacy databases across the departments (Kim et al., 2014). The challenge with big data may not concern all its' features such as volume, veracity and velocity, but rather what value can be derived from the data no matter what size that data is (Bodas-sagi & Labeaga, 2017). Thus, through big data analytics, the ability to analyse of big data enables the organization to gain insight and realize the value of the data (Gandomi & Haider, 2015).

2.3.1 Geospatial Big Data of government

The term geospatial refers to geographic data in reference to space or place in time (Meeks & Dasgupta, 2005). Pinnick (2017:180) defines geospatial data as one that "*conveys information about the Earth, the location of specific features, and attributes and properties of those geo-located features*." There has been significant increase in the production and consequent

availability of geospatial data (Lush et al., 2012). It is largely derived from sources such as remote sensors, satellites, and Global Positioning System (GPS) among others (Dasgupta, 2017). Lee and Kang (2015) argue that geospatial data has always been big data because of a large portion of all data generated having spatial (longitude, latitude, and/or altitude) features such as location referencing and geographic space. Thus, geospatial data has all the features of big data including value which can be derived from geospatial data by facilitating decision-making for organizations and delivery of government services (Yang et al., 2017; Lee & Kang, 2015). Geographic Information Systems (GIS) are software and hardware systems through which huge volumes of geospatial data is stored, retrieved, and analysed to assist with decision-making and value add in the area of service delivery through geospatial data such as mapping services, land use and urban planning (Barik et al., 2016).

It is argued by Kay (2017) that all government planning and services delivered to the citizens occur at a place and time and therefore requires geospatial data. Governments across the globe collect, analyse and use geospatial data to support decision-making and delivery of services to their citizens such as mapping services (Johnson, 2017). Access to geospatial data such as satellite imagery has expanded and increasingly made available due to investments by government and is being used to capture and record information critical to provision of services such as roads and human settlement infrastructure (Pezzulo et al., 2017). From the resultant satellite imagery, vast landscapes can be mapped and provide critical information to government for service delivery purposes (ibid).

Geospatial data consists of extremely large sets of data which renders traditional methods of storing geospatial data limited and inadequate (Liu et al., 2016). One of the contributing factors to the volume of geospatial data is that data needs to be pre-processed before it is analysed and this generates huge amounts of data (Larraondo et al., 2017). This has in many ways influenced the need to revisit the traditional ways of processing and storing geospatial data (ibid). Both tradition and non-traditional geospatial acquisition methods produce huge amounts of data at faster speeds which categorizes geospatial data under big data (Yang et al., 2017). As stated by Wagemann et al. (2018), the challenge with geospatial data is that the capacity to collect data surpasses the capacity to process, manage and analyse due to technical and infrastructural capacity.

As argued by Georgsiadou and Reckien (2018), when geospatial data is integrated and accessible, it leads to cost savings and improved service delivery. It is also useful for spatial management and planning of government services such as transportation, housing, mapping services and urban planning (Kouziokas, 2016). Thus, geospatial information can be exploited

through technology to support government in decision-making leading to improved service delivery (Fardusi et al., 2017). The rate at which geospatial data is collected, volume and various sources of geospatial data from which it is derived renders traditional databases and human effort unfeasible, requiring use of big data analytics (Budgaga et al., 2017). Furthermore, the collection of geospatial data is an expensive and time-consuming exercise and requires high level of expertise to collect such data, hence, efforts by government departments should be guard against duplication of efforts thus wasting scarce and valuable resources (Kay, 2017).

Spatial Data Infrastructures

The purpose of spatial data infrastructure (SDI) is to "improve the sharing and use of geospatial data and services, which helps different users of a given community" (Torres et al., 2017:110). The need for SDI was predicated by the need to effectively manage geospatial infrastructure, create sharing platforms, avoid duplication of data and promote access to spatial information (Siebritz & Fourie, 2015). Thus, SDI, is "*a collection of technologies, policies, and institutional arrangement that facilitate the availability of and access to geospatial data"* (Othman et al., 2017:325).

Owing to the complex, multifaceted and dynamic environment in which SDI operate in, Vandenbroucke et al. (2013:58) define SDI as "*a combination of technological and non-technological set-ups within and between organisations to facilitate access, use and sharing of spatial data thereby contributing to the performance of work processes*". This complex, multifaceted and dynamic environment requires the identification and allocation of stakeholder roles as this is critical to the implementation of national SDI especially in the developing countries such as South Africa (Sinvula et al., 2017). Therefore, the goals and objectives of SDI will be achieved through the integration of work processes from those stakeholders that produce and/or acquire geospatial data (ibid). More importantly, the implementation of SDI enables government to provide services that are dependent on geospatial information more efficiently, thus reducing costs and increase productivity (Latre et al., 2013).

However, as pointed out by Kay (2017) the implementation of SDI in South Africa is fraught with challenges such as (i) lack of sharing of geospatial data; (ii) metadata of available geospatial data not submitted in a central repository thus rendering geospatial data undiscoverable; (iii) lack of or inadequate communication between data custodians and users; and (iv) lack of expertise and capacity of data custodians in the collection and management of geospatial data.

2.3.2 Big Data Analytics

Gaining meaningful insights from massive amounts of data has become increasingly challenging to organizations, thus, analytics has become important to realize the value of big data to improve performance and increase competitiveness (Zakir et al., 2015). Mgudlwa and Iyamu, (2018) point out that owing to the voluminous nature of big data, processing the data becomes more complex and challenging. Therefore, big data analytics is the process of mining or processing the large datasets to retrieve useful information (Cheng et al., 2016). There are a number of technologies that have been developed for analysing such huge datasets such as Hadoop, NoSQL, MapReduce, MongoDB, Cassandra, PIG, HIVE, Cloudera Impala, BDAS, Memcached and HDFS (Chang et al., 2016; Zakir et al., 2015).

Most of big data implementations have been dominated by the private sector and benefitted from real time decision making (Ali et al., 2016). Governments have considered leveraging on the big data potential especially since the public sector has been identified as one of the sectors that has collected and stored the highest amount of data (ibid). Governments generate petabytes of data every day and require technology that helps analyse this data in real time (Archenaa & Anita, 2015). The area of geospatial data presents governments with opportunities for big data analytics and the ability to extract data from the voluminous, variety and velocity of geospatial data (Kim et al., 2014).

It is argued by Li et al. (2016) that 80% of all data in the world is geographic and can be geo-referenced, thus indicating how big data analytics are important in extracting value for government services. Knowledge acquired from big data through big analytics can provide government with innovative and valuable ways of providing services to the citizens (Vassakis et al., 2018). Big data analytic tools are currently being utilized for geospatial data such as in the area climate data in order to gain value and assist decision-making (Hu et al., 2018). Countries such as South Korea are initiating geospatial big data analytics projects with the view of integrating the outcomes into the public services and will concentrate on real-time data and the archived data (Lee & Kang, 2015).

2.4 STRUCTURATION THEORY

Structuration is as a sociotechnical theory which focuses on the interaction between social structure and agent or agency (Iyamu, 2017). According to Twum-Darko (2014) structure is composed of the resources and rules which influence and play a vital role in the production of social practice. Twum-Darko and Iyamu (2015) posit that an agent is any conduit that can act,

such as a human actor or technology. It is argued by Jones et al. (2004) that the effects of non-human actors on social structure such as information technology artefacts, depend wholly on the knowledgeability of social actors, thus, the artefacts are influential insofar as the human actors are aware of their effects and therefore do not independently influence the actor's behaviour. For example, lack of knowledge on the use of word processing application means that the individual may not use it for the purposes for which it's well suited.

Rules are viewed as any principle or routine that guides an activity (Mcphee & Canary, 2012). On the other hand resources are defined as the means through which "*intentions are realized, goals accomplished, and power exercised*" Chang (2014:80). Regarding resources, they are distinguished between two types, (i.) allocative which involve "*transformative capacity generating command over objects, goods or material phenomena*", and (ii.) authoritative, which involve "*transformative capacity generating command over persons or actors*" (Jones et al., 2004:324).

Structure and agency are not mutually exclusive in that social phenomena are not a product of either structure or agency, but of both (Jones & Karsten, 2008). This interaction between structure and agents is known as the duality of structure and is one of the central themes of structuration theory (Savitri & Iskandar, 2018). This affirms the notion that social interactions of agents are influenced by structure and in the process, reproduce them (ibid). Social structure has the capacity not only to enable human actions but to constrain them as well (Vyas et al., 2017).

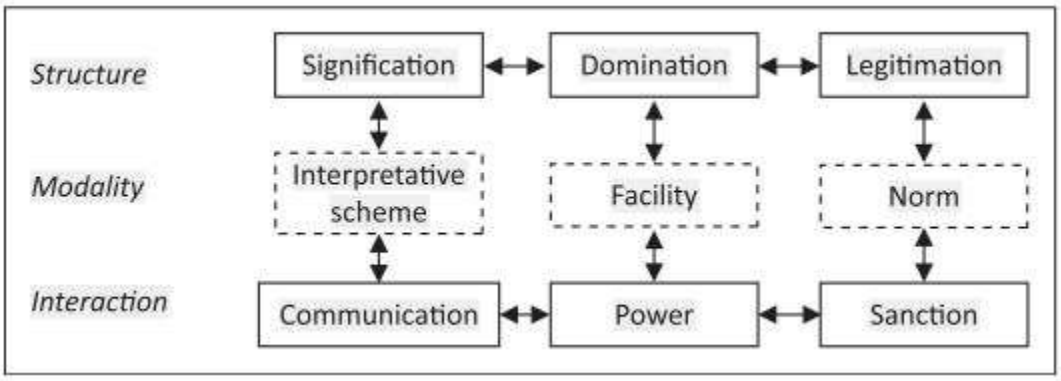

FIGURE 3: DUALITY OF STRUCTURE (TWUM-DARKO & IYAMU, 2015)

As seen on Figure 3, the duality of structure contains three dimensions which are structure, modality and interaction which are linked through modalities: the interpretative schemes, resources and norms (Letseka & Iyamu, 2011). The three fundamental elements of structure which are signification, domination and legitimation are ways in which organizations influence the understanding and behaviour of individuals (Hossain et al., 2011). It is further argued by Jackson et al. (2018) that in practice, the structures of domination, signification and legitimation are

overlapping and mutually reinforcing, thus, the actions of individuals may be guided by these structures or may seek to alter them.

First dimension of signification denotes organizational rules that govern interaction and through which phenomena is interpreted and understood (Daryaei & Mahdavi, 2015). The source of interaction in the structure of signification is basic communications such as spoken language, sign language and mannerisms (Treku & Wiredu, 2016). The second element, domination, is the application of power based on the control of resource (Lamsal, 2012). Legitimation is practised through the enactment of norms and values as a means of holding others accountable (Puron-Cid, 2013). It also denotes that individual action is influenced by the accepted norms within the structure such as performing a task following a particular process because it is the accepted norm with the structure (Jackson et al., 2018).

Interpretative schemes is the standardisation and stocks of knowledge used by people to interpret behaviour and events and through which interaction among individuals and groups is achieved (Iyamu, 2013). Facility refers to the "*knowledge acquired through the domination process reflected by the show of power by the actor*" (Amizan Omar et al., 2016:307). Lastly, norm refers to the rules that govern legitimate behaviour through the enactment of sanctions, thus producing and reproducing the legitimation structure through an interactive process (Chang, 2014).

2.5 STRUCTURATION THEORY AND INFORMATION SYSTEMS STUDY

Sociological theories such as Structuration theory have been increasingly used to underpin Information Systems (IS) studies primarily to guide collection and analysis of data, and to understand why IS deployments are deployed and implemented in the ways they've been (Iyamu, 2013). As shown in the preceding section on ICT, the components that make up ICT are people, technology and processes, their use therefore in IS studies identifies and seeks to explain the interplay of these components within the structure (Iyamu, 2015).

The use of structuration theory in IS studies focuses on how the development, implementation and management of IS/IT artefacts are enabled and at the same constrained within a social structure (Cao et al., 2009). Jeffries et al. (2017) employed ST to examine why failure of IT projects are widely attributed to poor design or implementation, through interactions between structure, humans and processes, to determine project failure or success. Thus, the use of structuration in IS studies ensures that the focus is not only on the functionality of systems, but rather takes a broader view and considers the complex dynamics of structure including the specific role played by IT (ibid). Similar studies have been conducted to identify influence of

technology, tasks and organizational environment as objects that convey social structure (Schmitz et al., 2016). Furthermore, in the field of information systems studies, variants of ST have been employed, such as duality of technology and adaptive structuration theory (AST) (Jones & Karsten, 2008). These variants seek to use ST in understanding the influence of technology and social processes at the same time creation of new structures within the technology (ibid). Howard (2017) further posits that AST has been used formulated to "*address the structures of IT and the structures of social action that emerge during their interaction with IT*".

2.6 CONCLUSION

Citizens measure the success or failure of their governments through the quality and standard of services delivery. On the other hand, one of governments' priorities is to render efficient and effective services to its citizens. These services vary from health, safety and security, housing and geospatial services. The introduction and growth of ICT has brought with it tools that enable governments to render services efficiently, effectively and cost-effectively. ICT also greatly assists government with decision-making thereby effectively use the scarce resources at its disposal. Whilst ICT artefacts enable and support business process, they, at the same time constrain business processes.

Technology has enabled interaction and communication between government and its citizens through platforms such websites, email and social media thereby promoting transparency and fostering trust between government and its citizens. It has also facilitated new opportunities for service delivery such as in the area of geospatial data where it can be accessed and processed through web-based platforms. It is important to note that technology is not a silver bullet that solves all problems but rather a blend of technology, people and processes needs to be festered in organizations in order to achieve success in implementing technology.

The revolution of ICT lead to the advent of Big Data which governments have started to use in order to gain insights thus enabling the provision of efficient and effective services to the citizens. Whilst governments have started to use big data there are challenges that need to be addressed for gaining maximum value from big data. These include systems operating in silos such as enormous amount of data in legacy databases across the departments. The government services that this study focuses on is in the area of geospatial data that has all the features of big data, volume, veracity and variety. It is argued that all government services require geospatial data as they occur within space and time. The sharing, use, and availability of geospatial data is facilitated by the spatial data infrastructure (SDI). However, South Africa for example, is encountering

challenges with the implementation of SDI such as lack of sharing geospatial data, lack of or inadequate communication between custodians and users and lack of expertise in the collection and management of geospatial data.

Lastly, structuration theory will be used to underpin this study and guide the collection and analysis of data. This sociotechnical theory has been widely used in Information Systems studies focusing on how IS/IT artefacts are enabled and at the same time constrained within a social structure. The next chapter (3) will discuss the research methodology used in this research which includes research philosophy, research approach, research strategy and data collection techniques, and how the data were analysed.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

Research methodology provides broad guidelines and principles to the research process against which a study is evaluated (Miller & Brewer, 2003). According to Walliman (2011:7), it "*represents the tools of the trade, and provide you with ways to collect, sort and analyse information so that you can come to some conclusions*". Figure 4 shows a research onion which is a visual representation of the research process and methodologies available which can be applied in a research study. Included in the research onion are the philosophies, approaches, design/strategies, techniques and procedures used in the research process. The following facets of research are discussed herein below: (i) Research philosophy; (ii) research approach; (iii) research methods; (iv) research design; (v) data collection; vi) data analysis and vii) Ethical considerations.

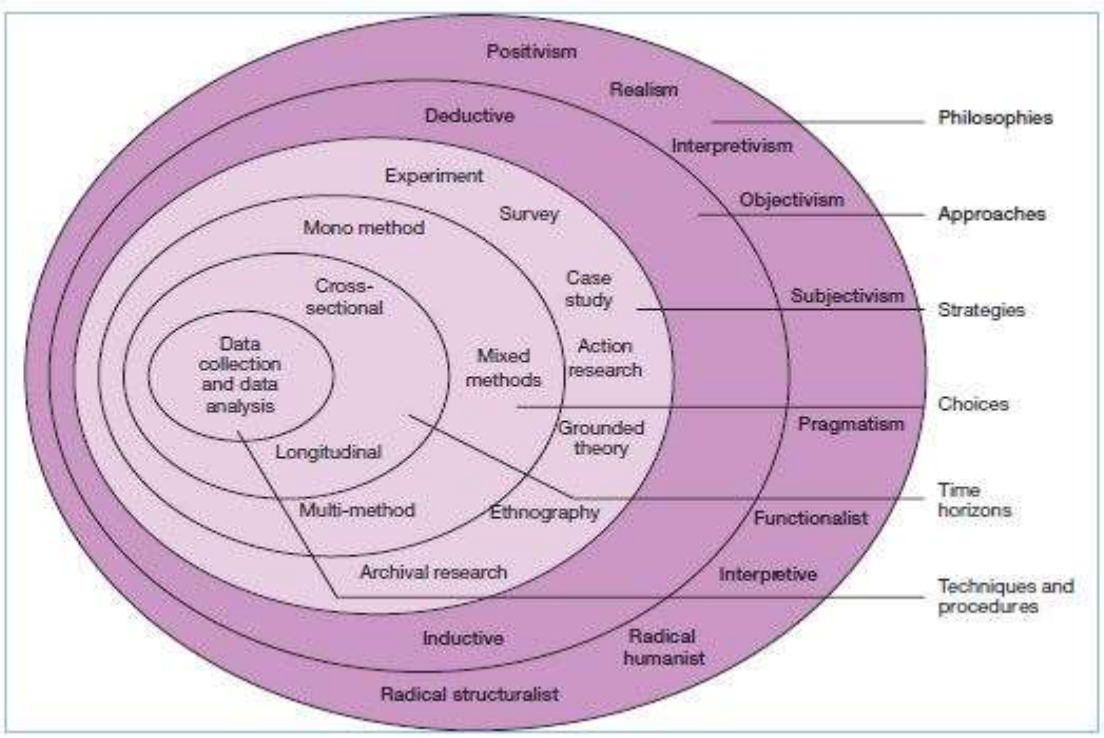

FIGURE 4: RESEARCH ONION (SAUNDERS, LEWIS & THORNHILL, 2007)

3.2 RESEARCH PHILOSOPHY

Research philosophy provides the basis and framework for conducting a research study (Noordin & Masrek, 2016). According to Bilau et al. (2018:599), research philosophy "*helps to determine the appropriate method by which a research can be conducted*". It is through the research philosophy that the researchers' philosophical stance is clarified in turn assisting in identifying the methods to be applied in the study (Bilau et al., 2018). The two major philosophical assumptions are ontology and epistemology (Saunders et al., 2007). There are other philosophical perspectives that have been used in research studies such as axiology (Valizadeh & Vaezi, 2016).

Axiology refers to the study of human values and ethics, exploring how human beliefs and values influence perceptions and decisions we make about a phenomena (Saunders et al., 2007; Melville et al., 2017). Thus, axiology is concerned with ethics and value as guiding principle for conducting a study (Biddle & Schafft, 2015). Since the aim of the study is to develop a conceptual framework through which big data can be used to improve service delivery, axiology as a philosophical assumption is found not suitable since this study's guiding principles will not be concerned with human ethics, values, and beliefs.

3.2.1 Ontology

Ontology is defined as a philosophical term concerned with the study of being or existence (Syamili & Rekha, 2018). It is also defined as being concerned with the nature of reality (Snowden, 2005). Ontology is significant for this study in that we seek to study and understand the existence of big data in a government department. According to Antwi and Kasim (2015:218), "*it specifies the form and nature of reality and what can be known about it*". This reality is knowledge that is based on the individuals' own knowledge, perspective and understanding (Johnson et al., 2007). The two contrasting positions from which reality can be observed are objectivism and subjectivism (Antwi & Kasim, 2015).

Objectivism

Objectivism is an ontological position predicated on the notion that knowledge is influenced and must be viewed from the perspective of all issues affecting the phenomenon (Nissen, 2015). Fisher et al. (2017) note that objectivism is truth informed by a set of defined characteristics or features and anything falling outside these perimeters is wrong. Based on the objectives of this study, objectivism was found not suitable as this study was not influenced or determined by any characteristics regarding big data in a government department.

Subjectivism

This study follows a subjective ontological stance. Subjectivism is characterized by the researcher's view and understanding of a phenomena (Fisher et al., 2017). This understanding is borne out of the interaction between the researcher and the participants without external factors influencing their point of view (MacLeod, 2015). Thus, a subjective view allows the researcher to apply their own judgment and what they consider to be true, independent of the participant's views of a phenomenon (ibid).

In the context of this study, ontologically we know that government possesses huge amounts of data. We also know that government delivers services to the public such as geospatial services. Thus, it is understood that big data in the sphere of geospatial service existed. For example, the organization used as a case used in the study holds over a petabyte of geospatial data. Thus, the ontological stance followed seeks to explore what else is not known about the big data in geospatial services.

3.2.2 Epistemology

Epistemology was very significant in this study as it was applied to understand services offered by government such as geospatial services. We sought to understand what is meant by geospatial services and apart from the products and services being offered, how much more knowledge can be obtained about these services. Epistemology refers to the understanding and theory of knowledge in terms of what we mean when we say we know something, and what more knowledge can be obtained about a subject (Mack, 2010; Hircshheim, 1985). This knowledge feeds the theoretical perspective of the researcher (Johnston, 2014). Thus, as alluded to by Assalahi (2015), epistemology focuses on how knowledge is constructed, the origins and nature of knowledge coupled with the relationship between the knower and the known. The three perspectives into which epistemology is categorized are critical theory, positivism, and interpretivism (Thomas, 2010).

Critical theory is distinguished by its refusal "*to restrict itself to merely contemplative ends, wanting also to contribute, with theoretical means, to practical efforts toward social transformation*" (Renault, 2016:18). This means that, from the critical theory perspective, rather than merely explaining the phenomena, a researcher would endeavour to transform it (D'Arrigo-Patrick et al., 2017). With regards to positivism, Assalahi (2015:313) contends that positivism assigns meaning to phenomena "*as long as they are observable, replicable and verifiable*". Therefore, research from a positivist paradigm is generalized as an end product of an observable reality which uses

existing theory to either prove or disprove hypotheses (Saunders et al., 2007). Positivism is associated with objectivism and quantitative research (Ngulube, 2015).

Based on the objectives of this study, critical theory and positivism were found not suitable for the study. The study does not seek to transform the big data phenomena. The study neither seeks to prove or disprove a theory, but rather to understand the factors that would enable service delivery to be enhanced using big data.

Interpretivism

Interpretivism seeks to explain and understand how actions influence a phenomena thus producing and reproducing a social order for an organization (van der Meer-Kooistra & Vosselman, 2012). According to van Zyl (2015:3), "*Adherents of interpretivism generally hold that there is no single, universal reality but that there exist multiple realities, of which persons are the internal constructors*". Therefore, as aptly put by Rowlands (2003:3), "*interpretive research does not predefine dependent or independent variables, does not set out to test hypotheses, but aims to produce understanding of the social context of the phenomenon and the process whereby the phenomenon influences and is influenced by the social context*".

The epistemological stance followed in this study allowed for a deeper understanding of big data in the geospatial services. It assisted in exploring big data from the different perspectives as understood by the participants. The phenomenon is explained, subjectively so, from the meanings, views and understanding of the participants about the phenomena. Interviews is one of the techniques that was used to probe the phenomena. It enabled exploring and understanding the phenomena from the different perspectives of the participants. This further allowed, as provided for in an interpretivist approach, for a subjective understanding of the phenomena considering the views of the participants. This was also done on the documentation collected.

3.3 RESEARCH APPROACH

Research approach is concerned with how the researcher interacts and make sense out of the data collected (Bilau et al., 2018). The research approach followed by the researcher is influenced by their ontological and epistemological stance (Johnston, 2014). Thus, the application of the approach chosen should be aligned and assist the researcher achieve the objectives of their study (Rowlands, 2003). There are two main research approaches, inductive and deductive approach.

3.3.1 Deductive Approach

The deductive approach "*entails moving from the general to the particular, as in starting from a theory, deriving hypotheses from it, testing those hypotheses, and revising the theory*" (Woiceshyn & Daellenbach, 2018:185). This approach presupposes that a research study is anchored on existing theory and this approach is applied through a predetermined sets of standards to validate the theory (Fischer & Maggetti, 2016). The deductive approach is generally associated with quantitative methods which are, according to Yilmaz (2013), more concerned with outcomes and cause-effect relationships through deductive reasoning.

3.3.2 Inductive Approach

The approach is unlike the deductive in that, it starts from specific to generalization (Ma, 2012). The approach was thus employed in this study, in that, a specific case study was used in the research. According to Ma (2015), case study approach allows holistic and in-depth exploration of phenomena that is being studied. An inductive approach is thus useful to develop and construct knowledge and new theories (Woiceshyn & Daellenbach, 2018). According to Kothari (2004), an inductive approach enable the researcher to build new theories thus arriving at generalisation. As stated in chapter one, the aim of the study was to develop a framework, which can be used to improve services to the citizens, such as geospatial services. The intention is for the framework to be used by other interested parties, organization, thereby generalizing the theoretical framework.

3.4 RESEARCH METHODS

Research methods give the researcher the framework on how the data will be collected, analysed and interpreted when undertaking a research study (Haddadi et al., 2017). The two main types of research methods are quantitative and qualitative (Keele, 2010).

Quantitative Methods

Quantitative research is "*based on observable facts (or data), is rid of subjectivity, and statistical methods and measures are rigorous because they do not depend on human* interpretation" (Ma, 2012:1860). Therefore, quantitative methods "*seek to analyse digital numbers, describe results, explain phenomena or complex educational issues by accurate means, and interpret phenomena using mathematically based methods*" (Liu & Zhang, 2015:46). "*It is a top-down approach that*

involves an identification of hypotheses based upon theory, which is then followed by hypothesis testing" (Gottfredson & Aguinis, 2017:576). When quantitative and qualitative methods are applied in the same study it is known as mixed methods (Ma, 2012). These methods are employed are applied simultaneously or sequentially to support the objectives of a research study (ibid).

Quantitative research	Qualitative research
Considered a hard science	Considered a soft science
Objective	Subjective
Deductive reasoning used to synthesize data	Inductive reasoning used to synthesize data
Focus—concise and narrow	Focus—complex and broad
Tests theory	Develops theory
Basis of knowing—cause and effect relationships	Basis of knowing—meaning, discovery
Basic element of analysis—numbers and statistical analyses	Basic element of analysis—words, narrative
Single reality that can be measured and generalized	Multiple realities that are continually changing with individual interpretation

TABLE 1: THE CHARACTERISTICS OF QUANTITATIVE AND QUALITATIVE RESEARCH METHODOLOGIES (KEELE, 2010)

Table 1 is not intended to compare both research methods, but to demonstrate the differences, and why qualitative methods was selected for this study.

Qualitative Methods

A qualitative study is a non-statistical method that considers people's subjective views, beliefs and attitudes about a phenomenon (Percy et al., 2015). It allows the researcher to carry out the study and understand phenomena in its natural setting thereby allowing for description and interpretation based on the meanings people bring to them (Mkhomazi & Iyamu, 2013). Qualitative methods allow for the researcher to understand the how and why of a phenomenon, and also produce rich data from which richer explanations can be derived (Liu & Zhang, 2015). Thus, as argued by Rahman (2015:2), "*qualitative research is interested in analysing the*

subjective meaning or the social production of issues, events, or practices by collecting non-standardised data and analysing texts and images rather than numbers and statistics".

The researcher applied qualitative research methods in line with the aim of the study, which is to develop a conceptual framework through which big data can be used to improve service. Qualitative methods were selected as they allowed for the study of the phenomena within its natural context. The interaction between the one carrying out the study and the participants resulted in richer understanding about how and why things happen the way they do in an organization. The focus, as provided by qualitative methods, was on the meanings participants assigned and understand about the phenomena. This brought out the subjective views of the participants. Qualitative methods also allowed for findings that can be generalized beyond the confines of the study.

3.5 RESEARCH DESIGN

Research design "*is the procedural framework between the research philosophical positioning and the choice of methods to be applied for data collection and analysis*" (Bilau et al., 2018:602). There are a number of research designs associated with qualitative research, namely, ethnography, grounded theory, observation, and case study (Ingham-Broomfield, 2014). Grounded theory is defined as "*a theory which has been systematically obtained through social research and is grounded in data*" (Matavire & Brown, 2013:120). It allows for the development of the theoretical account regarding core principles and features of a phenomenon whilst simultaneously grounding the account in empirical observations or data (Wiesche et al., 2017). Ethnography is defined as a methodology that allows the researcher to "*immerse him or herself in the field so that they come to see how life and the phenomena under investigation are viewed by the social group and/or organizations*" (Brown, 2014:171).

The above-mentioned research designs, even though associated with qualitative research, they do not fit with the objectives of this study. The objective is to create a conceptual framework. The research design which was more appropriate for this study was case study and is discussed extensively in the following section.

3.5.1 Case study

The research design employed in this is study is case study. Case study is one of the most used qualitative research methods (Ma, 2015). It has been applied in various disciplines including information systems studies (Reddy, 2015). It facilitates an in-depth and holistic studying of

phenomena in its natural context using various data sources and lenses (Baxter & Jack, 2008). The use of case study enabled different data collection techniques to be used which are interviews and documentation. This allowed for an in-depth exploration of big data within the organization. As noted by Yazan (2015), case study is the preferred research design when one needs to answer the how and why question such as provided for by the case study.

A directorate within a government department known as the Government Professional Geo-Spatial Services (GPGS), which renders geospatial services was selected as a case in the study. The directorate is involved in the collection, storing and processing of geospatial data. The directorate is a national mapping organization within a government department. GPGS is the primary custodian of geospatial data used by all government department and private sector organizations. Whilst there are private organizations that use geospatial data such as surveys and maps, they source their data from the GPGS. Thus, both the public and private sector organizations source their primary data from the GPGS. There are other government departments do collect geospatial data such as Department of Water and Sanitation and Department of Roads and Transport. However, they collect data based on their respective mandates, such as geospatial data related to rivers and dams, and roads respectively.

Furthermore, the process of capturing and sharing geospatial data across government departments is facilitated through the Spatial Data Infrastructure (SDI). GPGS is the directorate mandated by legislation to chair SDI, thereby, coordinating the capturing and sharing of geospatial data in South Africa. Moreover, GPGS possess all base data for all geospatial services. Using GPGS as a case in this study would allow for generalisation of the framework developed in this study to be applied across government departments.

3.6 DATA COLLECTION

Data collection is an important part of the research process which according to Frechtling (2002:43) "*provides a trade-off between breadth and depth, and between generalizability and targeting to specific (sometimes very limited) populations*". In qualitative research studies, interviews, observation and documentation are the most commonly used techniques (Mack et al., 2005). The data was collected from two main sources: interviews and documentations. In this study, the documentations were considered as secondary data, used to support and complement the interviews (primary data). Primary data is defined data that has not been collected before and is collected for the first time for the purposes of the study (Sabanari et al., 2017). Secondary data on the other hand is defined as data which has already exists and has been used for other

purposes (Manrapi et al., 2017). As has been discussed in research design, case study provides for data from a variety of sources. In turn this enhances the richness and validity of the study and the findings flowing from the data collected.

3.6.1 Interview

Interview technique is considered the best method to understand and explore the participants' experiences and knowledge about a phenomena (Wilson, 2016). Interviews also allow for a more personal and insightful access to data through the personal interaction the between the researcher and the participant (Dikko, 2016). They may be categorized as structured, semi-structured or unstructured interviews (Thomas, 2010). Structured interviews follow a rigid form where carefully worded questions are administered and followed throughout the interview process (Fretchling et al., 2002). Whereas semi-structured interviews are "*designed to ascertain subjective responses from persons regarding a particular situation or phenomenon they have experienced*" (McIntosh & Morse, 2015:1). Semi-structured interviews allow the researcher follow-up questions based on the responses from the participant thus enabling a deeper understanding of the participants' knowledge and understanding about a particular phenomenon (Kallio et al., 2016). This study applied semi-structured interviews.

Interview: The data collection process as follows:

i. Ethical clearance was approved by the university allowing for data collection at the organization.
ii. A letter to seek permission and conduct the study at GPGS was sent to the Director: Corporate Services. The letter outlined the aims and objectives of the study and how the study could be of benefit to the organisation.
iii. The letter to the GPGS was accompanied by an approval letter from the university indicating that the researcher is indeed conducting research under the auspices of CPUT.
iv. It took three before the GPGS could grant the permission. This was after the organisation had followed the administrative processes and ensured that all requirements has been fulfilled.
v. Once a letter of approval was granted, participants were approached personally and requested to participate in the research. There were no refusals except some, after having agreed to participate, however, at the time of interview, they were either busy or not available.

vi. Permission to record the interview session was sought from all the participants and none declined. All the interviews were recorded using a voice recorder after which they were transferred to a laptop.
vii. A total of 8 participants were interviewed (see sub-section 3.6.2 for criteria).

The interview process was conducted during office hours in the offices of the participants. Over and above the recordings that were taken, notes were also taken during the interview process. The notes taken enabled the researcher to note points that needed follow-up. All interviews were conducted in English. The length of the interviews ranged from 00:21:48 minutes to 1:11:27 hours. The participants' work experience in the GIS field ranges between 2 years and 30 years.

The challenge that was encountered when organizing the interviews was related to time management on the side of the participants. Getting participants to honour the appointment that has been set, but due to work challenges several interviews had to be rescheduled. For example, Participant 1 had agreed to meet on a Monday at 11:00. When the researcher arrived in the office, the participant had forgotten a prior appointment he had and asked to reschedule to 14:00 on the same day. The researcher duly obliged but when the time came the participant had an extended lunch and requested the interview for the next day.

3.6.2 Criteria

The criteria that was followed to select the participants in the study was as follows:

i. IT Staff working in the GIS environment
ii. GIS Professionals currently working in a GIS environment. The professionals should be responsible for both processing and delivery of geospatial services and products
iii. Managers in the GIS field.
iv. All the participants should have been working with geospatial data for at least 2 years.

The criteria for selection of participants was based on those who would add value and richness of data in the study due to their expertise. Factors that were considered were the length of employment in the organization, expertise and relevance of work to the study. Participants who had been working in the GIS environment for at least 2 years were considered to have practical and in-depth knowledge about the GIS environment. They would be abreast with the processes in their current working environment. Expertise in the IT and GIS environment enabled the study to be focused and help achieve the objectives of the study. A section within GPGS that deals with processing and delivery of geospatial services and products was identified and selected in line with the objectives of the study, which are to enhance service delivery in government.

Though a detailed organogram of GPGS is presented in Chapter 4, in summary, the management structure of GPGS consists of a total of 24 managers categorized as follows: 4 Directors, 8 Sub-directorate managers and 16 Division Managers. Within GPGS, the sub-directorate and division that was the focus of this study, responsible for the processing and delivery of geospatial services and products is known as Imagery and Geospatial Data. The section has been divided into two division, Information/Data Management and Imagery Acquisition and Analysis. It consists of 1 Director, 1 Sub-directorate managers, 2 division managers and 17 GIS professionals. There were eight participants that were interviewed over a period of 3 weeks which included GIS Professionals, Information/Data Managers and Division Managers. The researcher interviewed 1 Director, 1 Sub-directorate manager, 2 GIS Professionals, 2 Information/Data Managers and 2 Divisional Managers.

3.6.3 Demography

The demography of the interviewees based on the criteria is tabled herein below:

Job Title	Years of experience	Job category	# of Interviewees
Director	35 years	GIS Managers	4
Sub-directorate Manager: Topographical Compilation	30 years		
Division Manager: Medium Scale Maps	27 years		
Division Manager: Topographical Compilation	15 years		
Geographical Data Management	9 years	Information/Data Managers	2
Professional Support	20 years		
GIS Remote Sensing Specialist	3 years	GIS Professionals	2
GIS Professional	2 years		
Total	**8**		

TABLE 2: INTERVIEWEE DEMOGRAPHY

3.6.4 Interview guidelines

Based on the research questions as presented in Chapter 1, interview guidelines were formulated. These were formulated to probe the participants understanding about the big data phenomena. They served as a guide both the researcher and the participants to be within the ambits of the study. The interview guidelines were also formulated to be able to answer the research questions. This in turn allows for the aims and objectives of the study are fulfilled. They also provide for consistency and uniformity among the participants, so that all participants are asked questions related to the study. Since the study applied semi-structured interviews, it allowed for further probing of the participants thus gaining a deeper understanding of each of the participants' views. (See Appendix A) for the interview guidelines.

3.6.5 Documentation

Documentation contains key information about an organization or phenomena that may not be captured through other data collection methods such as interviews or observation (Navidi et al., 2017). Through documentation, a researcher can glean deeper insights into the workings and decisions of an organizations (Warwick et al., 2009).

Documentation: The data collection process as follows:

i. Permission was sought to access documents that were relevant to the study
ii. Both strategic and operational documents were accessed on the basis of confidentiality
iii. Documents such organizational organogram, workflow document, operational standards, and policy framework memorandum were accessed.
iv. Only the researcher and his supervisory were privy to the documents based on confidentiality

Documents that were accessed were obtained from the participants and the website of the organization. Documentation obtained during the study has been labelled and is attached as Appendix B. The table herein below shows the detail of the documents accessed.

Document Category	Document Label	Document Description
Operational Documentation	GPGS_OP_01 GPGS_OP_02 GPGS_OP_03	Workflow document Operational Standards Process document
Strategic Documentation	GPGS_ST_01 GPGS_ST_02	Policy framework memorandum Organizational Organogram
Total documents	5	

TABLE 3: DOCUMENTATION COLLECTED

Point of Saturation

In the process conducting the interviews the researcher reached a point where the participants' responses were similar. This is known as a point of saturation. While this point may be a difficult concept to define, it is a point at which no new data can be attained (Chenail, 2011). Whilst there are no fixed guidelines on reaching the point of saturation, one of the generally accepted principles alluded by Fusch and Ness (2015) is that no new data can be obtained. It is further suggested that the point of saturation is not about the numbers but the depth, richness and thickness of the data (ibid). From the participants that were interviewed, and the documentation obtained in the study, the researcher has been able to reach the point of saturation. The data that was collected using the mentioned techniques has provided no new data, thus it was regarded not prudent to continue with more interviews.

3.7 DATA ANALYSIS

Data analysis is described as the process that allows the researcher to make sense of the data collected from participants such as the participants' definitions, themes, categories and regularities (Male, 2016). Pandey and Pandey (2015) define data analysis as the process of studying all the data and material gathered to discover inherent facts. In qualitative research, the analysis of data "*often involves an inductive exploration of the data to identify recurring themes, patterns, or concepts and then describing and interpreting those categories*" (Nassaji, 2016:130). Therefore data analysis process allows for "*moving from collected data into some form of explanation, understanding or interpretation of the people or situations being investigated*" (Ma, 2015:567). The analysis of the data was guided by structuration theory.

Structuration theory was used as a lens to guide the data analysis as follows:

i. Relationship – relationship: human-to-human; human-to-technology (data included); and technology-to-technology. Duality of structure was used to examine how relationships between humans and technology and their effect on the use of big data. The use and extent of power in these relationships and what impact did it have on the way big data was collected and used for delivery of services.
ii. Roles and responsibilities – Duality of structure was used to examine the role played by the agents (human and non-human), this includes how they applied the rules and the resources that were available in the use of big data. This has a direct effect on the type of services that resulted from the use of big data. Also, how were the rules communicated within the organization and what resources were applied to communicate within the organization.
iii. Structure – The ST was used to examine the various types of resource that were available in the use and operationalization of big data in the organization. Also, the use of ST helps to understand the different rules and processes that existed in the organization, regarding how big data was gathered, used and managed towards providing services to the community.

3.7.1 Unit of analysis

Unit of analysis is defined as the "*who or what, for which information is analysed and conclusions are made*" (Sedgwick, 2014:1). Neuendorf (2016) alludes to the fact that the selection of the unit of analysis is informed by the objectives of the study with greater considerations to the theoretic principles and expert knowledge of the units thereof. Thus, the unit of analysis becomes the source of information within the case sought and obtained by the researcher to answer the research questions (Yin, 1994). According to Sabaghian et al. (2015), unit of analysis commonly used in IS studies comprise of data, information, hardware, software, system, process and people. Based on the objectives of this study and as discussed above, the following are the units of analysis:

- GIS Professionals
- Information/Data Managers in the Geospatial environment
- Business Managers in the Geospatial environment

The analysis was done using units of GIS Professionals, Information/Data Managers and Business Managers. Within the organization under consideration, these units play a pivotal role

in the collection, processing and use of geospatial data. Business Managers are responsible for managing of the sections, strategies and rules around the collection and processing of geospatial data within their units. They develop the standards to be followed by their respective units as well. GIS Professionals are responsible for the processing of geospatial data once it has been captured. Using technological tools, they process the data which culminates in geospatial products and services. Thus, they are well vested with what products and services are possible based on the geospatial data collected and processed. Information/Data managers are mainly responsible for technical support of all business units using geospatial data. The technological tools such as hardware and software used to store, and process geospatial data are managed by the Information/data Managers. Thus, the units selected assisted the researcher in achieving the objectives of the study which are to (I) investigate how big data within GPGS is stored, managed and used for service delivery; and (ii) examine and understand how big data influence the services that GPGS provide to South African citizen.

Therefore, within these units the researcher examined the interaction between the three units. What factors influenced the interaction enabled or constrained interaction between the units. Furthermore, the roles and responsibilities each of the units had, what power was vested across the units. How was this power used in the interaction between the units? Lastly, we looked at what factors influence the interaction between the units. What factors influence the communication between the units, how are things communicated.

3.8 ETHICAL CONSIDERATIONS

Ethics guide the values with which a research study is conducted (Porra et al., 2014). Ethical considerations ensure the integrity and oversight of the research study (Mack et al., 2005). The rights and concerns of the participants are protected through regard of the ethical considerations (ibid). The study was conducted within the rules that govern research in the Cape Peninsula University of Technology and the ethical considerations were applied in the following manner:

The researcher applied for ethical clearance detailing the objectives of the study, the organization wherein data will be collected and ethical considerations. An ethical clearance was granted to the researcher by the University after which consent was obtained from the organization through the Director: Corporate Services to collect data from the organization. Furthermore, consent and permission to interview was sought and granted from the participants in the study. An undertaking was made that neither the name of the organizations nor the names of the participants will be used in the study. Instead, pseudonyms will be applied.

Before the commencement of interviews, the participants were made aware of their right to withdraw at any time from the process and they are not obliged to answer any questions if they feel uncomfortable or for whatever reason.

3.9 CONCLUSION

In Chapter 3, the researcher discussed the research methodology which was followed and applied in this study. The discussion included research philosophy, research approach, research methods, research design, data collection, data analysis, and ethical considerations.

As discussed herein above, the research methods applied in the chapter are associated with qualitative research studies. These include subjectivism, interpretivism, and inductive approach. The research design used in the study is case study research design using a government department as a case in the study. Furthermore, semi-structured interview and documentation techniques were used for data collection. Structuration theory was used as a lens for analysis. The chapter concluded with the ethical considerations that were applied to guide the research process.

In the next chapter, the overview of the case used in the study will be discussed.

CHAPTER FOUR: CASE OVERVIEW

4.1 INTRODUCTION

This chapter presents an overview of the case which was selected for the study. The South African government is constituted of 3 spheres of government which are national, provincial and local government. The Republic of South Africa has 47 national government departments, 9 provincial legislatures and over 220 local municipalities which have been grouped into 44 district municipalities (SALGA, 2017). Based on the objectives of the study, a directorate within a national department that deals with geospatial data was selected as a case. The selection was based on the directorate being the primary custodian of all geospatial data according to government legislation. The head office of the department is based in Pretoria; however, the directorate is situated in Cape Town, South Africa.

4.2 FIELD WORK

Based on the objectives of the study, the qualitative methods were followed as stated in Chapter three. The research design followed was case study as it enabled the researcher to obtain an in-depth understanding of the phenomenon within its real-life situation. An undertaking was made not to use the name of the department, instead a pseudonym was used. The name given to the organisation is Professional Geo-Spatial Services (GPGS). Making use of semi-structured interviews, 8 participants were interviewed consisting of technical users and managers.

All the interviews were recorded using a voice recorder, it was then transferred to a laptop for increased security of the recordings. All the interviews were conducted during office hours at the premises of GPGS. The interviews were then transcribed word for word and referenced during the analysis stage. The length of the interviews ranged from 00:21:48 minutes to 1:11:27 hours. Since an undertaking was made not to use the names of the participants, codename GPGS_01 to GPGS_08 will be used to identify the participants.

4.3 ORGANISATION – GOVERNMENT PROFESSIONAL GEO-SPATIAL SERVICES

Government Professional Geo-Spatial Services (GPGS) is a directorate which was established to provide mapping and aerial imagery coverage of the country (South Africa). It is known as the

national mapping organisation. It oversees geodetic and topographic surveying and geo-spatial information services in South Africa as mandated by the Land Survey Act. GPGS consists of four directorates which include (I). Survey Services; (II). Imagery & Topographical Data; (III) Geo-Spatial Information & Professional Support; (IV). and Mapping Services. Each of these directorates has sub-directorates and divisions which are briefly discussed herein below. The unit of analysis within GPGS is the Sub-directorate: Imagery and Geospatial Data under the Directorate: Imagery & Topographical Data. The organization is based in Cape Town, South Africa. Herein below is list and functions of each of the directorate, sub-directorate and division. A table that shows the linkage between the directorates, sub-directorates and divisions is provided herein below for ease of reference and provide a clearer picture of the organisation. Special attention is given to the Sub-directorate: Imagery and Geospatial Data which is the unit of analysis in this study.

4.3.1 Directorates

The organisation is composed of four (4) directorates that together are responsible for the workflow of the products and services. The directorates are (I) Geo-Spatial Information and Professional Support, (II) Mapping Services, (III) Survey Services, and (IV) Imagery and Topographic Data. Each directorates' work is an output or input from the work of another directorate. There is therefore a dependency on the directorates to achieve the goal of the organisation. The purpose and function of each directorate is discussed herein below.

Geospatial Information and Professional Support

The Geo-Spatial Information and Professional Support provides geo-spatial information and professional support services. The functions of the directorate are as follows:

1. Provide geo-spatial information products and services; and
2. Provide professional support and technical training

Mapping Services

The mapping services directorates' purpose is to provide mapping services. Functions performed by the directorate are:

1. Produce line maps
2. Produce orthophoto images, maps, and elevation data

Survey Services

The directorate exists to provide survey services. Functions performed by the directorate are as follows:

1. Manage control survey networks
2. Manage the collection of geo-spatial data

Imagery and Topographic Data

The imagery and topographic data directorates' purpose is to collect and maintain earth imagery and geo-spatial data. The functions performed by the directorate are:

1. Manage earth imagery and geo-spatial data
2. Process topographical data
3. Undertake development projects

As has been discussed, the work of the directorates has been divided into sub-directorates. The purpose and functions of all the sub-directorates are briefly discussed in the section below.

4.3.2 Sub-Directorates

The directorates at GPGS consists of eight (8) sub-directorates which are as follows: (I). Geo-Spatial Information Services; (II). Professional and Technical Support Services; (III) Medium and Small-Scale Maps; (IV). Ortho-Imagery and Elevation Data; (V). Control Surveys; (VI). Geo-Spatial Data Collection; (VII). Imagery and Geo-Spatial Data; and (VIII). Topographic Data. We will discuss the purpose and functions of each of the sub-directorates.

Geo-Spatial Information Services

Geo-Spatial Information Services falls under the Geo-Spatial Information and Professional Support directorate. The sub-directorates' purpose is to provides geo-spatial information products and services. The functions performed include:

1. Supply geo-spatial information products and services
2. Print and reproduce geo-spatial information products

Professional and Technical Support Services

Professional and Technical Support Services falls under the Geo-Spatial Information and Professional Support directorate. The sub-directorate exists to provide professional support services and technical training. Its functions have been encapsulated as follows:

1. Provide professional advisory services and undertake relevant research and development

2. Provide technical training, library, and museum services

Medium and Small-Scale Maps

Medium and Small-Scale Maps falls under the Mapping Services directorate. The purpose of the sub-directorate is to produce line maps. The functions of the sub-directorate are listed as follows:

1. Produce small-scale and ancillary maps
2. Produce medium scale maps
3. Archive and retrieve hard-copy records

Ortho-Imagery and Elevation Data

Ortho-Imagery and Elevation Data sub-directorate falls under the Mapping Services directorate. The purpose of the sub-directorate is to produce orthophoto images, maps and elevation data. The functions of the sub-directorate are as follows:

1. Provide orthophoto images and maps
2. Provide photogrammetric absolute orientation and capture of elevation data

Control Surveys

Control Surveys sub-directorate falls under the Survey Services directorate. The sub-directorate manages control survey networks. The functions of the sub-directorate are to:

1. Provide control survey networks
2. Provide beacon services

Geo-Spatial Data Collection

Geo-Spatial Data Collection sub-directorate falls under the Survey Services directorate. The purpose of this sub-directorate is to manage the collection of geo-spatial data. Its functions are:

1. Collection of ancillary geo-spatial data
2. Undertake field work.

Imagery and Geo-Spatial Data

Imagery and Geo-Spatial Data falls under the Imagery and Topographic Data directorate. The purpose of the sub-directorate is to manage earth imagery and geo-spatial data. The functions are as follows:

1. Manage geo-spatial data
2. Acquire and analyse earth imagery

Topographic Data

Topographic Data sub-directorate falls under the Imagery and Topographic Data directorate. The purpose of the sub-directorate is to process topographical data. The function linked to this purpose is to compile and structure topographical data.

We have briefly discussed the sub-directorates with their purpose and functions. In the following section we discuss the purpose and functions of each of the divisions linked to the sub-directorates.

4.3.3 Divisions

The work of the sub-directorates within GPGS have been further segregated to divisions with a total of sixteen (16) divisions. The divisions are listed as follows:

Production Distribution

The purpose of product distribution is to supply geo-spatial information products and services. Their core functions are:

1. Supply geo-spatial products and services
2. Maintain information on products available and;
3. Manage established outlets for products and services

Reprographic Services

The purpose of reprographic services is to print and reproduce geo-spatial information products. Listed as part of their functions are:

1. Provide photo-lithographic services
2. Provide aerial photographic reproduction services
3. Provide reproduction services
4. Print maps
5. Produce aerial photo mosaics

Professional Services

The purpose of the professional services division is to provide advisory services and undertake relevant research and development. Its functions are listed as follows:

1. Provide professional advisory and support services
2. Undertake relevant research and development
3. Plan and supervise special projects
4. Support implementation of new systems and equipment

Regarding the work done by the Professional Services, GPGS_08, 57:2296-2298 said, "*We offer advisory services, someone would come and want advice about proving that a dam wall existed 100 years ago. We then got to prove that it existed and produce letters to that effect. A lot of times we provide assistance to courts with geospatial information*."

Technical Training

The purpose of the division is to provide technical training, library and museum services. The functions of the division include:

1. Conduct geomatics officer certificate training
2. Provide experiential training for diploma students
3. Provide a specialised library and museum services
4. Develop and present technical training courses.

When asked about the products and services offered by the organisation, GPGS_08, 57:2298-2301 noted that as an organisation; "W*e do training as well, we sign service level agreements with district municipalities and that is basically to get our digital geospatial datasets out there, covering each district municipality but broken down into local municipality level*." This is part of the training done by the division.

Topographic Compilation

The two divisions under the directorate Topographic Data are (I). Topographic Compilation Region A and; (II). Topographic Compilation Region B. The purpose and functions of these divisions is the same but for practical purposes, the divisions were split into two. The purpose of the divisions is to compile and structure topographic data. The functions are as follows:

1. Compile topographic detail primarily at 1:50 000
2. Structure and integrate topographic features
3. Ensure quality control of contract work for topographic data compilation
4. Update topographic data into the database

It is in this division that GPGS_07, 53:2142 said, "*Topo compilation is a subjective environment, it's your own understanding and knowledge of the area*". GPGS_07, 53:2148-2151 further noted that, "*When this was prepared they didn't care much for rural areas, it was solely based on the township environment, so those are some of the challenges. Now we are compiling a lot of rural areas as they need to be in the database and they are there. Informal settlements were not there before. That's mainly where we are having challenges*."

Control Survey Networks

Control Survey Networks division falls under the Control Surveys sub-directorate. The purpose of the Control Surveys Networks is to provide survey networks. The functions of the division are listed herein below:

1. Process field survey data
2. Calculate horizontal control survey networks
3. Calculate vertical control survey networks
4. Control the networks of permanently operating GNSS stations
5. Update the integrated database

Beacon Services

Beacon services division falls under the Control Surveys sub-directorate. The beacon services division's purpose is to provide beacon services. The functions of the division are as follows:

1. Build new beacons and benchmarks
2. Inspection and maintenance of beacons and benchmarks

The work of this division is summarised by GPGS_01, 01:38-40 in this way, "*There are things called trig beacons, you see them in the mountains, those are used by our surveyors for reference purposes when they calculate distances and directions when they do their surveys for different purposes".* "*I think they use the beacons for land survey, for example, I think you've seen those guys sometimes they survey, so the beacons are used for land survey*" (GPGS_06, 41:1717-1718).

Ancillary Data

The purpose of the division is to collect ancillary geo-spatial data for mapping purposes. Its functions are to acquire and process ancillary data.

Field Surveys

The purpose of the field surveys division is to undertake field work. The following are its functions:

1. Undertake field surveys for mapping
2. Undertake field surveys for control survey networks

When asked about the work done in surveys, GPGS_06, 46:1894-1895 mentioned that, "*Remember they check whether this place, can we build this kind of structure like 10 storey building, that's their responsibility to check*."

Small Scale and Ancillary Maps

The purpose of the division is to produce small scale and ancillary maps. The functions of the division are listed as follows:

1. Prepare and generalise map data
2. Produce small scale maps
3. Produce ancillary maps and plans
4. Provide specialised cartographic services
5. Prepare maps for printing

When asked about whether the different maps categories come from the same data source GPGS_06, 45:1849 made this comment, "*Yes, I think I showed you these guys responsible for Small Scale when it deals with smaller one*".

Medium Scale Maps

The purpose of the medium scale maps is to produce medium scale maps. The functions of the division are as follows:

1. Prepare and generalise map data
2. Produce medium scale maps
3. Prepare maps for printing

The two divisions that fall under the Ortho-Imagery and Elevation Data are (I). Orthophoto Images and Maps and; (II). Aerial Triangulation and Elevation Capture

Orthophoto Images and Maps

The purpose of the Orthophoto Images and Maps division is to produce orthophoto images and maps. The functions of the divisions are listed as follows:

1. Scan aerial photographs
2. Produce orthophoto images
3. Produce orthophoto maps
4. Prepare maps for printing

Aerial Triangulation and Elevation Capture

The purpose of Aerial Triangulation and Elevation Capture is to provide photogrammetric absolute orientation and capturing elevation data. The functions of the division are as follows:

1. Capture photogrammetric elevation data
2. Derive elevation models
3. Manage photogrammetric contract work
4. Determine photogrammetric absolute orientation

Geo-Spatial Data Management

The Geo-Spatial Data Management division falls under the Imagery and Geo-Spatial Data sub-directorate. The purpose of the division is to manage geo-spatial data. The division performs the following functions:

1. Ensure integrity of data in the database,
2. Maintain versioning of data,
3. Maintain the digital data archive,
4. Maintain the integrated topographic data model,
5. Ensure access to digital data and web-based services, and
6. Apply data standards.

The structure of the division consists of three (3) posts, Control Survey Technician, Senior Data Technologist, and Principal Geomatics Officer.

The database referred to in this division is the one mentioned by the participants when they said, "*They are kept on Integrated Topographical Information System (ITIS) database server, so all the information that you get from outside infiltrates to our system. So, all this information is stored there on ITIS*" (GPGS_01, 01:76-78). The division is also responsible for the portal that enables the customers to access the services of the organisation. "*They must implement a geoportal, a data repository where people can access the data, not necessarily to edit because we do all this for other people*" (GPGS_01, 04:191-192).

The employee responsible for the database in the organisation assists all the directorates with data management issues and challenges on the database. In his own words he said, "*I'm a professional so what I do I assist all the production environments when they have problems, I set up standards and procedures for capturing the data* (GPGS_02, 07:313-314). All other

participants when they were asked about their role in the Data Management, they refereed to this employee and to the division.

The role of the database is central to the work of the organisation including the historical data. "*So, what we are doing, we are inserting, deleting and modifying features but we are also keeping a history in ITIS. Even though it's deleted, it keeps a record of it, so it's got a version. Like we had historical imagery going back many years, the digital data is also going to be versioned, that's the new technology. We can go back over years, with ITIS now it's maybe 5 years, maybe longer*" (GPGS_04, 19:809-814).

Imagery and Acquisition and Analysis

Imagery & Acquisition and Analysis is the second division that fall under the Imagery and Geo-Spatial Data sub-directorate. The purpose of the division is to acquire and analyse earth imagery. The functions performed by the division are as follows:

1. Acquire earth imagery,
2. Undertake image interpretation and classify land cover and land use,
3. Manage contract work,
4. Prepare imagery for change detection, and
5. Determine major changes from imagery of different epochs.

Within the division are the following positions; Control Geomatics Technician, Chief Geomatics Technician, Chief Imagery Analyst, Principal Imagery Analyst, Principal Geomatics Technician, Principal Geomatics Officer, and Senior Geomatics Officer. In all there are 13 positions within this division.

The work of the division is critical to the whole organisation in that it acquires all data required to produce the services and products which the organisation delivers to its customers. "*We put a Service Level Agreement (SLA) out, we put a tender out to fly a ¼ of the country every year and we keep on doing it every year and when we get that imagery, we process it and that imagery is used to do all the vector data, elevation data and the maps*", (GPGS_02, 06:272-274). The work of acquiring the data is done through service providers which the division manages those contracts. "*We own our own camera that does the flying, but it's contracted to a service provide. They fly that imagery and that imagery comes to us. When the image comes, it comes into our system, there are other clients who will want an image and others want information that is extracted from the image*", (GPGS_01, 01:30-33).

Herein below is a table that shows how the directorates, sub-directorates and divisions as discussed in the sections above, are linked.

Directorate	Sub-directorate	Divisions
Geospatial Information Services	Geospatial Information Services	Geospatial Information
		Reprographic Services
	Professional and Technical Support	Professional and Scientific Services
		Technical Training
Mapping Services	Medium & Small-Scale Mapping	Small Scale & Ancillary Mapping
		Medium Scale Mapping
	Ortho Imagery and Elevation Data	Aerial Triangulation & Elevation Capture
		Orthophoto Images and Maps
Survey Services	Geo-Spatial Data Collection	Ancillary data
		Field Surveys
	Control Surveys	Beacons
		Control Survey Networks
Imagery & Topographic Data	**Imagery and Geospatial Data**	**Geo-Spatial Data Management**
		Imagery Acquisition and Analysis
	Topographic Data	Topographic Compilation Region A
		Topographical Compilation Region B

TABLE 4: GPGS DEPARTMENTAL STRUCTURE

Organisational Structure (Imagery and Geo-Spatial Data)

The preceding section has provided a comprehensive description of the Directorate: Imagery & Topographic Data. Herein below is the organizational structure wherein the unit of analysis resides.

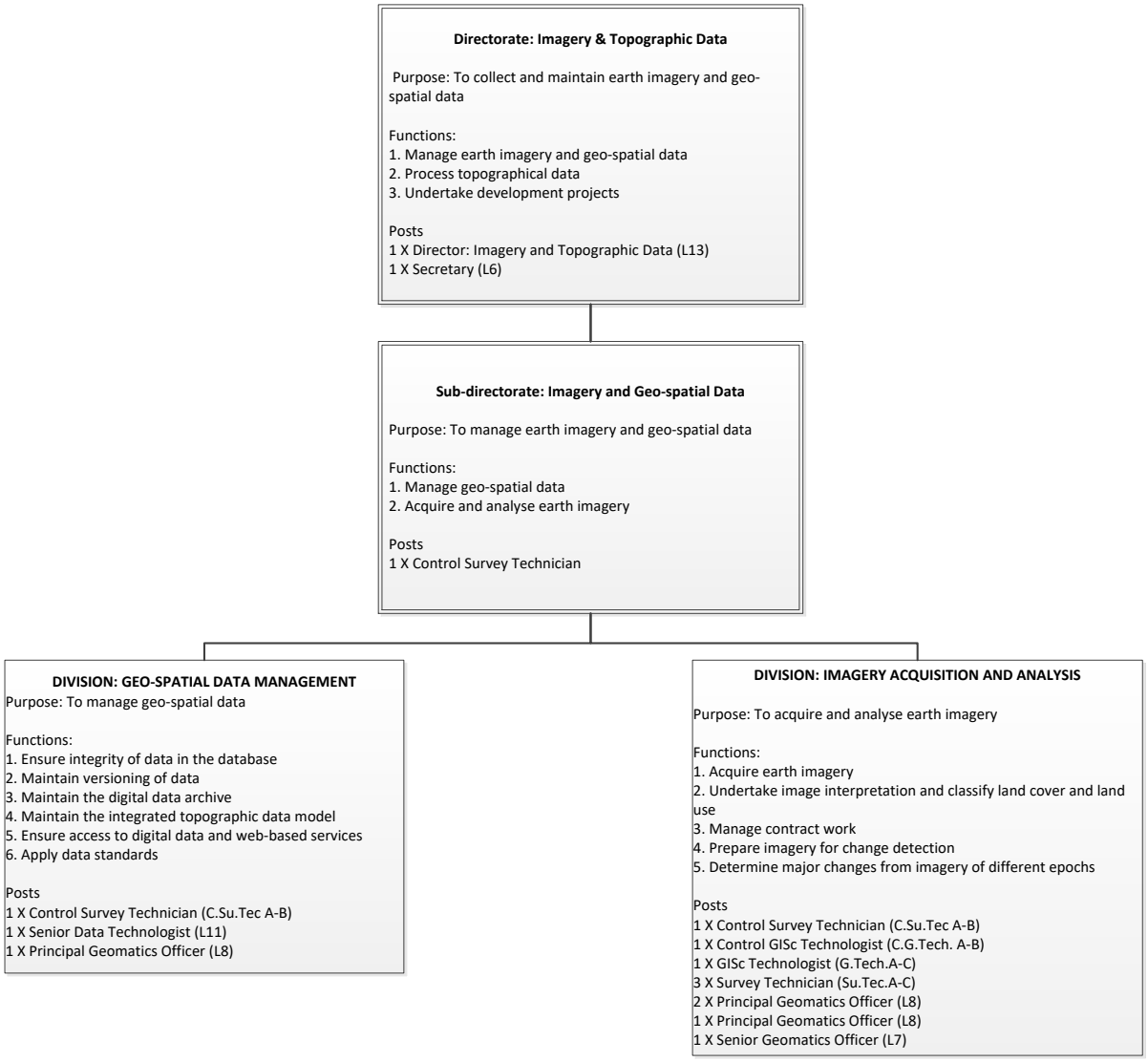

FIGURE 5: ORGANISATIONAL STRUCTURE

4.4 Conclusion

This chapter provided an overview of the organisation that was selected in the study. In the preceding sections was discussed the purpose and functions of each of the directorates, sub-directorates and divisions. How these are linked in the structure has also been provided in a tabular format. The focus of the investigation has been on the last two divisions discussed which are (I) Geo-Spatial Data Management and, (II) Imagery & Acquisition and Analysis. The two divisions are responsible for the support and management of the data in the organisation. As has been mentioned by all the participants, all issues related to information/data management, they are directed to the Geo-Spatial Data Management division.

CHAPTER FIVE: DATA ANALYSIS AND RESULTS

5.1 INTRODUCTION

The aim of this study was to develop a conceptual framework, which can be used to guide the use of big data in improving service delivery to the community of South Africa. The intended use of the framework includes guiding the use of geospatial big data and maps, to allow community members to, among other things, accurately identify and submit claims for dispossessed land, settle boundary disputes as well as survey landed properties prior to building and construction. As mentioned and discussed in chapters 1 and 3 respectively, a government department that is responsible for geospatial big data was used a case in the study.

The chapter is divided into five sections. The first section provides an overview of data analysis wherewith Structuration Theory (ST) through duality of structure has been applied to guide data analysis. The second section covers structuration view of the case used in the study. The third section will discuss the findings from the analysis. The fourth section presents the interpretations of the findings including the framework that was developed. The last section provides the summary of the chapter.

5.2 OVERVIEW OF DATA ANALYSIS

Based on the objectives of the study, data was collected as discussed in chapter three. In achieving the objectives, the data was analysed by following the interpretivists approach, which was guided by structuration theory. The theory is introduced in chapter one, and comprehensively discussed in chapter two. Rational for selecting, and how structuration theory is applied are presented in chapter three.

Thus, structuration theory is only briefly discussed in this chapter. The theory is sociotechnical theory, which has been employed in IS research for many years. Tapia et al. (2012:244) define ST as "*knowledgeable actions of human agents discursively and recursively forms the sets of rules, practices and routines which, over time and space constitutes the concept of structure*". The duality of structure, one of the core concepts in ST, as shown in Figure 6 is employed as a lens, to examine and understand the interaction and relationship between structure (rules and resources) and, agents (technical and non-technical factors or entities) in storing, using, and

management of geospatial big data, to provide services to the community in South Africa. From the perspective of ST, the duality of structure is employed as a lens in the analysis of the data.

As shown in Figure 6, the duality of structure is divided into three dimensions: structure, modality and interaction (Giddens, 1984). Structure consist of signification, domination and legitimation (Bernardi, 2017). The interaction are communication, power, and sanction (Jones & Karsten, 2008). The interaction and structure is linked through modalities namely; interpretative scheme, facility and norms (Bae & Choi, 2017). Chapter two: Literature Review, presents a comprehensive discussion about ST and the dimension of duality of structure.

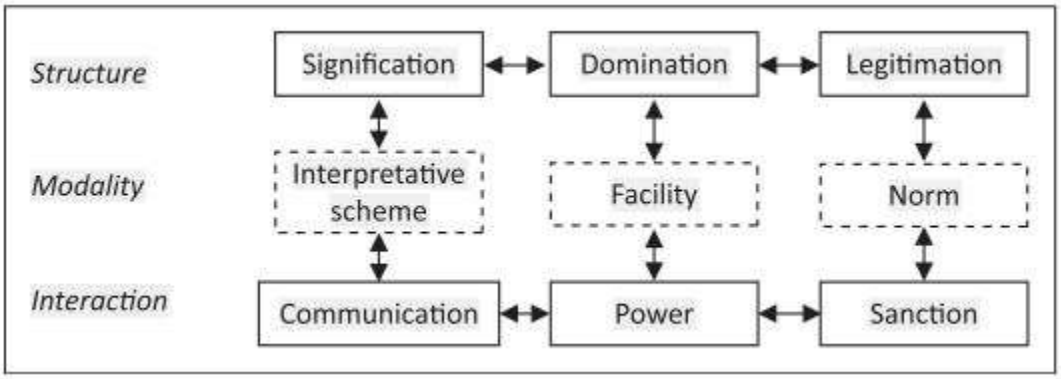

FIGURE 6: DUALITY OF STRUCTURE (GIDDENS, 1984)

From the perspective of ST, the duality of structure, as shown in Figure 6, was employed in this study to focus on the roles, responsibilities and actions of agents (people), and how rules (policies and regulations) were applied on big data in the service delivery to the community. In achieving the objectives of the study as stated in Chapters 1 and 3; which were to investigate and understand how big data within GPGS is stored, managed, and used for service delivery; and how big data influence the services that GPGS provide to South African citizens; the analysis primarily focused on the following:

(i) The processes and activities that are involved in the use of geospatial big data to provide services to the community.

(ii) The relationships that happen between: human-to-human; human-to-technology (data included); and technology-to-technology, in the delivering of service to the community;

(iii) Roles of both technical and non-technical agents within the organisation in service delivery; and

(iv) Examine the various types of resource that were available in the storage, usage and management of big data for service delivery in the organisation.

As discussed in Chapter three, the case study approach was employed, and eight (8) people participated in the study. For analysis purposes, the participants were coded. This was to ease referencing and identification of the participants from the data, the following reference pattern was used as follows, “ORG_ID, PP: LL” which refers to the following:
ORG – represents the name of the organisation that was used in the study.
ID – refers to the numeric number assigned to the participants.
PP – identifies the page number of the document.
LL – represents the line number in the page of the document.

For example, GPGS_01, 02:11 means the first participant at Government Professional Geo-Spatial Services, page 2, and line 11 on the document.

The next section presents the analysis of data, using structuration theory, from the perspective of Government Professional Geo-Spatial Services (GPGS), the organisation used as a case in the study.

5.3 DATA ANALYSIS: STRUCTURATION THEORY VIEW

As already established in the course of this study, there are two main tenets of the ST, structure and agent (Englund et al., 2017). The tenets are discussed in the context of this study as follows:

5.3.1 Agent

Agents are defined as individuals within a social structure which have the power to make a difference and are regarded as active, purposeful and knowledgeable (Jones et al., 2004; Dutta et al., 2016). ST comprise of technical and non-technical agents (Odejide & Iyamu, 2012). Some of the technical agents at GPGS include hardware (servers and storage network), software applications (ArcGIS and AutoCAD) and databases (Oracle database). Non-technical agents involved in the storage, management, and use of geospatial big data at GPGS include the following:

- Information/Data Manager – Manage earth imagery and geo-spatial data
- Senior Data Technologist - Ensure access to digital data and maintain digital archive
- Database Administrator – Manage and maintain Oracle database
- Professional Support – Provide geo-spatial information and professional support services

As stated above, the agents had different roles and responsibilities. Through the roles and responsibilities, service delivery was supported and enabled on one hand. On another hand,

some areas of the service delivery were constrained. These actions were of conscious or unconscious behaviour. According to one of the interviewees who is Professional Support:

> "*I'm professional support so what I do, I assist and support the production environment when they have problems. I set up standards and procedures for capturing the data. I also support the data management and other directorates"* (GPGS_02, 7:313 – 318).

As discussed herein above, different types of agents existed at GPGS such as technical and non-technical agents. These agents did not exist in isolation, but within the rules and regulations of the organisation. Agents made use of resources available to them in fulfilling their roles and responsibilities and in order to carry out tasks and actions. The actions that agents carry out consciously or unconsciously influence the production and reproduction of a social system.

5.3.2 Structure

In structuration, structure is defined as "*rules and resources, recursively implicated in the reproduction of social systems"* (Giddens, 1984:377). Legal environment or entities such as an organisation are referred to as a social system in structuration theory. Structure are used by agents to enable or constrain the actions and thoughts of other agents within a social system (Iyamu, 2015). At GPGS, some of the rules that existed are as follows:

- Government Legislation – enacted laws to govern and guide the functions of government departments, (such as Spatial Data Infrastructure Act 54 of 2003, and Land Survey Act 8 of 1997),
- Standards – rules and guidelines to measure and monitor operations (such as Standard for Data Elevation Model, Standard for Integrated Topographical Information Systems),

In delivering services to the community, resources were critical. Some of the resources that were available to the employees at GPGS include:

- Hardware – this includes personal computers, application servers and Storage Area Network.
- Software – computer applications to process and manage the acquired data. This include ArcGIS, GeoMedia, and AutoCAD. ArcGIS and GeoMedia are geospatial software applications used for viewing spatial data, creating and using maps, analysing mapped information, creating and validating geographic data, and publishing geospatial information.
- Data - geospatial data and geographical maps.

Agents and structure interwoven within a social system in which they operate consciously or unconsciously. The interaction between structure and agents is mutually constitutive in that social structure is reproduced by human action, at the same time structure enables or constrains human action. Giddens (1984) refers to the reproductive nature between agent and structure as a dimension of duality of structure.

5.3.3 Duality of Structure

Structure	**Signification**	**Domination**	**Legitimation**
	The organisation wholly depends on big data to carry out its services to the community on behalf of the government. This makes big data critically important. Service delivery was most significant to both GPGS and the community members.	Information/Data Managers and business managers in the organisation monitored and managed the use, storage and processing of big data for service delivery.	Big data was used, stored, and managed for service delivery to the community within the rules and regulations, as mandated by government legislation and departmental standards.
Modality	**Interpretative scheme**	**Facility**	**Norm**
	Government legislation, departmental standards and processes were used to define how big data was used and managed in communicating and establishing relationship with the community through the services that are provided.	Employees used organisation-approved tools and resources to achieve their tasks and responsibilities in the course of service delivery.	Directorates within GPGS perform their tasks and actions based on the standards pertaining to their area of responsibility.
Interaction	**Communication**	**Power**	**Sanction**
	Departmental standards and processes were communicated within the directorates at GPGS.	Managers use their authority based on their roles and responsibility to monitor the use of big data for service delivery.	Relevant committees approve the standards with input from the directorates affected.

Signification

The criticality of the geospatial big data attributes to achieving the service delivery goals of the organisation. Some employees within the organisation regarded some aspects of the big data, such as imagery as one of the primary sources of data for geospatial services for the South African government. From the imagery a number of outputs are generated such as vector data, elevation data, raster data and maps. One of the geospatial specialists who participated in the study explain as follows:

> "*We have a tender out to fly a ¼ of the country every year and we keep on doing it every year and when we get that imagery, we process it and that imagery is used to do all the vector data, elevation data and the maps"* GPGS_02, 06:272 – 274).

The significance of the geospatial data to the organisation is attributed to the organisation being the custodian of geospatial data from which products and services are derived. This data spans a period of almost a century which makes it both a strategic and critical resource from the government point of view in upholding constitutional requirements such as land reform and restitution. Thus, for the organisation to deliver such products and services, the need to collect geospatial data is critical and the only way the organisation can function according to its mandate. One of the participants commented as follows:

> *"We are the formal custodians of the national photography archives, so we got all history of imagery for roughly 70 years because they started flying in 1930s"* (GPGS_04, 18:767 – 768).

Apart from geospatial big data being critical to the organisation and the communities, it was also critical to other spheres of government and various government agencies. These include municipalities, government departments and agencies. There are certain requirements that each of these entities need to fulfil in the exchange of geospatial big data for purposes of service delivery. These include the formatting of the data which in turn affects the output products or services. Thus, to fulfil the needs of each of these government entities for the different tasks such as urban planning, housing projects, road constructions and assist in decision-making, geospatial big data was obtained from GPGS. Furthermore, how the government departments and agencies utilise the geospatial big data for various service delivery purposes, it points to the use of big data as a service. These government entities utilise geospatial big data as an input into their products and services without altering the contents of the data they received from GPGS.

> "*We've got various government departments such as Planning, Eskom, Water Affairs who all take our data but use it as backdrops to produce what they need to produce. STATSA is a big user of our data*" (GPGS_08, 59:2373 – 2375).

Once all this geospatial big data is input into the system and processed, it allows the organisation to deliver services to the community. Some of the services provided to the community assist with the program of land reform and land restitution (a government program to return land to communities that were dispossessed of their land and properties). This points to a duality between the government and the community in that the services provided by GPGS are critical to the livelihood and social cohesion within the communities. As the citizens consume and utilise the products and services provided by government to fulfil their various needs, this in turn informs the need and the rationale for government to provide such services.

> "*You would use our data if you wanted a map, you could use our photography to get the picture of your house. You could use it to prove something in a court case. Also, you could use our data to determine the size of a farm or any property*" (GPGS_08, 64:2526 – 2528).

However, there are challenges which the community are experiencing when accessing some of the services from GPGS. These challenges can be attributed to technical factors such as web portals. While the organisation receives feedback from the clients through a survey they administer, it still falls short in providing efficient services to the clients. The technological tools in the organisation do not meet the service needs of the community which in turn, negatively impacts the community who utilises their services. These challenges can be attributed to the failure by the organisation to conduct continuous assessment of the environment in order to detect any shortfalls and enhancements for the future state of the organisation's technical and non-technical factors such as IT infrastructure and policies and standards. The organisation also needs to continually assess their service offerings to the community.

> "*I think first we need to go back to the people (clients) and ask what they really need. From my own perspective, everything is done correctly but I believe it's done in the old way. The world is moving forward but we don't want to move forward, we don't want change*" (GPGS_17, 61:729 - 731).

Interpretative Scheme

The criticality of the geospatial big data to the organisation and the significance of service delivery to both GPGS and community members was defined by the government legislation, departmental standards and processes. Government legislation defines the role of the organisation as a data custodian. It is in the legislation where the purposes for which the geospatial big data was used and how it should be used is defined. This is what some of the participants had to say:

> *"Most of our work is governed by SDI Act 54 of 2003. GPGS is the data custodian of imagery in South Africa and landcover"* (GPGS_01, 03:130 – 131).

Based on the requirements of the government legislation such as the SDI Act, GPGS developed standards and processes through which daily operations are monitored and managed. These standards are based on the roles and responsibilities of the different directorates within the organisation. The standards also dictate how geospatial data is obtained and processed.

> *"We basically are responsible for maintaining the national maps series. What we put on there we have to then basically create a standard for. It's basically the source of your data that creates a standard for that data"* (GPGS_05, 27:1096 – 1097).

Furthermore, since these standards provide a guideline for the provision of services to the community, GPGS has been active in establishing relationships with its clients which include other government entities and the community. It has been acknowledged by some participants that the community is not aware of the services and products provided by GPGS. This also includes the geospatial big data that could be helpful to other government entities especially in municipalities. The implication is that there'll be a misalignment between the services offered by the organisation against the needs of the community. The other implication is that GPGS doesn't conduct a continuous assessment of its services and products to ascertain any challenges that may need to be addressed from both technical and non-technical viewpoints. This then calls into question if the requirements which the organisation relies on to gather and process the data for service delivery are adequate.

> *"I think the most important thing is being able to get the data out there but not just getting it out there, we need to convert the users to using our data. First of all, people don't know that our data exists, so that's why we are having huge engagements with district municipalities."* (GPGS_08, 63:2516 – 2518).

Communication

The employees at GPGS followed departmental standards and processes which were communicated amongst the employees. After the approval process, the standards were communicated through meetings, presentations within the directorates. The organisation implements an orientation process so that staff members are kept abreast with the standards and processes. These standards are communicated after they have been approved by the relevant standards committees.

> *"Yes I have been here for a long time and have an idea of what they do but it would be better if you spoke to the colleagues at Map Sales and ask for the PowerPoint presentation they did and ask the colleagues at Quality Assurance because there's other things when we had our orientation in the building that you can take information from"* (GPGS_04, 19:791 – 795).

The importance of communicating the standards amongst the directorates ensures that the employees are on the same par in terms of what standards to follow and how they must apply them.

> *"If you were to go to Mark and ask for 132DD, he'll tell you for example it's Khayelitsha, that's how they are able to use and know those codes to allocate, pinpoint the area"* (GPGS_06, 37:1535 – 1536).

GPGS has facilitated communication with the users of their products and services. Thus, the communication is not only restricted to the standards and processes within the organisation. This enables them to gather feedback from the community. The community is able then to communicate their feedback and requests directly to the organisation. This enables the organisation to improve their services and address any challenges that may arise in the course of delivering services and products to the clients. Talking about the feedback system in place, one of the managers comments:

> "*Yes, we have a client feedback system which is managed by Quality Assurance division. We have a link on our automated reply and clients can click on that link. For example, if you want to order data you send an email to our sales email address and you get an automated email. From there there's a survey button which takes you to Google Forms. The QA division tracks the surveys to see if there's any bad comments then they do follow ups*" (GPGS_08, 61:2414 – 2418).

While the committees have been setup to coordinate the work or creating and updating standards, at an operational level, some of the processes are not communicated satisfactorily across the directorates. There are some gaps that were identified regarding communication between the directorates. This is related to articulating one's environment thus helping people from other directorates to understand what they are doing and how it fits to the bigger scheme of things.

> "*The other thing is the communication part, if you don't understand your environment and understand your expertise that's required, how can you communicate effectively?*" (GPGS_05, 34:1397 – 1398).

Domination

Across the different sections at GPGS, managers from the IT department and business units such as Topographic Compilation were responsible for managing the use, storage and processing of big data. This monitoring manifested itself through various ways. For example, when a service provider is contracted to collect data for the organisation, processes are put in place to verify the accuracy of the data within specified parameters of the organisation. This is to make sure that the data was captured correctly.

> "*Yes, when it comes to me I check accuracies are met, how the aircraft was flying, all the files and all angles are within the parameters of our specifications then I pass to our system*" (GPGS_01, 02:93 - 94).

The IT department was responsible for the storage and monitoring of the big data. Participants from the business units always referred to IT when asked about the storage or monitoring of the data. IT is also responsible for managing the database which is used by all other units, thus controlling who gets access and how. Whenever there is an issue with the big geospatial data, employees refer to IT to solve the problem.

How IT monitored the storage and processing of the data is through access to the database that stores all the processed data. Some of the participants have referred to IT as being custodians of the storage database and what kind of access rights each user has. While IT bears the responsibility of assigning access rights, this is done in conjunction with the business units utilising the database. After business units process the data, they then need to commit or store it in the database, which then becomes the responsibility of IT. Asked about where data is stored, one participant commented:

> "*On ITIS (Integrated Topographic Information System) database, that is the storage. And everyone can connect to this storage, but some have limited rights to it*" (GPGS_07, 50:2034 – 2035).

There are technical factors that influence how geospatial big data was managed and used by the IT department at GPGS. The technical factors include the server, storage and network infrastructure through which availability of the geospatial big data is dependent. For example, the IT department needs to ensure there is adequate space for all the geospatial data that collected in the organisation. The database which is the engine for managing and processing geospatial big data, need to also be available. These technical factors are under the direct supervision of the IT department thus, are able to dictate and directly influence how data is managed within GPGS. However, IT is grappling with various challenges within the IT infrastructure which includes the lack of adequate storage for the voluminous data collected and processed within the organisation. The organisation has experienced prolonged periods of downtimes due to failure of such technical components. There is no evidence of the organisation conducting any readiness assessment or risk assessment. It is known that the data within the organisation is growing at a phenomenal rate and yet no assessment of the infrastructure is done.

> "*Yes, it's their function to manage all the data for the whole office. They also manage the storage*" (GPGS_07, 52:2105).

The non-technical factors that influence the collection, managing and processing of geospatial big data include both IT and business managers. Together they determine and assess the scope and frequency of the data to be collected and the target area for such data collection. Even though it is the responsibility of IT to manage the processing and storage of data, it is the duty of both IT and business managers to determine the big data updates that are needed in the process of service delivery. There are engagements which produce a plan that will determine the scope of the work to be done.

> "*Basically, there's this whole engine room that sits and looks at the data, look at the frequency of the data, if certain areas of the country need to be updated because of the frequency, it becomes old then they identify the area of interest, they then fly the photography and the data gets run down by the sections at the bottom*" (GPGS_05, 29:1175 – 1178).

Furthermore, in conjunction with business managers, the IT department determines the employees access rights to the database used to process the geospatial big data at GPGS. Even

though there is no clear process of how permissions are given to the employees, it is understood that some users have limited access rights to the database for editing and deleting information. This was confirmed by one of the participants, though he pointed to security purposes for such varied access to the data. One of the reasons pertains to verification of the data so that the database's accuracy and veracity is maintained.

> "*So, for data security purposes, not everyone can edit or delete on the database*" (GPGS_01, 03:105 - 106).

Facility

The organisation has made available tools and resources that the employees use to achieve their tasks and responsibilities. The resources include software packages used to manage and process geospatial big data within the organisation. The IT infrastructure such as computer servers, network infrastructure, desktop computers, laptops, and software applications are the technical resources that have been made available and approved for use by the employees in the process of service delivery. Employees perform various tasks which are specific to their areas of responsibilities. Some of the tasks performed include extraction of data from the images and processing data to produce geospatial products such as maps. One of the participants comments:

> "*I use various software. I have a mapping software, data transaction/transaction software, imaging software, or let's call it image manipulation software, that's it in a nutshell*" (GPGS_05, 32:1327 – 1328).

The process of choosing the tools and resources used by the organisation was an elaborate and interactive process. The organisation had previously done an assessment which indicated an inadequacy of the resources in assisting the organisation achieve its goals and objectives as far as service delivery is concerned. The organisation also considered certain technical requirements that needed to satisfy which ultimately led to the choice of tools in the organisation. The organisation went through a benchmarking process and ultimately a tender process which ultimately satisfied the organisational requirements. Thus, according to one employee, the resources used were regarded as the best.

> "*We did a paper tender, but we also did benchmarking. They came and presented, we gave them material to fix, the session was interactive and through the process we chose GEOMEDIA. There were other software companies but the one we chose was considered the best. And Oracle is the main database software, banks use it, everyone uses it. We use the*

Geospatial cartridge of Oracle to store the geospatial data" (GPGS_04, 20:828 – 833).

However, the organisation has not done a continual assessment of the software tools and the whole IT infrastructure at large, against the technical skills of the employees. For instance, some of the employees use the software tools because it is what they are used to even though they may be more modern tools for processing and manipulating data, hence the resistance in considering other software tools for the processing and use of geospatial data. This is also a source of controversy among some employees because they regard the methods and tools being used as backward.

"*There are other applications that people in other departments are using but here I've always used Geomedia. I've never used them myself but when you study our course you get to be exposed to other applications. Since I've only used Geomedia, my expertise is limited to it*" (GPGS_07, 51:2075 – 2080).

Furthermore, the resources and tools available to the employees are not without challenges. These challenges can be attributed to the strain put on the infrastructure by the voluminous data in the organisation, which grows at a rapid pace. The maintenance of the infrastructure is also not up to date partly due to the rising cost of procuring modern infrastructure at short intervals. One of the employees had this to say about their challenges when accessing the information from the data centre:

"*There is always challenges and risks. For example, our IT infrastructure has not been kept up to date and things are breaking. Therefore, that's what we are finding in our current situation as well. It's working but the database was down for a while, that was just the database, but if the network goes down we can't do anything, we can't connect to Oracle, we can't connect to Stornext where our imagery is, that's the raster data, and then the vector data is in oracle and you can't work*" (GPGS_04, 22:917 – 922).

The challenges of the organisation are not limited to the technical resources used to manage and process geospatial big data but are also found in non-technical resources such as the methods and processes of the organisation. Some of the employees have berated the backwardness and archaic forms of methods and tools used which may not render the services as of high quality. For instance, one of the major challenges is getting the services to the users efficiently and faster because of bandwidth capacity challenges.

> "*The problem is not so much from us to ITIS, but it's getting our data out to the users, it's an enormous problem. Because we don't have the bandwidth, we cannot supply the huge datasets via the internet to our clients. We use an archaic system of clients sending hard drives whereas if we had the bandwidth we can just send it to them but now can't because we don't have those facilities available*" (GPGS_08, 58:2334 – 2338).

Power

Managers within the organisation used their power and authority to monitor the use and processing of big data in the process of service delivery. This power has been used in various ways within the organisation. On one hand it has been used to monitor the use of bog data for services through managing the employees and making sure they are performing their daily duties. Due to their position and influence, this power has been applied to quell any input or challenge to how things are done within the organisation. For example, whilst it has been established from some of the participants that some of the tools used in the organisation are tools which most of the employees are comfortable with, however, some managers discourage or quell any suggestion for different tools. One participant commented:

> "*Since I came here, the meetings I have attended have always been talking about renewal. I heard that someone proposed but he was crushed, he was told that no, it will be difficult to move from this to the other application. But I think it's more about being afraid of change, people don't want to change*" (GPGS_06, 42:1732 – 1735).

Even though the organisation has preapproved software packages to use in the processing of the data, some employees use their position to dictate and influence the software they use based on the personal preferences. This was confirmed by one participant who said, because she's the only one qualified as a GIS practitioner in her unit, she can dictate which software package she wants to use. It can be accepted that the organisation avails to the employees the necessary tools and resources to achieve their responsibilities. When the participant was asked why they are using the software package they use they replied:

> "*Because I demanded it. Remember where I work I'm the only qualified GIS person so the moment something becomes complicated they dump it on my desk. I therefore must get proper software to work on*" (GPGS_03, 06:676 – 678).

It is evident that the managers use their power and influence to stifle progress or do things as they see them with little input from their subordinates. Some employees believed the managers are threatened by their qualifications and instead of listening to other opinions, they use their power to dictate how things should be done. This in turn negatively affects the organisation in that its processes are not modernised which in turn affects efficiency and accuracy of the geospatial big data being delivered to the community.

> "..*the problem is with them they are so stubborn or they are so scared of those who just came back from university they will overpower and take over their jobs which is a reality because they learned in the old analog system which was good for them but now there's new ways of doing things why can't we adapt but they are adamant this has been used for years and we've been operating under this system. They are scared of change*" (GPGS_03, 18:754 – 758).

Legitimation

How the organisation used, stored and managed big data is governed by government legislation such as the Spatial Data Infrastructure Act (SDI). This piece of legislation informs data custodians such as GPGS how they should handle data, what features need to be safeguarded. This is to ensure that data veracity, accuracy and completeness is kept. Ultimately, this makes sure that services rendered to the communities are of good standard.

> "*They are trying to enforce the SDI act which tells how custodians must treat their data. It's a question of making the custodians to comply. One of the means of complying to that act is making sure your metadata is compliant with the regulations of how metadata should look like."* (GPGS_05, 27:1083 – 1086).

When we drill down to the organisation, the different directorates develop standards pertaining to their areas of responsibilities. These standards as well need to be compliant with the overarching national legislation. This means, every directorate and sub-directorate is held accountable based on their area of responsibility with the confines of their standards.

> "*We are responsible for maintaining the national maps series. What we put on there we have to then basically create a standard for. It's basically the source of your data that creates a standard for that data.*" (GPGS_05, 27:1096 – 1098).

Norm

All the tasks and actions performed within the organisation in the process of managing and using big data is done within the confines of standards. This helps to maintain veracity and quality of the data which has a direct influence on the quality of services offered to the clients. According to one participant, the overarching legislation for all their tasks is the Spatial Data Infrastructure (SDI) which is an act of government, managing how big geospatial data is handled.

> "*The data that we use that we don't generate internally is data that we display as combination with our data. So, we manipulate for our purposes, but we can only manipulate it within the bounds of Spatial Data Infrastructure (SDI). We can't go outside the bounds of SDI because as soon as we manipulate that data, we alter what the custodian deemed to be sufficient to hand out*" (GPGS_05, 26:1075 – 1079).

The significance and the criticality of the big data for services can be applied or understood based on the personal understanding and general organisational attitude towards geospatial big data. While geospatial big data may be viewed as critical to the organisation, how it is managed or perceived to be managed may give rise to the perception that it is not treated which the importance it deserves. Some of the employees viewed with suspect the practise of deleting old geospatial big data especially since the reasons for doing so are not clearly articulated by the organisation. The GIS Specialist commented as follows:

> "*What I have noticed with our organisation, they do get rid of the old data, I don't know maybe the problem is space or what because if you go back and look for vector data 5 years ago, it's no longer there. So, when they keep on doing new jobs they delete the old ones, for what good reason I don't know*" (GPGS_03, 11:501 – 504).

Since the organisation is a custodian of geospatial data, it has attempted to instil an understanding on the importance of big geospatial data as it relates to service delivery. This has influenced individuals to ensure that services and products offered to clients are of good quality in terms of their correctness and validity. Various methods are in place to test the correctness of the data for example by comparing with other data custodian or external entities such as NASA. The GIS Specialist continued as follows:

> "*Remember the organisation is the custodian of such data we are providing, and then there are records, remember each aerial photograph they were flown, there are records that were made so we are quite sure what we are*

giving to clients is correct. We also test it before we give it out to clients" (GPGS_03, 12:542 – 545).

Even though the organisation views geospatial big data critical for service delivery, and understands its mandate according to the SDI Act, it has shown bias towards other areas of the country in terms of the geospatial data it gathers. This has given rise to complaints from various sectors of the community that the products and services, in terms of maps, are outdated. This is caused partly by neglecting rural areas of the country and concentrating more on urban areas. One GIS Specialist commented:

"*Yes, and what I've noticed is that they do update big cities, nature reserves because that's where we believe more clients are. But our villages and rural areas, because there's no development, nothing much is happening there*" (GPGS_03, 13:567 – 569).

The geospatial field can be regarded as subjective and requires individuals to apply their understanding and knowledge. This can also be assisted with the experience and exposure of the individual in the geospatial field. However, this subjectivity may pose a challenge for service delivery. Moreover, as has been pointed out, the geospatial field and consequently the organisation is biased towards the urban areas at the expense of townships and rural areas. For example, in the area of standards and classification, disagreements arise because of how individuals perceive the area of geospatial data. One participant commented:

"…what I've noticed is that they do update big cities, nature reserves because that's where we believe more clients are. But our villages and rural areas, because there's no development, nothing much is happening there" (GPGS_03, 13:567 – 569).

Some of the employees who have years of experience in the geospatial field, can point out the inconsistencies, lack of data completeness and accuracy in the geospatial big data within the organisation. This obviously has a negative impact on the services and products offered by the organisation. This can be linked to communities who have complained about the substandard services which can be directly attributed to how individuals within the organisation understand the critical nature of the geospatial big data for service delivery.

"*…. I see stuff missing in that database, I see inconsistencies in that database, I can't give you more. All I can tell is what I see, because of our*

experience, cartographic experience, because of us working consistently with data like that." (GPGS_05, 30:1224 – 1226)

Sanction

As has been alluded to, GPGS has developed standards and processes that manage the use, storage and processing of geospatial data across the directorates. Committees have been setup to create and revise standards relevant to each of the directorates from the organisation. Taking into account that the work of each directorate is related to other directorates, the standards committees are representative of those who will be affected by a certain standard. Other people who may be affected by the standards are also invited to the committees for their contribution.

"The individuals in the teams are picked in terms of the added contribution. Normally you will have people heavily involved in a specific area, who's the core of that team and then you have people who might have an influence, for example, if you are my client internally then you might want to sit in my standard because of certain contributions you can make towards our standard" (GPGS_05, 29:1183 – 1187).

Apart from the internal standards committees that draw up and approve standards, there are other standards that the organisation complies with. There are national and international standards that the organisation has to comply with. The national standards GPGS complies with include SANS and as the national maps' organisation, GPGS is represented. International standards governing GIS industry globally that the organisation subscribes to includes ISO standards. Commenting on the standards that the organisation has to comply with, the GIS specialist said:

"Each organization has its own standards, but they must comply with the national standards and the ISO standards. Those standards must be interlinked and correlated. Whatever mapping that we do, it's not done to suit us but must comply with SANS, ISO standards which are defined in our line of work" (GPGS_01, 05:205 – 208).

The work of the committees is not without any challenges. There is evidence of competing interests, but the nature of these committees is to ensure that the interests of each directorate and the organisation at large is taken into account. Furthermore, these committees are created to safeguard the quality of the services and products for service delivery.

The work of the committees is also managed and guided by a sub-directorate created specifically to guide and keep track of all the standards within the organisation known as the Quality Assurance. Once the standards have been signed off by the head of the organisation, they are kept in a repository by the Quality Assurance sub-directorate. This ensures that all the standards in the organisation are done within an acceptable standard in line with other national or international standards.

> "*A team sets up standards, it is the Quality Assurance division which gives guidance and make sure the standard is kept accordingly*" (GPGS_08, 60:2389 – 2390).

5.4 DISCUSSION OF FINDINGS

This section presents the findings, from the analysis that is presented above. The findings, Organisational Requirements, Readiness Assessment, Continuous Assessment, Compatibility, and Big data as a Service are the factors, which influence the use of big data for service delivery by government (GPGS). The findings as presented in Table 5 are discussed in the remainder of this section. The findings were reached from an understanding, which was based on subjective reasoning from an interpretivist perspective. According to Kankam (2019), "*interpretivists believe that the human experience of the world is subjective, and they have a concern to understand it as it is*".

Findings	Description
Organisational Requirements	The requirements for gathering the big data for services should be guided by the vision of the organisation. This is to ensure balance between the rural and peri-urban areas. Also, this is to cover both technical and non-technical needs. This means that the requirements must be a duality between the service provider (government) and the community.
Readiness Assessment	The maturity and readiness of the organisation to manage and use big data. This is to manage and reduce the risk and its impact thereof on the organisation.
Compatibility	Infrastructures must be compatible, to ensure and enable effectiveness and efficiency. And to ensure compatibility, the infrastructure should be defined and designed enable flexibility.
Continuous Assessment	This is to detect deficiencies that might arise from both technical and non-technical viewpoints.
Big data as a service	This is to ensure that big data services are provided in an efficient and effective manner.

TABLE 5: FACTORS THAT INFLUENCE BIG DATA FOR SERVICE DELIVERY

First, the factors are briefly described in the table (Table 5). This is to put each of the factors in context and perspective of the study. Second, a diagram (Figure 7) is used to depict the

relationship between the factors, as they influence the use big data in GPGS. Table 5 and Figure 7 should be read with the discussion that follows in order to gain better understanding of how the factors influence the use of big data for service delivery in the organisation.

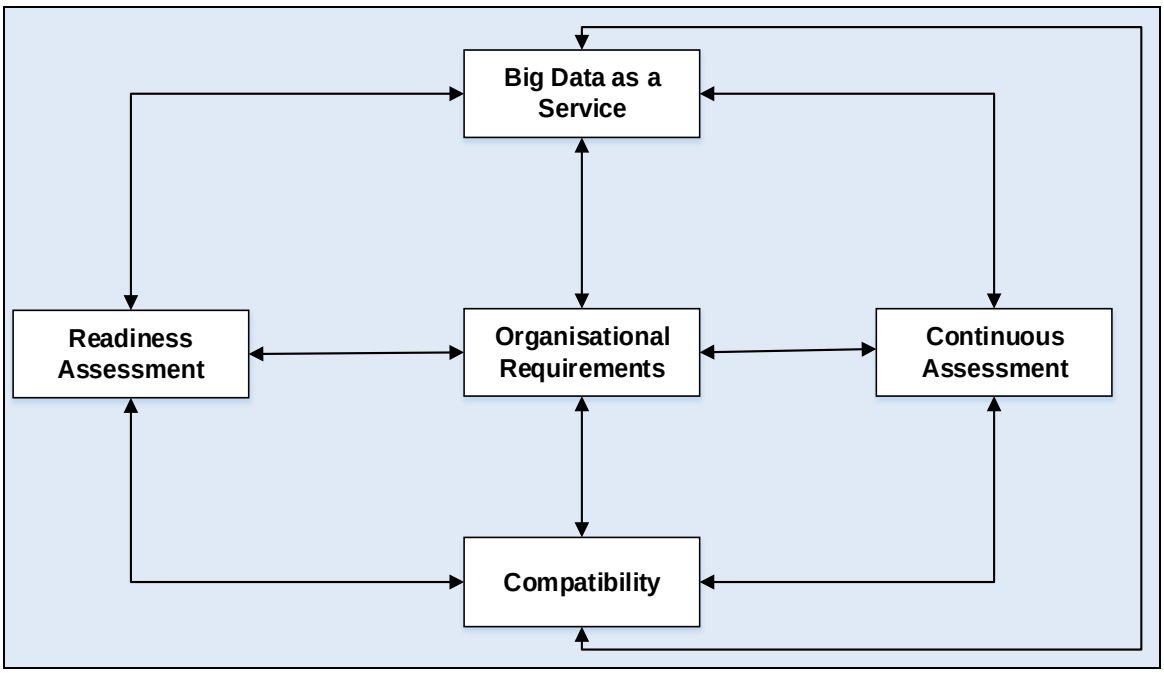

FIGURE 7: FACTORS INFLUENCING BIG DATA FOR SERVICE DELIVERY

Organisational Requirements

The goal of the organisation, GPGS is to render geospatial services to the community of South Africa. The geospatial consists of big data, which include text, imagery and maps, which are in high volume and of various types. In providing the services to the community, a set of requirements are needed as revealed from the data analysis. According to Negri et al. (2017:169), a requirement is "*a goal, in the scope of a specific problem, that describes environmental conditions to be achieved through a desired solution resulting in satisfaction of the underlying strategic goals*". In GPGS, the use of big data to provide services require organisational requirements, which is to understand *where, how, and when* services are needed. The requirements are of both technical and business in covering the where, how, and when services can be provided.

In terms of the location (*where*), different types of maps are used, to detect, population spread, infrastructure deployment (such as access to telecommunication network). Technologies are mainly the vehicles (*how*) used in providing the services. The technologies (server, database and

network protocols) are able to handle the voluminous data-sets, including the speed and variety of data-sets, which are structured and unstructured. In providing services to community, big data is also driven by time factor, in that the data-sets change in size and types, from time-to-time.

Readiness Assessment

Readiness assessment can be describe as a process of evaluating an organisation's maturity and readiness level, to ascertain management and use of technology (Farzaneh et al., 2019). This means that through readiness assessment, the organisation will understand their environment better, and can plan healthily towards its goal and objectives. This includes detecting potential risks and mitigation strategy. Thus, the use of big data is assessed on one hand, to determine where, how and when the various data-sets can be applied. On another hand, the environment (community) can be assessed to understand its readiness to receive services from the GPGS.

Without readiness assessment, there are different types risks that can arise. This includes lack of technology, inappropriate deployment of technology infrastructure, environmental culture. Each of these potential risks' factors can influence the use of data-sets to provide service to a community. This is to manage and reduce the impact of various risks in the organisation. This includes the risk of non-conformity to approved standards and the risk of inadequate infrastructure to handle the volume and variety of the data stored and managed in the organisation. If this was done, some of the challenges such as insufficient storage, failing server infrastructure, and slow network infrastructure would have been eradicated or reduced in the process of collecting, storing and using geospatial data for service delivery in the organisation.

Compatibility

In the context of IT, compatibility is defined as the capability to share data efficiently across any IT component and the level at which those IT components can be integrated within the organisation (Murthy et al., 2019). This means that to ensure and enable effectiveness and efficiency in the processing, use and sharing of geospatial data, technology infrastructures (hardware and software) must be compatible. And to ensure compatibility, the infrastructure should be defined and designed to enable flexibility. Flexibility is further defined as "*the dynamic managerial capability to sense and seize opportunities for competitive action by changing the operational processes, organisational structure, and business strategies"* (Benitez et al., 2018:27).

The organisation (GPGS) has been stuck with "*proven*" yet archaic methods of operations as revealed from the analysis. Technology continue to evolve, yet the organisation has not refined or updated its processes and standards to take advantage of technological advancements in the use of big data to deliver services to the community. This is evident in its IT infrastructure that continue to experience downtimes, sometimes, in the process of transport data-sets, to enable services. This ultimately results in loss of production, which has negative impact on services that are rendered to the community. As a result, lack of efficiency and flexibility are experienced, which manifest into failure to take advantage of other technological advancements such as cloud computing. According to Sinnot and Voorsluys (2016), cloud computing has been the dominant technology in the processing and analysing of big data.

Continuous assessment

Continuous assessment is an ongoing process that enhances the organisations' decision-making processes and allows the detection of problems before they negatively affect the operations (Cochran et al., 2016; Marques et al., 2015). For the organisation to continue to provide geospatial services to the community through big data, there are various components that are connected. This includes technologies (servers and databases) where big data are stored; information flow between the technologies in the use of the big data; business processes and logics that dictates the use of information and the big data; and the applications (software) that are used as interfaces. This means that deficiency in one of the components affect others, and services are derailed. To ensure stability, each of the components must be continually assessed in an iteration manner to assist the organisation gain efficiency in its operations. One of the approaches through which this can be achieved is by enterprise architecture (EA).

"*Enterprise architecture defines the current and desirable future states of an organisation's processes, capabilities, application systems, data, and IT infrastructure and provides a roadmap for achieving this target from the current state"* (Shanks et al., 2018:139). Therefore, if the organisation fails to utilise such approaches as EA in continually assessing its environment, it will continue to experience inefficiencies borne from archaic processes and standards, inadequate technological infrastructure. This will result in the organisation not fulfilling its service delivery mandate of providing efficient geospatial services.

Big data as a service

Big data is increasingly used to provide services efficiently and effectively in many industries including government administrations (Zheng et al., 2013). In South Africa, communities have constitutional rights to geospatial services such as aerial photography and maps as provided by GPGS. As shown in the analysis, aerial photography has been used as evidence for communities that were removed in their lands during the apartheid era. Aerial photography can also be used to revise maps and to have a historic record of what existed in a particular area at the time the aerial photograph was taken. Maps of different scales are also available to the community such as provincial maps, national maps and aeronautical maps. Similarly, in achieving its service delivery obligations to the communities through the use of big data, GPGS need to understand and treat big data as a service. This can be done by, first, categorise the big data into its various types and variants, such as text, imagery, video, and maps, store them in repository. This approach enables appropriate analytics tools to be selected and applied. This is intended to enable ease of access and promotes response time for effective and efficient service delivery to the community.

The use of big data analytics (BDA) tools assist the organisation to gain insights and generate value from the huge datasets (volume), which include structured and unstructured data that are and available in different formats (variety), such as imagery, vector data, and maps (Ghosh, 2016). Also, this approach enables GPGS to structure its services in a more transparent manner, which can increase its productivity.

5.5 BIG DATA FRAMEWORK FOR SERVICE DELIVERY

The findings that emerged from the data analysis were discussed as presented in section 5.4 above. From the discussion, interpretation was undertaken. An interpretivist approach is employed in order to understand the views and subjective experiences of the participant about a phenomenon (Blitz et al., 2018). This approach also allows the researcher to analyse and interpret the phenomenon based on their subjective understanding of the participants views (Iyamu, 2018). According to Saunders et al. (2007), subjectivism is based on the understanding that social phenomena is informed by perceptions and actions of social actors. By using the interpretivist approach, the factors of influence (as revealed in section 5.4) were found to manifest themselves into a large scale in the use of big data, in providing services to the community. This results in the development of a conceptual framework (Figure 8), a Big data Framework for Service Delivery (BFSD).

The components that manifest from the influencing factors are discussed below. The discussion should be read with the framework (Figure 8) in order to gain better understanding of the BFSD, and how to employ it.

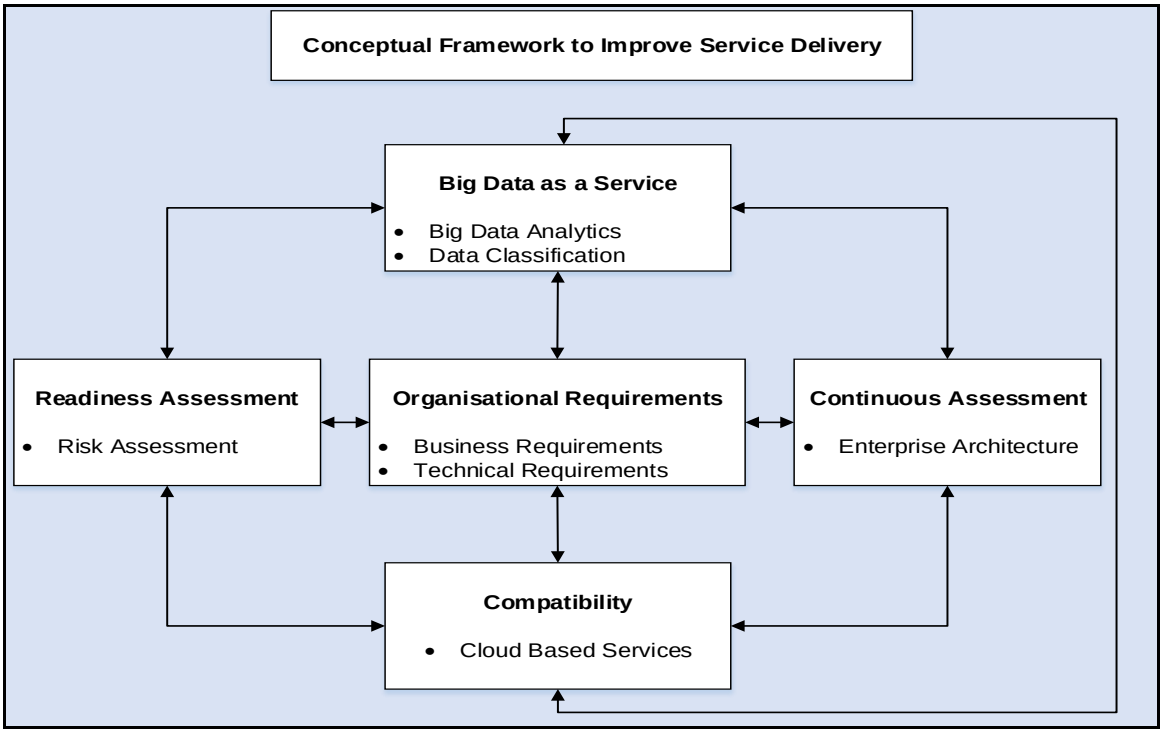

FIGURE 8: A BIG DATA FRAMEWORK FOR SERVICE DELIVERY (BFSD)

Business requirements

Business requirements consist of business processes, rules and standards which guide and moderate the tasks and responsibilities of the different directorates within the organisation to achieve service delivery goals. These processes take into account the methods and techniques to be used for collecting, managing and using big data for service delivery. This is also determines the human resources and the skillset required in achieving these goals. As the custodian of the national maps series in South Africa, GPGS engages in processes that determine the areas, the frequency and the methods of collecting data that will be used for service delivery. This culminates in other processes such as the contracting of service providers to collect geospatial data such as imagery that will be used to deliver services and products to the community. The standards include the Medium Scale map series standard which ensures that maps fit the requirements for maps produced at that scale. Fulfilling these requirements ensures that the organisation fulfils its

mandate and obligations as the custodian of the national map series and its service delivery targets to the community.

Technical requirements

The technical requirements in GPGS consists of IT infrastructure which includes servers, network infrastructure, databases, applications (software) and desktop computers. These play a huge factor in the operations of GPGS, which depends on the IT infrastructure to store, manage and use geospatial data for service delivery. The geospatial data stored in the servers is voluminous, of different formats and growing at a phenomenal rate which requires servers that are scalable, efficient and compatible.

The network infrastructure is required to transport and handle the speed at which data is processed within the network (velocity). Network availability is one of the key factors as any downtime impedes the transportation and processing of the geospatial data within the organisation which negatively affects service delivery. The database is at the heart of the data processing as the geospatial data is accessed, processed and distributed from the database. The database handles the processing of the structured and unstructured datasets such as maps and imagery (variety), applications used to process and manipulate data, and desktop computers. Thus, the organisation requires IT infrastructure that is scalable, capable and reliable to handle high volume, high variety, and high velocity data.

Risk assessment

Risk assessment is defined as "*the process of identifying risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the nation, resulting from the operation of an information system"* (Silva & Jacob, 2018:1). Turskis et al. (2019) consider risks assessment as a critical factor for effective decision-making and management of critical IT infrastructure in organisations. As revealed from the findings, the challenges faced by the organisation include insufficient storage capability, ailing server infrastructure state, and slow network infrastructure. These challenges pose risk to the organisation's ability to achieve its service delivery goals to the community. It is thus important to consider that, for an organisation such as GPGS, working with big data critical for service delivery, managing risks is of importance. Therefore, the organisation requires a risk assessment plan to

help it to define all risks the organisation is susceptible to, assess the likelihood of the risk, the impact of the risk and how it can be mitigated.

Enterprise Architecture

Enterprise Architecture (EA) is a useful method to support business and IT alignment by defining how IT supports business operations to benefit the business (Lakhrouit & Baïna, 2016). To achieve business and IT alignment, Nikpay et al. (2017:928) posit that "*EA describes the baseline architecture (As-Is), elaborates the desired architecture (To-Be), and represents the migration plan for transition from baseline architecture to desired architecture for the enterprise*". Furthermore, four architectural levels which include business, data, application, and infrastructure need to be described in the process of implementing EA (ibid) for the purpose of using big data for service delivery. Therefore, a proper and effective implementation of EA ensures a stable and flexible environment for the organisation. For GPGS, implementation of EA would present a strategy to assess its environment, achieve efficiency in service delivery.

Big data analytics

Big data analytics describe the process of analysing and processing massive datasets to retrieve useful information (Hariri et al., 2019). According to Suthaharan (2014), Big data poses challenges to applications which include network traffic risk analysis, geospatial classification and forecasting. Therefore, as mentioned by Li et al. (2016), classification of big data enables network efficiency in handling big data streams, and real-time processing of big data. As shown in the discussion of findings, the organisation is still using traditional methods of processing geospatial data, resulting in the organisation not gaining valuable information that can be retrieved by using big data analytics tools. Thus, the implementation of big data analytics tools will enable GPGS to gain valuable information that can be used to enhance and improve service delivery to the community.

Big Data Classification

Big data consists of attributes such as text, image, and video, which can be structured or unstructured (Tonidandel et al., 2018). This classification of the attributes is critical in the use of big data for service delivery. This is helps to differentiate and contextualise the aspects of big data

(or data-sets) for specific needs for organisational purposes. Also, it assists to select technology infrastructures for its enablement and support. Through classification, the use of big data is optimised, and increases its value for both service providers and the recipients. Value is one of its characteristics (Leelavathy et al., 2017).

Cloud-based Services

This is referred to as the services that are available and accessed through the Internet. This reduces both business and IT units' financial spend on technology infrastructures such as servers, software, and network capability. Cloud-based solution solves optimisation challenges (Yaghmaee et al., 2017). The approach of cloud-based assists the organisation, GPGS to increase response time in the services that they provide to the community. For example, members of the community can access information and other services, such geo-map from anywhere and at any time. The cloud facility may be host by GPGS within its premises, or outsourced. This should not affect the levels of service that the cloud-based approach enables and supports.

5.6 CONCLUSION

As stated in the beginning of this chapter, analysis of the data in which the duality of structure was employed as a lens has been presented. The findings from the analysis were discussed, and also forms part of the chapter. The findings reveal the factors that influence the use of big data for service delivery by GPGS, which is depicted in Figure 7. Based on the interpretation of the findings, a framework was developed. Thus, through sections 5.4 and 5.5 including the associated Figures 7 and 8 respectively, the aim and objectives of the study has been achieved. This is further elaborated in the next chapter.

CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter presents the conclusions and the recommendations related to the research. The aim of this study was to develop a conceptual framework through which big data can be used to improve services, which the Government Professional Geo-Spatial Services provides to the citizens. Based on the research problem, this chapter summarises how the research aim, objectives and research questions were addressed. This chapter is divided into six sections; section one presents the summary of the study through a brief summary of each of the chapters of the study, section two evaluates how the research questions were addressed, section 3 provides the contribution of the study from theoretical and practical perspective, section 4 presents the recommendations and benefits of the study, section 5 presents suggestions for further research based on the findings and limitations of the study, and lastly, section 6 presents a summary of this chapter.

6.2 SUMMARY OF THE STUDY

Chapter 1 introduced and provided an overview of the research study and identified the research problem. The challenges faced by government relating to service delivery, how big data can be used to improve service delivery and address the service delivery shortcomings which have negative implications for social imbalance, were articulated leading to the formulation of the research problem. This informed the main research question and the objectives of the study which are; (i) to investigate how big data within the government department is stored, managed, and used for service delivery, (ii) to examine and understand how big data influence the services that the government department provide to South African citizens.

Chapter 2 provided a detailed review of literature in the following areas and sub-areas relating to the study:

1. Information and Communication Technology
    a. People, Process and Technology
    b. Electronic government
2. Big Data
    a. Geospatial Big Data of government
    b. Big data analytics
3. Structuration theory
4. Structuration theory and information systems study

Chapter 3 presented a detailed overview of research methodology focusing on the following facets; (i) Research philosophy; (ii) research approach; (iii) research methods; (iv) research design; (v) data collection; vi) data analysis and vii) Ethical considerations. The chapter also presented justification for the research methods employed and followed in this study. Furthermore, the chapter provides the demography of the participants which were interviewed.

Chapter 4 presented an overview of the case which was selected for the study. This includes the organogram of the organisation including the directorates from which the participants belong.

Chapter 5 presents the data analysis using duality of structure from the structuration theory perspective. From the analysis, factors that influence the use of big data for service delivery were identified, culminating in a conceptual framework was developed which guides the use of big data for improved service delivery in government.

6.3 EVALUATION OF THE STUDY

The research questions were presented in Chapters One and Three. The questions are revisited in this section to evaluate the research:

What are the factors that can influence the development of a conceptual framework through which big data can be used to improve service delivery by GPGS?

iii. How are big data stored, managed, and used for service delivery by GPGS in South Africa?

iv. What are the factors that influence how big data is stored, managed, and used for service delivery by GPGS in South Africa?

The Dane method is used to evaluate the research. Dane (2010) proposes six components (who?, what?, where?, when?, how? and why?) for his approach to the evaluation of research. These components are used as presented in Table 6 below. Following Table 6, the research questions are further discussed in summary. The discussion should be read as complementary to Table 6 in order to have a better understanding to the evaluation of the study.

Component	Evaluation
Who	Views and opinions were gathered from selected participants, by using a set of criteria. The organisation from which the participants belonged was also selected based on a set of criteria. The criteria followed to select the participants in the study as articulated in chapter 3 is as follows: v. IT Staff working for government in the GIS environment vi. GIS Professionals currently working for government in a GIS environment. The professionals should be responsible for both processing and delivery of geospatial services and products vii. Managers working for government in the GIS field. viii. All the participants should have been working with geospatial data for at least 2 years. The set of criteria was based on identifying participants who, through their expertise, length of employment, and understanding of the GIS environment in government could add value and richness of data in the study. The study had 8 participants who consisted of 2 IT Practitioners, 4 GIS Managers and 2 GIS Professionals. An undertaking was made that the names of the participants be not used in the study, thus, codenames GPGS_01 to GPGS_08 were used to identify the participants. The criteria followed to select the organisation used as a case in the study was as follows: I. An organisation that is a government entity or department that is regarded as a custodian of geospatial data. II. The organisation should be based in the Western Cape Province of South Africa. This was due to the researcher being based in the Western Cape province and influence by limited resources and budgetary constraints of the researcher. The organisation used as a case in the study was selected based on the following reasons. I. The organisation was a government department which is regarded as a custodian of geospatial data. II. The organisation is the primary custodian of all geospatial data in South Africa.

Component	Evaluation
	III. The organisation has been working with geospatial data for over 70 years. IV. The organisation is the chair and custodian of the Spatial Data Infrastructure Act (SDI Act 53 of 2004) which governs all data custodians in South Africa. V. The organisation is a national government department based in Cape Town, South Africa. Permission to use the organisation as a case in the study was granted on condition that the official name of the organisation is not revealed or used in the study. Therefore, a pseudonym was given, and the organisation is used in the study as Government Professional Geo-Spatial Services (GPGS).
What	The use of big data for government administration's service delivery was investigated. The concept of big data has gained a lot of prominence especially in the private sector and is being used to gain competitive advantage and assist with decision-making. The investigation on big data was in relation to government service delivery. Even though big data has been predominantly used by profit-driven organisations, the role of government is delivering services to citizens, thus, big data is as important to the government sector as it is in the private sector. This study investigated how big data was stored, managed and used for service delivery. The organisation collects huge datasets in the form of geospatial data. This data is growing at a phenomenal rate such that the server infrastructure which stores this information is unable to handle such data volumes. The aim of this study was to develop a big data framework that can be used to improve service delivery, thus, this aim was achieved as shown in the preceding chapter.
Where	The study was conducted within the premises of GPGS which is based in Cape Town, South Africa. Within GPGS, data was collected from various directorates involved in storing, managing and using big data. The interviews were conducted in the offices of the participants based on convenience, so that they don't have to travel outside of their offices. This was also due to the

Component	Evaluation
	fact that the interviews were conducted during working hours which would not allow for a different location. Secondly, the case study research design followed in this study allows for the study to be conducted within the natural setting of the phenomenon, this allowed the researcher to gain first-hand experience of the environment. Thirdly, all the participants had their own offices, thus providing a comfortable and free environment for them to discuss their views without any intimidation or fear of being heard by other colleagues within the organisation.
When	The study has been conducted over a period of 3 years. A project plan which is presented in Chapter 1 was developed to guide the progress and duration of the study. However, due to numerous factors, there were delays which affected the project plan timelines. Some of the factors were personal in nature, some were due to work demands since the researcher is a full-time employee. Other factors can be attributed to the process of seeking permission to conduct the study at GPGS. Significantly, the data collection process was carried out from 21 August 2018 to 22 November 2018. This was based on the availability of the participants which the researcher had to work around. Since the study was conducted during working hours, there were instances where participants postponed the appointments due to work demands. An updated project plan is presented in Chapter 1, indicating the timelines for each chapter in the process of conducting this study.
How	The most suitable methodology (methods, approaches and techniques) were employed in the study based on the objectives of the study. These have been discussed in the detail in Chapter 3. The study followed a subjective ontological stance which is based on the premise that government possesses huge amounts of data. The epistemological stance of this study was from the interpretivist perspective. Qualitative research method was employed allowing for the development of the conceptual framework. This was based on the subjective views gathered from the participants. Case study research design was employed (see 3.5.1). The process leading to data collection has been extensively discussed in Chapter 3 (see sub-

Component	Evaluation
	section 3.6.1). In summary, data was collected by using semi-structured interview technique. All the interviews were recorded and stored in a password protected laptop computer for confidentiality. After data was collected, the researcher personally transcribed the data from the recordings. Documentation was also used a data collection technique. Data collected from documentation was used as secondary data, to complement data obtained from interviews. The documentation collected was also stored in a password protected laptop for confidentiality. The process of collecting documentation from GPGS has also been extensively discussed in Chapter 3 (see sub-section 3.6.5). Data was analysed using duality of structure from the perspective of structuration theory (ST) as a lens to guide the analysis. Data analysis and the use of ST has been discussed extensively in Chapter 5. From the analysis a conceptual framework was developed, and its features discussed (see section 5.5 for conceptual framework).
Why	The study on the use big data in the government sector was based on the interest on the subject by the researcher. As articulated in previous chapter, government holds huge datasets but is seemingly not able to extract value for use in service delivery like the private sector has done for competitive advantage in their various domains. Furthermore, literature is littered with how the private sector has benefited and continues to use of big data. Since the researcher is a government employee, their interest was on how government can gain efficiency in delivering services to the citizens using technologies such as big data. Based on the fact that South Africa is experiencing frequent service delivery protests which are attributed to failure to deliver timely and adequate services to the community, this study was pursued to offer theoretical and practical solutions to the government and academic domains. The study was also conducted for personal development and contribution to the body of knowledge in the area of big data in the government sector. Thus, the objectives of the study were developed with the aim to investigate and understand the factors that can influence the development of a conceptual

Component	Evaluation
	framework through which big data can be used to improve service delivery by a government department.

TABLE 6: COMPONENTS FOR EVALUATING RESEARCH (DANE, 2010)

Research Sub-Question 1

I. How are big data stored, managed, and used for service delivery by GPGS in South Africa?

From the analysis it was found that the organisation stores the big data in its IT infrastructure (servers). The organisation has in its possession over a petabyte of data which is stored in its servers. This data is managed through various software which manage the archiving and backup of the data. Furthermore, GPGS manages the big data through a database which is maintained and monitored by the IT department. The big data such as aerial photography is the base product from which a variety of products and services are derived within the organisation is availed and processed through the database. Some of products and services which are derived in the organisation include aerial triangulation data, vector data, and maps.

Research Sub-Question 2

II. What are the factors that influence how big data is stored, managed, and used for service delivery by GPGS in South Africa?

Based on the analysis conducted in Chapter 5, the factors that influence how big data is stored, managed, and used for service delivery by GPGS in South Africa were analysed and interpreted. These factors have been presented in Figure 7 in Chapter 5 namely; organisational requirements, readiness assessment, compatibility, continuous assessment, and big data as a service. These factors have been extensively discussed (see section 5.4 for discussion of findings). A recap of these factors is provided herein below:

Organisational requirements imply that the gathering of big data for service delivery should be guided by the vision of the organisation. This covers both business and technical requirements. Secondly, there needs to be an assessment of the organisation's readiness to manage and use big data. This will enable the organisation to understand their environment and plan towards goals and objectives of the organisation. Furthermore, this results in the organisation to identify and manage risks and their impact on the organisation. The third factor stressed on the compatibility

of technological infrastructure (hardware and software). This ensures effectiveness and efficiency in the processing, use and sharing of geospatial data.

Continuous assessment highlighted the need to engage in this ongoing process to ensure that problems are detected before they negatively affect the operations of the organisation. This process was shown to be achievable through the approach of enterprise architecture. Lastly, for GPGS to achieve its goals and objectives through the use of big data, it needs to understand and treat big data as a service. This includes using appropriate big data analytics for gaining insights and generate value from big data. It also includes classification of big data to enable optimal use of big data for service delivery.

Main Research Question

III. What are the factors that can influence the development of a conceptual framework through which big data can be used to improve service delivery by GPGS?

Through the analysis conducted in Chapter 5, a Big data Framework for Service Delivery (BSFD) was developed as presented in Figure 8 in Chapter 5. The government sector can use the framework to improve service delivery through the use of big data. The framework also shows the areas which government departments and agencies need to be cognisance of in their use of big data for service delivery. These areas have been articulated in detail in section 5.5 of Chapter 5.

6.4 CONTRIBUTION OF THE RESEARCH

This section focuses on and presents the contribution of the research from both a theoretical and practical perspective.

6.4.1 Theoretical contribution

The use of duality of structure as a lens to guide from the perspective of Structuration Theory enabled this study to provide understanding on the roles, responsibilities and actions of agents (people), and how rules (policies and regulations) were applied on big data in the service delivery to the community. Furthermore, the study highlights the factors which influence the use of big data for service delivery by government (GPGS). These factors include Organisational Requirements, Readiness Assessment, Continuous Assessment, Compatibility, and Big data as a Service. Furthermore, literature has been inundated with use of big data for competitive advantage in the private sector, this study brings a fresh perspective from which government can also take advantage of the benefits of the big data in its repository to improve service delivery.

6.4.2 Practical contribution

The practical contribution of this study is the framework which was developed based on the analysis of this study. The framework is intended to guide the use of big data for improved service delivery within the government sector in South Africa.

6.5 LIMITATIONS OF THE STUDY

The aim of this study was limited to creating a conceptual framework through which big data can be used to improve service delivery by a government department. Thus, generalising this study to sectors other than the government sector would be limited.

6.6 RECOMMENDATIONS

Based on the findings as discussed in Chapter 5, the recommendations are summarised and described herein below.

6.6.1 IT/Business alignment

For government departments to implement the framework, there needs to be synergy between business (operational units within government departments) and the IT department. This is because any IT implementation has implications for business and the framework developed in this study directly implicates business processes, technology, people etc. For example, the framework recognises that part of the requirements that are critical are business requirements. How those business requirements are crafted will inform and influence the IT solutions that are presented as solutions. Government departments need to use such approaches as enterprise architecture to integrate and assess government operations in a continuous manner.

6.6.2 Government policy

The world is experiencing major technological advances which are exploited in the private sector such as big data and cloud computing. However, the same technological advances take long to proliferate the government sector. For example, it has been shown in the analysis as well that government is reluctant in using the cloud computing and there are no policies that facilitate implementation of technologies such as cloud computing in the government sector. Thus, the government departments should consider being proactive in influencing policy makers on developing policies that will enable the implementation of technologies that can be used improve and enhance service delivery for the citizens.

6.7 BENEFIT OF THE STUDY

The benefit of the study is twofold. It contributes to the body of knowledge and to the industry, particularly the cases used in the study: The benefits are presented as follows: (i) government sector and (ii) academic domain.

The benefit to the government sector is that the study will create awareness for government policy makers, managers and IT managers regarding the benefits of big data towards service delivery. Implementation of the framework can also bring the integration and synergy between IT and business ensuring that the core business of government which is service delivery to the citizens is done efficiently and effectively by unleashing the potential of big data in the government sector. The study also brings to the fore factors that government departments can consider when implementing technologies in their sector.

For the academic domain the contribution is to the existing body of knowledge. The study present empirical evidence on the factors that can influence how big data is stored, managed, and used for service delivery by a government department. The other benefit is the application of the concepts of structuration theory in the government sector in the use of technology for service delivery. The theory as a lens helped to focus on the roles, responsibilities and actions of agents (people), and how rules (policies and regulations) were applied on big data in the service delivery to the community. Furthermore, the aim of the study which was to develop a conceptual framework through which big data can be used to improve service have been achieved.

6.8 FURTHER RESEARCH

This study was holistically and comprehensively carried out within the scope as demarcated in Chapter One. The findings and the analysis of the study indicate that further research relating to big data could be conducted. Some of the suggestions are: (i) use other theoretical frameworks such as Actor Network Theory (ANT) to analyse the data. ANT can be used as a lens to understand the relationship between actors, networks and how actors influence networks in the course of service delivery. Lastly, this study was limited to creating a conceptual framework through which big data can be used to improve service delivery. Thus, a study on the implementation or operationalising of the framework in a government department or entity can be pursued.

6.9 SUMMARY

This chapter presented the summary of this study by evaluating the research and illustrating how the research aims and objectives have been met. The answers to the research questions as defined in Chapter 1 were presented on the basis of the analysis. The contribution of the study from the theoretical and practical perspectives were provided. Recommendations for the organisation and the government sector were proffered indicating areas that need attention in government's continued endeavour to deliver efficient services to the citizens. Furthermore, the benefits of the study from the government sector and the academic domains were presented. Finally, the chapter presented recommendations for further research.

REFERENCES

Abu-shanab, E.A. 2017. E-government familiarity influence on Jordanians' perceptions. *Telematics and Informatics*, 34: 103–113.

Acemoglu, D. & Restrepo, P. 2016. The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares and Employment. *National Bureau of Economic Research (No. w22252)*.

Akinboade, O.A., Kinfack, E.C. & Mokwena, M.P. 2012. An analysis of citizen satisfaction with public service delivery in the Sedibeng district municipality of South Africa. *International Journal of Social Economics*, 39(3): 182–199.

Al-htaybat, K. & Alberti-alhtaybat, L. Von. 2017. Big Data and corporate reporting : impacts and paradoxes. *Accounting, Auditing & Accountability Journal*, 30(4): 850–873.

Alexander, P. 2010. Rebellion of the poor: South Africa's service delivery protests – A preliminary analysis. *Review of African Political Economy*, 37(123): 25–40.

Algozzine, B. & Hancock, D. 2016. *Doing Case Study Research: A Practical Guide for Beginning Researchers*. Teachers College Press.

Ali, M.A., Hoque, R. & Alam, K. 2018. An empirical investigation of the relationship between e-government development and the digital economy: the case of Asian countries. *Journal of Knowledge Management*.

Ali, R.H., Mohamad, R. & Sudin, S. 2016. A proposed framework of big data readiness in public sectors. In *AIP Conference Proceedings*. American Institute of Physics.

Amankwah-Amoah, J. 2015. Safety or no safety in numbers? Governments, big data and public policy formulation. *Industrial Management & Data Systems*, 115(9): 1596–1603.

Anom, M. & Rashid, A. 2010. User adoption and use of e-government online service. *Gading Business and Management Journal*, 14(1985): 55–66.

Antwi, S.K. & Kasim, H. 2015. Qualitative and Quantitative Research Paradigms in Business Research: A Philosophical Reflection. *European Journal of Business and Management*, 7(3).

Archenaa, J. & Anita, E.A.M. 2015. A Survey Of Big Data Analytics in Healthcare and Government. In *2nd International Symposium on Big data and Cloud Computing (ISBCC' 15)*. 408–413.

Assalahi, H. 2015. The Philosophical Foundations of Educational Research: a Beginner's Guide.

American Journal of Educational Research, 3(3): 312–317.

Assunção, M.D., Calheiros, R.N., Bianchi, S., Netto, M.A.S. & Buyya, R. 2015. Big Data computing and clouds: Trends and future directions. *Journal of Parallel and Distributed Computing*, 79: 3–15.

Bae, S. & Choi, J. 2017. Exploring interaction between human action and organization structure in the process of adopting information systems. *International Information Institute (Tokyo), Information*, 20(7B): 5093–5105.

Barik, R.K., Dubey, H., Samaddar, A.B., Gupta, R.D. & Ray, P.K. 2016. FogGIS : Fog Computing for Geospatial Big Data Analytics. In *3rd IEEE Uttar Pradesh Section International Conference on Electrical, Computer and Electronics Engineering*. Varanasi, India.

Batara, E., Nurmandi, A., Warsito, T. & Pribadi, U. 2017. Are government employees adopting local e-government transformation? The need for having the right attitude, facilitating conditions and performance expectations. *Transforming Government: People, Process and Policy*, 11(4): 612–638.

Baxter, P. & Jack, S. 2008. Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. *The Qualitative Report*, 13(4): 544–559.

Benitez, J., Ray, G. & Henseler, J. 2018. Impact of Information Technology Infrastructure Flexibility on Mergers and Acquisitions. *MIS Quarterly*, 42(1): 25–43.

Bernardi, R. 2017. Health Information Systems and Accountability in Kenya: A Structuration Theory Perspective. *Journal of Association for Information Systems*, 18(12): 931–957.

Bhat, S.A., Zahid, A.T., Bhat, S.A. & Zahid, A.T. 2018. Role of ICT facilitation in mobilizing the performance of business research process in North India An empirical study on HEIs. *Global Knowledge, Memory and Communication*, 67(1/2): 70–90.

Bhat, W.A. & Quadri, S.M.K. 2015. Big Data promises value : is hardware technology taken onboard ? *Industrial Management & Data Systems*, 115(9): 1577–1595.

Biddle, C. & Schafft, K.A. 2015. Axiology and Anomaly in the Practice of Mixed Methods Work: Pragmatism, Valuation, and the Transformative Paradigm. *Journal of Mixed Methods Research*, 9(4): 320–334.

Bilau, A.A., Witt, E. & Lill, I. 2018. Research methodology for the development of a framework for managing post-disaster housing reconstruction. *Procedia Engineering*, 212: 598–605.

Blitz, J., De Villiers, M. & Van Schalkwyk, S. 2018. Implications for factulty development for emerging clinical teachers at distributed sites: a qualitative interpretivist study. *Rural and Remote Health*, 18(2): 1–10.

Bodas-sagi, D.J. & Labeaga, J.M. 2017. Big Data and Health Economics: Opportunities, Challenges and Risks. *International Journal of Interactive Multimedia and Artificial Intelligence*, 4(7): 47–52.

Brown, A. 2014. The place of ethnographic methods in information systems research. *Internation Journal of Multiple Research Approaches*, 8(2): 166–178.

Budgaga, W., Malensek, M., Pallickara, S.L. & Pallickara, S. 2017. A framework for scalable real-time anomaly detection over voluminous, geospatial data streams. *Concurrency Computat: Pract Exper.*, 29(e4106).

Busch, P.A. 2017. The Role of Contextual Factors in the Influence of ICT on Street-Level Discretion. *Proceedings of the 50th Hawaii International Conference on System Science (HICSS-50)*: 2963–2972.

Cao, L., Mohan, K., Xu, P. & Ramesh, B. 2009. A framework for adapting agile development methodologies. *European Journal of Information Systems*, 18: 332–343.

Carayannis, E.G. & Hanna, N.K. eds. 2016. Transforming Government. In *Mastering Digital Transformation*. Emerald Group Publishing Limited: 77–110.

Carillo, K.D.A. 2017. Let's stop trying to be "sexy" – preparing managers for the (big) data-driven business era. *Business Process Management Journal*, 23(3): 598–622.

Cassell, C. & Symon, G. 2004. *Essential Guide to Qualitative Methods in Organizational Research*. London: Sage Publications.

Chang, B.-R., Tsai, H.-F., Tsai, Y.-C., Kuo, C.-F. & Chen, C.-C. 2016. Integration and optimization of multiple big data processing platforms. *Engineering Computations*, 33(6): 1680–1704.

Chang, C.L.H. 2014. The interaction of political behaviors in information systems implementation processes - Structuration Theory. *Computers in Human Behavior*, 33: 79–91.

Chenail, R.J. 2011. Interviewing the Investigator: Strategies for Addressing Instrumentation and Researcher Bias Concerns in Qualitative Research. *The Qualitative Report*, 16(1): 255–262.

Cheng, S., Zhang, Q. & Qin, Q. 2016. Big data analytics with swarm intelligence. *Industrial Management & Data Systems*, 116(4): 646–666.

Cochran, D.S., Kinard, D. & Bi, Z. 2016. Manufacturing System Design Meets Big Data Analytics for Continuous Improvement. *Procedia CIRP*, 50: 647–652.

Collins, B. 2016. Big Data and Health Economics: Strengths, Weaknesses, Opportunities and Threats. *PharmacoEconomics*, 34(2): 101–106.

Cotenescu, V. 2016. People, Process, and Technology; A Blend To Increase An Organization Security Posture. *Scientific Bulletin of Naval Academy*, 19(2): 394–396.

D'Arrigo-Patrick, J., Hoff, C., Knudson-martin, C. & Tuttle, A. 2017. Navigating Critical Theory and Postmodernism: Social Justice and Therapist Power in Family Therapy. , 56(3): 574–588.

Dahiya, D. & Mathew, S.K. 2018. IT infrastructure capability and eGovernment system performance: an empirical study. *Transforming Government: People, Process and Policy*.

Daniel, B. 2015. Big Data and analytics in higher education: Opportunities and challenges. *British Journal of Educational Technology*, 46(5): 904–920.

Daryaei, A.A. & Mahdavi, G.H. 2015. Giddens' Structuration Theory, Corporate Governance and Audit Marketing. *Ludus Vitalis*, XI: 1–7.

Dasgupta, A. 2017. Unlocking the Potential of Geospatial Data. In R. P. Rajagopalan & N. Prasad, eds. *Space India 2.0: Commerce, policy, security and governance perspectives*. Observer Research Foundation: 51–70.

Deng, H., Karunasena, K. & Xu, W. 2018. Evaluating the performance of e-government in developing countries: A Public value perspective. *Internet Research*, 28(1): 169–190.

Dikko, M. 2016. Establishing Construct Validity and Reliability: Pilot Testing of a Qualitative Interview for Research in Takaful (Islamic Insurance). *Qualitative Report*, 21(3): 521–528.

Englander, M. 2012. The Interview : Data Collection in Descriptive Phenomenological Human Scientific Research. *Journal of Phenomenological Psychology*, 43: 13–35.

Englund, H., Gerdin, J. & Burns, J. 2017. A structuration theory perspective on the interplay between strategy and accounting: Unpacking social continuity and transformation. *Critical Perspectives on Accounting*.

Etoundi, R.A., Tobie, A.M. & Mvoa Onana, B.S. 2016. Using ICT in Controlling Staff and Payroll in the Cameroonian Public Service: Lessons Learned and Perspectives. *The Electronic Journal of Information Systems in Developing Countries*, 72(2): 1–18.

Fardusi, M.J., Chianucci, F. & Barbati, A. 2017. Concept to Practices of Geospatial Information

Tools to Assist Forest Management and Planning under Precision Forestry Framework: a review. *Annals of Silvicultural Research*, 41(1): 3–14.

Farzaneh, M., Mozaffari, F., Ameli, S.P., Karami, M., Mohamadian, A. & Arianyan, E. 2019. Designing an Organizational Readiness Framework for Big Data Adoption. *9th International Symposium on Telecommunication: With Emphasis on Information and Communication Technology, IST 2018*: 387–391.

Fischer, M. & Maggetti, M. 2016. Qualitative Comparative Analysis and the Study of Policy Processes. *Journal of Comparative Policy Analysis: Research and Practice*, 6988(March): 1–17.

Fisher, M., Knobe, J., Strickland, B. & Keil, F.C. 2017. The Influence of Social Interaction on Intuitions of Objectivity and Subjectivity. *Cognitive Science*, 41(4): 1119–1134.

Fletcher, A.J. 2017. Applying critical realism in qualitative research: methodology meets method. *International Journal of Social Research Methodology*, 20(2): 181–194.

Fosso Wamba, S., Akter, S., Edwards, A., Chopin, G. & Gnanzou, D. 2015. How 'big data' can make big impact: Findings from a systematic review and a longitudinal case study. *International Journal of Production Economics*, 165: 234–246.

Frechtling, J. 2002. An Overview of Quantitative and Qualitative Data Collection Methods. In *The 2002 User-Friendly Handbook for Project Evaluation*. 43–62.

Fredriksson, C., Mubarak, F., Tuohimaa, M. & Zhan, M. 2017. Big Data in the Public Sector: A Systematic Literature Review. *Scandinavian Journal of Public Administration*, 21(3): 39–61.

Fretchling, J., Westat, Frierson, H., Hood, S. & Hughes, G. 2002. *The 2002 User-Friendly Handbook for Project Evaluation*. The National Science Foundation.

Frizzo-Barker, J., Chow-White, P.A., Mozafari, M. & Ha, D. 2016. An empirical study of the rise of big data in business scholarship. *International Journal of Information Management*, 36(3): 403–413.

Furuholt, B. & Sæbø, Ø. 2018. The role telecentres play in providing e-government services in rural areas. *Electronic Journal of Information Systems in Developing Countries*, 84: e12006.

Fusch, P.I. & Ness, L.R. 2015. The Qualitative Report Are We There Yet? Data Saturation in Qualitative Research Are We There Yet? Data Saturation in Qualitative Research. *The Qualitative Report*, 20(9): 1408–1416.

Gandomi, A. & Haider, M. 2015. Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management*, 35(2): 137–144.

Ganiyu, B.O., Fapohunda, J.A. & Haldenwang, R. 2017. Sustainable housing financing model to reduce South Africa housing deficit. *International Journal of Housing Markets and Analysis*, 10(3): 410–430.

Gascó, M., Cucciniello, M. & Nasi, G. 2018. Determinants and barriers of e-procurement: A European comparison of public sector experiences. In *Proceedings of the 51st Hawaii International Conference on System Sciences*. 2342–2351.

Gatautis, R. 2008. The Impact of ICT on Public and Private Sectors in Lithuania. *Engineering Economics*, 4(4): 18–28.

Georgiadou, Y. & Reckien, D. 2018. Geo-Information Tools, Governance, Governance, and Wicked Policy Problems. *Internation Journal of Geo-Information*, 7(21): 1–10.

Ghosh, J. 2016. Big data analytics: A field of opportunities for information systems and technology researchers. *Journal of Global Information Technology Management*, 19(4): 217–222.

Gichuki, J., Wanyembi, G. & Kibaara, D. 2017. Barriers Affecting E-Government Adoption in County Governments in Kenya: A Case of Laikipia County. *African Journal of Computing & Information Systems*, 1(II): 46–55.

Giddens, A. 1984. *The Constitution of Society*. Cambridge, UK: Polity Press.

Gil-garcia, J.R., Dawes, S.S., Pardo, T.A., Dawes, S.S. & Digital, T.A.P. 2018. Digital government and public management research: finding the crossroads. *Public Management Review*, 20(5): 633–646.

Gottfredson, R.K. & Aguinis, H. 2017. Leadership behaviors and follower performance: Deductive and inductive examination of theoretical rationales and underlying mechanisms. *Journal of Organizational Behavior*, 38(4): 558–591.

Graff, C.J. 2014. Mixed Methods Research. In *H.R. Hall & L.A. Rousell (Eds.), Evidence-Based Practice: An Integrative Approach to Research, Administration, and Practice*. Burlington, MA: Jones and Bartlett Learning.: 45–64.

Groves, P., Kayyali, B., Knott, D. & Van Kuiken, S. 2013. The 'big data' revolution in healthcare: accelerating value and innovation. *McKinsey Global Institute*, (January): 1–22.

Haddadi, A., Hosseini, A., Johansen, A. & Olsson, N. 2017. Pursuing Value Creation in

Construction by Research - A Study of Applied Methodologies. *Procedia Computer Science*, 121: 1080–1087.

Halcomb, E.J. & Hickman, L. 2015. Mixed Methods Research. *Nursing Standard*, 29(32): 41–47.

Hansen, H.K. & Porter, T. 2017. What do Numbers do in Global Governance? *Global Governance*, 23(1): 31–42.

Hariri, R.H., Fredericks, E.M. & Bowers, K.M. 2019. Uncertainty in big data analytics: survey, opportunities, and challenges. *Journal of Big Data*, 6(1): 44.

Hashem, I.A.T., Yaqoob, I., Anuar, N.B., Mokhtar, S., Gani, A. & Ullah Khan, S. 2015. The rise of 'big data' on cloud computing: Review and open research issues. *Information Systems*, 47: 98–115.

Hilbert, M. 2016. Big Data for Development : A Review of Promises and Challenges. *Development Policy Review*, 34(1): 135–174.

Hircshheim, R. 1985. Information Systems Epistemology: An Historical Perspective. In *Research Methods in Information Systems*. 13–35.

Ho, J.K. 2016. A Literature Review on Employability With Diagramming Techniques. *American Research Thoughts*, 2(6): 3771–3784.

Hofacker, C.F., Malthouse, E.C. & Sultan, F. 2016. Big Data and consumer behavior: imminent opportunities. *Journal of Consumer Marketing*, 33(2): 89–97.

Holloway, I. & Galvin, K. 2017. *Qualitative Research in Nursing and Healthcare*. John Wiley @ Sons.

Hossain, M.D., Moon, J., Kim, J.K. & Choe, Y.C. 2011. Impacts of organizational assimilation of e-government systems on business value creation: A structuration theory approach. *Electronic Commerce Research and Applications*, 10(5): 576–594.

Howard, G. 2017. IT-Related Organisational Change: An IS Theory of Reciprocal Change. In *5th International Conference on Management Leadership and Governance (ICMLG)*. Johannesburg, South Africa: Academic Conferences and Publishing International Limited (ACPI): 183–190.

Hu, F., Yang, C., Schnase, J.L., Duffy, D.Q., Xu, M., Bowen, M.K., Lee, T. & Song, W. 2018. ClimateSpark: An in-memory distributed computing framework for big climate data analytics. *Computers & Geosciences*, 115(October 2016): 154–166.

Hughes, P. & Smart, J. 2012. You Say You Want a Revolution ... The Next Stage of Public Sector Reform in New Zealand. *Policy Quarterly*, 8(1): 3–8.

Ingham-Broomfield, R. 2014. A nurses' guide to Qualitative Research. *Australian Journal of Advanced Nursing*, 32(2): 32–40.

Iyamu, T. 2018. Collecting qualitative data for information systems studies: The reality in practice. *Education and Information Technologies*, 23(5): 2249–2264.

Iyamu, T. 2017. Improvising information technology projects through the duality of structure. *South African Journal of Information Management*: 1–9.

Iyamu, T. 2015. The Interplay between Human and Structure in IT Strategy. In *Strategic Information Technology Governance and Organizational Politics in Modern Business.* IGI Global: 31–33.

Iyamu, T. 2013. Underpinning theories: order-of-use in information systems research. *Journal of Systems and Information Technology*, 25(3): 224–238.

Jackson, C., Crowston, K., Østerlund, C. & Harandi, M. 2018. Folksonomies to Support Coordination and Coordination of Folsonomies. *Computer Supported Cooperative Work (CSCW)*.

Jeffries, M., Phipps, D., Howard, R.L., Avery, A., Rodgers, S. & Ashcroft, D. 2017. Understanding the implementation and adoption of an information technology intervention to support medicine optimisation in primary care: qualitative study using strong structuration theory. *BMJ Open*, 7: e014810.

Jin, S. & Cho, C.M. 2015. Is ICT a new essential for national economic growth in an information society? *Government Information Quarterly*, 32(3): 253–260.

Johnson, P.A. 2017. Models of direct editing of government spatial data : challenges and constraints to the acceptance of contributed data to the acceptance of contributed data. *Cartography and Geographic Information Science*, 44(2): 128–138.

Johnson, R.B., Onwuegbuzie, A.J. & Turner, L.A. 2007. Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, 1(2): 112–133.

Johnston, A. 2014. Rigour in research: theory in the research approach. *European Business Review*, 26(3): 206–217.

Jones, M., Orlikowski, W. & Munir, K. 2004. Structuration Theory and Information Systems: A

Critical Reappraisal. In J. Mingers & L. Willcocks, eds. *Social Theory and Philosophy for Information Systems*. John Wiley @ Sons: 297–328.

Jones, M.R. & Karsten, H. 2008. Gidden's Structuration Theory and Information Systems Research. *MIS Quarterly*, 32(1): 127–157.

Kallio, H., Pietilä, A.M., Johnson, M. & Kangasniemi, M. 2016. Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing*, 72(12): 2954–2965.

Kanika, Alka & Khan, R.A. 2018. An Improved Security Threat Model for Big Data Life Cycle. *Asian Journal of Computer Science and Technology*, 7(1): 33–39.

Kankam, P.K. 2019. The use of paradigms in information research. *Library and Information Science Research*, 41(2): 85–92.

Kassongo, R.F., Tucker, W.D. & Pather, S. 2018. Government Facilitated Access to ICTs: Adoption, Use and Impact on the Well- Being of Indigent South Africans. In P. Cunningham & M. Cunningham, eds. *IST-Africa 2018 Conference Proceedings*. 1–10.

Kay, S.E. 2017. Challenges in sharing of geospatial data by data custodians in South Africa. In *Proceedings of the International Cartographic Association*. 4–9.

Keele, R. 2010. Quantitative Versus Qualitative Research, or Both? In R. Keele, ed. *Nursing research and evidence-based practice: Ten steps to success*. 35–52.

Kim, G.-H., Trimi, S. & Chung, J.-H. 2014. Big-data applications in the government sector. *Communications of the ACM*, 57(3): 78–85.

Klievink, B., Romijn, B.-J., Cunningham, S. & de Bruijn, H. 2017. Big data in the public sector: Uncertainties and readiness. *Information Systems Frontiers*, 19(2): 267–283.

Koma, S.B. 2010. The State of Local Government in South Africa: Issues, Trends and Options. *Journal of Publlic Administration*, 45(11): 111–120.

Kothari, C.. 2004. *Research Methodology: Methods and Techniques*. Second Rev. New Delhi: New Age International (P) Limited.

Kouziokas, G.N. 2016. Geospatial Based Information System Development in Public Administration for Sustainable Development and Planning in Urban Environment. *European Journal of Sustainable Development*, 5(4): 347–352.

Lakhrouit, J. & Baïna, K. 2016. A pattern based methodology for analyzing enterprise architecture

landscape. *International Journal of Computer Science Issues*, 13(6): 15–24.

Lamsal, M. 2012. The Structuration Approach of Anthony Giddens. *Himalayan Journal of Sociology & Antropology*, V: 111–122.

Larraondo, P.R., Pringle, S., Antony, J. & Evans, B. 2017. GSKY: A scalable , distributed geospatial data-server. In *Proceedings of the Academic Research Stream at Annual Conference Locate, Research@ Locate*. 7–12.

Latre, M.Á., Lopez-pellicer, F.J., Nogueras-iso, J., Béjar, R., Zarazaga-soria, F.J. & Muro-medrano, P.R. 2013. Spatial Data Infrastructures for environmental e-government services : The case of water abstractions authorisations. *Environmental Modelling and Software*, 48: 81–92.

Lee, J.G. & Kang, M. 2015. Geospatial Big Data: Challenges and Opportunities. *Big Data Research*, 2(2): 74–81.

Leelavathy, B., Arvind, T. & Sngh, H.R. 2017. Big data analytics: Challenges, research issues, tools and applications survey. *International Journal of Engineering Sciences & Reserach Technology*, 6(11): 548–554.

Letseka, M. & Iyamu, T. 2011. The Dualism of the Information Technology Project. In *Proceedings of the South African Institute of Computer Scientists and Information Technologists Conference on Knowledge, Innovation and Leadership in a Diverse, Multidisciplinary Environment*. Cape Town: ACM: 294–297.

Li, S., Dragicevic, S., Anton, F., Sester, M., Winter, S., Coltekin, A., Pettit, C., Jiang, B., Haworth, J., Stein, A. & Cheng, T. 2016. Geospatial Big Data Handling Theory and Methods: A Review and Research Challenges. *ISPRS Journal of Photogrammetry and Remote Sensing*, 115: 119–133.

Liu, C. & Zhang, X. 2015. Critically Analyse the Contribution Made by Qualitative Research to ELT (English Language Teaching) in China. *International Journal of English Language Teaching*, 2(2): 45–55.

Liu, K., Wang, H. & Yao, Y. 2016. On storing and retrieving geospatial big-data in Cloud. In *Proceedings of the Second ACM SIGSPATIALInternational Workshop on the Use of GIS in Emergency Management*. ACM: 16.

Loh, S., Oliveira, J.P.M. de & Gastal, F.L. 2001. Knowledge discovery in textual documentation: qualitative and quantitative analyses. *Journal of Documentation*, 57(5): 577–590.

Lohr, S. 2012. The Age of Big Data. *New York Times*: 1–5.

Louise Barriball, K. & While, A. 1994. Collecting data using a semi-structured interview: a discussion paper. *Journal of Advanced Nursing*, 19(2): 328–335.

Lush, V., Bastin, L. & Lumsden, J. 2012. Geospatial Data Quality Indicator. In *Proceeding of the 10th International Symposium on Spatial Accuracy Assessment in Natural Resources and Enviromental Sciences*. Florianopolis-SC, Brazil: 82.

Ma, F. 2015. A review of research methods in EFL education. *Theory and Practice in Language Studies*, 5(3): 566–571.

Ma, L. 2012. Some Philosophical Considerations in Using Mixed Methods in Library and Information Science Research. *Journal of American Society for Information Science and Technology*, 63(9): 1859–1867.

Ma, L. 2010. Theory and Education: A Case of Structuration Theory. In *School of Library and Information Science*. Bloomington, IN 47405-3907.

Mack, L. 2010. The philosophical underpinnings of educational research. *Polyglossia*, 19: 5–11.

Mack, N., Woodsong, C., MacQueen, K., Guest, G. & Namey, E. 2005. *Qualitative Research Methods: A Data Collector's Field Guide*. North Carolina: Family Health International.

MacLeod, A.K. 2015. Well-Being: Objectivism, Subjectivism or Sobjectivism? *Journal of Happiness Studies*, 16(4): 1073–1089.

Male, T. 2016. Analysing Qualitative Data. In I. Palaiologu, D. Needham, & T. Male, eds. *Doing Research in Education: Theory and Practise*. London: SAGE: 177–191.

Manrapi, R., Tawe, A., Haerani & Hisyam. 2017. The Influence of Entrepreneurial Education and Managerial Skills toward the Productivity of Silk Industry in Wajo Regency. *International Review of Management and Marketing*, 7(2): 367–371.

Maramura, T.C. & Thakhathi, D.R. 2016. Analyzing the Electronic Governance Policies and Legislative Frameworks on Public Service Delivery in South Africa. *Journal of Communication*, 7(2): 241–245.

Marques, R.P., Santos, H. & Santos, C. 2015. Monitoring organizational transactions in enterprise information systems with continuous assurance requirements. *International Journal of Enterprise Information Systems*, 11(1): 13–32.

Masuku, M., Bhebhe, S. & Khumalo, N.B. 2017. An Information Management Framework for the

Support of E-Government in Zimbabwe. *Tidsskriftet Arkiv*, 8(1): 1–14.

Matavire, R. & Brown, I. 2013. Profiling grounded theory approaches in information systems research. *European Journal of Information Systems*, 22(1): 119–129.

Matei, A. & Savulescu, C. 2014. Enhancing the capacity for innovation of public administration. An exploratory study on e-Governance, ICT, knowledge management in Romania. *Theoretical and Applied Economics*, XXI(11): 7–26.

Mauro, A. De, Greco, M., Grimaldi, M., Greco, M. & Grimaldi, M. 2016. A formal definition of Big Data based on its essential features. *Library Review*, 65(3): 122–135.

Mawela, T., Ochara, N.M. & Twinomurinzi, H. 2016. Missed opportunities for introducing transformational government: Assessing the contentious e-toll project in. *Transforming Government: People, Process and Policy*, 10(1): 168–188.

Mcafee, A. & Brynjolfsson, E. 2012. Big Data: The Management Revolution. *Harvard Business Review*.

McCusker, K. & Gunaydin, S. 2015. Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion*, 30(7): 537–542.

Mcfarlane, C. & Silver, J. 2016. The Poolitical City: “Seeing Sanitation” and Making the Urban Political in Cape Town. *Antipode*, 00(0): 1–24.

McIntosh, M.J. & Morse, J.M. 2015. Situating and Constructing Diversity in Semi-Structured Interviews. *Global Qualitative Nursing Research*, 2: 1–12.

Mcphee, R.D. & Canary, H.E. 2012. Structuration Theory. In *The International Encyclopedia of Communication Theory and Philosophy.* 75–100.

Meeks, W.L. & Dasgupta, S. 2005. *The Value of Using GIS and Geospatial Data to Support Organizational Decision Making*.

van der Meer-Kooistra, J. & Vosselman, E. 2012. Research paradigms, theoretical pluralism and the practical relevance of management accounting knowledge. *Qualitative Research in Accounting & Management*, 9(3): 245–264.

Melville, W., Campbell, T. & Jones, D. 2017. Axiology, the Subject and the Chair. *Research in Science Education*: 1–18.

Mgudlwa, S. & Iyamu, T. 2018. Integration of social media with healthcare big data for improved service delivery. *South African Journal of Information Management*, 20(1): a894.

Miller, R.L. & Brewer, J.D. 2003. *The A-Z of Social Research: A Dictionary of Key Social Science Research Concepts*. R. L. Miller & J. D. Brewer, eds. Sage Publications.

Miranda, J., Mäkitalo, N., Garcia-alonso, J. & Mikkonen, T. 2015. From the Internet of Things to the Internet of People. *IEEE Internet Computing*, 19(2): 40–47.

Mishra, D., Luo, Z., Jiang, S., Papadopoulos, T. & Dubey, R. 2017. A bibliographic study on big data: concepts, trends and challenges. *Business Process Management Journal*, 23(3): 555–573.

Mkhize, H. 2015. SA govt taps into big data | GovTech. *GovTech2016*. https://www.govtech.co.za/sa-govt-taps-big-data 14 March 2017.

Mkhomazi, S. & Iyamu, T. 2013. A Guide to Selecting Theory to Underpin Information Systems Studies. In *International Working Conference on Transfer and Diffusion of IT (TDIT)*. Bangalore, India: Springer: 525–537.

Mokosch, G., Klesel, M. & Niehaves, B. 2015. Putting flesh on the Duality of Structure: the case of IT Consumerization. In *Twenty-first Americas Conference on Information Systems*. Puerto Rico: 1–10.

Mpinganjira, M. 2015. Use of e-government services : the role of trust. *Internation Journal of Emerging Markets*, 10(4): 622–633.

Municipal IQ. 2017. 201702010920416649.

Murshed, F. & Zhang, Y. 2016. Thinking orientation and preference for research methodology. *Journal of Consumer Marketing*, 33(6): 437–446.

Murthy, U.S., Smith, T.J., Whitworth, J. & Zhang, Y. 2019. The Effects of Information Systems Compatibility on Firm Performance Following Mergers and Acquisitions. *SSRN Electronic Journal*.

Nassaji, H. 2016. Qualitative and descriptive research: Data type versus data analysis research. *Language Teaching Research*, 19(2): 129–132.

Nath, A. & Kanjilal, D. 2018. Addressing the challenges of e-Government: learning from the IT industry. *VINE Journal of Information and Knowledge Management Systems*, 48(1): 62–82.

National Planning Commission. 2011. *National Development Plan 2030: Our future - make it work*.

Navidi, F., Hassanzadeh, M. & Shojai, A.Z. 2017. Organizational knowledge documentation in project-based institutes: A case study at the satellite research institute. *The Electronic*

Library, 35(5): 994–1012.

Negri, P.P., Souza, V.E.S., Leal, A.L.D.C., Falbo, R.D.A. & Guizzardi, G. 2017. Towards an Ontology of Goal-Oriented Requirements. In *CIbSE 2017*. 165–178.

Neuendorf, K.A. 2016. *The Content Analysis Guidebook Second Edition*. 2nd ed. K. Omer, S. Dillard, L. Larson, & A. Harris, eds. Los Angeles: Sage Publications.

Ngulube, P. 2015. Trends in Research Methodological Procedures used in Knowledge Management Studies (2009 – 2013). *African Journal of Library, Archives and Information Science*, 24(2).

Nikpay, F., Ahmad, R.B., Rouhani, B.D., Mahrin, M.N. & Shamshirband, S. 2017. An effective Enterprise Architecture Implementation Methodology. *Information Systems and e-Business Management*, 15(4): 927–962.

Nissen, M.A. 2015. Social workers and the sociological sense of social problems: Balancing objectivism, subjectivism, and social construction. *Qualitative Sociology Review*, 11(2): 216–230.

Noordin, S. & Masrek, M.N. 2016. Adopting the Quantitative and Qualitative Methods in the Social Science Research: Justifying the Underpinning Philosophical Orientation. In *Proceeding of the 28th International Business & Information Management Association (IBIMA) Conference Seville, Spain, 9-10 November 2016*.

Nulhusna, R., Sandhyaduhita, P.I., Hidayanto, A.N. & Phusavat, K. 2017. The relation of e-government quality on public trust and its impact on public participation. *Transforming Government: People, Process and Policy*, 11(3): 393–418.

Odejide, A.A. & Iyamu, T. 2012. Structuration analysis of factors influencing risk management system deployment. In *2012 IEEE 6th International Conference on Management of Innovation and Technology, (ICMIT)*. IEEE: 405–411.

Omar, Azmi, Bass, J.M. & Lowit, P. 2016. Exploring The Factors That Influence The Success of Insourced Government ICT Projects. *EJISDC The Electronic Journal on Information Systems in Developing Countries*, 77(5): 1–22.

Omar, Amizan, Weerakkody, V. & Millard, J. 2016. Digital-enabled Service Transformation in Public Sector: Institutionalization As a Product of Interplay Between Actors and Structures During Organisational Change. In *Proceedings of the 9th International Conference on Theory and Practice of Electronic Governance 9th International Conference on Theory and*

Practice of Electronic Governance (ICEGOV '15-16). Montevideo: ACM: 305–312.

Othman, R.B., Mahamud, K.R.B.K. & Bakar, M.S.B.A. 2017. Public private collaboration model in spatial data infrastructure: Potential elements. *International Journal of Supply Chain Management*, 6(3): 325–331.

Pandey, P. & Pandey, M.M. 2015. *Research Methodology: Tools and Techniques*. Brige Center.

Pasquini, L., Cowling, R.M. & Ziervogel, G. 2013. Facing the heat : Barriers to mainstreaming climate change adaptation in local government in the Western Cape Province , South Africa. *Habitat International*, 40(2013): 225–232.

Percy, W.H., Kostere, K. & Kostere, S. 2015. Generic Qualitative Research in Psychology. *The Qualitative Report*, 20(2): 76–85.

Pezzulo, C., Hornby, G., Sorichetta, A., Steele, J., Ruktanonchai, C., Ruktanonchai, N., Wetter, E., Bengtsson, L., Tatem, A.J. & Ii, S. 2017. Big Data and the Well-Being of Women and Girls Applications on the Social Scientific Frontier. , (April).

Pinnick, J. 2017. Exploring digital preservation requirements: A case study from the National Geoscience Data Centre (NGDC). *Records Management Journal*, 27(2): 175–191.

Porra, J., Hirschheim, R. & Parks, M.S. 2014. The Historical Research Method and Information Systems Research. *Journal of the Association for Information Systems*, 15(9): 536–576.

Porumbescu, G.A. 2017. Does transparency improve citizens ' perceptions of government performance ? Evidence from Seoul , South Korea. *Administration & Society*, 49(3): 443–468.

Pozzebon, M. & Pinsonneault, A. 2005. Challenges in Conducting Empirical Work Using Structuration Theory: Learning from IT Research. *Organization Studies*, 26(9): 1353–1376.

Puron-Cid, G. 2013. Interdisciplinary application of structuration theory for e-government: A case study of an IT-enabled budget reform. *Government Information Quarterly*, 30(SUPPL. 1): S46–S58.

Raghupathi, W. & Raghupathi, V. 2014. Big data analytics in healthcare: promise and potential. *Health Information Science and Systems*, 2(3): 1–10.

Rahimi, R. 2017. Customer relationship management (people, process and technology) and organisational culture in hotels: Which traits matter? *International Journal of Contemporary Hospitality Management*, 29(5): 1380–1402.

Rahman, S. 2015. The Contribution Made By Qualitative Research To Tesol (Teaching English to Speakers of Other Languages). *International Journal of English Language Teaching*, 3(2): 1–14.

Rakodi, C. 2016. The Urban Challenge in Africa. In *Managing Urban Futures*. Routledge: 63–86.

Ramli, R.M. 2017. E-Government Implementation Challenges in Malaysia and South Korea: A Comparative Study. *Electronic Journal of Information Systems in Developing Countries*, 80(7): 1–26.

Reddy, K.S. 2015. Beating the Odds! Build theory from emerging markets phenomenon and the emergence of case study research—A 'Test-Tube' typology. *Cogent Business & Management*, 2(1): 1037225.

Renault, E. 2016. Critical Theory and Processual Social Ontology. *Journal of Social Ontology*, 2(1): 17–32.

Ritchie, J. & Lewis, J. 2003. *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. Sage Publications.

Roman, A. V. & Miller, H.T. 2013. New Questions for E-Government. *International Journal of Electronic Government Research*, 9(1): 65–81.

Rose, J., Persson, J.S., Heeager, L.T. & Irani, Z. 2015. Managing e-Government: value positions and relationships. *Information Systems Journal*, 25: 531–571.

Rose, J. & Scheepers, R. 2001. Structuration Theory and Information System Development - Frameworks for Practice. In *Global Co-Operation in the New Millenium: The 9th European Conference on Information Systems*. Bled, Slovenia: 217–231.

Rowlands, B. 2003. Employing Interpretive Research to Build Theory of Information Systems. *Australian Journal of Information System*, 10(2): 3–22.

Ruhode, E. 2016. E-Government for Development: A Thematic Analysis of Zimbabwe's Information Communication Technology Policy Documents. *Electronic Journal on Information Systems in Developing Countries*, 73(7): 1–15.

Sá, F., Rocha, Á. & Pérez, M. 2016. Potential dimensions for a local e-Government services quality model. *Telematics and Informatics*, 33: 270–276.

Sabaghian, E., Stromer-galley, J. & Sawyer, S. 2015. Converging Technologies Information Systems and Communication: A Story of Separation and Reunion. In *iConference 2015*

Proceedings. 1–8.

Sabanari, A.E., Lambey, L. & Rumokoy, F.S. 2017. Comparative research of customer experience and customer expectation between male and female customers of KM. Majestic Kawanua. *Jurnal EMBA*, 5(3): 3975–3984.

Sæbø, Ø., Braccini, A.M. & Federici, T. 2014. From the Blogosphere into Real Politics: The Use of ICT by the Five Star Movement. In *From Information to Smart Society*. 241–250.

SALGA. 2017. MUNICIPALITIES: About Municipalities. http://salga.org.za/Municipalities AM.html 19 October 2018.

Sarkar, S. 2012. The Role of Information and Communication Technology (ICT) in Higher Education for the 21st Century. *The Science Probe*, 1(1): 30–41.

Saunders, M., Lewis, P. & Thornhill, A. 2007. Understanding research philosophies and approaches. In *Research methods for business students*. Harlow: Pearson Education: 100–127.

Savitri, S. & Iskandar, N. 2018. A study of commuter line social practice on anthony giddens' structuration theory. *Jurnal Makna*, 3(1): 37–54.

Schmitz, K.W., Teng, J.T.C. & Webb, K.J. 2016. Capturing the complexity of malleable IT use: Adaptive Structuration Theory for Individuals. *MIS Quarterly*, 40(3): 663–686.

Sedgwick, P. 2014. Unit of observation versus unit of analysis. *BMJ*, 348: g3840.

Segal, D.L., Coolidge, F.L., O'Riley, A. & Heinz, B.A. 2006. Structured and Semistructured Interviews. In *Clinician's Handbook of Adult Behavioral Assessment*. 121–185.

Shanks, G., Gloet, M., Asadi Someh, I., Frampton, K. & Tamm, T. 2018. Achieving benefits with enterprise architecture. *Journal of Strategic Information Systems*, 27(2): 139–156.

Siebritz, L.-A. & Fourie, H. 2015. The South African Spatial Data Infrastructure: a collaborative SDI. In *Geomatics Indaba Proceedings 2015 - Stream 1*.

Silva, F.R.L. & Jacob, P. 2018. Mission-centric risk assessment to improve cyber situational awareness. In *Proceedings of the 13th International Conference on Availability, Reliability and Security*. ACM: 56.

Sinnot, R.O. & Voorsluys, W. 2016. A scalable Cloud-based system for data-intensive spatial analysis. *International Journal on Software Tools for Technology Transfer*, 18(6): 587–605.

Sinvula, K.M., Coetzee, S., Cooper, A.K., Owusu-, W., Nangolo, E., Rautenbach, V. & Hipondoka, M. 2017. A comparative analysis of stakeholder roles in the spatial data infrastructures of South Africa, Namibia and Ghana. *International Journal of Spatial Data Infrastructures Research*, 12: 1–25.

Sivarajah, U., Kamal, M.M., Irani, Z. & Weerakkody, V. 2017. Critical analysis of Big Data challenges and analytical methods. *Journal of Business Research*, 70: 263–286.

Smith, R. & Teicher, J. 2006. Improving Governance and Services: Can e-Government Help? *Chinese Public Adminsitration Review*, 3.

Snowden, D.J. 2005. Multi-ontology sense making: a new simplicity in decision making. *Informatics in Primary Care*, 13: 45–53.

Soomro, K.A., Curtis, R., Kale, U. & Akcaoglu, M. 2017. Development of an instrument to measure Faculty's information and communication technology access (FICTA). *Education and Information Technologies*.

Statistics South Africa. 2017. *Quarterly Labour Force Survey*.

Statistics South Africa. 2016. *The state of basic service delivery in South Africa : In-depth analysis of the Community Survey 2016 data*. Pretoria.

Stefanovic, D., Marjanovic, U., Delic, M., Culibrk, D. & Lalic, B. 2016. Assessing the success of e-government systems: An employee perspective. *Information & Management*, 53: 717–726.

Stol, K., Ralph, P. & Fitzgerald, B. 2016. Grounded Theory in Software Engineering Research : A Critical Review and Guidelines. In *International Conference on Software Engineering*.

Suthaharan, S. 2014. Big data classification: Problems and challenges in network intrusion prediction with machine learning. *Performance Evaluation Review*, 41(4): 70–73.

Syamili, C. & Rekha, R. 2018. Developing an ontology for Greek mythology. *The Electronic Library*, 36(1): 119–132.

Tapia, A.H., Maldonado, E., Tchouakeu, L.M.N. & Maitland, C.F. 2012. Coordinating humanitarian information: The problem of organizational and technical trajectories. *Information Technology & People*, 25(3): 240–258.

Tellis, W.M. 1997. Application of a Case Study Methodology Application of a Case Study Methodology. *The Qualitative Report*, 3(3): 1–19.

Thomas, P.. 2010. Research Methodology and Design. In *Research Methodology and Design*.

291–334.

Tonidandel, S., King, E.B. & Cortina, J.M. 2018. Big data methods: Leveraging Modern Data Analytic Techniques to Build Organizational Science. *Organisational Research Methods*, 21(3): 525–547.

Torres, R.M., Lisboa-filho, J., Oliveira, I.L., Moura, C.A. & Gonçalves, A. 2017. Specifying the Engineering Viewpoint of ICA's Formal Model in a Corporate Spatial Data Infrastructure. In *GEOProcessing 2017: The Ninth International Conference on Advanced Geographic Information Systems, Applications, and Services*. 110–116.

Treku, D.N. & Wiredu, G.O. 2016. Information Systems Implementation and Structural Adaptation in Government- Business Inter-Organization. In *Thirty Seventh International Conference on Information Systems*. Dublin: 1–20.

Trochim, W.M. 2002. *Research Methods Knowledge Base*.

Turskis, Z., Goranin, N., Nurusheva, A. & Boranbayev, S. 2019. Information security risk assessment in critical infrastructure: A hybrid MCDM approach. *Informatica*, 30(1): 187–211.

Twum-Darko, M. 2014. Factors influencing readiness for transformational e-government: A perspective of local governments in South Africa. *Journal of Public Administration*, 49(2): 512–523.

Twum-Darko, M. & Iyamu, T. 2015. Politicking Information Technology Strategy in Organisations: A Case Study of a selected Organisation in South Africa. *Journal of Governance and Regulation*, 4(3): 107–115.

Uluyol, C. & Sahin, S. 2016. Elementary school teachers' ICT use in the classroom and their motivators for using ICT. *British Journal of Educational Technology*, 47(1): 65–75.

Valizadeh, M. & Vaezi, S.H. 2016. Educational Teachings of Molla Hadi Sabzevari. *International Journal of Humanities and Cultural Studies*, (1): 729–744.

Vandenbroucke, D., Dessers, E., Crompvoets, J., Bregt, A.K. & Orshoven, J. Van. 2013. A methodology to assess the performance of spatial data infrastructures in the context of work processes. *Computers, Environment and Urban Systems*, 38: 58–66.

Vassakis, K., Petrakis, E. & Kopanakis, I. 2018. Big Data Analytics: Applications, Prospects and Challenges. In *Mobile Big Data*. Cham: Springer: 3–20.

Veenstra, A.F. Van, Melin, U. & Axelsson, K. 2014. Structuration Theory in Public Sector

Information Systems Research. In *Twenty Second European Conference on Information Systems*. Tel Aviv: 1–12.

Verkijika, S.F. & De Wet, L. 2018a. Electronic Commerce Research and Applications E-government adoption in sub-Saharan Africa. *Electronic Commerce Research and Applications*, 30: 83–93.

Verkijika, S.F. & De Wet, L. 2018b. Quality assessment of e- government websites in Sub - Saharan Africa: A public values perspective. *Electronic Journal of Information Systems in Developing Countries*, 84(2): 1–17.

Vyas, D., Chisalita, C.M. & Dix, A. 2017. Organizational affordances: A structuration theory approach to affordances. *Interacting with Computers*, 29(2): 117–131.

Wagemann, J., Clements, O., Figuera, R.M., Rossi, A.P. & Mantovani, S. 2018. Geospatial web services pave new ways for server- based on-demand access and processing of Big Earth Data. *International Journal of Digital Earth*, 11(1): 7–25.

Waller, L. & Genius, A. 2015. Barriers to transforming government in Jamaica: Challenges to implement initiatives to enhance the efficiency, effectiveness and service delivery of government through ICTs (e-Government). *Transforming Government: People, Process and Policy*, 9(4): 480–497.

Walliman, N. 2011. *Research methods: The basics*. Routledge.

Wart, M. Van, Roman, A., Wang, X. & Liu, C. 2017. Telematics and Informatics Integrating ICT adoption issues into (e-)leadership theory. *Telematics and Informatics*, 34(5): 527–537.

Warwick, C., Galina, I., Rimmer, J., Terras, M., Blandford, A., Gow, J. & Buchanan, G. 2009. Documentation and the users of digital resources in the humanities. *Journal of Documentation*, 65(1): 33–57.

Webster, E. 2017. Marikana and Beyond: New Dynamics in Strikes in South Africa. *Global Labour Journal*, 8(2): 139–158.

Wiesche, M., Jurisch, M.C., Yetton, P.W. & Krcmar, H. 2017. Grounded Theory methodology in information systems research. *MIS Quarterly*, 41(3): 685–701.

Wilson, V. 2016. Research Methods: Interviews. *Evidence Based Library and Information Practice*, 11(1(S)): 47–49.

Woiceshyn, J. & Daellenbach, U. 2018. Evaluating inductive vs deductive research in

management studies. *Qualitative Research in Organizations and Management: An International Journal*, 13(2): 183–195.

Yaghmaee, M.H., Leon-Garcia, A. & Moghaddassian, M. 2017. On the performance of distributed and cloud-based demand response in smart grid. *IEEE Transactions on Smart Grid*, 9(5): 5403–5417.

Yang, C., Yu, M., Hu, F., Jiang, Y. & Li, Y. 2017. Utilizing Cloud Computing to address big geospatial data challenges. *Computers, Environment and Urban Systems*, 61: 120–128.

Yang, L. 2013. Big Data Analytics: What's the Big Deal? *CKGSB Knowledge*. http://knowledge.ckgsb.edu.cn/2013/12/30/technology/big-data-analytics-whats-big-deal/ 23 June 2017.

Yates, J. 1997. Using Giddens' Structuration Theory to Inform Business History. *Business and Economic History*, 26(1): 159–183.

Yazan, B. 2015. The Qualitative Report Three Approaches to Case Study Methods in Education: Yin, Merriam, and Stake. *The Qualitative Report*, 20(2): 134–152.

Yilmaz, K. 2013. Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. *European Journal of Education*, 48(2).

Yimer, M. 2014. The Role of ICT for Good Governance and Agricultural Development in Ethiopia : Local Evidence from Southern Ethiopia. *International Journal of Political Science and Development*, 3(1): 30–39.

Yin, R.K. 1994. Designing Case Studies. In *Case Study Research: Design and Methods*. London: Sage Publications: 18–53.

Zainal, Z. 2007. Case study as a research method. *Jurnal Kemanusiaan*, 9: 1–6.

Zakir, J., Seymour, T. & Berg, K. 2015. Big Data Analytics. *Issues in Information Systems*, 16(2): 81–90.

Zheng, Z., Zhu, J. & Lyu, M.R. 2013. Service-generated big data and big data-as-a-service: An overview. In *2013 IEEE International Congress on Big Data*. 403–410.

van Zyl, I. 2015. Disciplinary kingdoms: Navigating the politics of research philosophy in the information systems. *Electronic Journal of Information Systems in Developing Countries*, 70(1): 1–17.

APPENDIX A: INTERVIEW GUIDELINE

1. **How are big data stored, managed, and used for service delivery by a government department in South Africa?**

    1.1. What type of services does your organization deliver to the citizens?
    1.2. Do you make use of information in providing the services?
        1.2.1. What types of information?
        1.2.2. Where does the information come from?
        1.2.3. Where are the sets of information kept in the organisation?
        1.2.4. In your view, why do you think the information is kept there?
        1.2.5. How is the information kept?
        1.2.6. In your view, do you think that the information should be kept there?
    1.3. What are some of the challenges that you face in trying to access the information?
        1.3.1. Why do you think that you encounter those challenges?
        Please share with me 1 or 2 examples of those challenges.
        1.3.2. How can those challenges be overcome?
    1.4. For what other purposes do you think the data you collected could be used?
    1.5. In your opinion, what do you think of the way in which information is used in this organisation?

2. **What are the factors that influence how big data is stored, managed, and used for service delivery by a government department in South Africa?**

    2.1. Who is responsible for information management in the organisation?
    2.2. In your view, why do you think these persons are responsible?
    2.3. What is your role in the use and management of information in the organisation?
    2.4. How do you categorise information in the organisation?
    2.5. In your opinion, why are the sets of information categorised?
    2.6. What steps do you follow in categorizing the information?
    2.7. Are technologies used in the management of information in the organisation?
        2.7.1. If yes, what types of technologies are used?
        2.7.2. If no, why not?
    2.8. What challenges have you faced by the way that data is stored, managed and used?
        2.8.1. Please share with me 1 or 2 of those challenges
        2.8.2. What solutions would you recommend to overcome those challenges?
    2.9. Is there anything that I have missed that you would kindly like to add?

APPENDIX B: INDIVIDUAL CONSENT LETTER

FACULTY OF INFORMATICS AND DESIGN

DEPARTMENT OF INFORMATION TECHNOLOGY – MTECH

INDIVIDUAL CONSENT FOR RESEARCH PARTICIPATION

Title of the study: A Big Data Framework to Improve Service Delivery by a Government Department in South Africa

Name of researcher: Khayalethu Nunu
Contact details: email: kayz84@gmail.com phone: 074 032 8202

Name of research supervisor: Tiko Iyamu, PhD
Contact details: email: IyamuT@cput.ac.za phone: 0214603025

Aim of the Study: To develop a conceptual framework through which big data can be used to improve service, which a government department provides to the citizens, such as geospatial services.

Participation: My participation will consist essentially of interview.

Confidentiality: I have received assurance from the researcher that the information I will share will remain strictly confidential unless noted below. I understand that the contents will be used only for **A Big Data Framework to Improve Service Delivery by a Government Department in South Africa** and that my confidentiality will be protected by the use of pseudonyms.

Anonymity will be protected by use of pseudonyms.

Conservation of data: The data collected will be kept in a secure manner. Recorded interviews are kept in password-controlled device.

Voluntary Participation: I am under no obligation to participate and if I choose to participate, I can withdraw from the study at any time and/or refuse to answer any questions, without suffering any negative consequences. If I choose to withdraw, all data gathered until the time of withdrawal will destroyed.

Additional consent: I make the following stipulations (please tick as appropriate):

	In project report	**In research publications**	**Both**	**Neither**
My name may be used:				
My exact words may be used:				
Any other (stipulate):				

Acceptance: I, (print name) _____

agree to participate in the above research study conducted by **Khayalethu Nunu** of the Faculty of Informatics and Design in the department of Information Technology at the Cape Peninsula University of Technology.

If I have any questions about the study, I may contact the researcher or the supervisor. If I have any questions regarding the ethical conduct of this study, I may contact the Postgraduate Officer on 021 469 1012, or email NaidooV@cput.ac.za.

Participant's signature: _____ Date: _____

Researcher's signature: _____ Date: _____

APPENDIX C: ETHICAL CLEARANCE

Cape Peninsula
University of Technology

P.O. Box 652 • Cape Town 8000 South Africa •Tel: +27 21 469 1012 • Fax +27 21 469 1002
80 Roeland Street, Vredehoek, Cape Town 8001

30 October 2017

TO WHOM IT MAY CONCERN

This is to confirm that **Mr Khayelethu Nunu**, student number 199111243 is registered for the MTech: Information Technology degree. His research topic is titled: *A big data framework for government improved service delivery in South Africa*

Mr Nunu successfully defended his proposal on 20 October 2017 and the Faculty Research Committee intends to recommend approval of his research at the next meeting of the Higher Degrees Committee.

Do not hesitate to contact me should you have any questions.

Yours sincerely

Veda Naidoo
Postgraduate Officer

APPENDIX D: ORGANISATIONAL CONSENT LETTER

rural development
& land reform

Department:
Rural Development & Land Reform
REPUBLIC OF SOUTH AFRICA

PROVINCIAL SHARED SERVICES CENTRE - CORPORATE SERVICES
PRIVATE BAG X9163 CAPE TOWN, 8000: TEL: 021 409 0300 FAX: 021 409 0570

CONSENT LETTER TO CONDUCT ACADEMIC STUDY AT DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM

Good day Mr. Nunu

It gives me pleasure to inform you that you have been granted permission to conduct your academic study at the Department of Rural Development and Land Reform.

We view this study as a benchmark and step in the right direction in assisting government with ways and means of improving service delivery to the many citizens of this country. At a practical and methodological perspective, the envisaged framework promises to add value to the work of the department by providing insight and guidance on how big data can be used to improve services to the citizens of the country such as geospatial services.

Please be informed that the use of the department's name is strictly restricted to your study and may not be published unless consent to do so is requested and authorized by the Minister or their authorized designee.

Be further informed that consent is granted on condition the department will be furnished with the copy of your study and its results thereof. The department reserves the right to revoke the permission granted.

Your sincerely

MR ZONWABELE BASTILE
DIRECTOR: CORPORATE SERVICES
PROVINCIAL SHARED SERVICE CENTRE: WESTERN CAPE
DATE: 2018/06/04