THE USE OF BIG DATA BY MUNICIPALITIES IN SOUTH AFRICA: A CASE OF THE CITY OF TSHWANE METROPOLITAN MUNICIPALITY

by

MODJADJI PRESSINAH KGOALE

51285630

submitted in accordance with the requirements

for the degree of

MASTER OF SCIENCE

in the subject of

COMPUTING

at the

UNIVERSITY OF SOUTH AFRICA

SUPERVISOR: Prof. M.M. PHAHLANE

July 2026

DECLARATION

Name: Modjadji Pressinah Kgoale

Student number: 51285630

Degree: Master of Science in Computing

I declare that the thesis, which I hereby submit for the degree of Master of Science in Computing at the University of South Africa is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of a complete list of references.

Date: 19 July 2026

Signature:



DEDICATION

To my late grandmother, Mokgadi Maria Moloto, thank you for always loving, encouraging and praying for me.

ACKNOWLEDGEMENTS

I would like to extend my heartfelt gratitude to the many individuals who have supported me throughout my research journey. In particular, I want to express my sincere appreciation to the following people:

- Firstly, I would like to thank God, the source of all wisdom and the guiding light that has illuminated my path throughout my research journey.
- To my supervisor, Prof Mampilo Phahlane, thank you for the many hours you have invested in my work, the guidance you have provided, and your commitment to ensuring the success of my studies.
- A big thank you to the City of Tshwane Metropolitan Municipality for allowing me to use them as a case study. I would also like to show appreciation to all interviewees from the municipality for their hospitality, cooperation and willingness to share their insights.
- I am profoundly grateful for my husband, Derick Kgoale for his understanding, patience and his ability to balance the household responsibilities while I was busy with my research. Your love and support have sustained me through the long hours of research, and I could not have reached this milestone without you.
- I am also immensely proud of my children for the patience and understanding they have shown in this journey and may God continue to bless them and make His face shine on them.
- Finally, words cannot express my gratitude towards my dear friend Manthiba Letsoalo, who often was more confident in my abilities than I am. My friend, you played a significant role during this research, offering valuable insights, engaging in thoughtful discussions, and providing unwavering moral support. I appreciate you.

PUBLICATIONS FROM THIS RESEARCH

Kgoale M.P. & Phahlane M.M. 2024. Structuration Theory Perspective of Big Data in a Typical South African Municipality. *South African Journal of Information Systems*.

ABSTRACT

Big data originate from a range of sources such as corporate transactions, user-generated material, social networking sites, mobile purchases and internet clicks. Big data can be used to extract meaningful insights for better decision making, such as hidden patterns, unknown relationships, market trends and customer preferences. Realising the potential benefits of embracing and utilising big data, governments and multinational corporations are already putting big data technologies into practice and growing them. However, lack of research around how, why and when municipal knowledge workers use big data for decision making remains underexplored. This problem highlights that decision and policy makers in municipalities are not well equipped with the necessary information or skills to access crucial data points when needed.. This study highlights big data usage for the support of organisational strategies, innovation and the overall decision making process in the City of Tshwane metropolitan municipality of South Africa (CoT). Structuration theory was used as an underpinning lens to create a better understanding of the environment.

The study adopted a qualitative research approach, and the collection of data was through a case study and semi-structured interviews. The qualitative nature of this study, combined with the case study approach and semi-structured interviews was aimed at providing an insight into the complex aspects of big data usage and its implications in practical organisational settings. Thematic analysis was used to examine the collected data.

The findings suggest that despite the recognition by users of the potential of big data, there are significant challenges related to technology infrastructure, communication channels and a fragmented work environment, and there is improvement in overall collection of the data and is used mostly for operational tasks. There is currently no evidence of how big data is supporting decision making, organisational strategies and innovation in the CoT. The CoT lacks effective data integration, and existing data is not being properly utilized to help identify or resolve some of the city's problems. Even so, the study has revealed the eagerness to adopt big data technologies by CoT.

This research adds to the pool of knowledge already in existence by offering empirical insights into the challenges faced and benefits realised in integrating big data into the public sector. The findings shed light on practical implications for decision-makers and policymakers seeking to leverage big data for improved governance strategies.

LIST OF ABBREVIATIONS

Abbreviation	Definition
BD	Big Data
CoT	City of Tshwane Metropolitan Municipality
IS	Information System(s)
IT	Information Technology
ST	Structuration Theory

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION AND BACKGROUND 1
1.1 INTRODUCTION AND BACKGROUND 1
1.1.1 How big data are used to assist with citizenry? 3
1.1.2 Definition of keywords 4
1.2 BACKGROUND TO THE RESEARCH PROBLEM 6
1.2.1 Gap 1 – Decision making backed by big data in South African municipalities is new 6
1.2.2 Gap 2 – Inadequate awareness and knowledge in the use of big data in South Africa 7
1.2.3 Gap 3 – Lack of availability of resources in South African municipalities .. 7
1.3 PROBLEM STATEMENT 8
1.4 RESEARCH QUESTIONS 9
1.4.1 Research sub-questions 9
1.5 RESEARCH AIM AND OBJECTIVES 9
1.5.1 Research Aim 9
1.5.2 Research objectives 9
1.6 UNDERPINNING THEORY OVERVIEW 9
1.7 PROPOSED CONCEPTUAL RESEARCH FRAMEWORK 11
1.7.2 Stakeholders 13
1.7.3 Organisation 14
1.7.4 Impact 15
1.7.5 Decision making 15
1.8 RESEARCH METHODOLOGY OVERVIEW 15
1.8.1 Research Philosophy 16
1.8.2 Research Approach 16
1.8.3 Research Strategy 16
1.8.4 Data Collection Methods 18
1.8.5 Data analysis method 18
1.9 ETHICAL CONSIDERATIONS 18
1.10 CONTRIBUTION OF THE STUDY 19
1.10.1 Theoretical contributions 19

1.10.2 Methodological contribution 19
1.10.3 Practical contributions 19
1.11 SUMMARY OF CHAPTER 19
1.12 LAYOUT OF THE DISSERTATION 19

CHAPTER 2 LITERATURE REVIEW 21
2.1 INTRODUCTION 21
2.2 WHAT IS BIG DATA 21
2.2.1 Characteristics of big data 22
2.2.2 How big data is analysed 25
2.2.3 Big data challenges 26
2.3 BIG DATA IN GOVERNMENT 28
2.4 SOUTH AFRICAN MUNICIPALITIES 31
2.5 SUMMARY OF CHAPTER 33

CHAPTER 3 UNDERPINNING THEORY 34
3.1 INTRODUCTION 34
3.2 STRUCTURATION THEORY 34
3.2.1 Duality of structure 35
3.3 STRUCTURATION THEORY IN BIG DATA RESEARCH 35
3.3.1 Structure 37
3.3.2 Modality 38
3.3.3 Interaction 39
3.4 CONCEPTUAL FRAMEWORK 40
3.4.1 Big data 41
3.4.2 Stakeholders 43
3.4.3 Organisation 44
3.4.4 Impact 44
3.4.5 Decision making 45
3.5 SUMMARY OF CHAPTER 46

CHAPTER 4 RESEARCH METHODOLOGY 47
4.1 INTRODUCTION 47
4.1.1 Research Philosophy 47

4.1.2 Research Approach 49
4.1.3 Research Strategy 50
4.1.4 Data Collection Method 53
4.1.5 Data Analysis Method 55
4.2 ETHICAL CONSIDERATIONS 57
4.2.1 Consent 57
4.2.2 Confidentiality 57
4.2.3 Privacy 58
4.2.4 Security 58
4.3 SUMMARY OF CHAPTER 59

CHAPTER 5 DATA ANALYSIS AND DISCUSSION OF FINDINGS 60
5.1 INTRODUCTION 60
5.2 THEME 1: KNOWLEDGE AND UNDERSTANDING OF BIG DATA 60
5.2.1 Structure 61
5.2.2 Modality 62
5.2.3 Interaction 63
5.3 THEME 2: HOW BIG DATA IS MANAGED TO IMPROVE DECISION MAKING 64
5.3.1 Structure 65
5.3.2 Modality 66
5.3.3 Interaction 67
5.4 THEME 3: BIG DATA GOVERNANCE 68
5.4.1 Structure 68
5.4.2 Modality 69
5.4.3 Interaction 70
5.5 THEME 4: IMPACT OF MANAGEMENT DECISIONS 71
5.5.1 Structure 71
5.5.2 Modality 72
5.5.3 Interaction 73
5.6 SUMMARY OF FINDINGS 74
5.7 SUMMARY OF CHAPTER 74

CHAPTER 6 INTERPRETATION OF FINDINGS AND RECOMMENDATIONS 75
6.1 INTRODUCTION 75
6.1.1 Knowledge and understanding of big data 75
6.1.2 How big data is managed to support decision making 75
6.1.3 Big data governance in the CoT 76
6.1.4 The type of big data that is produced and interpreted 76
6.1.5 Knowledge, skills, attitude, and appropriate management practices 77
6.1.6 Impact of management decisions in the CoT 77
6.2 CONCEPTUALISED FRAMEWORK FOR MUNICIPALITIES 77
6.2.1 Knowledge and Understanding of Big Data 78
6.2.2 Big Data Management 79
6.2.3 Communication and Collaboration 79
6.2.4 Challenges and Barriers 79
6.2.5 Impact on Decision Making 80
6.3 SUMMARY OF CHAPTER 80

CHAPTER 7 EVALUATION OF RESEARCH 81
7.1 INTRODUCTION 81
7.2 OVERVIEW OF THE RESEARCH 81
7.3 REVIEW OF THE RESEARCH PROBLEM 82
7.4 HOW RESEARCH QUESTIONS ADDRESS THE RESEARCH PROBLEM 83
7.4.1 How preliminary research question was supported by sub-questions 83
7.5 EVALUATION OF RESEARCH METHODOLOGY 84
7.5.1 Why a case study approach was relevant for this study 84
7.5.2 Appropriateness of unit of analysis 84
7.5.3 Appropriateness of data collection technique 84
7.5.4 Appropriateness of analysis method 85
7.6 CONTRIBUTIONS 85
7.7 IMPLICATIONS 85
7.8 LIMITATIONS 86
7.9 CONCLUSION 86

REFERENCES 87

APPENDIX A: ETHICAL CLEARANCE CERTIFICATE 114

APPENDIX B: PARTICIPANTS INFORMATION SHEET 117

APPENDIX C: INTERVIEW GUIDELINES 121

APPENDIX D: CITY OF TSHWANE PERMISSION LETTER 123

APPENDIX D: PUBLISHED JOURNAL ARTICLE 124

LIST OF FIGURES

Figure 1.1 Dimensions of the Duality of Structure (Giddens, 1984) 10
Figure 1.2 Proposed Conceptual Research framework 12
Figure 2.1 The 5Vs of Big Data Characteristics (Hariri et al., 2019) 23
Figure 3.1 Proposed Conceptual Research Framework 40
Figure 4.1 Philosophical Paradigms (Ryan, 2018)..... 48
Figure 4.2 Data Collection Methods (Taherdoost, 2021)..... 54
Figure 6.1 Actual Conceptualised Framework..... 78

LIST OF TABLES

Table 3.1 Duality of Structure (adapted from Giddens, 1984)..... 36
Table 4.1 Research Methodology..... 47
Table 4.2 Participant Profile..... 53

CHAPTER 1 INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION AND BACKGROUND

An information system (IS) is a network of interconnected components that collect, process, store, and distribute information and providing feedback for task completion (Zemmouchi-Ghomari, 2021). Information technology (IT) is the management, processing, and storing of data as well as information exchange and distribution through the use of computers, software and networks (Oláh, Karmazin, Pető & Popp, 2018). IT focuses on the technology infrastructure and tools, while IS encompasses the strategic application of IT to manage information and support organisational functions, yet both share the fundamental aim of leveraging technology for efficient data management and organisational success (Touriano, Sutrisno, Kuraesin, Santosa, & Ausat, 2023). The field of ISs studies how people, groups, organisations and society use and build ISs in actual social and organisational contexts (Zemmouchi-Ghomari, 2021), and this is the field in which big data analytics and the study of large data belong.

Big data is the huge quantity of digital information gathered and collected from several sources (Woodside, Amiri, & Boldrin, 2015). As more and more data become available, the study of big data becomes well positioned in the field of IT and IS as well as the fields of Computer Science, Mathematics, Statistics, Health Care, Engineering. IS is about people, processes, and IT (Rainer, Prince, Sánchez-Rodríguez, Splettstoesser-Hogeterp, & Ebrahimi, 2020), and for that reason, the IS field has in the last few years welcomed big data with a common belief that more data is desirable (Johnson, Gray & Sarker, 2019) and many companies across various industries use big data to draw insights, make data-driven decisions, and improve their operations (Awan, Shamim, Khan, Zia, Shariq & Khan, 2021). Big data analytics capability and decision making: The role of data-driven insight on circular economy performance. One example from the private sector is Netflix, the most popular American entertainment corporation that specialises in providing its users with online on-demand streaming video. Netflix is able to accurately predict what its users will find enjoyable by using big data (Mukhtarov, 2023). Big data has also allowed Netflix to make data-driven decisions in content creation, marketing and international expansion while ensuring its continued relevance and growth in the entertainment industry (Mixon, 2021). Companies like Amazon, Google, Facebook and Uber are incorporating big data into their operations to gain a competitive edge, improve customer experiences, and drive innovation (Kumari, 2021).

However, although significant amounts of IS research relevant to the information value chain have looked at the creation and maintenance of knowledge as well as decision making and actions, studies show an ongoing showing that organizations continue to struggle in translating big data analytics into tangible value chain outcomes (El-Haddadeh, Fadlalla & Hindi, 2025). Both developed and developing nation governments have praised the advancements brought about by utilising big data to enhance knowledge and decision making (Misra, Dixit, Al-Mallahi, Bhullar, Upadhyay & Martynenko, 2020). The government in Singapore uses big data for urban planning through its 'Smart Nation' initiative (Xu & Chen, 2023). It collects and analyses big data on traffic flow, public transportation, and environmental conditions to improve city living (Tan, 2022). In addition, big data is used by the UK's National Health Service (NHS) to manage patient records, maximise healthcare resources, and enhance patient outcomes (Lu & Keech, 2015).

The CoT, South Africa's largest municipality, is ranked second in Gauteng province's GDP and one of the six largest metropolitan municipalities (eTshwane, n.d.). It offers citizens democratic government, sustainable services, social and economic development, and community involvement (Nkhabu, 2021).

The CoT, in collaboration with the South African government, has initiated the creation of regulations intended to transform the city into a more ICT-integrated community that incorporates the populace, fosters green economies, and improves environmental sustainability in recent times (eTshwane, n.d.). Despite these smart city initiatives and projects, the city is yet to embrace the full opportunities created by modern technologies and data solutions to build a data-driven service delivery (Cilliers, 2022).

The frequent use IS tools means that people's routine activities such as sending messages, tweets and credit card payments leave digital trails that are combined to form big data (Udeh, Amajuoyi, Adeusi, & Scott, 2024). In today's digital environments, engagement on social media platforms, activities like website visits, online transactions, and video consumption, require careful recording, monitoring, and analysis (Yuniarti, Aziz & Gani, 2024). As a result, these operations generate a large amount of data that is collected quickly and extensively from various sources ()Muniswamaiah, Agerwala, & Tappert, 2023). With this increased availability of data, it is therefore assumed that big data that is produced is readily available for use by the South African government, especially municipalities to leverage and assist them in addressing some of the challenges they face regarding access to basic services.

The definition of big data and its application by the municipal government of South Africa are elaborated further in the sections that follow. The remainder of the document is structured as follows: background to the research problem, the problem statement, research questions, research aim and objectives, underpinning theory, conceptual research framework, methodology, ethical considerations, and the expected contribution of the study.

1.1.1 How big data are used to assist with citizenry?

Global businesses and government organisations realise the potential gains of adopting and using big data and they are currently implementing and expanding big data technologies (Trom & Cronje, 2019). Government organisations can improve decision making, learn new capabilities and services, boost IT utilisation, and identify correlations and patterns in underlying data by putting big data technology into practice (Nunu, 2019).

Numerous studies show that big data positively impacts various domains such as traffic management, public safety, crime reduction, health, environment, transportation, energy management, smart cities, and education thus demonstrating its positive impact on the population (Tzika-Kostopoulou, Nathanail & Kokkinos, 2024; Schuilenburg, & Soudijn, 2023; Vance, Huang, & Butler, 2024; Selowa, Ilorah, & Mokwena, 2022).

In the United States of America, the public sector has been leading with big data initiatives to enhance service delivery (Anna & Nikolay, 2015). The Obama administration initiated a programme to make tools and methods for deriving insights and knowledge from big data more accessible in 2012 (Jin, Wah, Cheng, & Wang, 2015). Countries like Singapore, Malaysia, France, Britain and Japan, Great Britain, France, Australia, China and South Korea are also utilising big data projects providing government with insights into citizen needs and priorities (Anna & Nikolay, 2015; Hajirahimova & Aliyeva, 2017). Big data has shown to be extremely useful in tracking and forecasting disease transmissions like the COVID-19 pandemic, Ebola and influenza (Amusa, Twinomurinzi, Phalane & Phaswana-Mafuya, 2023). Through careful analysis of many data sources, including social media, search inquiries, and healthcare records researchers have been able to develop predictive models that anticipate disease outbreaks, allocate necessary resources, and swiftly implement effective interventions (Corsi, de Souza, Pagani, & Kovaleski, 2021).

While emerging research indicates the potential of big data initiatives, this study examines the need for more comprehensive investigations into how such technologies are leveraged to enhance decision making in South African municipalities.

1.1.2 Definition of keywords

1.1.2.1 Big data

Big Data is generated by technological devices like laptops, mobile phones, and personal sensors (Mneney & Van Belle 2016). These devices collect information such as preferences and interests, behavioural data, demographic data, financial data, location data, healthcare data, government records and similar facilities (Misra et al., 2020). According to Hemlata and Gulia (2016), the process of analysing large data to extract insights and make well-informed decisions for public or private entities is called big data analytics. While there are many definitions of big data and big data analytics, there is a consensus that they both capture new opportunities presented by the management and analysis of structured and unstructured data (Monino, 2021). The basic idea is to use the available data sets to generate new knowledge that will enable organisations to make well-informed decisions (El-Astal, Allaymoun & Mustafa, 2025). In this dissertation, the phrase 'big data' is used to refer to both big data and big data analytics. The processes involved in big data include finding the data's sources, gathering and analysing the data, and eventually deriving conclusions from the data to help with decision making.

1.1.2.2 South African municipalities

According to the South African government's Local Government Municipal Structures Act, 1998 Act 117 of 1998), South Africa consists of 278 municipalities, which consist of 226 local municipalities, 44 districts, and eight metropolitans. These communities concentrate on growing the local economy while providing their residents with the necessary services and infrastructure (Van der Berg, 2020).

As required by the Constitution, the Municipal Structures Act of 1998 sets guidelines for classifying municipalities into three categories: those that fall under metropolitan municipality (category A), those that fall under local government (category B), and those that fall under district municipalities (category C) (van der Hoogen, Fashoro, Calitz & Luke, 2024). The municipality is in charge of making sure that every citizen has access to services that fulfil their

fundamental needs (Magagula, Mukonza, Manyaka, & Moeti, 2022). The main services of the South African municipalities are:

1. Ensuring democratic and accountable governance for local communities
2. Providing local communities access to transparent and democratic governance
3. Ensuring communities receive services for an extended period of time
4. Encouraging a healthy and secure environment
5. Promoting the involvement of neighbourhood groups and communities in local government affairs.

South African municipalities face a public outcry due to the government's failure to deliver basic services, as evidenced by media protests (Ngobeni, 2018; Ede & Jili, 2020). To minimise these protests, municipalities should enhance the provision of basic services, especially in high-population-density areas (Fransman & von Fintel, 2024). Big data has a big potential impact on minimising citizen dissatisfaction by enabling governments and public organisations to make data-driven decisions, improve services, and enhance overall governance (Yigzaw, 2020). By analysing historical data, South African municipalities can predict service demands allowing governments to allocate resources more efficiently and reduce wait times (Akinnagbe, Peiris & Akinloye, 2018). Also, big data may assist municipalities in monitoring data in real-time which helps identify service disruptions or issues quickly, allowing for rapid responses and resolutions.

The South African government has also expressed interest in learning more about the big data concept believing that it offers advantages that could lead to better service delivery (Nunu, 2019). There are several e-government projects that reflect the government's commitment to leveraging technology to enhance public services and improve the lives of its citizens (Jakoet-Salie, 2020.). It is important to note that the implementation and success of these e-government initiatives vary across different regions and government departments (South African Government, n.d., 2020; Mandiwana, 2022) and these efforts to expand and improve digital services have the potential to generate mass volumes of data.

A study of the South African public sector's readiness for big data revealed that many businesses, being directly involved in public service activities, manage substantial amounts of data on a regular basis (Motau & Kalema, 2016). Nevertheless, there is a lack of empirical documentation regarding the usefulness of these big volumes of data in their role in enhancing

decision making processes to increase the quality of services offered to citizens. South Africa has the potential to become a consumer of its own big data rather than just a producer, thus accelerating the transition towards a vibrant digital economy (Hassa, 2020). Big data is a crucial first step in the right direction although it cannot be used to address every issue facing society (Chang, 2021).

1.2 BACKGROUND TO THE RESEARCH PROBLEM

To describe the background of the research problem, this section identifies gaps in big data usage in South African municipalities.

1.2.1 Gap 1 – Decision making backed by big data in South African municipalities is new

There is evidence that governments are utilising big data to inform decision making processes. For example, Singapore has developed *Virtual Singapore*, a nationwide digital twin platform that integrates both real time and historical data to support urban planning, flood risk assessment, and public service design (OECD, 2024). This initiative proves how big data can improve services and enhance the quality of governance through big data informed decision making.

In their studies, Anna and Nikolay (2015); Hajirahimova & Aliyeva (2017) have described how countries like the United States of America, Malaysia, France, Britain and Japan, Great Britain, France, Australia, China and South Korea have used big data analytics to improve their services. However, with these benefits gained by other countries, big data phenomenon to support decision making in South African municipalities is new and its influence in making decisions affecting community service delivery to maximise citizen satisfaction and minimize service delivery protests is relatively unknown (van der Hoogen, Fashoro, Calitz & Luke, 2024; Bunyula, Lungisa & Mathentamo, 2025).

A study by Seko, Garbutt and Tsibolane (2022) focused on the readiness of stakeholders to adopt a big data governance framework. While this study provides insights into the adoption barriers and stakeholder engagement in big data governance, it does not provide insights on the practical application of big data tools to enhance municipal services, reduce service delivery protests, and improve citizen satisfaction. Another research paper by Nunu (2019), provides a

broad framework for implementing big data in South African government service delivery while this research specifically targets the City of Tshwane Metropolitan Municipality, providing a focused case study on the application of big data in local governance. As a result, there is limited evidence of how municipalities apply big data when making decisions related to service delivery and this makes it difficult to determine whether big data approaches meaningfully influence the strategies and prioritisation during decision making. This gap highlights the need for research that examines how big data is used in practice within South African municipalities to support decision making.

1.2.2 Gap 2 – Inadequate awareness and knowledge in the use of big data in South Africa

Big data, argued by Bertot, Gorham, Jaeger, Sarin, and Choi (2014), could be profitably used as evidence-based data to help the government identify critical areas that need intervention n and develop some form of workable partnerships with the community for decision making to find ways of handling the problems. While platforms like GovChat exist as a channel for South African citizens to engage with government for services and report issues, however, the public knowledge, awareness and benefits of big data in South African municipalities has not been explored to their full potential (van der Hoogen, Fashoro, Calitz & Luke, 2024). Therefore, data is commonly treated as a reporting tool rather than as a resource for learning and making informed decisions. When officials lack a shared understanding of how big data can inform decision making, their views on adopting it tend to be inconsistent and as a result the benefits of big data remains underexplored. This gap highlights the need for greater public awareness on the potential benefits of big data.

1.2.3 Gap 3 – Lack of availability of resources in South African municipalities

South Africa's current skills base is insufficient to effectively utilise big data (Olaitan, Issah, & Wayi, 2021). However, when presenting at a conference, Dr D Visser, CSIR Research and Development Strategy Manager (2018) emphasised how South Africa has made strides in managing massive data sets which have facilitated quicker decision making and independent projects like the Fourth Industrial Revolution, National Development Plan, and Sustainable Development Goals. Research shows that although some municipalities are adopting smart city technologies, knowledge workers still face challenges in skills, data literacy, integrated data access, IT infrastructure, and management support (van der Hoogen et al., 2024; Bunyula et al.,

2025). This reveals a clear necessity in addressing required knowledge, skills, attitudes, appropriate management practices and enabling IT architecture resources to access, analyse and use big data for decision making.(Mikalef, Boura, M., Lekakos & Krogstie, 2019).

In addition, it is unclear how much and what kind of big data South African municipalities receive. South African municipalities need to understand the kind of big data that is now generated and made available to them to fully profit from big data (Steyn, 2022). These characteristics include the amount, speed, diversity and accuracy of the data generated.

1.3 PROBLEM STATEMENT

Globally, big data has proven innovative in addressing such challenges by enabling data-driven decision making and therefore improving service delivery (Bruintjies & Njenga, 2024). Countries world such as Singapore, the United States, Malaysia, France, Britain, Japan, Australia, China, and South Korea have made significant progress in governance and service delivery by adopting big data and have already achieved success (OECD, 2024). However, in South African, government still lack substantial experience in using big data to improve decision making and there is still limited public awareness about how big data could benefit South African municipalities (van der Hoogen, 2024). Decision making in municipalities tends to be fragmented, reactive and poorly evidence-based despite the wealth of available data. As a result, an inability to derive meaning from data to inform decision making may in fact be the key challenge faced by municipalities rather than a lack of data. This limits the quality of decisions and reduces the organisation’s capacity to respond effectively to complex and evolving challenges. Moreover, the municipalities are facing challenges of shortages of skilled workers, inadequate IT infrastructure, and a lack of managerial support (Mofokeng, Ramolobe & Bogopa, 2025).

Despite the proven success of big data in service delivery in other governments around the world, its potential remains largely untapped in South African government municipalities. As a result, services may be delayed which leads to widespread dissatisfaction among residents. If these challenges are not addressed, the continued inefficiencies could hinder sustainable development which will lead to social unrests (Bruintjies & Njenga, 2024). The South African municipalities are collecting data in large volumes but are losing insight into how that data is interpreted, managed, and used in the decision-making process. This could mean that they will

continue to collect data but may not necessarily use that data to improve the quality, consistency.

1.4 RESEARCH QUESTIONS

How do municipalities in South Africa use big data to support decision making?

1.4.1 Research sub-questions

1. What type of big data that is produced and interpreted by the municipalities to support decision making?
2. What requisite knowledge, skills, attitude and appropriate management practices influence big data use in South African Municipalities?
3. How is big data currently managed and applied in municipal operations?

1.5 RESEARCH AIM AND OBJECTIVES

1.5.1 Research Aim

The aim of this study is to examine the use of big data in municipalities to support decision making for service delivery to enable citizen satisfaction.

1.5.2 Research objectives

1. Determine the type of big data that is produced and interpreted by the municipalities to support decision making.
2. Evaluate the requisite knowledge, skills, attitude and appropriate management practices influence big data use in South African Municipalities.
3. Describe how South African municipalities use big data to improve service delivery.

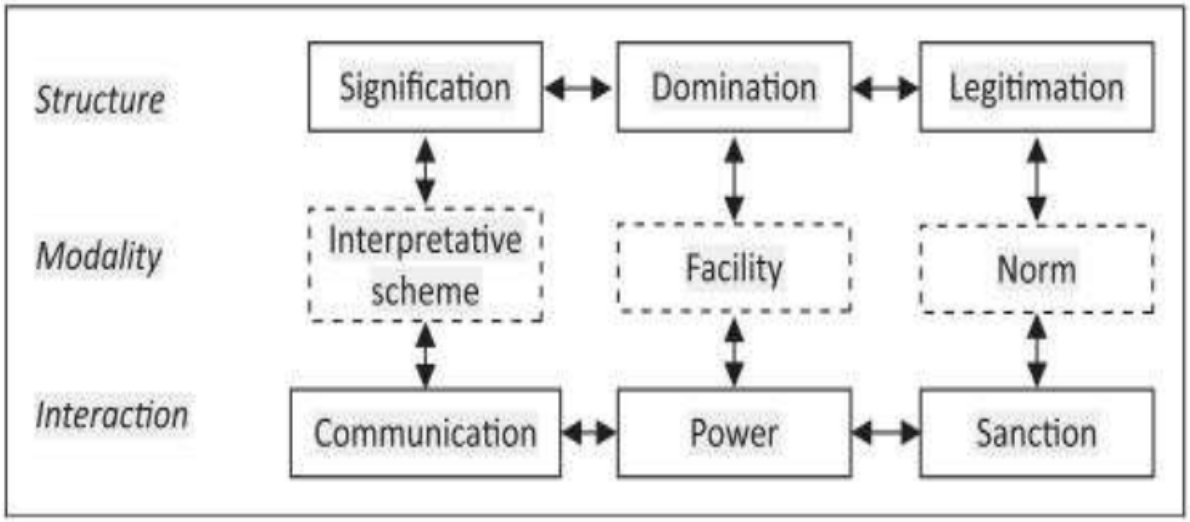
1.6 UNDERPINNING THEORY OVERVIEW

This research used the Structuration Theory (ST) as an underpinning theoretical lens. ST concentrates on the agents and structures that produce and reproduce actions (Giddens, 1984). Numerous studies in the field of IS have been supported by theories from the sociology discipline. According to the analysis, research employing socio-technical theories like ST has

contributed theoretically, practically and methodologically to the IS area over the years (Mkhomazi & Iyamu, 2013). IS research frequently uses ST to look into how IT (IT) is developed, implemented and used in businesses (Jones & Kirsten, 2008) which is similar to what this study aims to achieve ST contributes to IS studies by looking at in-depth descriptions of how various agents and relevant structures are integrated within a social structure (Iyamu, 2020). This theory is appropriate for this study as it clarifies how organisational structures and individual actions interact by showing that municipal policies, IT infrastructure and employees skills can enable or limit big data adoption. It also demonstrates how employees may reshape these structures over time.

Giddens (1984) suggests that due to duality, the activities of the agent and the structure are inextricably linked and produce and duplicate over time. Figure 1.1 depicts the three analytically relevant dimensions of structural duality: signification, domination and legitimation. These are all common interpretive strategies for maintaining reflexive communication within social systems.

Figure 1.1 Dimensions of the Duality of Structure (Giddens, 1984)



According to Khando, Islam and Gao (2022), the component of structure highlights the rules and resources that shape social life and it includes the established patterns of social relations, norms and institutions that guide individual behaviour. The interaction component highlights the actual social practices and behaviours of individuals as they engage with one another (Chatterjee, Kunwar & 2019). This means that the dynamic and ongoing processes through which individuals communicate, cooperate or compete are involved in this component. Modalities highlight ways in which the duality of structure works out in practice (Khando, Islam

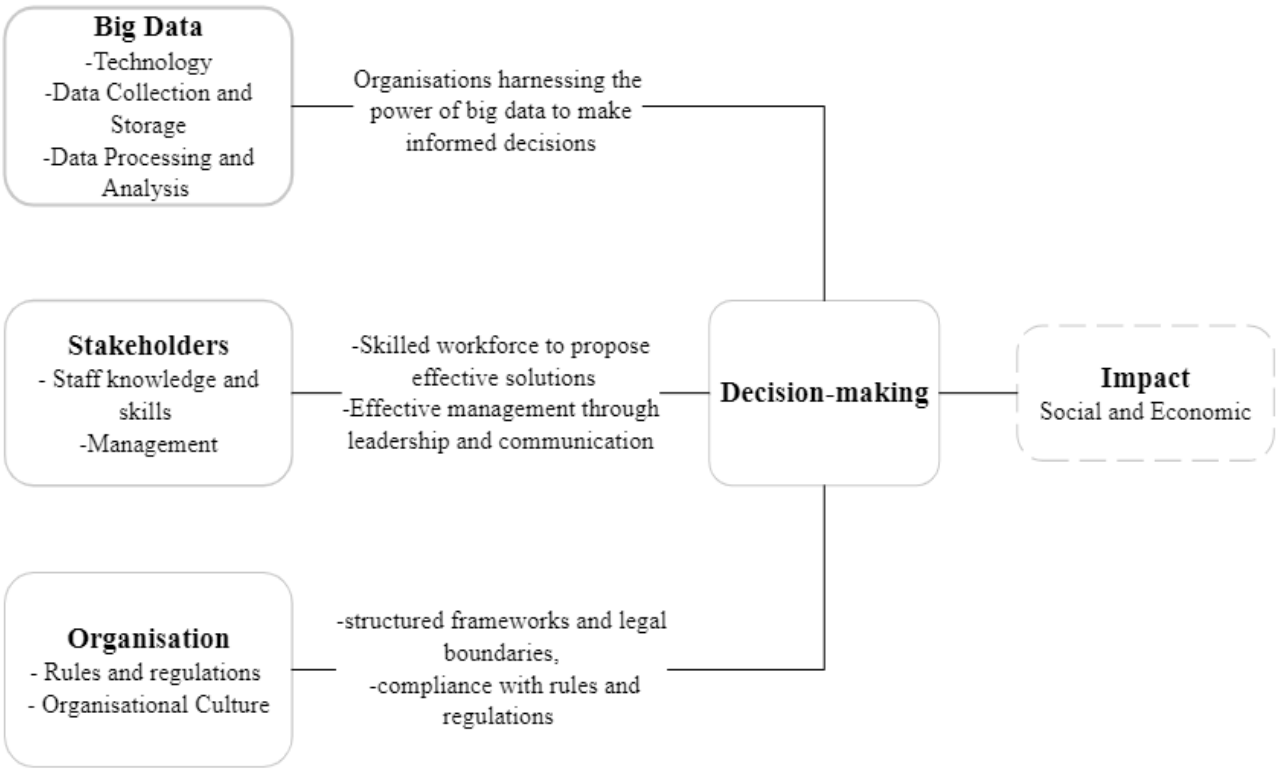
& Gao (2022). For instance, institutions of domination mean that power resources are available as facilities to some agents (e.g. managers) and not others. Moreover, the ways that facilities are applied and maintained help reproduce domination in society and organisations (Lukomska, 2020). As seen in Figure 1, the modalities (interpretative schemes, facilities and norms) connect the elements of the structure (signification, domination and legitimation) of social systems with the process of interaction (communication, power and sanction) [Giddens, 1984].

For this study, structuration theory seeks to determine how big data supports decision making for in South African municipalities. The theory's capacity to offer a deeper comprehension of the social context of technology adoption in the public sector guides the choice of structuration theory. Structuration theory offers a suitable framework to explore how organizational elements influence the big data activities carried out by municipalities. In the City of Tshwane, the rules of governance such as policies, regulations and organisational norms shape how data is collected and applied in municipal decision making. Resources such as technological infrastructure, databases and analytic tools provide the facilities that enable employees in their use of big data. Also, agency is exercised by municipal employees through the actions they take in interpreting and applying big data to make decision. This interaction between rules, resources and agency illustrates that using big data is not only a technical process, but also socially embedded activities that reshape organisational structures.

1.7 PROPOSED CONCEPTUAL RESEARCH FRAMEWORK

To achieve this aim of this study, the framework below (Figure 1.2), outlines the critical components for leveraging big data in municipalities. It emphasizes the integrated social and economic impact of technology, stakeholders, organizational readiness and desired outcomes.

Figure 1.2 Proposed Conceptual Research framework



1.7.1.1 *Technology*

Figure 2 shows the framework where technology serves as the foundation for effective big data implementation. Hadoop is an open-source framework widely used for distributed storage and parallel processing of large datasets, while Apache Spark extends its capabilities through in-memory processing, which dramatically increases the speed of data calculations (Basha, Vincent & Rajput, 2019). These computing systems provide fast access to large amounts of data and in order to fully leverage these technologies, robust infrastructure and advanced data and technology must be available (Gathu, 2024).

1.7.1.2 *Data collection and storage*

Roh, Heo, and Whang, (2019) define data collecting as the acquisition, labelling and augmentation of previous data or models. When completing straightforward tasks like electronically filling out tax forms, residents' data that has been stored in public sector IT systems might be automatically utilised (Siying, 2020). Additional instances comprise utilising information from publicly available datasets from third parties, government output, or private sector entities collaborating with public sector entities (van Ooijen, 2019). It is critical that

towns make a clear distinction between the many data sources that are accessible to them for big data collecting (Kandt & Batty, 2021).

Big data can be managed and stored in a diverse and affordable approaches in addition to the conventional on-premises data warehouse (SAS, 2016). In order to effectively manage their data processing and storage resources, municipalities must build highly adaptive systems due to the irregularities in the pace and variety of data flows (Tomar, Guicheney, Kyarisiima, Zimani, Roseth, & Acevedo, 2016).

1.7.1.3 *Data processing and analysis*

Analytical methods provide a means to decision making. Big data contain more merit than traditional analysis methods and organisations need to capitalise on different forms of data by doing an in-depth analysis (Ittman, 2015). Big data analysis differs from typical traditional analysis due to the volume of data (Hilbert, 2016). Big data is very complex and needs sophisticated data analysis methods and steps (Wang, Xu, Zhang, & Zhong, 2022).
Ittmann (2015) suggests that the analysis process should consider past events, current events, future predictions, modelling, experimental design, recommendations and prediction. For South African municipalities to fully benefit from big data analytics, defined methods and tools are necessary.

1.7.2 Stakeholders

The framework positions stakeholders as key enablers, whose skills and leadership influence the success of big data initiatives. For instance, municipal staff require training to utilize data analytics effectively, as highlighted in Figure 1

1.7.2.1 *Staff knowledge and skills*

The biggest challenge in light of big data is finding people possessing the essential knowledge and skills to transform data into a meaningful set of rules for decision making and these people are currently scarce (Mikalef, Pappas, Krogstie, & Giannakos, 2018). To capitalise on the potential of big data, it is essential that South African municipalities have employees with the right skills and knowledge sufficient for the enterprise performance of the data analytics process (Qwabe, 2020). These also include the skills to comprehend the societal differences and the needs of the communities that embark on service delivery protests (Ragolane, 2022).

1.7.2.2 *Management*

The adoption and implementation of technology in both public and private sector organisations are heavily influenced by management officials (Matsepe & Van der Lingen, 2022). Information on how public sector organisations innovate and how methods of leadership affect the kinds of innovations created to achieve their strategic goals is needed by the government (Arundel, Bloch, & Ferguson, 2018). It is therefore important in this case, that South African municipality management personnel ensure that big data is implemented and used to its full capacity. To evaluate this, management must have a system that measures big data usage, make tools and procedures for accomplishing big data tasks available, evaluate employee performance and encourage communication and consultation within the municipality for robust decision making (Yoshikuni, Dwivedi, Zhou & Wamba, 2023).

1.7.3 Organisation

1.7.3.1 *Rules and regulations*

Big data in the public sector is concerned with public data management which raise the need for clear rules and regulations to govern its use, storage, ownership, privacy and security (Löfgren & Webster, 2020). These rules ensure that data practices and conform to legal, ethical and social expectations and protect the operational integrity of the public sector. One of the important aspects is ensuring compliance with data protection laws and regulations in South Africa is complying to the Protection of Personal Information Act (POPIA) which mandates the responsible collection, processing and storage of personal data with emphasis on creating information necessary to obtain individual approvals (Ramruthan, 2022). Monetising big data in South African financial services.). Non-compliance of these regulations can have legal consequences and undermine public confidence, underscoring the need for a strong regulatory framework in municipalities (Adams et al., 2021).

1.7.3.2 *Organisational culture*

Organizational culture, as illustrated in the framework, fosters the adaptability needed for big data adoption. Municipalities must nurture an environment that supports innovation and aligns employee behaviour with the framework's goals (Lunde, Sjusdal & Pappas, 2019.). Employees in every organisation are supposed to organise their work and behaviours in accordance with the organisation's culture, although this is not always the case (Schulman, 2020.). To facilitate

decision making, it is critical that South African towns foster a positive culture that welcomes and supports big data efforts. The achievement of management's objective to use big data as a tool to assist in making decisions is promoted by the appropriate attitude shown toward the adoption and utilisation of big data technologies (Seko et al., 2022).

1.7.4 Impact

1.7.4.1 *Social impact*

The use of big data and improved data governance can enhance public service delivery by enabling municipalities to make more informed decisions and ultimately provide services more responsively to citizen needs and expectations (Mudzunga, Adeyelure & Kalema, 2025). In South Africa, where service delivery protests have escalated in recent years, the successful implementation of big data has the potential to significantly reduce protests driven by dissatisfaction with public services (Lee, 2020).

1.7.4.2 *Economic impact*

Studies have shown that businesses that use big data analytics can see a 5%–10% boost in productivity (Claros & Davies, 2016). However, the public sector is not a progressive sector, (Munné, 2016) and big data technology's impact on the South Africa's economy must also be experienced in the public sector (Bruintjies & Njenga, 2024).

1.7.5 Decision making

At the heart of the framework is decision making, which relies on the effective analysis and interpretation of big data to guide strategic choices within municipalities (Osman, 2019). Decision makers play a key role in translating insights from big data into actionable strategies and ensure that these decisions align with community needs and organisational goals (Garcia & Adams, 2023). Big data provides real time insights for strategic planning, resource allocation and policy decisions that align with organisational goals and community priorities (Mudzunga et al., 2025).

1.8 RESEARCH METHODOLOGY OVERVIEW

This section presents the detailed methods and approaches that will be used in this study to determine how big data can be useful to enhance service delivery in South African

municipalities. The section contains the following content: research philosophy, research approach, research strategy, sampling strategy, population, unit of analysis, data collection methods and data analysis methods.

1.8.1 Research Philosophy

The study utilised an interpretivist philosophy which emphasises on understanding the subjective meanings individuals or groups attach to phenomena (Cuthbertson, Robb & Blair, 2020). Interpretivist philosophy is a theoretical framework focused on understanding the subjective meanings individuals attach to their experiences and actions within their social, cultural, and historical contexts (Paudel, P., 2024). It differs from positivism by rejecting the idea of objective, universal truths and emphasizing the co-creation of knowledge between researchers and participants (Ikram & Kenayathulla, 2022). Interpretivism is commonly used in qualitative research methods such as interviews, ethnographies, and case studies to explore social phenomena in depth to uncover insights into human behaviours, relationships, and cultural practices that are not easily captured through quantitative methods (Pervin & Mokhtar, 2022). The interpretive philosophy was well suited for this research as it seeks to explore the meanings and conceptual perspectives associated with big data in South African municipalities. This approach aligns with this study as it focused on how stakeholders perceive and interact with big data within their organizational and cultural contexts.

1.8.2 Research Approach

This study applied a qualitative research approach. The qualitative research approach focuses on how people perceive and interpret a phenomenon based on their experiences and the environment they live in (Holloway & Galvin, 2023). According to Alharahsheh and Pius (2020), qualitative research prioritizes depth over generalization, aiming to provide a rich, detailed understanding of a phenomenon. This approach can reveal overlooked aspects of a topic, leading to new ideas, theories, or research frameworks (Alharahsheh & Pius, 2020).

1.8.3 Research Strategy

Scientific experiments, field tests, interviews, case studies, phenomenology studies, comprehensive conclusions, story studies, and action research are just a few of the approaches used in ISs research (Taherdoost, 2022). A case study strategy was selected for this study. This strategy focuses on specific people or areas and highlighting the importance of culture and

context in understanding the specific nature of an example and highlighting case differences (Silverman, 2013). This strategy was suitable for this study because it focuses on examining a single unit in detail which allows for the identification of key features and insights specific to that unit. These findings can then contribute to a broader understanding of big data and its implications in similar contexts. The City of Tshwane (CoT) was selected as the main case study for this research due to its need to improve service delivery. Big data has the potential to be a useful tool in addressing this challenge and enhancing urban governance. The CoT is the second biggest municipality in Gauteng province among the six main metropolitan areas in South Africa (Department of Cooperative Governance and Traditional Affairs, (n.d.)). This municipality was selected because of the increase in protests for service delivery it is experiencing.

1.8.3.1 Unit of Analysis

The Department of Economic Development and Spatial Planning was selected as the unit of analysis in this study. This department is in charge of the public and private sector's geographical and economic orientation within the city while ensuring that the urban shape embodies the idea of the capital city in order to guarantee seamless service delivery that is both accessible and sensitive to the demands of the population (City of Tshwane, (n.d.))

1.8.3.2 Population and Sampling

Lim (2024) states that in qualitative research, the process of selecting a population is intentional, focusing on identifying individuals or groups who can offer comprehensive insights into the phenomenon under investigation. The population must be contextually relevant to reflect the lived experiences within their natural settings and align with the study's goals (Lim, 2024). The population for this research consists of management personnel involved in the decision making in the City of Tshwane.

Purposive sampling, or non-probability sampling, is a qualitative research method that involves deliberately selecting participants based on specific characteristics relevant to the study's objectives (Shamsudin, Hassim & Abd Manaf, 2024). This approach allows researchers to gather in-depth insights from individuals who have significant knowledge or experience regarding the phenomenon being studied (Lim, 2024). For example, in a study on big data implementation in the City of Tshwane's Department of Economic Development and Spatial Planning, management and staff were selected for their roles in decision making processes

related to big data. This method enhances the quality of findings by ensuring that participants provide contextually rich information, thereby minimizing bias and facilitating a deeper understanding of complex issues (Andrade, 2021; Campbell et al., 2020).

1.8.4 Data Collection Methods

Collecting data accurately is crucial for maintaining the quality of research and making informed decisions (Karunarathna, Gunasena, Hapuarachchi, & Gunathilake, 2024). This study used semi-structured interviews to collect relevant data that can be analysed. Semi-structured interviews are a helpful method for collecting data when the researcher wants to, firstly, obtain qualitative, open-ended data, secondly, explore participant views, attitudes and opinions about a certain topic and lastly, probe deeply into personal and sometimes sensitive issues (DeJonckheere & Vaughn, 2019).

1.8.5 Data analysis method

Thematic analysis, a popular technique for analysis in qualitative research, was applied in this study. Castleberry and Nolen (2018) define thematic analysis as a method for finding, examining, and presenting the patterns (themes, concepts and repeated meanings) that emerge in data. It is frequently utilised due to the great range of research questions and subjects that may be covered by this data analysis technique (Busetto, Wick & Gumbinger, 2020) as well as its adaptability in enabling a comprehensive, in-depth and complicated description of data (Lester, Cho & Lochmiller, 2020).

1.9 ETHICAL CONSIDERATIONS

The researcher ensured that the use of all data used in this research will respect ethical agreements. Consent for publishing any document was sought beforehand. The researcher ensured that all participants take part in this research voluntarily and confidentiality and integrity of information are ensured.

1.10 CONTRIBUTION OF THE STUDY

1.10.1 Theoretical contributions

This study contributes to our knowledge of how South African municipalities have accessed and implemented big data to assist in the decision making for service delivery. The study extends the literature on how ST provides ways to understand the interaction of the social and technological aspects of IS. While its core principles have been influential in understanding the interplay between agency and structure in social contexts, the ST application and evolution may continue in several ways and its future remains dynamic and open to further development and adaptation.

1.10.2 Methodological contribution

The experiences obtained from applying the case study strategy, an interpretative approach and other approaches employed in this study constitute the primary methodological contribution of this research. Other IS researchers looking to apply these techniques to enhance government service delivery may find these experiences helpful.

1.10.3 Practical contributions

It is anticipated that this study will reveal the importance of understanding the public sector employee's skills, technology, employee tasks and organisational influence in order to implement big data. This will help in understanding how big data can be initiated and implemented to contribute to the service delivery of South Africa.

1.11 SUMMARY OF CHAPTER

This chapter presented the context of the problem to be solved, the problem statement, the research aim, objectives, the proposed theoretical foundation, the conceptual framework, and the importance of the study. In doing so, the problem that this research study aims to solve was described and the benefits of conducting this research study were highlighted.

1.12 LAYOUT OF THE DISSERTATION

The rest of the dissertation is outlined as follows:

- Chapter 1 provides the background information of the research topic, outlines the specific aims and objectives of the study and justifies the relevance of research within the broader academic
- Chapter 2 reviews the literature to identify and highlight all aspects of the research problem. The main factors that were stated in Chapter 1 are discussed in detail
- Chapter 3 discusses the underpinning theory
- Chapter 4 explains the research methodology or approach used to carry out the study including the methods of data collection, presentation and analysis
- Chapter 5 focuses on the data analysis and the discussion of the results
- Chapter 6 focuses on the interpretation of findings and makes recommendations
- Chapter 7 evaluates the research

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

The first chapter covered the main concepts related to the research topic. This chapter deliberates on the literature review of the use of big data to improve service delivery by government entities. A literature review is conducted in order to support a proposed study or research project (Cronin, Ryan & Coughlan, 2008). The literature review aims to help highlight a research problem, give an overview of the body of knowledge pertinent to the topic being investigated, and demonstrate the significance of the proposed research (Alonso-Garcia, Pablo-Martí & Nunez-Barriopedro, 2021). Another key topic covered in this review includes concepts of Structuration theory, which is important for the design of the theoretical frameworks for this research study. Academic journals, conference proceedings, online news sources, books and magazines were among the materials that were examined.

2.2 WHAT IS BIG DATA

Big data is the huge quantity of digital information gathered and assembled from several sources (Abdalla, 2022.). Big Data is generated by technological devices like laptops, mobile phones, and personal sensors (Ilmudeen, 2022). These devices collect information such as preferences and interests, behavioural data, demographic data, financial data, location data, healthcare data and government records (Chang, 2021). Furthermore, big data is becoming increasingly widely used in industries such as biology, medical services, the field of engineering, management of operations, manufacturing, the internet and financing (Awrahman, Aziz Fatah, & Hamaamin, 2022). Strong computational tools are needed to extract patterns and trends from these incredibly huge socioeconomic datasets, both within and between them and the objective is to draw conclusions from the available data sets (George, Haas & Petland 2014).

There is an increasing focus on the impact of data on individuals, organisations, business models and society as a whole (Jones, 2019). Big Data is a phrase that has been around since the early 1990s. While the original originator of the word remains unknown, the majority of people attribute its popularisation to John R. Mashey, who was employed at Silicon Graphics at the time (Bustamante & Clark, 2021). It is also believed that Roger Mougalas and the O'Reilly Media group coined the term in 2005 (Barnes, 2013). We can all agree, though, that big data is not something that emerged in the previous two decades or is entirely new, regardless of its origins. It is commonly recognised that businesses may find trends, make educated decisions

and increase productivity by using big data solutions to provide insights (Hajirahimova & Aliyeva, 2017).

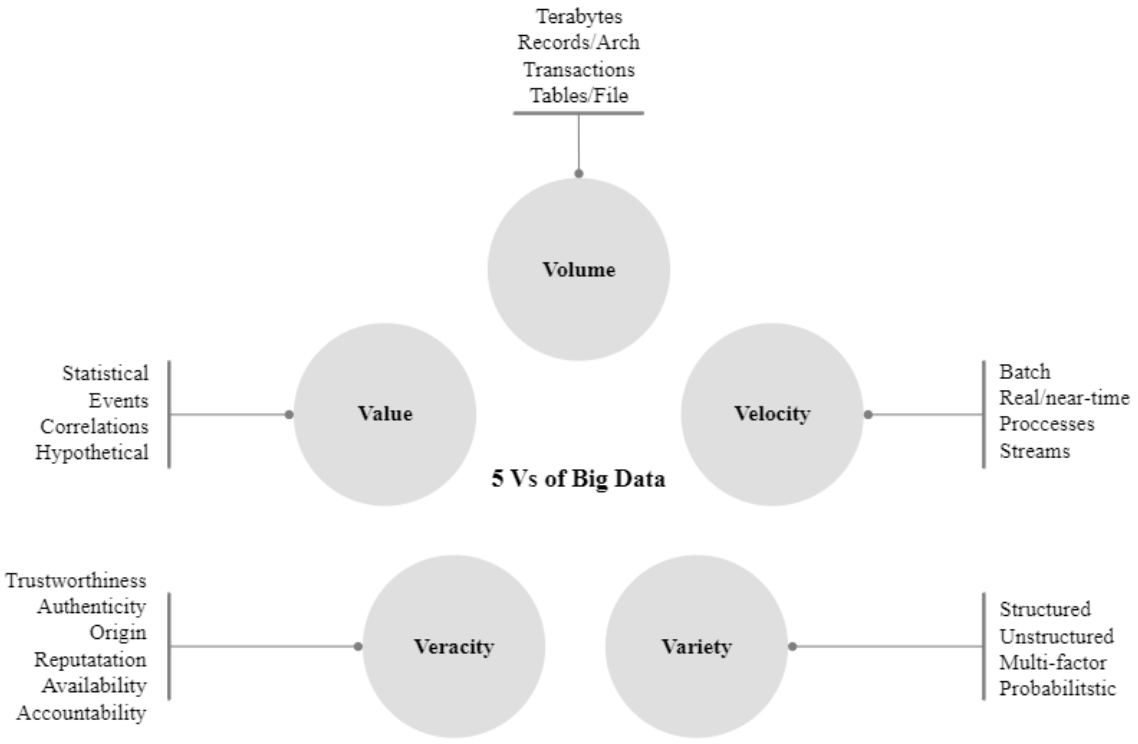
Big data and its use methods are a rapidly emerging management phenomenon that significantly enhances efficiency and effectiveness, and the public and private sectors are increasingly aware of the potential of data availability and innovative use methods for public benefit (Shamim, Zeng, Shariq, & Khan, 2019). Public administration offers similar opportunities to the private sector but requires data science skills like computer programming, modelling and analytics to fully harness big data potential (Maciejewski, 2017). The public sector may need a different strategy than the private sector, aligning with its specific goals and policies (Hossin, Du, Mu, & Asante, 2023).

2.2.1 Characteristics of big data

When dealing with the volume of big data, it becomes even more crucial to understand the source of the raw data and the preparation that must be done before analysis (Rehman, Naz & Razzak, 2022). The key to both dealing with the data and gaining insights from it is understanding its structure (Li, Lin, Ouyang & Luo, 2022). The speed and the volume at which data is collected have caused many to classify it.

According to Naeem et al., (2022), big data is described using four dimensions: 1. Volume, the quantity of the data; 2. Velocity, the speed at which information is created, processed and analysed; 3. Variety, the diverse forms of data (unstructured, structured and semi-structured) that are gathered into a data set. Unstructured data is disorganised, whereas structured data is displayed in the tabular form found in spreadsheets; 4. Veracity, how the data sources are reliable and 5. Value, the possible value of big data and how it connects to the ways that businesses can use the data they collect. These dimensions describe key characteristics that researchers must address in order to efficiently manage and derive meaningful insights from these massive datasets. With the rapid advancements in technology and the increasing amount of data generated across industries, it is important to understand these dimensions to effectively use big data for decision making. Figure 2.1 below summarizes the 5Vs of big data characteristics.

Figure 2.1 The 5Vs of Big Data Characteristics (Hariri et al., 2019)



2.2.1.1 Volume

This amount of data produced globally is increasing at an exponential rate (Sandhu, 2021) due to the increase in data volumes driven by IoT devices, social media, and sensor networks, all contributing to large streams of information (Bansal, Chana & Clarke, 2020), hence managing these large quantities of data may require advanced infrastructure and storage systems capable of processing large datasets. Cloud computing and distributed systems, such as Hadoop and Apache Spark, are essential in handling the large amounts of data generated daily, as they enable distributed storage and parallel processing, making it feasible to scale solutions to meet growing demands (Guan, Wang, & Liu, 2024).

2.2.1.2 Velocity

In various industries, especially those involved in real-time decision making such as financial markets, healthcare, and e-commerce, it is important to rapidly process and analyze data to derive meaningful insights (Boppiniti, 2021). As velocity increases, there is a growing need for advanced algorithms that can manage large-scale, fast-moving data without compromising accuracy (Abed, 2024). The increasing demand for real-time analytics is also promoting the

development of technologies capable of facilitating the continuous flow of data and ensuring that businesses can base their decisions on the current information.

2.2.1.3 Variety

The data collected may come in diverse types, structured, semi-structured, or unstructured, and handling this variety also presents unique challenges. Structured data in relational databases is easy to analyze, while handling unstructured data like text, images, and videos needs advanced techniques (Seenivasan, 2021). Recent advancements in machine learning and Artificial Intelligence (AI) have significantly enhanced the ability of organizations to manage unstructured data (Tahir & Khan, 2023). However, integrating and analysing this diverse data still requires robust architectures capable of processing different types of data simultaneously to transform it into value (Batko & Ślęzak, 2022).

2.2.1.4 Veracity

Big data is frequently derived from various sources, such as social media, sensors, and user-generated content and these sources may contain inconsistencies, errors, or biases (Regulwar, Mahalle, Pawar, Shamkuwar, Kakde & Tiwari, 2024). Ensuring the veracity of data is important because any low-quality or unreliable data can result in flawed analysis and decision making (Assiri, 2020.) and this is addressed through processes like data cleaning, filtering, and validation (Chu, Ilyas, Krishnan & Wang, 2016). Moreover, recent research focuses on building robust models that can handle noisy, incomplete, or biased data (Hariri, Fredericks & Bowers, 2019). Ensuring that data is both accurate and ethical is important in sensitive applications such as healthcare, finance, and autonomous systems, where mistakes or biases could have serious consequences (Wang, Zhang & Zhong, 2022).

2.2.1.5 Value

Value refers to the usefulness of the data (Millham, Agbehadji & Frimpong, 2021). For data to hold value, it Data must be analyzed and processed in a way that generates meaningful insights that can be useful and provide business or operational benefits (Mikalef, 2019). This means that raw data on its own holds no value until it is transformed into a form that informs decision making. The value of big data is often achieved through its application to specific organizational objectives (Hariri et al., 2019). For example, organizations can use big data to identify market trends, streamline operations, or improve resource allocation to support and enhance innovation.

2.2.2 How big data is analysed

To make informed decisions, big data must first be collected from various sources, stored in a distributed file system, and analyzed using multiple technologies and the final step requires making visualisations that help to turn the unprocessed data into valuable information (Misra et al, 2020). This helps to deduce useful insights as well as understand the value of the processed data (Shaqiri, 2017).

Big data analysis is different from standard statistical methods because of its many connected devices, priorities and varied data formats (Rehman et al., 2017; Hilbert, 2016). In contrast to traditional statistical data analysis, big data analysis is more challenging due to its heterogeneity, variable data formats, priorities, and the numerous connected devices, and therefore, the software providers must offer powerful analytical capabilities to handle these vast datasets (Rehman, Fahad, Ullah & Abdullah, 2017; Hilbert, 2016). The most popular technological instrument is Hadoop, a free software platform that uses a collection of scattered computers and particular computer programming paradigms to allow the distributed processing of enormous amounts of data (De Mauro, Greco & Grimaldi, 2015). A challenging task of big data is not only to collect it but also to manage and interpret it (Lv, 2017).

The analysis of big data involves several phases, each of which plays a crucial role in converting raw data into actionable insights. According to (Ali, Jusoh, Abdullah & Nor, 2018), the process of analysing big data consists of the following phases:

Phase 1: Acquisition

The acquisition phase is the initial stage of big data analysis, where data is collected from various sources, either manually or through automated systems. This phase involves selecting relevant data sources based on the business goals or research objectives and subsequently collecting the data from those sources (Li, Yu & Koudas, 2021). According to Wang, Xu, C., Zhang, and Zhong, (2022), the acquisition phase can include both structured data from databases and unstructured data. In this phase, the diversity of data sources can pose a challenge of determining which data is essential and how it can be accessed efficiently.

Phase 2: Preparation

The preparation phase involves cleaning, filtering, and organizing data to ensure its quality and usability, thus addressing the inconsistencies, missing values, and irrelevant information often

found in raw data (Kaya & Yildirim, 2024). The preparation phase is a significant task in big data analytics as dirty or inconsistent data can result in misleading conclusions (Hosseinzadeh, Azhir, Ahmed, Ghafour, Ahmed, SRahmani & Vo, 2023).

Phase 3: Analysis

The analysis phase involves transforming data into useful information through various statistical, machine learning, or AI-based models. At this stage, raw data is processed and analyzed to uncover patterns, trends, and insights relevant to the user's objectives (Golfarelli, & Rizzi, 2020). The choice of analysis technique depends on the type of data and the specific goals of the analysis (Hariri, Fredericks, & Bowers, 2019). This stage can also involve multiple iterations, particularly if the data analysis is exploratory, where the analysis is repeated until a relevant pattern or correlation is identified.

Phase 4: Visualisation

The visualization phase focuses on presenting analyzed data in a clear and accessible form and in this phase decision-makers are able to interpret large datasets by displaying complex information in an insightful way (Qin, Luo, Tang & Li, 2020). Good data visualization enhances comprehension and facilitates decision making by presenting insights clearly and understandably. Tools like Tableau, Power BI, and Qlik are often used to provide dynamic visualizations of big data (Ghaffar, 2020).

Phase 5: Interpretation

Analysing big data will be less valuable if the results cannot be interpreted correctly by the decision makers. The interpretation phase involves understanding and making sense of the data and then drawing conclusions from it (Sun, Shang, Xia, Bhowmick & Nagarajaiah, 2020). This involves a thorough examination of all underlying assumptions and a thorough review of the analysis process (Mariani, Wamba, 2020).

2.2.3 Big data challenges

Although big data provides organisations with more decision making resources and insights, it also brings big challenges and in order to capitalise on vast amounts of incoming data, organisations will have to address these challenges (Naeem at al., 2022). In the era of big data, data is increasing rapidly and this creates difficulties in data collection, storage, management

and analysis (Chen, Mao& Liu, 2014). The rapid growth of data necessitates stricter storage and management requirements, particularly for big data storage, ensuring reliable and accessible data access (Hwang & Chen, 2017). Hossin, Du, Mu, & Asante (2014) identify several challenges in using big data for governments. These include breaking down silos, regulating technologies, dealing with large amounts of legacy data, addressing privacy concerns, accessing various data types, and expanding the use of unstructured data. Similarly, Löfgren and Webster (2020) highlight challenges associated with data quality, digital inequalities that contribute to biases, privacy and consent issues, and security concerns.

Privacy

Protecting confidential information is a major challenge due to the volume and diversity of data collected by municipalities (Johnson & Nick, 2023). Unauthorized access or data breaches can expose citizens' personal information and potentially leading to serious consequences (Asasfeh, Tarawneh, Pradhan & Al-Dmour, 2024). It is therefore crucial to balance the benefits of data driven decision making with safeguarding citizens' privacy and ensuring that ethical data handling practices are in place (Munshi, 2023).

Security

The large scale of big data storage makes it vulnerable to cyber threats and attacks (Josphineleela, Kaliappan, Natrayan & Garg, 2023). Breaches can compromise sensitive information and jeopardize both public safety and national security (Rawat, Doku & Garuba, 2019). Municipalities must therefore allocate sufficient resources to establish and maintain robust cybersecurity infrastructure to protect data from potential attacks (Zhang, Pee, Pan & Cui, 2022).

Data Access and Sharing

Balancing open access to data with controlled access to prevent misuse remains a significant challenge (Hasan et al., 2022). Poorly implemented legal frameworks or policies can lead to unintended or unauthorized sharing, increasing the risk of data misuse (Johnson & Nick, 2023). Ethical data-sharing practices, including clear communication about how data will be used and shared, are essential to mitigate these risks (Kitchin, 2021).

Storage and Processing Issues

The vast amounts of data generated require scalable storage and processing solutions. Many organizations are forced to rely on cloud services due to pressure on local networks, storage, and servers (Anandan, Kumar, Kalaivani & Swaminathan, 2018). Inadequate storage or poor data management can result in data loss, corruption, inefficiencies, and delays (Naeem et al., 2022). Maintaining data integrity and ensuring accuracy and consistency is therefore a critical ethical consideration (Duggineni, 2023).

Analytical Challenges

Analysing complex big data requires advanced tools and technical expertise (Naeem et al., 2022). Incorrect algorithms or biased models can produce misleading results, potentially leading to poor decision making (Norori et al., 2021). Ethical practices, including bias mitigation in analytical algorithms, are necessary to ensure fair and accurate outcomes (Abkenar, Kashani, Mahdipour & Jameii, 2021).

Skill Requirements and Technical Challenges

The knowledge and skill set of staff of the organisation are critical in liveraging the potential of big data in promoting informed decision-making (Chen, Ramanathan & Alazab, 2021). The staff at an organization who are data skilled and are able to understand, interpret and critically evaluate data are key for translating insights from big data into meaningful organizational decision making (Mikalef et al., 2018; Shamim et al., 2019). Egala et al. (2025) also highlights that limited analytical capability amongst staff means that data has limited function except for routine reporting and compliance activities. This ultimately limits the ability of organisations to use data for evidence-based reasoning and sustains dependence on intuitive decision-making. So, knowledge of staff and their analytic capability is not an afterthought. It is what makes possible the data-driven decision-making to occur.

2.3 BIG DATA IN GOVERNMENT

Like some commercial companies, governments are looking to increase their effectiveness and efficiencies through big data usage in their operations (Khine & Shun, 2017). Hence, it is important to increase the understanding of how big data affects the public sector and the possible economic gains that governments could obtain from large datasets (Bruintjies & Njenga, 2024).

By maximising the potential of large data, African governments can also improve economic growth, decision making, opportunities identification, and operational scalability (Joubert, Murawski, & Bick, 2023). According to Kalema & Mokgadi (2017), an organisation's readiness to use big data is influenced by a variety of factors, including scalability, ICT infrastructure, management support, organisational size, financial capabilities, culture, and the technological skills of consumers, vendors and staff. Nonetheless, Ganeshto (2023) claims that South Africa is among the nations that led with big data adoption in the year 2023.

According to Marzullo (2016), the United States of America is the nation that has adopted big data the fastest when the Big Data Research and Development Initiative was started by the Obama Administration in 2012 to create technologies, educate data scientists, and support open data to guarantee that big data is utilised in ways that advance the administration's fundamental values, such as civil liberties and privacy. The administration, therefore, released a strategic plan that outlines new skills and rules to make use of the benefits of big data sources (Marzullo, 2016). Meanwhile, other nations have adopted Barack Obama's Big Data plan, including Australia, the UK and Italy (Veljković, Bogdanović-Dinić& Stoimenov, 2014), advancing the idea of optimising the value of open data by recycling information from the public sector (Baek & Park, 2015).

As a result of London’s high rate of population growth which put a strain on the city’s infrastructure, the UK's London government provided a report aimed to create Smart City initiatives by efficiently collecting and analysing huge amounts of data from various public and private organisations in the city (Louisa, Guicheney, Kyarisiima & Zimani, 2016). The organisation was able to improve data management and analytics to understand customer behaviour and identify critical transport network components (Cowley, Joss & Dayot, 2018).

According to Kalema and Mokgadi (2017), organisations in poor nations face obstacles due to restricted access to technology, money, infrastructure and skilled labour, whereas coastal countries and islands such as Mauritius are prepared to integrate big data analytics. (Joubert et al., 2023). The term ‘big data’ occurs more often now than before and its emergence has added a new aspect to conceptualise the use of digital technologies in the delivery of public services (Löfgren & Webster, 2020).

South Africa lacks studies focusing on the usage of big data by businesses and governments (van der Hoogen et al., 2024). Although South African retail companies are already leveraging loyalty cards to their benefit, it is unclear just how capable and ready these companies are to

use big data (Maimela, K., 2020). The role of data analytics in formulating a business model in the South African metals manufacturing sector.). A study by Mneney and Belle, (2016) indicates that South African retail organisations are ready to adopt big data, but more organisational work and support from big data technology vendors are needed. Similar research findings about South African municipalities by Seko, Garbutt, and Tsibolane (2022) showed that the stakeholders were not only prepared for the adoption of big data technology but also had a solid understanding of the components of the big data framework.

The body of literature in the big data space show an uneven understanding of how public sector organisations adopts and utilise big data, however ST appears in several works including those by Hainze and Hu (2005), Meneklis and Doulekris (2008) and Rawahi, Coombs and Doherty (2019), who each argue that technology use must be understood through the shared relationship between agency and structures. These studies clarify the complex interaction between public sector institutions, citizens and digital systems collectively and show that technology adoption cannot be reduced to technical capacity alone.

Unsworth (2016) and Loughlin and Bukowitz (2021) focused on the ethical and political components such as transparency, justice, and the social contract. This work recognise that imbalances of power and insufficient transparency threaten public trust in big data initiatives. Their arguments address critical governance concerns that suggesting that any technological advancement in the public sector must be accompanied by systems that protect the right of citizens.

A significant portion of the literature focuses on organisational readiness and capability development. According to Motau and Kalema (2016); Merhi and Bregu (2020); Gamane (2016), and Anna and Nikolay (2015), effective adoption of big data in the public sector is centred around organisational structures, skilled personnel and coordinated processes. These studies used theories such as the Technology Organisation Environment (TOE) and the Technology Acceptance Model (TAM) to highlight that readiness is multidimensional and extends beyond infrastructure to include managerial support and collaboration for competent analysis. These studies offer useful insights into the types of organisational capabilities necessary for successful big data implementation.

Across these studies, it can be widely concluded that while the literature covers a wide theoretical landscape and acknowledges the social, organisational and ethical complexities of big data, most works remain exploratory. This means that successful public sector transformation using big data requires more than technological investment but also on the readiness, capability, ethical governance and an understanding of the social structures that shape the use of technology.

The South African public sector's adoption of digital innovations has not been widely acknowledged due to a lack of readiness to transition to a digitalised service (Boyle & Staines, (2019); Shava & Hofisi, 2017). Attour and Chaupain-Guillot (2020) advise that to adopt digital innovations, local governments need to create channels for citizen input which is essential for a two-way relationship that enhances service delivery. The studies by Wirtz and Daizer (2016); Arduini and Zanfei (2014) used empirical evidence to show the evolution of public service entities that use digital technologies through the spread of digital devices However, there are relatively limited studies that focus on the efficacy of digital innovations in South African municipalities (Mawela, Ochara & Twinomurinzi, 2017). Studies often focus on the ICT aspect to evaluate e-governance effectiveness, despite the wide range of digital innovations available in the public sector for service enhancement (Shava & Vyas-Doorgapersad, 2022).

The integration of big data in governance presents new challenges such as complexity, security, privacy and the need for current technology and human capabilities (Hossin, Du, Mu & Asante, 2023). South Africa's government is urged to improve service delivery and citizen consultation through the implementation of e-services, enhancing service delivery to its citizens (Dlodlo, Olwal & Mvelase, 2012).

2.4 SOUTH AFRICAN MUNICIPALITIES

Municipalities provide many important services such as water, sewage, waste, electricity, gas, municipal health, roads, stormwater, street lights, and parks and recreation (Masuku & Jili, 2019). South African municipalities have the responsibility to provide services that ensure local communities have government that is transparent and democratic, deliver services to communities in a way that is lasting, promoting social and economic development, creating a safe and healthy environment, encouraging the involvement of communities and community organisations in local government matters (Msenge, & Nzewi, 2021). The South African Constitution requires municipalities to deliver basic services to citizens (Constitution of the Republic of South Africa, 1996). Three categories of municipalities are established by the

Constitution. There are 278 municipalities in total which are made up of 226 local municipalities, 44 districts, and 8 metropolitan municipalities (Local Government: Act 117 of 1998, the Municipal Structures Act). Their priorities are service and infrastructure provision as well as the expansion of local economies (Department of Cooperative Governance and Traditional Affairs (n.d.)). These municipalities are categorised as follows:

Category A: Metropolitan Municipalities

This municipality is the only one in its region with exclusive municipal executive and legislative authority. The metropolitan municipalities are broken into wards and their role is to coordinate the delivery of services in the area. The metropolitan municipalities are the CoT, Buffalo City, Ekurhuleni Metropolitan Municipality, Mangaung Municipality, City of Cape Town, Nelson Mandela Bay Metropolitan Municipality, City of eThekwini and the City of Johannesburg ((Department of Cooperative Governance and Traditional Affairs (n.d.)).

Category B: Local Municipality

This municipality, which is part of a category C municipality, shares legislative and executive responsibility within its boundaries and all municipal duties not delegated to the district fall under the view of the local governments, especially providing local services. This municipality is the only one in its region with exclusive municipal executive and legislative authority. Areas outside of one of the six metropolitan municipal areas are under the jurisdiction of local municipalities. There are 226 wards in total that make up these local municipalities (Department of Cooperative Governance and Traditional Affairs (n.d.)).. The responsibility of representing the residents of each ward falls on a ward councillor (South African Local Government Association, (n.d)).

Category C: District Municipality

This municipality oversees an area that is home to multiple municipalities and possesses both legislative and executive branch authority. District municipalities are in charge of more general issues including public transportation, large-scale water and electricity supply, infrastructure development, and integrated planning and these municipalities are made up of four to six nearby municipalities often make up a district council (Department of Cooperative Governance and Traditional Affairs (n.d.)). Even though metropolitan municipalities are fully liable for them, district and local municipalities jointly oversee the development and provision of all local

services inside the metropolitan area. This is particularly true in extremely rural areas, where district municipalities will be in charge of development and providing services (Enaifoghe, 2022).

2.5 SUMMARY OF CHAPTER

This chapter examined related literature that supported the study of big data as a transformational factor across different industries, fostering innovation, and facilitating data-driven decision making. The literature review gave a thorough summary of the features, uses, obstacles and future directions of big data. The following chapter describes the theory that guides this study.

CHAPTER 3 UNDERPINNING THEORY

3.1 INTRODUCTION

This chapter explains the theoretical framework that guides the study, which is Structuration Theory (ST). ST was used to explore how municipalities use big data in decision making (Dhlamini, 2023). The chapter covers structuration theory and its application in big data research.

3.2 STRUCTURATION THEORY

Understanding the role of technology as the success formula for implementing ISs (IS) holds a lot of promise for understanding a key aspect of the IS research process (Andrade, 2007.) An IS, according to Bostrom and Heinen (1977), is the result of the introduction of IT into an already existing social system. Briefly, ISs are about people, processes and IT (Rainer et al, 2020). This research applied Structuration Theory (ST), a theory that was created by Anthony Giddens, a British sociologist who describes it as a social theory that concentrates on the agents and structures that generate and sustain actions (Giddens, 1984). Structuration theory has contributed to the IS field in theoretical, practical and methodological ways (Mkhomazi & Iyamu, 2013), and it is a common framework in IS to study how IT is developed, implemented and used in organisations (Jones & Kirsten, 2008; Orlikowski & Robey, 1991). Structuration theory helps IS studies by analysing how different structures and various actors interact within a social system (Iyamu, 2020). In brief, the theory argues that human action simultaneously constitutes and is constrained by social structure (Iyamu, 2019).

The basis of structuration theory is that social systems are produced and reproduced in social interaction and that social action is not fully explained by either the theory of structure or the theory of agency. Rather, it acknowledges that actors follow the rules that are created by social structures and that these structures are maintained only when actors behave in a compliant way (Stones, 2020). Since the publication of 'The Constitution of Society' in 1984, this formulation of structuration theory has been available and has been adopted and adapted by a number of researchers in the IS field (Chatterjee, Kunwar & den Hond, 2019). Structuration theory is also regarded as a theory of organisational communication (McPhee, Poole & Iverson, 2014).

3.2.1 Duality of structure

Giddens argues that the agent and the structure influence each other and create and sustain over time, which is due to duality (Giddens, 1984),). One way to analyse the duality of structure, as indicated earlier, is to look at three aspects: signification, domination and legitimation as the rules and norms that people use to communicate effectively in social systems (Chatterjee at al., , 2019). Modalities highlight ways in which the duality of structure works out in practice. For instance, institutions of domination mean that power resources are available as facilities to some agents (for example managers) and not others (Pham, 2019). Moreover, the ways that facilities are applied and maintained help reproduce domination in society and organisations (Lukomska, 2020). The modalities (interpretative schemes, facility and norms) link the process of interaction (communication, power and sanction) with the structural components (signification, domination and legitimation) of social, systems (Giddens, 1984), as shown in Figure 1. By using structuration theory, we can better comprehend how the social setting of technology deployment in the public sector works (van Veenstra, Grommé, & Djafari, 2021). In structuration theory, technology's capability to be effective and the idea that social systems, ISs and technologies can effectively enhance human function within companies is not widely acknowledged (Andrade, 2007).

3.3 STRUCTURATION THEORY IN BIG DATA RESEARCH

Nunu (2019) developed a conceptual framework using structure theory to analyse how agencies enhance healthcare services. The framework consists of four components: structure, agency, facility and agent, and provides insights into how structure influences interactions between healthcare stakeholders and government representatives.

Using structuration theory, Wanyama and Zheng (2010) examined how an Integrated Financial Management IS was put into practice in Kenya's public sector. They identified key elements such as meanings, norms and power concerns, highlighting the importance of understanding organisational structure and culture in project implementation. Power struggles are evident in daily actions within and between different levels of government.

Using structuration theory as a basis, Hossain et al. (2011) created a model to examine how e-government system adoption affects the generation of business value. They found that e-government system integration significantly impacts commercial value development, and top

management support significantly influences absorption. This study expands the existing literature on IS assimilation by including e-government systems.

It seems that structuration theory, from the IS perspective, offers a number of distinctive concepts and positions that are appealing to researchers. Structuration theory also offers an account of IT that is heavily embedded in social practice and, therefore, should remain faithful to the main Giddens' thinking (Andrade, 2007). This research paper thus proposes the following elements that can be used in the duality of structure to assess the state of big data use in South African municipalities as shown in Table 3.1.

Table 3.1 Duality of Structure (adapted from Giddens, 1984)

Structure	**Signification**	**Domination**	**Legitimation**
	-The value of big data - Relative benefit of using big data	-How big data is used to improve decision- making	-Rules and regulations of big data in the municipality
Modality	**Interpretive scheme**	**Facility**	**Norm**
	-Practical assumptions about effectiveness of using big data - Underlying beliefs about the practice of using big data -Perceived role of the technology in accomplishing the practice	-Tools and procedures for accomplishing big data tasks -Performance measurement system in the municipality -Communication and consultation	-Big data public interest disclosure -Freedom of information - Public big data municipality documents in a written form -Observations -Types of norms
Interaction	**Communication**	**Power**	**Sanction**
	-Efficient and effective operation -To the executives	-Management's role in enforcing the use of big data -Management framework	-Measures to enforce compliance

In addition, these interactions preserve and change the interpretive frameworks embedded in social structure as meaning or signification (Rose & Scheepers, 2001). Similarly, the ability to allocate resources is exercised in the wielding of power and generates and reproduces social structures of dominance to assist define what can be sanctioned in human interaction, which

repeatedly produces frameworks of legitimation. As indicated in the table 3.1, for example, efficient and effective communication may draw practical assumptions about the effectiveness of using big data and at the same time, this effective communication among humans may reproduce and modify these assumptions.

3.3.1 Structure

Structure refers to the main rules and resources that underpin social systems, shape social practices and it influences the actions of individuals and organizations within the system (Stones, 2017). Table 4 shows the structural dimensions of big data governance its role in decision making within municipalities. This aligns with structuration theory (Giddens, 1984), which examines the interplay between agency and structure in organizational settings.

Signification

This component relates to the production of meaning and the establishment of shared understanding that offer interpretive frameworks that enable effective communication and mutual comprehension between individuals (Löfgren and Webster (2020). Big data improves decision making processes by providing more insightful and meaningful frameworks. For example, Kim et al. (2014) highlight that breaking silo between departments enables a shared understanding of data's significance and facilitates informed policymaking and this is crucial for service delivery improvements in the public sector.

Domination

The role of big data in domination can be visible in how it provides tools and facilities that enable decision making power (Iyamu, 2019). Structures of domination encompass both material resources (e.g., wealth and infrastructure) and authoritative resources (e.g., institutional control), which individuals use to apply their authority (Lukes, 2021). Mikalef et al. (2018) argue that organizations leveraging big data effectively achieve dominance in operational efficiency which is a necessary outcome for municipalities.

Legitimation

According to Gidden (1984), legitimation revolves around the norms, values, and moral principles that establish what is considered acceptable behaviour within a society. These frameworks justify actions and maintain societal order. In the context of big data, rules and regulations around big data implementation play a critical role in ensuring ethical practices,

thus promoting trust and enhancing the legitimacy of the big data systems (Dhlamini, 2023). Löfgren and Webster (2020) highlight it is necessary to have robust privacy and consent frameworks to prevent misuse and cultivate public confidence in data governance. By aligning technological advancements with societal expectations, legitimation helps balance innovation with ethical accountability.

3.3.2 Modality

Giddens (1984) describes the modality component as an important connection between structure and interaction as it focuses on the tools that enable the interpretation and normalization of systemic elements within organizational or societal contexts. In municipal governance, the modality aspects can highlight the utilization and incorporation of big data into everyday municipal practices to facilitate decision making processes. Modalities facilitate the translation of the principles and frameworks of big data governance into practical applications and sustainable practices and ensure their relevance in daily operations (Nunu et al., 2019).

Interpretive Scheme

Interpretive schemes are 'the modes of typification incorporated within actors' stocks of knowledge, applied reflexively in the sustaining of communication (Giddens, 1984). They shape how individuals interpret their actions and those of others (van Mierlo, Bondarouk, & Sanders, 2018). The adoption of big data may be influenced by practical assumptions and beliefs about its adoption and these interpretive schemes help stakeholders understand the potential and limitations of technology (Maguire et al. 2011).

Facility

According to Giddens (1984), facilities represent the resources that agents use to apply power and influence and this enables individuals or organizations to shape outcomes and achieve strategic goals. In the context of big data, facilities can include tools and procedures essential for accomplishing data-related tasks, as well as performance measurement systems that evaluate and improve the effectiveness of big data initiatives within municipalities (Batko, 2022). These processes can also be enhanced by effective communication and consultation ensuring that stakeholders are engaged and aligned with the objectives of big data projects. (Pesce, Neirotti, & Paolucci, 2019).

Norms

Norms are shared expectations that guide behaviour and offer agents a framework for distinguishing acceptable from unacceptable actions and contributing to social order, a concept closely tied to legitimation (Giddens (1984). In the context of big data, norms play a vital role in increasing transparency and accountability (Flyverbom, Deibert & Matten, 2019). Ethical guidelines, such as big data public interest disclosures, freedom of information, and the publication of public big data municipality documents in written form, ensure that stakeholders have equitable access to data insights (Ingrams, 2019.). furthermore, observations of these norms help maintain trust and reduce digital divides (Pei & Wang, 2022).

3.3.3 Interaction

Interactions represent the methods through which structures are drawn upon and reproduced in social contexts (Giddens, 1984). These methods establish a concrete connection between theoretical frameworks and practical applications by illustrating how abstract systems impact and mould real-world behaviours (Iyamu, 2019).

Communication

The exchange of meaning through language and symbols, facilitated by interpretive schemes, is central to the process of signification, enabling individuals and organizations to derive shared understandings (Giddens, 1984). In the context of big data, effective communication between departments and executives is critical to aligning big data initiatives with primary organizational goals. Unsworth (2016) highlights the importance of communication in bridging a gap between technological capabilities and public expectations.

Power

Quality control and influence in organisations is achieved through the strategic use of facilities and availability of these advanced tools significantly enhance leadership power to make informed decisions that drive organizational success. Veenstra et al. (2021) highlight that effective leadership competencies are crucial for guiding analytics projects to ensure their alignment with organizational in public sector performance. By integrating robust facilities with strong leadership, organizations can improve their ability to navigate complex data environments and deliver superior outcomes for stakeholders (Nisar, Nasir, Jamshed, Naz, , Ali & Ali, 2021).

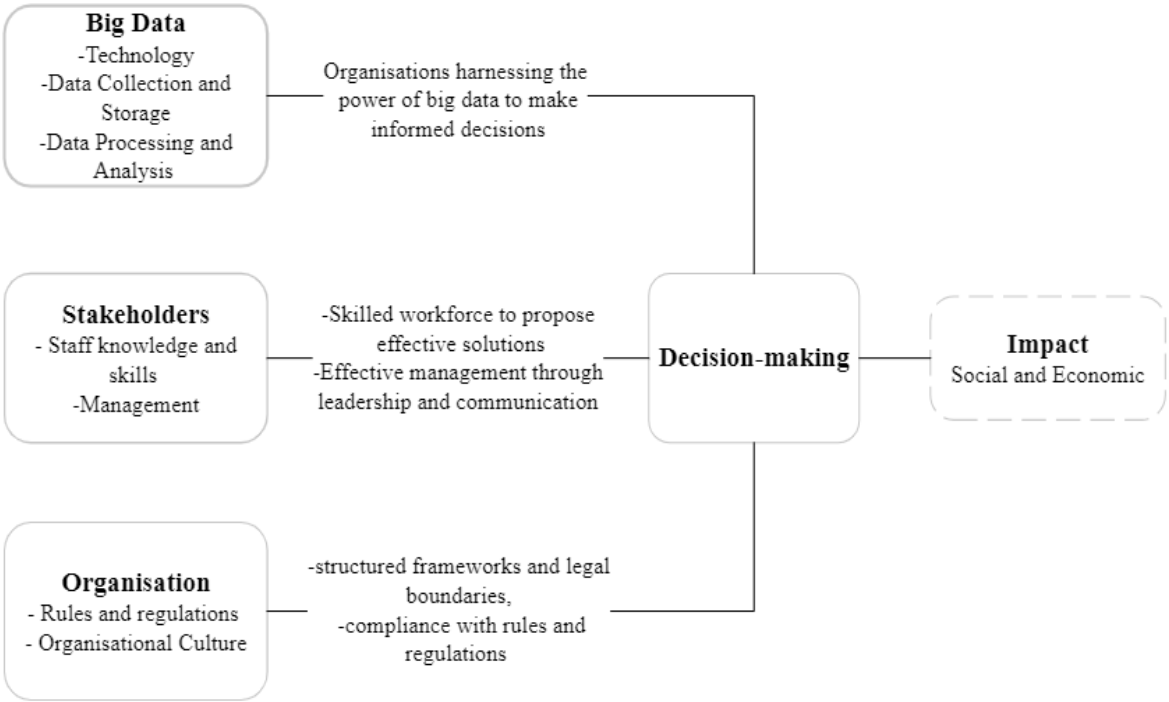
Sanction

Sanctions refer to the implementation of rewards and penalty functions to encourage or challenge societal norms and this process is fundamentally connected to the concept of legitimation (Giddens, 1984). This process is essential for upholding accountability by ensuring that actions adhere to set expectations. Enforcing accountability through mechanisms such as performance evaluations and compliance frameworks is essential for upholding ethical standards and fostering public trust (Shava & Mazenda, 2021). Gamane (2016) suggests that governments should use big data to improve service efficiency, ensure transparency, and distribute resources fairly. This approach helps monitor performance and legitimize decisions, reinforcing fairness and accountability in the public sector.

3.4 CONCEPTUAL FRAMEWORK

Based on the elements in the duality of structure shown in Table 4 above, this study suggests the following proposed conceptual framework in the Figure 3 (also shown in Chapter 1), to support decision making in the municipalities to improve service delivery.

Figure 3.1 Proposed Conceptual Research Framework



3.4.1 Big data

3.4.1.1 Technology

Because of the massive volume, velocity, and variety of the data involved, the processing and analysis of big data may require sophisticated technological infrastructure and tools (Ikegwu, Nweke, Anikwe, Alo & Okonkwo, 2022.). Advanced technologies, such as Apache Hadoop and Apache Spark are critical in processing big datasets by distributing computations across computer networks (Ahmed, Barczak, Susnjak, and Rashid, 2020). Machine learning algorithms and data visualization tools are used to extract important insights from the data, revealing patterns, trends, and correlations that can drive strategic decision making (Li, Chai, Khan, Jan, Verma, Menon, Kavita, and Li, 2021). In essence, the effective utilization of sophisticated technology is crucial in unlocking the potential of big data and deriving meaningful value from it (Ikegwu et al., 2022).

3.4.1.2 Data Collection and Storage

Data collection and storage are fundamental components of managing big data effectively (Hajjaji, Boulila, Farah, Romdhani & Hussain, 2021). In the public sector, data collection and storage play crucial roles in facilitating evidence-based decision making, improving service delivery, and enhancing citizen engagement (van Ooijen et al., 2019). Data collection in the public sector often involves gathering vast volumes of structured and unstructured data from a variety of sources, including administrative records, sensor networks, social media platforms, and citizen feedback mechanisms (Hossin, 2023). This data encompasses a wide range of domains, including healthcare, transportation, education, and public safety, among others (Kankanhalli, Charalabidis & Mellouli, 2019).

Cloud computing systems such as Amazon Web Services (AWS) and Microsoft Azure also provide scalable storage solutions, allowing enterprises to store and retrieve big datasets in a flexible and cost-effective manner (Chakraborty & Dey, 2023.). These platforms commonly adopt pay-as-you-go pricing models, allowing organizations to only incur costs for the storage resources they utilize, thereby mitigating unnecessary expenses (Schleier-Smith, J., Sreekanti, V., Khandelwal, Carreira, Yadwadkar, Popa, Gonzalez, Stoica, and Patterson, 2021). Moreover, organizations can harness distributed file systems, such as the Hadoop Distributed File System (HDFS), and object storage systems like Amazon S3 and Azure Blob Storage, to accommodate large-scale datasets across multiple nodes or servers, thereby facilitating efficient data retrieval

and processing (Liao, 2022.). By distributing data across a network of interconnected nodes, these systems offer the flexibility needed to manage vast volumes of data effectively (Ahmed et al., 2020). In addition, the implementation of data compression techniques may serve as a viable strategy for reducing storage costs and optimizing data retrieval speed (Wu, Sun, Zhang, Wei, and Chanussot, 2021). By compressing data prior to storage, organizations can significantly decrease storage requirements while still maintaining the ability to swiftly access and retrieve data when necessary (Guan et al., 2024).

Furthermore, data storage must adhere to strict standards and protocols to safeguard sensitive information and ensure data integrity (Riaz, Khan, Haroon, Latif & Bhatti, 2020). Government agencies must implement robust data governance frameworks and security measures to protect against unauthorized access, data breaches, and cyber threats (Singh, 2020). In addition, data anonymization techniques may be used to protect individual privacy and confidentiality while still enabling data analysis (Murthy, Bakar, Rahim & Ramli 2019).

3.4.1.3 Data Processing and Analysis

Big data processing and analysis are key aspects of modern data management (Oussous, Benjelloun, Lahcen & Belfkih, 2018), and can viewed through structuration theory, which highlights how structures and human actions shape social practices (Giddens, 1984). Recent research highlights the growing dependence on sophisticated analytical techniques, including data mining, machine learning, statistical analysis, and natural language processing to derive actionable insights from extensive datasets (Bharadiya, 2023.). These methods form the modalities that connect abstract systems to practical decision making (Khando et al., 2022; Veenstra et al., 2021).

The steps involved in big data processing, including data cleaning and transformation, are crucial for maintaining data quality which is essential for reliable analytics (Habeeb, Nasaruddin, Gani, Hashem, Ahmed & Imran, 2019). South African municipalities require the integration of effective data processing tools and techniques to address service delivery challenges and enhance transparency (Johnson, Sanghvi & Mehrotra, 2022). By aligning big data initiatives with ethical and performance standards, municipalities can improve their operational efficiency and accountability, thereby demonstrating the practical application of structuration theory (Nunu, 2019).

3.4.2 Stakeholders

3.4.2.1 Staff knowledge and skills

The successful implementation of big data requires concrete resources and worker skill development to assure its sustainability, as well as ongoing research (De Mauro, Greco, Grimaldi & Ritala, 2018; Bag, Pretorius, Gupta, and Dwivedi, 2021). In this era of big data, a big challenge is finding people who know how to turn raw data into useful information for making smart decisions (Mikalef et al., 2018). Proficiency in technical skills including programming (Python, R, SQL) for data management and cleaning, along with expertise with big data tools like Hadoop, Spark, and cloud platforms (AWS, Azure) is crucial to handle big data (Rao, Mitra, Bhatt & Goswami, 2019). To achieving proficiency in analytical and machine learning requires a robust foundation in statistical analysis and mathematical modelling. This includes natural language processing (NLP) for unstructured data, as well as data mining techniques to identify patterns and trends (Saeed & Ebrahim, 2024). More skills include strategic and business skills in big data that involve critical analysis and decision making to convert data insights into practical organizational strategies (Niu, Ying, Yang, Bao & Sivaparthipan, 2021). In addition, leadership and project management skills are needed to oversee cross-disciplinary teams, ensuring efficient implementation of big data initiatives that align with business goals (Jensen & Kadenic, 2024).

3.4.2.2 *Management*

The meaningful use of big data for decision-making is a strategic call of management. Studies indicate when leaders actively prioritise data use and devote resources to analytical capability, data becomes part of the normal organisational practice rather than an isolated technical activity (Yoshikuni, Dwivedi, Zhou & Wamba, 2023). However, decisions are still taken based on experience, routine or organizational politics (Magakwe, 2025; Li,Lin, Ouyang & Luo, 2022). This shows that management requirements should involve more than a general show of support, but rather an important connector between the availability of data and the quality of decision-making the data produces.

3.4.3 Organisation

3.4.3.1 *Rules and regulations*

Big data in the public sector is derived from public sources and therefore requires clear regulations concerning its use, storage, privacy, and security (Bruintjies & Njenga, 2024). Robust guidelines must be established to ensure that employees understand their responsibilities and the potential legal consequences of non-compliance, reducing the risk of misuse (Adams et al., 2021). According to Brown et al. (2020), the implementation of privacy and data protection frameworks is critical in mitigating risks, including legal consequences and breaches of public trust. Moreover, rewarding compliance or penalizing violations reinforces legitimacy and accountability within the public sector and these dynamics ensure that public big data practices not only align with legal standards but also support the broader societal expectations of transparency and security as underscored by recent studies on public data governance (Brown et al., 2020; Govindan et al., 2021)..

3.4.3.2 *Organisational Culture*

Organizational culture represents a structural component that shapes and is shaped by employee behaviours and promotes alignment with organizational objectives (Jerab & Mabrouk, 2023). Although employees generally adhere to established cultural norms, differences highlighting the importance of encouraging a positive and adaptable organizational culture may occur (Ababneh, 2021). A culture that embraces big data initiatives becomes a structure of legitimation, encouraging shared norms and values that support innovation and informed decision making (Giddens, 1984). Training programs and leadership exemplify modalities that connect these structures to daily practices to shape employee actions and emphasizing the strategic use of big data. Recent studies suggest that positive attitudes toward technological adoption are critical in leveraging big data for decision making and thereby ensuring that organisations can meet their service delivery mandates (Bag et al., 2021; Govindan et al., 2021).

3.4.4 Impact

3.4.4.1 *Social Impact*

While big data is frequently associated with improved public sector service outcomes, studies indicate that social benefits develop only where data is thoroughly integrated into organisational decision-making processes (Magakwe, 2025). Research also shows that decision-making

informed by big data can contribute to improved transparency, management and awareness, but only when analytical insights are actively used in planning and oversight processes (Hossin et al., 2023). This suggests that social impact should be understood as an result of organisational knowledge rather than as a direct result of big data adoption.

The integration of big data into public sector operations has shown considerable advancements in service delivery on a global scale, resulting in increased efficiency and enhanced citizen satisfaction (Bruintjies & Njenga, 2024.). In South Africa, where service delivery protests have intensified due to public dissatisfaction (Mamokhere, 2020), the successful application of big data analytics offers an excellent potential. This proactive approach builds public trust and reduces complaints which can potentially reduce service delivery protests (Bag et al., 2021).

3.4.4.2 *Economic Impact*

While big data analytics has been linked to improved organisational performance in some instances and can enhance the efficiency of public services and contribute to economic prosperity (Latupeirissa, Dewi, Prayana, Srikandi, Ramadiansyah, & Pramana, 2024). Mathane (2024) also points out that big data technologies can greatly improve efficiency in the public sector and because this sector is non-productive, it does not directly impact the market or face competition. Even so, improved efficiency in South African municipalities is expected to have positive effects on the overall economy.

3.4.5 Decision making

Decision making is central element of this study and its conceptual framework, and it is the point at which data creates organisational value. In this context, decision-making is the systematic use of big data analysis to influence choices to improve the quality of organisation. Big data remains a technical asset rather than a strategic organisational if it not integrated into decision-making processes (Jerab & Mabrouk, 2023).

According to Hossin, Du, Mu, and Asante (2023), research in the public sector consistently demonstrates that the availability of big data does not automatically lead to better decisions. Instead, the impact of big data depends on whether analytical insights are embedded within governance structures, decision-making routines, and accountability mechanisms. ST provides a useful lens for understanding this challenge. This theory suggests that decision-making practices are shaped by organisational rules, norms, and power relations, which can be

reproduced over time unless deliberately changed (Giddens, 1984). This implies that data will only influence decisions when decisions-making structures are intentionally designed to incorporate analytical evidence (Turlapati, Vichitra, Raval, Khaja Mohinuddeen & Mishra, 2024). Therefore, big data technologies, governance structures, stakeholder capabilities, and organisational culture only generate value when they converge within decision-making processes. Moreover, understanding how decisions are made, who makes them and what evidence is considered legitimate is therefore essential for explaining why big data initiatives succeed or fail in transforming organisational practices.

From the lens of structuration theory, big data outcomes serve as both resources (linked to domination) and norms (associated with legitimation) that influence decision making processes in municipalities. Clear and significant insights derived from big data improve decision-makers' ability to assess their influence on organizational goals (Chatterjee at al., 2023). This clarity allows agents (decision-makers) to draw upon these structures effectively to ensure that their actions align with broader institutional goals (Jerab, 2023). This iterative process ensures that decision making is both guided by established norms and responsive to evolving organizational and societal needs (Giddens, 1984).

In ST, the results of big data analysis are understood to serve a dual function in municipal decision-making. They act both as resources that strengthen power and control (domination) and as norms that present legitimacy to certain practices (legitimation), and together these elements shape how decisions are made. Chatterjee et al. (2023) states that when big data produces clear and significant insights, it strengthens decision-makers' ability to determine how their actions impact organizational goals. Jerab (2023) further explains that this clarity enables decision-makers to leverage those resources and norms more effectively and align with the organisational objectives.

3.5 SUMMARY OF CHAPTER

This chapter examined how structuration theory can be used in big data research. It showed how Anthony Giddens' structuration theory can offer a useful lens for analysing the complex interactions between people, technology, and the changing environment of big data. The next chapter presents the methodology of this study.

CHAPTER 4 RESEARCH METHODOLOGY

4.1 INTRODUCTION

Research methodology is the general research design that outlines how a research project will be carried out and, among other things, determines the methods to be used in it (Alharahsheh & Pius, 2020). In this chapter, a roadmap of how this study proceeded with the investigation of the research problem to determine the use of big data in South African municipalities is outlined.

Table 4.1 below summarises the research methodology for this study. The remainder of the research topic will be provided in detail later in chapter.

Table 4.1 Research Methodology

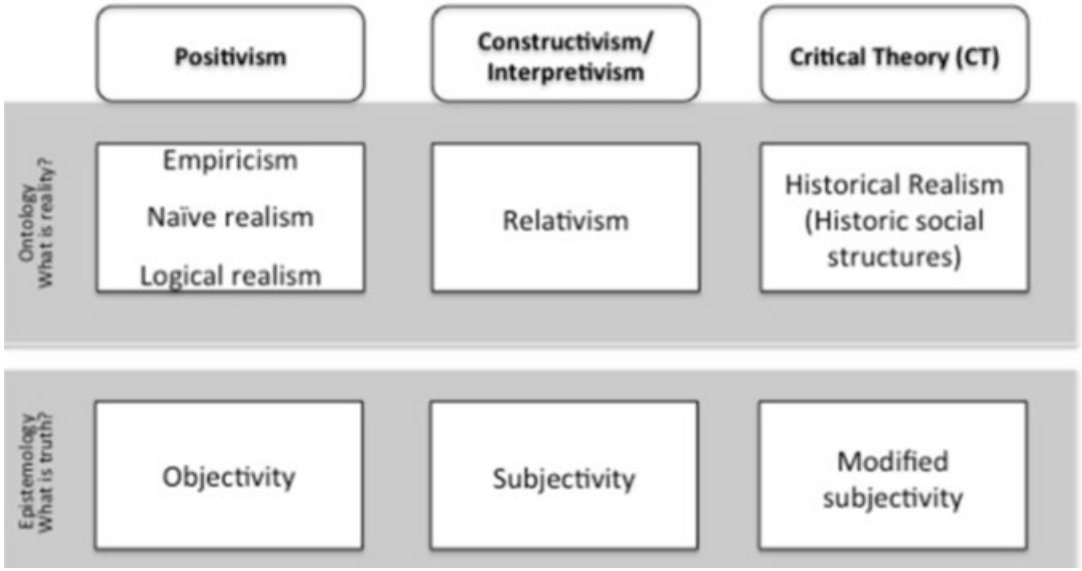
Methodology Section	**Methodology Choice**
Research philosophy	Interpretivism
Research approach	Qualitative approach
Research strategy	Case study (City of Tshwane metropolitan municipality)
Data collection method	Semi-structured interviews
Unit of analysis	Department of Economic Development and Spatial Planning
Population	Department of Economic Development and Spatial Planning managers and general staff members
Sample	Purposive sampling (7)
Data analysis method	Thematic analysis
Ethical consideration	Informed consent and anonymisation

4.1.1 Research Philosophy

The research philosophy is a set of ideas guiding the collection, assessment and application of facts on a specific subject, essentially encompassing the process of knowledge development (Sciberras & Dingli, 2023). Research philosophies are a worldview that defines an individual's place in the world, their relationships with it, and the nature of the world (Hackfort & Schinke, 2020). It significantly influences the methods for determining how data is collected, analyzed, and interpreted (Saliya, 2023). This section examines three fundamental research philosophies

and their significance to research: positivism, interpretivism, and critical theory as shown in Figure 4.1.

Figure 4.1 Philosophical Paradigms (Ryan, 2018)



4.1.1.1 Positivism

Positivism is a research philosophy based on the belief that reality is objective and can be observed, measured, and quantified through empirical methods (Singh, 2019). It proposes that knowledge is obtained from sensory experiences and that scientific methods are considered effective for discovering truths about the world (Mbanaso, Abrahams & Okafor, 2023). Positivism emphasizes numerical data and statistical analysis to uncover patterns, relationships, and causal links where the focus is on eliminating bias to produce reliable and valid results (Mohajan, 2020).

4.1.1.2 Interpretivism

This study followed an interpretivist philosophy (also known as constructivism). Interpretivism focuses on understanding the subjective meanings and experiences of individuals within their social and cultural contexts (Ryan, 2018). Interpretivism focuses on understanding that truth and knowledge are not objective but influenced by people's experiences and how they make sense of them, depending on their culture and history (Kankam, 2019). Interpretive research uses qualitative methods like interviews, focus groups and ethnography to explore and interpret meaning (Mbanaso, Abrahams & Okafor, 2023). This assertion supported the research strategy and the methods used in this study because while there have is a lot of organisations that are

using big data with broad similarities, each organisation has specific social interactions that constitute a unique interpretative context.

4.1.1.3 Critical Theory

Critical theory is a philosophical approach that seeks to examine issues of power, inequality, and injustice to reform societal structures (Winkle-Wagner, Lee-Johnson, & Gaskew, 2019). It serves as a framework for uncovering systemic biases and proposing transformative solutions that address inequities within society (Jackson & Mazzei, 2022). It suggests that knowledge is influenced by historical, cultural, and ideological factors rather than being neutral (Ormston, Spencer, Barnard & Snape, 2014). This philosophy emphasizes the importance of understanding the social context in which knowledge is produced and aims to empower marginalized groups by highlighting systemic injustices.

4.1.2 Research Approach

The research approach is the overall plan and procedures used by a researcher to collect, analyze, and interpret data in a study (Taherdoost, 2022). It aligns with the research problem, objectives, and the philosophical assumptions underpinning the inquiry (Huyler & McGill, 2019). Research approaches are generally classified into three categories: quantitative, qualitative, and mixed methods. Each approach aligns with particular research questions and philosophical orientations which is crucial for the success of a study.

4.1.2.1 Quantitative Research Approach

The quantitative research approach involves measuring variables and using statistical methods to analyze numerical data (Huyler & McGill, 2019). This approach aligns with the positivist paradigm which focuses on objectivity, measurability, and identifying generalizable patterns (Mohajan, 2020). Quantitative methods are commonly utilized in research that aims to test hypotheses or investigate relationships between variables using tools such as surveys, experiments, and structured observations are commonly used to collect data in this approach (Bryman, 2022).

4.1.2.2 Qualitative Research Approach

The study utilised a qualitative research method, utilising textual, audio or visual data to comprehend the experiences and meanings people attribute to a phenomenon (Hackfort & Schinke, 2020). This is the primary method of building or revising the theoretical basis of social

sciences (Morse et al., 1996). Qualitative research is crucial in educational research as it helps answer 'how' and 'why' questions, fostering a deeper understanding of experiences, phenomena and context and it enables the exploration of questions that cannot be easily quantified to comprehend human experiences (Cleland, 2017). Qualitative research is ideal for this study because it provides in-depth insights into the complex, context-specific dynamics of in an organisation (Lim, 2024). It allows researchers to explore stakeholder perspectives, challenges, and organizational processes that influence the use of big data (Hesse, Glenna, Hinrichs, Chiles & Sachs, 2019).

4.1.2.3 Mixed Methods Research Approach

The mixed methods approach integrates quantitative and qualitative techniques within a single study to utilize the advantages of both (Taherdoost, 2022). Quantitative methods enable the measurement of trends and patterns, while qualitative methods provide deeper understanding of stakeholder perspectives. This combination provides a comprehensive examination of the research objectives. This method is ideal for research questions needing multiple viewpoints or complex analysis.

4.1.3 Research Strategy

A research strategy is a systematic plan that guides a researcher in the planning, execution and monitoring of a study (Das, Ester & Kaczmirek, 2018). Choosing an appropriate research strategy is crucial for providing direction and selecting the right methodology for data collection and analysis (Opoku, Ahmed & Akotia, 2016). ISs research studies employ various strategies such as laboratory experiments, field experiments, surveys, case studies, phenomenological studies, interpretive studies, narrative studies and action research (Naidoo, 2009).

A case study is an extensive investigation into a person, group, or unit aimed at generalising over multiple units (Heale & Twycross, 2018). This design is widely used in social sciences, referring to spatially bounded phenomena observed at a single point or delimited period, with implicit temporal boundaries. (Gerring, 2004). The case study research method can utilise various research techniques to gain comprehensive, contextual and in-depth knowledge about a specific phenomenon ((Hancock, Algozzine & Lim, 2021). A case study strategy was selected for this study because it allows the researcher to have access to key stakeholders whose perspectives are essential for understanding the status of big data usage. It also enables the

researcher to gather detailed insights about big data practices that are crucial for understanding the specific challenges and opportunities.

The City of Tshwane metropolitan municipality (CoT) was selected as the case study for this research. The CoT, with a population of over 3.5 million people, faces challenges such as rapid growth, infrastructure development and service delivery (Ngobeni, 2018), and this experience is highly relevant for understanding the opportunities and challenges of big data adoption in urban management. Its ongoing technological innovation offers valuable insights for other municipalities in South Africa and beyond. Furthermore, the city is significant as the administrative capital of South and demonstrates significant progress in its transition to a smart city through the adoption of big data technologies (Seko, Garbutt & Tsibolane, 2022).

4.1.3.1 Case Study Overview

The City of Tshwane is located in the Gauteng Province of South Africa and it is the largest municipality in South Africa, as measured by land mass. CoT is situated in the northern part of Gauteng and it is home to Pretoria, the administrative capital of South Africa. The CoT was established in 2000 as a Category A Grade 6 Metropolitan Municipality which is managed by an executive mayoral system. It comprises of 13 former city and town councils and includes areas like Akasia, Atteridgeville, Bronkhorstspruit, Centurion, Cullinan, Ekangala, Ga-Rankuwa, Garsfontein, Hammanskraal, Irene, Kudube, Mabopane, Mamelodi, Pretoria. Tshwane is home to an estimated population of 3.5 million people (Statistics South Africa, 2021). The city has a diverse demographic, with a wide mix of ethnicities and languages, reflecting South Africa's multicultural society (City of Tswane, (n.d.)).

The City of Tshwane Metropolitan Municipality is tasked with providing public services and managing the region's resources efficiently. The municipality functions in accordance with the South African Constitution and municipal legislation led by an executive mayor and a municipal council (Department of Cooperative Governance and Traditional Affairs (n.d.). The city consists of sixteen departments responsible for environmental management; economic development and spatial planning; communication, marketing and events; emergency services; financial services; health and social development; housing and human settlement; metro police; service infrastructure; sports and recreational services; transport and roads; Tshwane market; ICT management and research and innovation. These departments have employed around thirty

thousand individuals across various municipal departments to provide essential services to residents and businesses (City of Tswane, (n.d.)).

The city has embarked on several initiatives aimed at transforming into a smart city by leveraging big data and digital technologies to improve service delivery and urban planning (Rwelamila, 2022). These advancements include traffic management improvements, environmental monitoring enhancements and increased citizen engagement via digital platforms (Seko, 2022). Although the city has made significant progress, it continues to face challenges related to rapid urbanization, financial sustainability, and infrastructure maintenance (Setona, 2023). These factors continue to strain service delivery and urban planning (City of Tswane, (n.d.)).

4.1.3.2 Unit of Analysis

The study focused on the CoT's Department of Economic Development and Spatial Planning as the unit of analysis. This department oversees the geographical and economic orientation of the city's public and private sectors and ensures that the urban structure represents the concept of the capital city in order to enable continuous service delivery that is both accessible and responsive to the needs of the population (City of Tswane, (n.d.)).

4.1.3.3 Population and Sampling

According to Lim (2024), in qualitative research, selecting population in a study is a deliberate process aimed at identifying individuals or groups who can provide in-depth insights into the phenomenon being studied. This group must be contextually relevant to reflect the lived experiences within their natural settings and align with the study's goals (Lim, 2024). The participants in this study include management and general staff in the Department of Economic Development and Spatial Planning involved in big data implementation and decision making in the City of Tshwane.

To select the participants, a purposive sample, also referred to as non-probability sampling, was used, wherein participants were selected based on specific characteristics deemed relevant to the research (Andrade, 2021). This sampling method is chosen due to its representativeness of the broader population, thereby minimizing bias (Campbell , Greenwood, Prior, Shearer, Walkem, Young, Bywaters, and Walker, 2020). The selected sample comprised of three managers and four staff members with diverse work experiences within the CoT's Department of Economic Development and Spatial Planning, all of whom are actively involved in the

municipality's government strategies and implementation processes. These participants were chosen based on their respective roles, expertise and involvement in big data-related processes within the department. The managers are key the decision makers within the department who are responsible for strategic planning, policy development, and overseeing the implementation of government initiatives. They guide the department and align it with the City of Tshwane's objectives. The four staff members are responsible for executing day-to-day activities, providing administrative support, and implementing directives from officials. To protect their anonymity the instructors were coded as P1, P2 and P3, P4, P5, P6 and P7 as shown in Table 4.2.

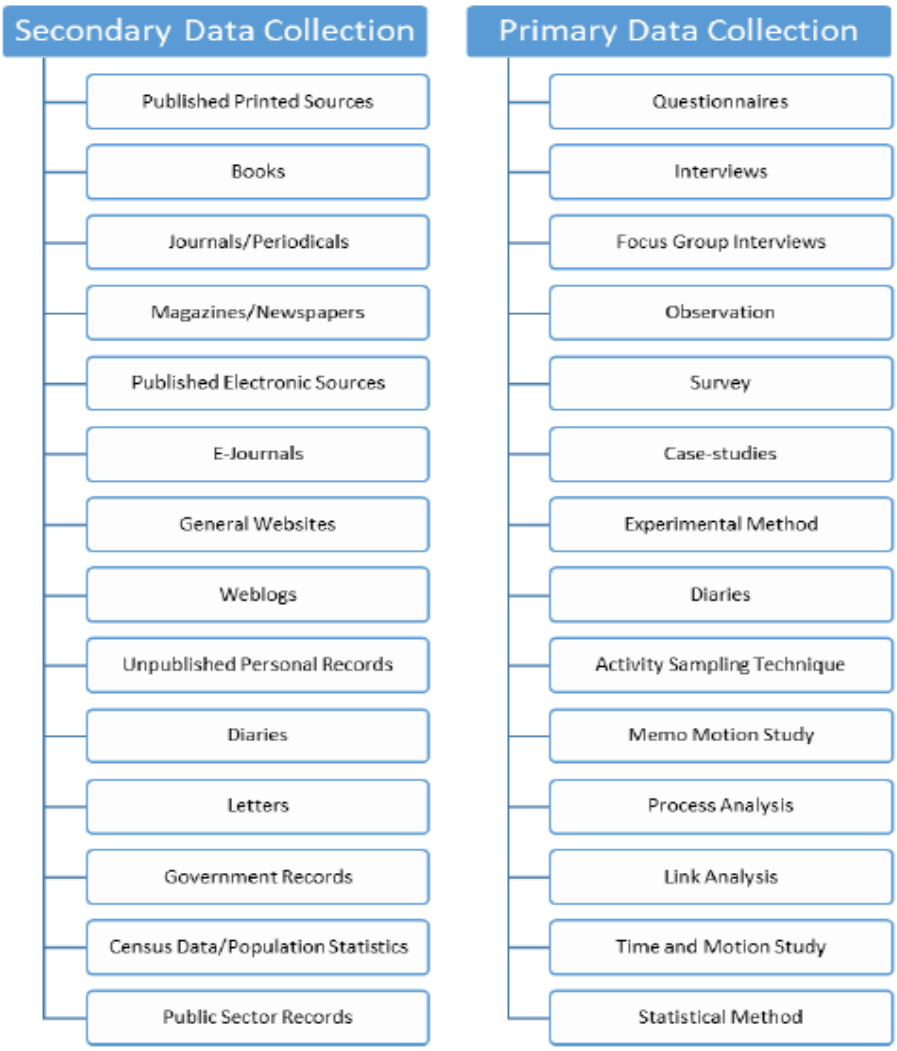
Table 4.2 Participant Profile

Name	Job Role
P1	Management
P2	Manager
P3	Manager
P4	General staff member
P5	General staff member
P6	General staff member
P7	General staff member

4.1.4 Data Collection Method

Data collection is the methodical process of collecting and examining data on relevant variables to address research questions, test hypotheses and assess outcomes (Kumari, 2022). Data collection methods can be broadly classified into primary and secondary categories. Primary data refers to information gathered directly from the source for a specific research purpose, enabling researchers to acquire firsthand data precisely tailored to their objectives, while secondary data, on the other hand, involves utilizing information that has already been collected by others such as government publications, academic research, or historical records (Karunarathna, Gunasena, Hapuarachchi & Gunathilake, 2024). While secondary data collection is often less expensive and quicker than primary methods, it may not always align perfectly with the specific needs of the current research. Figure 4.2 shows some of data collection methods for primary and secondary data.

Figure 4.2 Data Collection Methods (Taherdoost, 2021)



A good data collection method relevant to the research study makes it easier to identify ways to improve the experience of the entity that the research is being conducted on and, therefore, preserve the integrity of the research (Mohajan, 2020). In most research, interviews and focus groups typically are the two main qualitative data collection methods (Huyler & McGill, 2019).

4.1.4.1 Semi-Structured Interviews

The interview method was selected for this research on big data in the City of Tshwane due to its ability to provide in-depth insights into the complex issues surrounding big data adoption This method is well-suited to understanding organizational readiness, stakeholder attitudes, and the contextual factors influencing big data implementation ((DeJonckheere & Vaughn, 2019). Semi-structured interviews provide precise, comparable qualitative data, allowing informants to express their opinions in their own words (Cohen & Crabtree, 2008).

In qualitative research, the number of interviews conducted is typically guided by the principle of data saturation, which refers to the point at which no new themes or insights emerge from additional interviews (Braun & Clarke, 2021). Although the number of required interviews is not predetermined, research indicates that smaller sample sizes can often be adequate, especially when the objective is to gain detailed understanding of a particular phenomenon or context (Guest, Namey & Chen, 2020).

In this study, a total of eight semi-structured interviews were conducted as part of the data collection process. A pilot interview was conducted in person at the CoT offices in Pretoria to improve the reliability and validity of the interview protocol for better data collection during the actual interviews. Two of the interviews were conducted in person at the CoT offices in Pretoria using the researcher's recording device, while five interviews was recorded using Microsoft Teams. Each interview lasted between one to two hours depending on the depth of discussion. The interview participants were given a brief background about the study, including its goal, criteria for inclusion, and were informed that participation was voluntary, with the option to withdraw at any time before or during the interview. A full participant information sheet and interview protocol can be found in Appendix A and Appendix B, respectively.

4.1.5 Data Analysis Method

Data analysis involves systematically examining, cleaning, transforming, and modelling data to extract insights, support conclusions, and facilitate decision making (Islam, 2020). Qualitative research studies use data analysis that involve examining non-numeric information to understand concepts, opinions, or experiences.

4.1.5.1 Thematic analysis

The study used thematic analysis, a popular qualitative research method, to uncover, analyse, and present patterns in the data (Castleberry & Nolen, 2018). According to Christou (2022), thematic analysis involves a systematic process of familiarizing oneself with the data, generating initial codes, and identifying themes, which are then reviewed and refined to ensure they accurately represent the data. Once the themes are established, they are clearly defined and named and the findings are synthesized into a report that links the themes back to the research questions (Christou, 2022). It is widely used because of the large number of research issues and

themes that can be addressed with this particular method of data analysis and its flexibility in allowing for a comprehensive, detailed, and intricate description of data (Braun & Clarke, 2012).

Six steps that comprise the process of theme analysis were executed as described below (Vaismoradi, Jones, Turunen & Snelgrove, 2016; Braun and Clarke, 2021).

Step1: Familiarization with the Data

In this step, the researcher began the analysis process by listening to audio recordings and reading and re-reading the interview transcripts. The researcher then wrote down initial thoughts and observations to identify potential patterns, aiming to achieve a comprehensive understanding of the content and context of the data.

Step 2: Generating Initial Codes

In this step, the researcher organized the data into meaningful groups by identifying important features to generate a list of initial codes which were systematically applied across the dataset.

Step 3: Searching for Themes

In this step, the researcher reviewed all codes and identify connections between them.

Step 4: Reviewing Themes

In this step, the researcher reviewed each theme in relation to the coded data extracts to confirm consistency and relevance.

Step 5: Defining and Naming Themes

In this step, the researcher wrote a detailed descriptions for each theme, explaining its scope, meaning, and significance.

Step 6: Producing the Report

In this step, the researcher wrote a narrative explanation that connects the themes to the research questions and objectives.

One of the main advantages of thematic analysis is its flexibility, as it can be applied in various research settings and theoretical frameworks (Naeem, Ozuem, Howell & Ranfagni, 2023). In the context of this study on the use of big data by the City of Tshwane's Department of Economic Development and Spatial Planning, thematic analysis offers a structured approach to uncovering the patterns, challenges, and opportunities that shape how big data is utilized for decision making to improve service delivery.

4.2 ETHICAL CONSIDERATIONS

Research projects should strictly adhere to ethical guidelines when dealing with human participants (Cohen, Manion, & Morison, 2007). Interviews are considered private due to the time and sensitivity of questions, requiring a high standard of ethical consideration (Alshenqeeti, 2014). Several ethical considerations were observed by the researcher in this study and the following sub-sections explore the ethical dimensions that were considered. The study was conducted within the rules that govern research at Unisa. This study was acknowledged through written approval from the College of Science, Engineering and Technology Ethics Committee at Unisa. A copy of the approval letter can be acquired from the researcher upon formal request.

4.2.1 Consent

Informed consent is a willing decision made after having enough information and comprehension of the suggested research and its consequences (Spriggs & Gillam, 2008). Informed consent is one of the founding principles of research ethics. This study was open to all and participation was voluntary. Consent should be obtained before the participant can participate in the research and there must be no undue influence on participants to consent (Kang & Hwang, 2021)

The participants in this study were given a written consent form to sign. They were also informed that participating before or during the interview is not mandatory and that they can abandon participating in the research before or during the interview. However, the participants were informed that they could not withdraw their answers when the interview was completed, or the research was completed.

4.2.2 Confidentiality

Research should always maintain a high level of confidentiality during its execution to ensure the privacy and security of participants' information (Khoa, Hung & Hejsalem-Brahmi, 2023). In this research, participants were given the right to have their names kept confidential and only the researcher and identified team members would know about their involvement in the research. The researcher ensured participant confidentiality during interviews and advised the participants not to disclose personal or sensitive information.

4.2.3 Privacy

Privacy is a fundamental ethical consideration when collecting data from participants during research (Pina, Ramos, Jorge, Váz, Silva, Wanzeller, Abbasi & Martins, 2024.). To ensure privacy of the data, code numbers were assigned to interview responses to allow the researcher to examine them. Only authorized research personnel had access to participant records to ensure that sensitive data remained secure throughout the study. The research findings may be published, but participants' identities will remain confidential, with aliases used instead of real names. This method maintains the ethical obligation of researchers to safeguard participants' privacy and creating a reliable atmosphere where participants are assured that their participation will not lead to unintended breaches of confidentiality (Kang & Hwang, 2021).

4.2.4 Security

4.2.4.1 Data Security

Data security in research involves protecting research data from unauthorized access, theft, alteration or loss by encrypting data, restricting access to authorized personnel, securely storing data, and anonymizing sensitive information (Farayola, Olorunfemi & Shoetan, 2024). Data security is a critical aspect of ensuring the integrity and confidentiality of research information (Shukla, George, Tiwari & Kureethara, 2022). In this study, all interviews were recorded and the files for them were encrypted and kept on an external hard drive that had a password. The hard drive was then securely locked in a cabinet within the researcher's office to prevent unauthorized access. This approach guarantees that sensitive data is shielded from potential breaches and safeguarded against loss or tampering. Should the stored data be required for future use, it will undergo an additional ethics review and approval process to ensure compliance with privacy and security standards. Furthermore, when the data is no longer needed, it will be permanently deleted from the storage device using specialized software, thus upholding the highest standards of data security throughout the research process.

4.2.4.2 Participants Safety and Security

Participant safety and security are fundamental ethical principles in any research study (Bhalerao, Hamilton, McDonald, Redmiles & Strohmayer, 2022.). In this study, the researcher ensured that participants were informed about the potential risks and the measures implemented to protect their well-being. The researcher ensured that participants did not experience any harm

or adverse effects due to their involvement. To further enhance their comfort and reduce any potential stress, participants were encouraged to choose a comfortable, quiet space for the interviews to minimize distractions and ensure a relaxed environment. Interviews were conducted in the participants' workplaces which is a familiar setting that minimized any discomfort or disruption. This allowed participants to engage freely and openly. These measures were put in place to ensure that the safety, security, and overall experience of participants were prioritized throughout the research process.

4.3 SUMMARY OF CHAPTER

This chapter gave an overview of research philosophy, research approach, research strategy, data collection methods and ethical considerations. Interpretivism was selected as the research philosophy, a qualitative research approach was selected, a case study was selected as the research strategy, and semi-structured interviews were selected as the method to collect data. The chapter concludes by giving an overview of the ethics that were considered during the study. The chapter that follows is the data analysis and discussion of findings.

CHAPTER 5 DATA ANALYSIS AND DISCUSSION OF FINDINGS

5.1 INTRODUCTION

This chapter presents the analysis and discussion of findings obtained from semi-structured interviews conducted in the City of Tshwane (CoT). The purpose of the analysis is to address the research questions and objectives outlined in Chapter 1 regarding the use of big data to support informed decision-making within the municipality. The researcher collected data by conducting one-on-one interviews with the research participants to achieve these objectives. The analysis followed a thematic method by familiarizing with the data, generating initial codes, searching for themes, reviewing themes, defining, naming themes and producing the report. This analysis resulted in the four themes below emerging from the study and each theme was discussed using Structuration Theory's dimensions of structure, modality, and interaction to allow the findings to be analysed.

Theme 1: Knowledge and understanding of big data
Theme 2: How big data is managed to improve decision-making
Theme 3: Big data governance
Theme 4: Impact of management decisions

5.2 THEME 1: KNOWLEDGE AND UNDERSTANDING OF BIG DATA

This theme focuses on how big data is understood within the CoT. It looks at how participants make sense of big data and whether this understanding influences how decisions are made in practice. The results indicate an increasing understanding of big data in the CoT, however, this understanding remains largely theoretical, and it is not yet integrated into the everyday operations of the municipality. While participants recognize the potential of big data, the municipality's ability to act on this understanding is constrained without skills development, training programmes and analytical roles for the effective use of big data. The theme is examined using structuration theory to show how shared knowledge, skills, and practices influence the use of big data for improved decision-making.

5.2.1 Structure

Signification

The benefit that arises from utilising big data technology in the CoT will demonstrate the significance of big data decision making. This analysis of data suggests that big data's importance is acknowledged inside the organisational structure to improve operations and services. The participants have a narrative that supports this view. Participant 2's record that big data can be used to spot patterns and make informed decisions shows an understanding that big data can be leveraged to provide the organisation strategic value. Participant 3′s comment regarding making sure data is compliant also demonstrates big data means more than just information something that can be used to draw insights but also must be managed appropriately. These narratives provide evidence that big data has been accepted in CoT.

> For example, the population is a big data. The city here where I work, Tshwane for example, a number of complaints that can come, for example, water, energy, they are putting in a very huge system and people do attend. There is also data, for example, on our city population, you need to probably manipulate it, that you can retrain. So big data for me is really about the new oil, this aspect that ordinary people have never paid attention to mostly, except maybe big companies who want to lead into an economy, like customer behaviour of customers probably in a shop they want to look at the huge population out of which they can synthesise and take data and trends or analysis of that to determine their marketing, for example, strategy and profits and see where they're going wrong. (P2).

> [CoT] Organisation will benefit in this approach. Number one is data compliance. As I said, there's some environmental regulations that we need to adhere to when it comes to data and information we need to protect data that must be protected. We need to make accessible and available data that must be there. (P3).

Domination

The consistency with which participants expressed confidence in big data's potential indicates a form of domination through shared beliefs and strategic aspirations. This common belief may influence the CoT's decision-making procedures and the strategies of projects related to big data. Participant 2 explicitly points out that data is often used for limited purposes without recognising its broader analytical potential. Participant 1's reference to the city's strategic vision further demonstrates how big data initiatives align with broader organisational objectives.

> You only use it for one purpose, not knowing it can be integrated or it can be analysed. It can be synthesised into something that is more meaningful to improve the policy strategy of the city and even budgeting. (P2)

> So, our vision as a city is to be a prosperous capital city through fairness, freedom and opportunity. So once all of this is done, whether it is big data, whether it is another, say, smart city strategy, whether it is any other strategy, eventually we must all converge towards a prosperous capital city. (P1)

Legitimation

Participants clearly recognise the value of big data and this shared confidence highlights its importance while creating a supportive environment for future big data initiatives and contributions. However, to ensure the appropriate and effective use of big data, it is crucial to adhere to policies, rules, and procedures that govern the use of data. Legitimation of big data practices requires compliance with established data governance frameworks and privacy regulations, such as the Protection of Personal Information Act (POPIA). This compliance ensures that data is collected, managed, and applied ethically and transparently.

> Like I said, there are some environmental regulations that we need to adhere to when it comes to data and information. We need to protect data that must be protected. We need to make accessible and available data that must be there. (P3)

> We also adhere to acts like by promotion of access to information act. So if people need to have access to this information, let's make sure they have it. Usually, such an information is an integrated information, integrated data. So that's why when we establish this unit and provide it with its relevant applications or tools of trade in the form of systems or applications. (P3)

5.2.2 Modality

Interpretive Scheme

Participants' acceptance of the value of big data indicates an evolving interpretive scheme within the CoT, where data is viewed as a tool for to improve planning, budgeting, and strategic decision-making. This influences how information is perceived, understood, and utilised.

> Yes, we are on the project of creating one platform where we can integrate data from all the various sources. I mean we've got over 70 systems or applications that are used in day-to-day operations. So, we need to provide one common platform where we can source data from their raw or primary resources and integrate it at the enterprise level. That's what we'll be establishing.(P3)

> So big data is really about the new oil, this aspect that ordinary people have never paid attention to mostly, except maybe big companies who want to lead into an economy, like customer behaviour of customers probably in a shop they want to look at the huge population out of which they can synthesise and take data and trends or analysis of that to determine their marketing. For example, for strategy and profits and see where they're going wrong. Also for their service level complaints and also where they can innovate around so that they can get the value for money. (P2)

Facility

The data revealed that advanced data analysis tools and technologies improve the analysis of complex datasets. This leads to better policy formulation and budget allocation. Furthermore, the ability to integrate and utilize these technologies would reflect the CoT's competence in harnessing big data for decision making. Participants demonstrated that while there is recognition of the potential of big data in the CoT, there are significant challenges in terms of technology, communication, tools, and procedures. From a ST perspective, facilities function as supporting modalities only when accompanied by appropriate organisational aligned structures. According to Giddens (1984), the analytical skills function as key modalities that mediate between structural resources and practical interactions and where such modalities are weak, the data will fail to change established decision-making routines.

> Currently, we operate in silos, every system, every system owner. There is no accountability for data or big data at the enterprise level and organisational level. Now the reason why we bring this is because they are TOE, Technological, Organisational and Environmental drivers. I mean, we've picked up that in every application there is a BI, Business Intelligence or a reporting functionality built in it. But there's nowhere where we've got a platform to integrate all the data. Secondly, as an organization, we need to do what we call rationalization of resources. We have invested so much or we keep on investing so much in the licenses of all these applications. (P3)

Norm

In the CoT, there is an expectation for departments to measure customer satisfaction and report on big data usage regularly. However, there is a lack of a standardized approach to these practices across departments. There transparency issues and uneven sharing of public big data information create inconsistency in communication which results silos to persist.

management.

> So, the fact that we don't have an enterprise data management, enterprise data governance might be because we don't have an enterprise data leader. We know some mature organisations probably in the private sector, they've got chief data, analytics officers SCD, OT chief data officers as CDO people who are held accountable to make sure that data is managed within.(P3)

> Currently, we operate in silos, every system, every system owner. There is no accountability for data or big data at the enterprise level and organisational level. Now the reason why we bring this is because they are how they’re quality OE, technological, organisational and environmental. (P3)

5.2.3 Interaction

Communication

There is limited collaboration between departments in the CoT and the acknowledgement of big data's unrealised potential gives emphasis to communication within the CoT regarding the importance of using and synthesising data for informed strategic decisions and operations.

> So, the fact that we don't have an enterprise data management, enterprise data governance might be because we don't have an enterprise data leader. We know some mature organisations probably in the private sector, they've got chief data, analytics officers SCD, OT chief data officers as CDO people who are held accountable to make sure that data is managed within.(P3)

> Currently, we operate in silos, every system, every system owner. There is no accountability for data or big data at the enterprise level and organisational level. Now the reason why we bring this is because they are how they're quality OE, technological, organisational and environmental. (P3)

Power

In the CoT, decision making authority is primarily held by senior management. They are responsible for making critical decisions regarding which data is prioritized and how it is used in the decision-making process. As a result, certain ways of analysing data are prioritised, while other perspectives receive less attention.

> So in future whoever come with, they need to say no, I need a system that will help me analyze this and will spend money on that one system for the city,and the decision makers will be given appropriate accurate integrated information that will make them spend, invest or avoid spending unnecessarily (P3).

Sanction

The sanctions in the CoT concerning the use of big data are not explicitly defined. While there are expectations

> Currently, there doesn't seem to be any formal system in place to enforce compliance to data management protocols here in the city, I do not know of any. (P5)

5.3 THEME 2: HOW BIG DATA IS MANAGED TO IMPROVE DECISION MAKING

*This theme contributes directly to **Objective 3** by examining how big data is managed within the municipal environment and how management practices affect its use in decision-making. The focus is on operational and technical arrangements, including system integration, data ownership, and coordination across departments. Using a Structuration Theory lens, the discussion considers how structural resources (such as IT infrastructure), interpretive modalities, and interactional practices shape the effectiveness of big data management and its ability to support informed decision-making.*

5.3.1 Structure

Signification

The highlighted lack of data integration within the CoT signifies the importance of data in decision making processes. It indicates that data holds a critical role that is not fully realised within the organisational structure and therefore it is important to have structured and accessible data management processes. Thus, the meaning attached to big data is present in the CoT, but it is not yet firmly set in the organisation's everyday structures and practices.

> Currently, we operate in silos, every system, every system owner. There is no accountability for data or big data at the enterprise level and organisational level. Now the reason why we bring this is because they are how they're quality OE, technological, organisational and environmental. (P3)

> My thing is that, since we are quite heavily dependent on each other, we might need to break all the silos. This is one of the findings we did when we did survey in the city that people are so attached to their functionality and so cocooned that they do not even see the benefits of integrating or communicating with another department which is your service department by the way. You just get that data, you use it, you submit. It is like an arm swing, you just submit. If I take this data and that data and that data and that data, I am able to make this story which if I was to come back, all these departments are struggling. (P2)

> So, the fact that we don't have an enterprise data management, enterprise data governance might be because we don't have an enterprise data leader. We know some mature organisations probably in the private sector, they've got chief data, analytics officers SCD, OT chief data officers as CDO people who are held accountable to make sure that data is managed within.(P3)

Domination

The lack of data integration within the CoT suggests that existing traditional systems and methods of using data are preventing effective data utilization. While this might be established protocols or limitations in data accessibility within the organisation, participants expressed concerns expressed regarding the current inaccessibility of data where existing systems or barriers prevent smooth data access.

Legitimation

There is recognition of underutilised data for addressing and resolving municipality challenges which highlights the necessity for improved data integration within the CoT. This recognition may support future initiatives aiming at improving data utilisation..

> There is a programme that is actually supposed to be championed by ICT [Information and Communications Technology department at CoT] that the colleagues that you were interviewing they are working on, hand in hand with National Treasury. But in the department where I am

> coming from, the acting group had facilitated that process of integrating data. I know there are projects such as that one, which I am not involved in. (P1)

> Like I said, there's some environmental regulations that we need to adhere to when it comes to data and information we need to protect data that must be protected. We need to make accessible and available data that must be there. (P3)

5.3.2 Modality

Interpretive Scheme

Participants' concerns about who can access data and how sensitive information should be protected highlight the need to balance between openness and security. It is essential to address this balance for redesigning data management practices within the municipality in a way that supports more integrated and effective decision-solving.

> Now I have business intelligence (BI) solution and behind the scenes will be the data engineering for the creation of the data pipelines, data streaming, linking with the data sources and doing data governance. Who must get which role, who must get which access, and then how do you do the analytics? One common platform to save the cost in duplication and then how do you visualise how do you prepare reports and dashboards to their respective consumers or researchers? (P2)

Facility

The acknowledgement of the potential benefits of integrating Statistical Analysis System (SAS) and police data indicates a desire for increased capability within the CoT to utilise diverse datasets for decision making to address the municipality issues effectively. Although there is some awareness of future integrated solutions, the city's technical infrastructure remains underdeveloped and not yet able to fully support big data decision-making. Studies also indicate that without integrated and accessible infrastructure, organisations remain limited to descriptive reporting rather than predictive and prescriptive analytics (Mikalef et al., 2019.

> Even the systems that you see as the city residents, like the eTshwane, you've got our data there. You can utilise the data to make some decisions. That is fine. But I do not think research is done there. We also need to integrate data nationally. Like the SAS data, police data to know where crime is happening in the city. What are the drivers of that? (P2)

Norm

There is no uniform approach to data management across the municipality. This leads to inconsistencies in how data is collected, stored, and analyzed. This lack of standardization delays the overall effectiveness and integration of big data across departments.

> In my organization, we don't necessarily correlate big data. We just collect data. So the reason for establishing my unit was because there is no enterprise big data system or big data collection.

> Whatever data collection that is happening is happening in the various operational systems are operational solutions (P3).

5.3.3 Interaction

Communication

Communication within the CoT concerning big data management lacks consistency. There is an absence of consistent communication channels across the municipality. This reduces the sharing of insights and affects inter-departmental collaboration on big data initiatives. Furthermore, some departments rely on external providers to analyse the data.

> Interesting enough, it is the Bureau of Marketing and Research (BMR) from Unisa. They are the service provider that manage render the service on our behalf. So how they collect data from various regions. They interview businesses and the diplomats, as you know, we have diplomats in this, in the city. (P1)

> …the Bureau of Marketing and Research the ones responsible for collecting and analysing it [data]. They go out, do groundwork come back, feed it to the system and analyse it. And then they will then give us the data as analysed, not raw. (P1)

Power

Power over big data in the CoT is distributed across departments with each department having independence over its data collection and usage. This decentralized control leads to inconsistencies in how data is handled and analyzed by limiting the overall effectiveness of big data initiatives.

> …for example, one department might be focus on collecting data from businesses, while another might focus on gathering information from communities or users. Because each department works independently. (P6)

Sanction

There is no evidence of established formal sanctions or penalties to ensure compliance with data management protocols.

> Currently, there doesn't seem to be any formal system in place to enforce compliance to data management protocols here in the city. (P5)

> I have never seen that the governance, the enterprise management thereof as I don't feel it. People have never seen it, a communication that says people are not allowed to copy organisational data and take it somewhere, meaning that data may be easily entering and leaving the organisation. So, our floodgates are open not tight enough for compliance. That is the management part of it. (P3)

5.4 THEME 3: BIG DATA GOVERNANCE

*This theme supports **Objectives 2 and 3** by analysing governance arrangements that regulate how big data is accessed, protected, and used within the City of Tshwane. The discussion focuses on formal rules, regulatory compliance, and governance responsibilities, as well as how these are interpreted and enacted in practice. Drawing on Structuration Theory, the theme examines governance as a structuring mechanism that both legitimises data use and constrains analytical flexibility, influencing how big data is incorporated into decision-making processes.*

5.4.1 Structure

Signification

The data shows that the CoT, as one of South Africa's largest municipalities, produces vast amount of data. Participants highlighted the need for proper governance considering that big data is a resource that can be used to enhance decision making.

> So big data for me is really about the new oil, this aspect that ordinary people have never paid attention to mostly, except maybe big companies who want to lead in the economy, like customer behaviour of customers probably in a shop they want to look at the huge population out of which they can synthesise and take data and trends or analysis to determine their marketing, for example, strategy and profits and see where they're going wrong. (P2)

Domination

The power to govern and manage big data is concentrated at the executive level. Senior management sets the policies and decisions regarding how data is used across departments, but the implementation and oversight of these decisions are decentralized. This top-down approach influences how big data is governed where executives control the strategic direction while individual departments manage operational execution.

> We just collect data. So the reason for establishing my unit was because there is no enterprise big data system or big data collection. Whatever data collection that is happening is happening in the various operational systems are operational solutions (P3).

> Yes, we are on the project of creating one platform where we can integrate data from all the various sources. I mean we've got over 70 systems or applications that are used in day-to-day operations. So, we need to provide one common platform where we can source data from their raw or primary resources and integrate it at the enterprise level. That's what we'll be establishing.(P3)

Legitimation

Big data governance within the City of Tshwane (CoT) is achieved by adhering to national regulations such as the Protection of Personal Information Act (POPIA), and the municipality's internal policies. These frameworks establish a foundation for transparency and accountability in the collection, storage, and utilization of big data. This ensures that data management practices comply with legal and ethical standards.

> There is now POPIA which then protects them [CoT Management personnel]. But you say, it is my data, it is the city. But they say, no, you cannot use it because we are the consumers. They are now exposing us. To some of the biggest users, probably, EXCO might want to come and then say, you are the big users, how then do you sort of plug it? So, there are a lot of things. (P2)

> And procedures that say we need to govern data. I'm going to mention just two. One is the protection of personal information so if we are to protect the personal information, it will just be difficult to manage this through the various departments. If you don't have a centralised voice. (P3)

5.4.2 Modality

Interpretive Scheme

Participants highlighted that the big data strategy indicates an interpretive scheme within the CoT that values centralised data management. Governance is seen by decision-makers as a way to dismantle silos and encourage collaboration across departments which will facilitating an efficient use of data for decision making.

> I believe that managers must facilitate this process of big data, because I think it will help us use data more efficiently for decision making (P4)

Facility

There is a need to carefully control how data is accessed and shared and the municipality needs to develop better processes to manage the complexities of data governance while respecting existing regulations and individual data ownership.

> The Bureau of Marketing and Research the ones responsible for collecting and analysing it [data]. They go out, do groundwork come back, feed it to the system and analyse it. And then they will then give us the data as analysed, not raw. (P1)

> But in the long run, the city intends to build a capable organisational structure advertised to get skilled people and provide enough budget to get them to get and keep such skills, and also acquire technologies that are appropriate for the cause (P3)

Norm

Although departments are expected to follow data privacy and sharing rules, inconsistent enforcement means that big data governance within the municipality is still developing. Since these standards are not yet part of daily practice, there are no clear consequences for non-compliance.

5.4.3 Interaction

Communication

There is an ongoing discussion in the CoT about the challenges of managing data access and a growing awareness of the complexities of data governance and the need to comply with regulations such as POPIA.

> There is now POPIA which then protects them [CoT Management personnel]. But you say, it is my data, it is the city. But they say, no, you cannot use it because we are the consumers. They are now exposing us. To some of the biggest users, probably, EXCO might want to come and then say, you are the big users, how then do you sort of plug it? So, there are a lot of things. (P2)

> And procedures that say we need to govern data. I'm going to mention just two. One is the protection of personal information so if we are to protect the personal information, it will just be difficult to manage this through the various departments. If you don't have a centralised voice. (P3)

Power

There is an underlying tension within the CoT where the need to respect individual data ownership sits parallel to the city's growing dependence on data for its work and this points to the already ongoing negotiations about who controls data and who is responsible for how it is used.

> Yes, and of course, it is not everyone who understand this big data in the city. It is something that is lacking form managers. I think there should be awareness about it. I mean, there is already so much that the city is doing to improve its services using data. (P7)

Sanction

Participants acknowledge the existing regulations like POPIA and the need to balance data ownership sanctions within the CoT that approves specific approaches to data privacy and ethical considerations.

> There is now POPIA which then protects them [CoT Management personnel]. But you say, it is my data, it is the city. But they say, no, you cannot use it because we are the consumers. They are now exposing us. To some of the biggest users, probably, EXCO might want to come and

then say, you are the big users, how then do you sort of plug it? So, there are a lot of things. (P2)

And procedures that say we need to govern data. I'm going to mention just two. One is the protection of personal information so if we are to protect the personal information, it will just be difficult to manage this through the various departments. If you don't have a centralised voice. (P3)

5.5 THEME 4: IMPACT OF MANAGEMENT DECISIONS

*This theme is central to understanding how big data influences organisational outcomes and is closely aligned with **Objectives 2 and 3**, which examine management practices and the use of big data in decision-making. The discussion focuses on how management decisions related to resources, priorities, and organisational direction shape the extent to which big data informs decision-making. Using Structuration Theory, the theme analyses management decisions through the interaction of structure (resource constraints), modality (beliefs about data value), and interaction (power, communication, and accountability), while also considering the implications for organisational and citizen-level impact*

5.5.1 Structure

Signification

The findings show that limited resources and funding remain major obstacles to innovation within the city. They also highlight that stronger financial support is essential if the city is to encourage innovation and advance its technological capabilities.

Yes [CoT benefiting from big data], then we do cost benefits on all business assets. Hopefully, with that so I am speaking first. It might save the city much more money. (P2)

"One common platform to save the cost of duplication and then, how do you visualise. how do you prepare reports and dashboards to their respective consumers or researchers? (P3)

Domination

Participant 6 acknowledges how the city's progress can be delayed when decision-making power lies with leaders who are cautious and slow to act. Thus, the control of budgets and priorities by management determines whether big data initiatives progress or stall.

I also think we have a big issue with decision making in our workplace or maybe it is something to do with budget. I mean, we are an urban city but we seem to lack that someone who will come and make important decisions. Because this is also delaying or own progress as employees (P6)

Legitimation

There is an acknowledgement of the need to explore potential of big data for its integration into the decision-making processes and mainly within the framework of rules and regulations governing its use. As the world adopt data-driven approaches to make decisions, the CoT also has an opportunity to align with regulatory standards and best practices that ensure ethical use of big data.

> [CoT] Organisation will benefit in this approach. Number one is data compliance. As I said, there's some environmental regulations that we need to adhere to when it comes to data and information we need to protect data that must be protected. We need to make accessible and available data that must be there. (P3).

5.5.2 Modality

Interpretive Scheme

There is s general believe that the city can reduce costs and enhance services by using big data management approaches to better understand the requirements of their residents, fight fraud, reduce system failures, and improve operations.

> But the problem is they are not just capturing it in the right way, utilising, analysing it and disposing and getting value out of it. This is what I think is the problem. And then in terms of service delivery, because our research is mostly on service delivery, how is this going to assist an ordinary person? So, for us, we would know consumption patterns and in what areas the services are being consumed more and are we doing it in an efficient way? (P2)

Facility

This research shows a lack of capability within the city to finance innovation adequately. It suggests a need for improved financial strategies to secure funding for technological initiatives. A study conducted by Zheng et al. (2018) also shows that public sector organizations frequently find it difficult to justify investment in long term big data technologies because of immediate economic constraints. In contrast with the private sector that uses big data to gain a competitive maximise the return on investment (ROI), the public sector applies big data mainly to support non-profit goals such as improving policies and delivering services that benefit society (Vasilyeva & Richardson, 2022). This means that although the participants recognised the potential benefit in saving costs, the absence of a formal ROI frameworks limits strategic decision making by management.

> It is a shame that the city could have learned better and improved their service, probably pushed by that impossibility of human mobility to do things digitally, to save money which we do not have. So, the city is aware of the amount of data that is being produced but it is not utilising it properly. It could be lack of knowledge of the importance of big data, number one. Lack of leadership to drive that computer.(P2)

Norm

The CoT is one of the biggest municipalities in South Africa and therefore has the potential to have even more data at their disposal. With the big data strategy that the city is working to have a single data hub, the right to access and publish that information will have to be effectively managed.

5.5.3 Interaction

Communication

This research indicates communication gaps within management regarding the prioritisation of awareness and implementation of new technology and data frameworks. It emphasizes the need for better communication and coordination within the management to drive these initiatives effectively.

> I also think we have a big issue with decision making in our workplace or maybe it is something to do with budget. I mean, we are an urban city but we seem to lack that someone who will come and make important decisions. Because this is also delaying or own progress as employees (P6)

Power

This research reveals a power dynamic within the city that is suggesting potential barriers in consolidating efforts to prioritise awareness and implementation of big data technologies. It might involve decision making challenges or power struggles hindering effective management coordination.

> It is a cycle because you know what you are supposed to do, you know where the hurdles are, but your hands are tied because you do not have control over the purse. And there is only a limited amount of funds. So, you need to see how you manoeuvre that. Which service do you leave out? Are you going to provide a high-grade road or are you going to provide just the minimum, third road? That means the minimum standard, but it is not a world-class standard, which after 10 years it is rooted. So those are the tough decisions that you make with the limited resources. (P1)

Sanction

The CoT lacks clear sanctions for delayed services due to management actions. While departments are expected to follow data governance protocols and report customer satisfaction, the absence of formal penalties or incentives leads to inconsistent compliance.

> Currently, there doesn't seem to be any formal system in place to enforce compliance to data management protocols here in the city, I do not know of any. (P5)

5.6 SUMMARY OF FINDINGS

These themes collectively highlight how perceptions, beliefs and recognition of big data's potential shape the organisational dynamics within the CoT, influencing decision making processes, and potentially leading to changes in operational approaches. There is a clear recognition of the importance of data accuracy and timeliness in decision making. The findings collectively illustrate the organisational dynamics and the significance of structured data access, management, and compliance within the organisation. They also point towards potential shifts in approaches to data accessibility, protection and the influence of legal and ethical considerations in decision making processes.

5.7 SUMMARY OF CHAPTER

This chapter explored how data was gathered from semi-structured interviews conducted with employees in the CoT municipality. The goal was to assess the use of big data within the City for decision making. The interpretation of the findings in this study highlights the complex dynamics of big data in the public sector, providing valuable insights into both its potential and the challenges that lie ahead as big data continues to shape the City's future. The next chapter presents the interpretations of findings and recommendations.

CHAPTER 6 INTERPRETATION OF FINDINGS AND RECOMMENDATIONS

6.1 INTRODUCTION

The chapter introduces the research findings according to existing literature in relevant areas. It provides a comprehensive interpretation of the research results, clarifying their meaning and implications. The main aim of this study is to determine how big data can be used to improve service delivery in South African municipalities to enable citizen satisfaction. According to the findings, the following challenges must be resolved first for big data to enable informed support decision making.

6.1.1 Knowledge and understanding of big data

In this modern age, data is an asset and therefore it is important to understand big data concepts and technologies to effectively collect, manage, analyse and use big data. This knowledge includes understanding the different types of big data, how to collect and store big data, how to analyse big data using different tools and techniques, and how to interpret and use big data findings to make informed decisions. There is a lot of variation in how well public sector employees around the world know and comprehend big data. Some public sector employees may have a thorough grasp of big data ideas, tools, and uses, while others may have little or no understanding or appreciation of its possible advantages and effects (Mikalef, Boura, Lekakos, & Krogstie, 2019).

While this research has shown that the CoT generates massive volumes of data from its various municipal service delivery systems, it has also shown that the CoT generally have enough knowledge about big data. It is also believed that the full implementation of big data frameworks can benefit the CoT by enhancing the services that CoT offers, both to its own staff and to the public

6.1.2 How big data is managed to support decision making

This study has shown that the CoT is struggling to efficiently use big data to solve problems. Participants in this study expressed concerns about the limited integration of data within the CoT and its inadequate utilisation in problem-solving activities. This finding is consistent with

other research done in different contexts, which also highlight the need for strong data integration processes for public sector administration. The collaboration of various electronics and technology products support governments efforts to adopt or implement better and more efficient usage of big data (Anwar, Handoko, Rafi, & Lestari, 2022). Therefore, municipalities in South Africa are also being urged to prioritize initiatives aimed at improving data integration processes, which include updating protocols and removing barriers to data accessibility, allowing for more efficient information flow across departments and functions.

6.1.3 Big data governance in the CoT

It is important to create comprehensive standards and processes for overseeing and handling big data operations in organisations. This involves providing explicit instructions for accessing and using data appropriately to ensure dependability and coherence. Furthermore, complying with environmental regulations and data protection standards are essential steps to justify the need for data safeguards. However, the regulation of big data has often relied on the protection and restriction of standard concepts such as privacy, informed consent, and risk management (McMahon, Buyx, & Prainsack, 2020).

The study has revealed that it is imperative to control the access and publication of data, which means that the CoT needs to have more capacity or ability to deal with the challenges of data governance, while taking into account the current regulations and the data ownership of each individual. This highlights the importance of following legal and ethical guidelines in managing and accessing data to preserve trust and integrity. Wiltshire and Alvanides (2022) add that it is important to use data in a way that's both legal and fair by ensuring that it does not accidentally reveal information to unintended recipients. By implementing these recommendations, the CoT can improve data accessibility, integrity and utilisation while maintaining compliance with regulations and fostering innovation in data management practices.

6.1.4 The type of big data that is produced and interpreted

Big data is generated from various sources like transaction data, customer data, economic data, government databases, weather, seismic data, locations and maps, social media, and market research among others (Blazquez, & Domenech, 2018). Since the CoT is a public sector organisation, the study has revealed the most of its big data come from its customer and transactional data. The city has also shown dedication to using technology to improve public services and the well-being of its people through various e-government initiatives and these e-

government efforts generate large amounts of data. Thus, the vast amount of data produced at the CoT are mainly transactional and customer data.

6.1.5 Knowledge, skills, attitude, and appropriate management practices

There is a lack of evidence on how knowledge, skills and attitudes influence big data practices within the organisation. To harness the potential of big data effectively, municipalities must equip themselves with the necessary skills for data collection, management, analysis and communication. This includes proficiency in data mining, analysis, visualisation, and the ability to convey findings clearly. A positive attitude towards big data, along with a willingness to embrace change and learn new skills can further enhance its utilisation. In addition, establishing data governance policies is crucial to ensure responsible and ethical use of big data resources. Therefore, it is recommended that CoT invest in developing robust data management systems, fostering a culture of continuous learning and adaptation, and implementing governance frameworks to optimise the use of big data for informed decision making and improved service delivery.

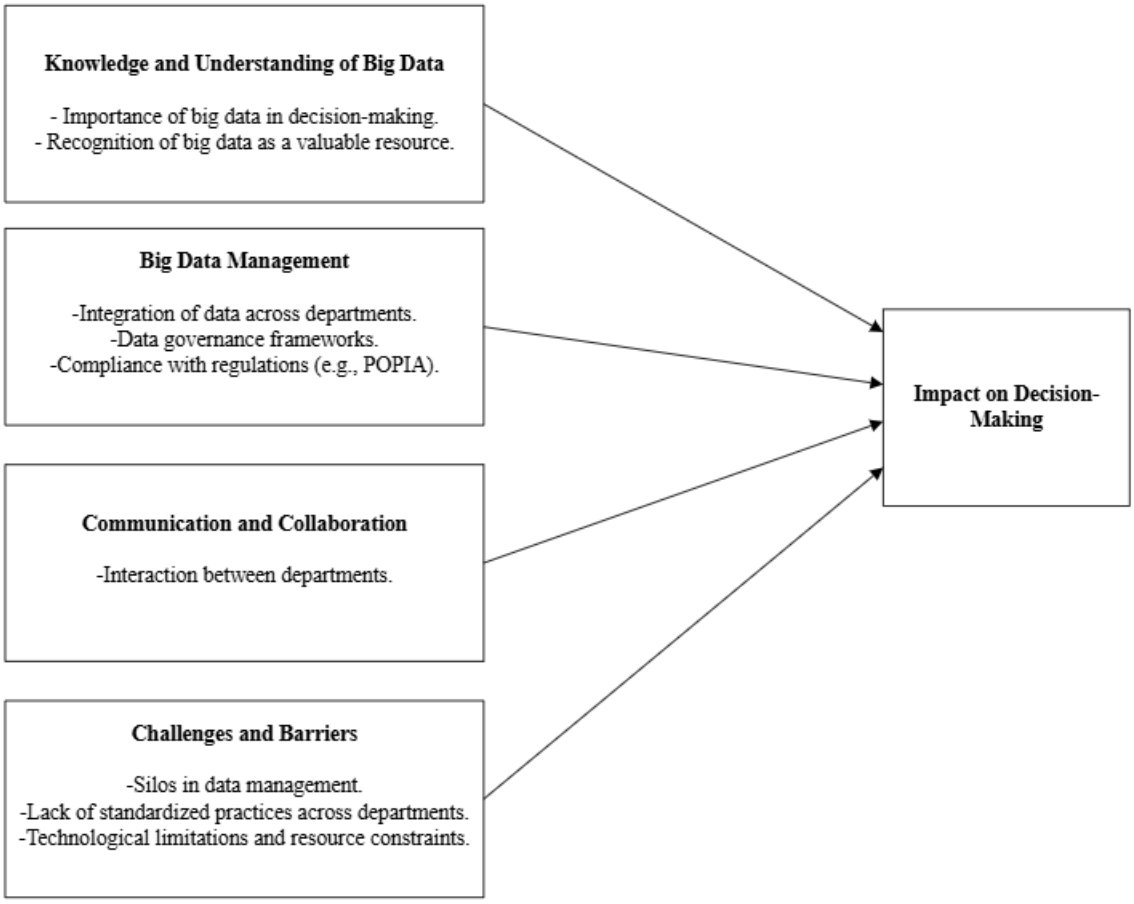
6.1.6 Impact of management decisions in the CoT

A very important feature of big data is how it affects the way decisions are made and who has the power to make them. The results of the study show a power imbalance within the CoT administration that could create difficulties for making awareness and implementation efforts more important. These difficulties may appear as challenges or conflicts in making decisions, affecting efficient management coordination. However, despite these possible barriers, the constant expression of confidence in big data among participants shows a group within the administration supporting data-driven initiatives. Therefore, it is suggested that attempts be made to deal with and navigate these power imbalances using the support for data-driven approaches to improve decision making processes and enable effective coordination within the administration.

6.2 CONCEPTUALISED FRAMEWORK FOR MUNICIPALITIES

A conceptualised framework for big data informed by the empirical evidence and the interpretation of findings was developed as illustrated in Figure 6.1.

Figure 6.1 Actual Conceptualised Framework



6.2.1 Knowledge and Understanding of Big Data

6.2.1.1 Importance of Big Data in Decision making

Municipalities are increasingly acknowledging the value of big data in enhancing decision making processes. By leveraging comprehensive knowledge of big data, municipalities can make well-informed, data-driven decisions that enhance resource allocation, service delivery, and operational efficiency.

6.2.1.2 Recognition of Big Data as a Valuable Resource

It is crucial for municipalities to view big data as a strategic asset and acknowledging its value empowers stakeholders to invest in the necessary infrastructure and training required to fully harness its capabilities. This recognition enables effective use of big data to deal with challenges in municipality and enhance services delivery.

6.2.2 Big Data Management

6.2.2.1 Integration of Data Across Departments

The effective use of big data requires integration across different municipal departments. This integration provides decision-makers with a complete view of all available data which is important for thorough analysis and informed decision making.

6.2.2.2 Data Governance Frameworks

Municipalities are required to develop robust data governance frameworks to ensure that there is ethical management of data in accordance with regulatory requirements. These frameworks establish guidelines for data utilization and ensure that all practices conform to standards.

6.2.2.3 Compliance with Regulations (e.g., POPIA)

It is important to comply to legal frameworks like the Protection of Personal Information Act (POPIA) to safeguard the privacy of individuals. Municipalities need to establish policies and practices that deal with data security and privacy concerns.

6.2.3 Communication and Collaboration

6.2.3.1 Interaction Between Departments

Effective communication and collaboration between departments are crucial for dismantling silos and facilitating the exchange of insights and data. This promotes a collaborative culture where departments work collectively towards shared a common goal. By establishing open communication channels, municipalities can ensure that decision-makers have access to complete information which will result in more accurate and informed decisions from the data.

6.2.4 Challenges and Barriers

6.2.4.1 Silos in Data Management

A major challenge to using big data effectively is the presence of silos within municipal departments. When data remains isolated within individual departments and is not shared, it restricts comprehensive analysis and informed decision making. Overcoming these silos is essential for fully leveraging the benefits of big data.

6.2.4.2 Lack of Standardized Practices Across Departments

Inconsistencies arise from how various departments perform data collection, storage, and analysis differently in municipalities. When standardizing these practices throughout the municipality, the data becomes comparable and useful across the entire organization.

6.2.4.3 Technological Limitations and Resource Constraints

Municipalities often face challenges related to outdated technology and insufficient resources for investing in necessary infrastructure for big data management. These limitations can prevent municipalities from effectively harnessing the full potential of big data, thereby impeding progress in service delivery improvements.

6.2.5 Impact on Decision Making

Using big data can significantly improve service delivery. The level of management commitment to big data utilization is crucial for its success. When management supports the use of data and allocates necessary resources, it becomes a part of municipal operations and this promotes a culture that values data-driven decision making that is recognised globally.

6.3 SUMMARY OF CHAPTER

This chapter provided a comprehensive understanding of how perceptions, challenges and potential opportunities surrounding big data shape the organisational structure and decision making processes within the CoT, offering valuable insights for future strategies and implementations. The chapter that follows is the evaluation of the research.

CHAPTER 7 EVALUATION OF RESEARCH

7.1 INTRODUCTION

This chapter concludes the study with an evaluation of the research. The primary goal of this research was to investigate the influence of big data utilisation on public sector governance in the framework of the CoT. The study applied a qualitative approach, a case study design, semi-structured interviews, and thematic analysis to collect and analyse data from empirical sources. The research resulted in the creation of a conceptual framework for the use of big data in South African municipalities. The structuration theory helped to improve our knowledge of how big data is used in the public sector. The analysis finds that the CoT has data integration issues, with operational systems missing a dedicated big data management platform. Despite this, the municipality is eager to implement big data technologies, providing practical evidence of the obstacles and benefits of incorporating big data into the public sector. The following section provides an overview of the research study and the final portion contains concluding observations regarding the research, as well as recommendations for how to proceed with this specific research issue.

7.2 OVERVIEW OF THE RESEARCH

This section is intended to remind the reader of the dissertation's structure and the contents of the chapters. The chapters are summarised below.

Chapter 1 introduced the research and explained why it was carried out. It provided a short background to the research problem, then stated the problem, the research aim, and objectives, as well as the research questions.

Chapter 2 presented the literature based on past research relevant to the subject. The case serves as a data source. The chapter defined the big data context, how big data is collected and analysed, and the overall benefits of using big data to make decisions.

Chapter 3 explored the theory that underpins the research: structuration theory. This chapter described ST, its various components, how it connects to this study, and why it was chosen as a lens for this research.

Chapter 4 discussed the research methodology and philosophy used in the study, informing the reader about various methods and philosophies that are suitable for ISs research.

Chapter 5 dealt with the analysis of acquired data and discoveries made by the researcher through semi-structured interviews with CoT personnel. ST was used to analyse the data according to predetermined themes.

Chapter 6 reviewed the results from Chapter 5 and then proposed some ways to enhance the present condition, as well as a theoretical model that can be applied in order to maximise the advantages of using big data technologies.

Chapter 7 concluded the study with an overview and evaluation of the research.

7.3 REVIEW OF THE RESEARCH PROBLEM

Big data analytics aids governments in understanding citizen demands, combating fraud, addressing system faults, improving operations, reducing costs and enhancing services. This research study was concerned with the use of big data in a South African municipality setting. The South African service delivery protests necessitate municipalities to enhance efficiency and speed in service delivery. The main research problem was that, despite the global benefits of big data, there is limited research on its potential role in improving service delivery in South African municipalities. This research problem statement has highlighted the need to investigate how big data can be employed to enhance service delivery in South African municipalities. The research addressed the identified gaps and conducted comprehensive research which will provide valuable insights for municipalities seeking to improve their services and address citizen concerns.

The following gaps were identified:

1. Decision making backed by big data in South African municipalities is new: Although other countries have utilized big data to enhance service delivery, research on its implementation within South African municipalities remains limited. Exploring this application could provide valuable insights for improving municipal services and addressing local challenges effectively.
2. Public awareness, knowledge, and benefits of big data in South African municipalities: It is essential to engage the public and foster collaboration between municipalities and

communities for the effective utilization of big data. By promoting transparency and inclusivity, municipalities can build trust and ensure that big data initiatives align with community needs. This collaborative approach also facilitates the creation of innovative solutions and therefore improving service delivery and enhancing the overall quality of governance.

- Resource Availability: The availability of resources is fundamental to the successful implementation of big data initiatives. To effectively manage and interpret big data, adequate financial investment is essential to purchase advanced technologies, tools and the necessary infrastructure for data collection, storage, and analysis. In addition, skilled personnel are crucial to effectively manage and interpret big data, ensuring that meaningful insights are derived. Without sufficient resources, municipalities may encounter challenges in adopting big data solutions which may result in missed opportunities for enhancing service delivery and decision making processes.

7.4 HOW RESEARCH QUESTIONS ADDRESS THE RESEARCH PROBLEM

This research was undertaken to address the preliminary research question: How do municipalities in South Africa use big data analytics to enable citizen satisfaction? Three secondary questions were used to assist in answering the primary question. The research questions are discussed below.

7.4.1 How preliminary research question was supported by sub-questions

The first question is *'What type of big data is produced to be accessed and used by municipalities in South Africa?'* A conclusion was made that the CoT produces mass volumes of data from the systems initiated such as eTshwane to provide municipal services. These systems collect information such as customer names, addresses, payment history and preferences.

The second question is *'What type of big data is produced to be accessed and used by municipalities in South Africa to assist in decision making?'* The CoT generates a massive amount of data through ICT activities such as eTshwane, aimed at med at facilitating municipal service delivery. These initiatives systematically store a variety of information such as customer names, addresses, payment history and preferences. As the use of these services expands, so

does data collection, requiring the city to actively use these resources to improve the decision making process.

The third question is '*How do the requisite knowledge, skills, attitude and appropriate management practices influence big data use in South African Municipalities for decision making?'* The study found that there is a lack of data integration within various departments within the City. The City does not have a big data management system in place. Therefore, there is currently no evidence of how knowledge, skills and attitudes influence big data in the CoT. The study did, however, demonstrate the City's readiness to embrace big data technologies and a unit is currently being established to tackle the challenge of drawing conclusions based on the vast amount of data collected by the city through its various ICT initiatives. Presently, the Bureau of Marketing and Research (BMR) conducts data analysis. This entity processes data from various City departments and delivers the final analysis to the City management responsible for decision making.

7.5 EVALUATION OF RESEARCH METHODOLOGY

7.5.1 Why a case study approach was relevant for this study

The main aim of this study was to determine how big data can be used to improve service delivery in South African municipalities to enable citizen satisfaction. A case study approach was suitable for this study as it provided a comprehensive understanding of the study, considering the social factors associated with this research. The case study research managed to provide concrete, contextual and in-depth knowledge about big data use in the public sector.

7.5.2 Appropriateness of unit of analysis

The CoT was chosen because of its spike in service delivery protests, despite being the second-largest municipality in Gauteng province, the richest and South Africa's fastest-expanding economic region.

7.5.3 Appropriateness of data collection technique

This study used semi-structured interviews to collect relevant data that can be analysed. This method was appropriate as it gave the researcher the freedom to invite the respondent to elaborate or take a different turn when responding to how the CoT is using big data. The

research focused on the Department of Economic Development and Spatial Planning's officials whose responsibility is to make sure that service delivery takes place seamlessly and participants were selected based on the positions they occupy within the municipality.

7.5.4 Appropriateness of analysis method

Thematic analysis was conducted for the qualitative data obtained from interviews, identifying recurring themes related to challenges, perceptions and opportunities concerning the use of big data in the CoT. Thematic analysis was appropriate as it offered flexibility, accessibility, transparency and the ability to generate data-driven insights.

7.6 CONTRIBUTIONS

This study contributes to our understanding of the question of how South African municipalities have accessed and implemented big data to assist in the decision making for service delivery. This study extends the literature on ST and reveals the strong position that ST holds on how it provides ways for understanding the interaction of social and technological aspects of IS in analysing social phenomena.

The experiences through the application of a case study strategy, an interpretive approach and procedures constitute the primary methodological contribution of this work. These insights could be helpful to other IS research projects that seek to employ these techniques to enhance government service delivery through the use of big data. The study also highlighted how crucial it is to comprehend staff tasks, technology, organisational influence, and skill sets in the public sector before implementing big data.

7.7 IMPLICATIONS

The research findings have practical implications for municipal policymakers, highlighting the importance of integrating data sources, addressing data privacy concerns, enhancing data literacy among stakeholders, and investing in robust data infrastructure for the effective utilisation of big data in decision making processes. The recommendations derived from this research hold promise, although the implementation may face challenges related to resource allocation, organisational structures and technology. In order to overcome these barriers, strategies that require careful consideration by municipal authorities must be considered.

7.8 LIMITATIONS

The research study covered only one urban municipality in South Africa and aimed to find out how big data was used for decision making. Further research is required to examine the importance and benefit of ST to create big data research frameworks in the public sector.

7.9 CONCLUSION

The findings of this research were integrated to provide a complete understanding of the nature of big data in public sector organisations. This integration allowed for a cohesive interpretation of the implications of big data adoption in South African municipalities. Based on the findings, recommendations are made to strengthen the data governance framework to foster collaboration among departments in the CoT in order to optimise the benefits of big data in municipal settings.

REFERENCES

Abbasi, A., Sarker, S. & Chiang, R.H., 2016. Big data research in information systems: Toward an inclusive research agenda. *Journal of the Association for Information Systems*, 17(2), p.3.

Vasilyeva, O. and Richardson, A., 2022. Big data and data analytics for enhanced decision-making in the public sector.

Egala, S. B., Alhassan, A. H. S., & Boakye, J. A. (2025, May). Unleashing public sector innovation: Exploring the impact of big data analytics and value-driven capabilities on digital governance. In Conference on Digital Government Research (Vol. 26).

Yoshikuni, A.C., Dwivedi, R., Zhou, D. and Wamba, S.F., 2023. Big data and business analytics enabled innovation and dynamic capabilities in organizations: Developing and validating scale. International Journal of Information Management Data Insights, 3(2), p.100206.

Magakwe, J., 2025. Advancing governance: Role of data analytics in driving evidence-based decision-making in public administration. In Recent advances in public sector management. IntechOpen.

Li, L., Lin, J., Ouyang, Y. and Luo, X.R., 2022. Evaluating the impact of big data analytics usage on the decision-making quality of organizations. Technological Forecasting and Social Change, 175, p.121355.

Latupeirissa, J.J.P., Dewi, N.L.Y., Prayana, I.K.R., Srikandi, M.B., Ramadiansyah, S.A. and Pramana, I.B.G.A.Y., 2024. Transforming public service delivery: A comprehensive review of digitization initiatives. Sustainability, 16(7), p.2818.

Jerab, D. and Mabrouk, T., 2023. The role of leadership in changing organizational culture. Available at SSRN 4574324.

Aldossary, M.A. and Pardaev, J., 2025. Leveraging Big-Data Management for Production Excellence: Decision-Making Capabilities, Decision Quality, and the Moderating Effect of Manufacturing IT Infrastructure. Reports in Mechanical Engineering, 6(1), pp.136-151.

Hossin, M.A., Du, J., Mu, L. and Asante, I.O., 2023. Big data-driven public policy decisions: Transformation toward smart governance. Sage Open, 13(4), p.21582440231215123.

Turlapati, V.R., Vichitra, P., Raval, N., Khaja Mohinuddeen, J. and Mishra, B.R., 2024. Ethical implications of artificial intelligence in business decision-making: A framework for responsible AI adoption. Journal of Informatics Education and Research, 4(1), pp.530-537.

Chatterjee, S., Chaudhuri, R., Gupta, S., Sivarajah, U. and Bag, S., 2023. Assessing the impact of big data analytics on decision-making processes, forecasting, and performance of a firm. Technological Forecasting and Social Change, 196, p.122824.

Jerab, D., 2023. How to be an effective leader in decision making in an unstable environment. Available at SSRN 4525803.

El-Haddadeh, R., Fadlalla, A. and Hindi, N.M., 2025. Big data analytics adoption success: value chain process-level perspective. Business Process Management Journal, 31(2), pp.686-707.

El-Astal, M., Allaymoun, M. and Mustafa, A.Y., 2025. What is big data? building a fuller understanding of the term. *Int. J. Innov. Res. Sci. Stud*, *8*, pp.2610-2617.

Udeh, E.O., Amajuoyi, P., Adeusi, K.B. and Scott, A.O., 2024. The role of big data in detecting and preventing financial fraud in digital transactions. World Journal of Advanced Research and Reviews, 22(2), pp.1746-1760.

Tzika-Kostopoulou, D., Nathanail, E. and Kokkinos, K., 2024. Big data in transportation: a systematic literature analysis and topic classification. Knowledge and Information Systems, 66(8), pp.5021-5046.

Schuilenburg, M. and Soudijn, M., 2023. Big data policing: The use of big data and algorithms by the Netherlands Police. Policing: A Journal of Policy and Practice, 17, p.paad061.

Vance, T.C., Huang, T. and Butler, K.A., 2024. Big data in Earth science: Emerging practice and promise. Science, 383(6688), p.eadh9607.

Selowa, K.T., Ilorah, A.I. and Mokwena, S.N., 2022. Using Big Data analytics tool to influence decision making in higher education: A case of South African Technical and Vocational Education and Training colleges. South African Journal of Information Management, 24(1), p.1489.

OECD (2024) Global trends in government innovation 2024: data-powered public services. Paris: OECD Publishing. Available at: https://www.oecd.org/en/publications/global-trends-in-government-innovation-2024_c1bc19c3-en.pdf

(Accessed: 8 February 2026

van der Hoogen, A., Fashoro, I., Calitz, A.P. and Luke, L., 2024. A digital transformation framework for smart municipalities. Sustainability, 16(3), p.1320.

Bunyula, L., Lungisa, S. and Mathentamo, Q., 2025. Municipal employee perceptions on the use of artificial intelligence to perform their work. South African Journal of Economic and Management Sciences, 28(1), p.6203.

Mofokeng, S., Ramolobe, K.S. and Bogopa, D.L., 2025. Assessing the impact of digital technologies on service delivery in local government. Journal of Local Government Research and Innovation, 6, p.234.

Basha, S.A.K., Basha, S.M., Vincent, D.R. and Rajput, D.S., 2019. Challenges in storing and processing big data using Hadoop and Spark. In Deep Learning and Parallel Computing Environment for Bioengineering Systems (pp. 179-187). Academic Press.

Gathu, S., 2024. High-performance computing and big data: Emerging trends in advanced computing systems for data-intensive applications. Journal of Advanced Computing Systems, 4(8), pp.22-35.

Mudzunga, P.P., Adeyelure, T.S. and Kalema, B.M., 2025. Factors influencing Big Data governance in enhanced service delivery in South African public sector. South African Journal of Information Management, 27(1), p.1931.

Bruintjies, A.N. and Njenga, J., 2024. Factors affecting Big Data adoption in a government organisation in the Western Cape. South African Journal of Information Management, 26(1), p.1690.

Abdalla, H.B., 2022. A brief survey on big data: technologies, terminologies and data-intensive applications. Journal of Big Data, 9(1), p.107.

Ilmudeen, A., 2022. Artificial intelligence, big data analytics and big data processing for IoT-based sensing data. In Transforming management with AI, big-data, and IoT (pp. 247-259). Cham: Springer International Publishing.

Abed, A.H., 2024. The Applications of Deep Learning Algorithms for Enhancing Big Data Processing Accuracy. *International Journal of Advanced Networking and Applications (IJANA)*, 16(02), pp.6332-6341.

Abkenar, S.B., Kashani, M.H., Mahdipour, E. and Jameii, S.M., 2021. Big data analytics meets social media: A systematic review of techniques, open issues, and future directions. *Telematics and Informatics*, 57, p.101517.

Adams, R., Adeleke, F., Anderson, D., Bawa, A., Branson, N., Christoffels, A., Vries, J.D., Etheredge, H., Flack-Davison, E., Gaffley, M. and Marks, M., 2021. POPIA code of conduct for research. *South African Journal of Science*, 117(5-6), pp.1-12.

Ahmed, N., Barczak, A.L., Susnjak, T. & Rashid, M.A., 2020. A comprehensive performance analysis of Apache Hadoop and Apache Spark for large scale data sets using HiBench. *Journal of Big Data*, 7(1), p.110.

Akinnagbe, A., Peiris, K.D.A. and Akinloye, O., 2018. Prospects of big data analytics in Africa healthcare system. *Global Journal of Health Science*, 10(6), p.114.

Akter, S. & Wamba, S.F., 2016. Big data analytics in E-commerce: A systematic review and agenda for future research. *Electronic Markets*, 26(2), pp.173-194.

Al-Ababneh, M.M., 2020. Linking ontology, epistemology and research methodology. *Science & Philosophy*, 8(1), pp.75-91.

Alharahsheh, H.H. & Pius, A., 2020. A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, 2(3), pp.39-43.

Alharthi, A., Krotov, V., & Bowman, M., 2017. Addressing barriers to big data. *Business Horizons*, 60(3), pp.285–292.

Ali, I.M., Jusoh, Y.Y., Abdullah, R. & Nor, R.N.H., 2018. A review on the performance measurement of big data analytics process. *Journal of Fundamental and Applied Sciences*, 10(2S), pp.103-115.

Alonso-Garcia, J., Pablo-Martí, F. & Nunez-Barriopedro, E., 2021. Omnichannel Management in a B2B context: Concept, research agenda and bibliometric review. *International Journal of Industrial Engineering and Management*, 12(1), pp.37.

Al-Sai, Z.A. & Abualigah, L.M., 2017, May. Big data and E-government: A review. In *2017 8th International Conference on Information Technology (ICIT)*, pp.580-587.

Alshenqeeti, H., 2014. Interviewing as a data collection method: A critical review. *English Linguistics Research*, 3(1), pp.39-45.

Amusa, L.B., Twinomurinzi, H., Phalane, E. and Phaswana-Mafuya, R.N., 2023. Big Data and Infectious Disease Epidemiology: Bibliometric Analysis and Research Agenda. *Interactive Journal of Medical Research*, 12(1), p.e42292.

Andrade, C., 2021. The inconvenient truth about convenience and purposive samples. *Indian Journal of Psychological Medicine*, 43(1), pp.86-88.

Anna, K. & Nikolay, K., 2015. Survey on big data analytics in the public sector of the Russian Federation. *Procedia Computer Science*, 55, pp.905-911.

Arundel, A., Bloch, C. & Ferguson, B., 2018. Advancing innovation in the public sector: Aligning innovation measurement with policy goals. *Research Policy*.

Asasfeh, A., Tarawneh, L., Pradhan, M.R. and Al-Dmour, N.A., 2024, February. Privacy and security concerns in big data. In *2024 2nd International Conference on Cyber Resilience (ICCR)*, pp. 1-5. IEEE.

Assiri, F., 2020. Methods for assessing, predicting, and improving data veracity: A survey. *ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal*, 9(4), p.5.

Awan, U., Shamim, S., Khan, Z., Zia, N.U., Shariq, S.M. and Khan, M.N., 2021. Big data analytics capability and decision making: The role of data-driven insight on circular economy performance. *Technological Forecasting and Social Change*, 168, p.120766.

Awrahman, B.J., Aziz Fatah, C. and Hamaamin, M.Y., 2022. A review of the role and challenges of big data in healthcare informatics and analytics. *Computational Intelligence and Neuroscience*, 2022(1), p.5317760.

Bag, S., Pretorius, J.H.C., Gupta, S. and Dwivedi, Y.K., 2021. Role of institutional pressures and resources in the adoption of big data analytics powered artificial intelligence, sustainable manufacturing practices, and circular economy capabilities. *Technological Forecasting and Social Change*, 163, p.120420.

Barnes, T.J., 2013. Big data, little history. *Dialogues in Human Geography*, 3(3), pp.297-302.

Batko, K. and Ślęzak, A., 2022. The use of big data analytics in healthcare. *Journal of Big Data*, 9(1), p.3.

Bertot, J.C., Gorham, U., Jaeger, P.T., Sarin, L.C. & Choi, H., 2014. Big data, open government, and e-government: Issues, policies, and recommendations. *Information Polity*, 19(1-2), pp.5-16.

Bhalerao, R., Hamilton, V., McDonald, A., Redmiles, E.M. and Strohmayer, A., 2022, June. Ethical practices for security research with at-risk populations. In *2022 IEEE European Symposium on Security and Privacy Workshops (EuroS&PW)*, pp. 546-553. IEEE.

Bharadiya, J.P., 2023. The role of machine learning in transforming business intelligence. *International Journal of Computing and Artificial Intelligence*, 4(1), pp.16-24.

Blazquez, D. & Domenech, J., 2018. Big data sources and methods for social and economic analyses. *Technological Forecasting and Social Change*, 130, pp.99-113.

Boppiniti, S.T., 2021. Real-time data analytics with AI: Leveraging stream processing for dynamic decision support. *International Journal of Management Education for Sustainable Development*, 4(4).

Boyle, L. & Staines, I., 2019. Overview and analysis of Cape Town's digital city strategy. Shava, E. and Hofisi, C., 2017. Challenges and opportunities for public administration in the fourth industrial revolution. *African Journal of Public Affairs*, 9(9), pp.203-215.

Braun, V. & Clarke, V., 2012. Thematic analysis. In H. Cooper, ed. *APA Handbook of Research Methods in Psychology, Vol 2: Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological*. Washington, DC: American Psychological Association, pp.57-71.

Braun, V. & Clarke, V., 2021. To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health*, 13(2), pp.201-216.

Breakfast, N., Bradshaw, G. & Nomarwayi, T., 2019. Violent service delivery protests in post-apartheid South Africa, 1994–2017: A conflict resolution perspective. *African Journal of Public Affairs*, 11(1), pp.106-126.

Breakfast, N.B., Nomarwayi, T. & Bradshaw, G., 2020. Electoral violence and municipal demarcation in South Africa, 1994-2019: A violent service delivery protests perspective. *Gender and Behaviour*, 18(1), pp.14857-14871.

Bruintjies, A.N. & Njenga, J., 2024. Factors affecting big data adoption in a government organisation in the Western Cape. *South African Journal of Information Management*, 26(1), p.1690.

Bryman, A., 2016. *Social research methods*. 5th ed. Oxford: Oxford University Press.

Bula, M.Y., 2023. Research design and methodology for empirical research. In M.Y. Bula, ed. *Transnational Communication and Identity Construction in Diaspora: A Comparative Analysis of Four Diaspora Communities from the Horn of Africa*. Wiesbaden: Springer Fachmedien Wiesbaden, pp.125-158.

Burns, R.W. & Badiali, B.J., 2015. When supervision is conflated with evaluation: Teacher candidates' perceptions of their novice supervisor. *Action in Teacher Education*, 37(4), pp.418-437.

Busetto, L., Wick, W. & Gumbinger, C., 2020. How to use and assess qualitative research methods. *Neurological Research and Practice*, 2(1), pp.1-10.

Bustamante, D. & Clark, W.E., 2021. What is 'big data' anyway? *Florida State University Libraries Blog*. Available at: https://fsulibraryblog.example.com [Accessed 9 August 2023].

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D. & Walker, K., 2020. Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, 25(8), pp.652-661.

Castleberry, A. & Nolen, A., 2018. Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning*, 10(6), pp.807-815.

Cavanillas, J.M., Curry, E. & Wahlster, W., 2016. The big data value opportunity. In J.M. Cavanillas, E. Curry & W. Wahlster, eds. *New Horizons for a Data-Driven Economy*. Cham: Springer, pp.3-14. https://doi.org/10.1007/978-3-319-21569-3_1

Cecchinel, C., Jimenez, M., Mosser, S. & Riveill, M., 2014. An architecture to support the collection of big data in the Internet of Things. In *2014 IEEE World Congress on Services*, pp.442-449. IEEE.

Chakraborty, S. & Dey, L., 2023. Impact of big data and cloud computing on data analysis. In S. Chakraborty & L. Dey, eds. *Computing for Data Analysis: Theory and Practices*. Singapore: Springer Nature Singapore, pp.23-49.

Chang, V., 2021. An ethical framework for big data and smart cities. *Technological Forecasting and Social Change*, 165, p.120559.

Chatterjee, I., Kunwar, J. & den Hond, F., 2019. Anthony Giddens and structuration theory. In I. Chatterjee, J. Kunwar & F. den Hond, eds. *Management, Organizations and Contemporary Social Theory*. London: Routledge, pp.60-79.

Chen, C.P. & Zhang, C.Y., 2014. Data-intensive applications, challenges, techniques and technologies: A survey on big data. *Information Sciences*, 275, pp.314-347.

Chen, J., Ramanathan, L. & Alazab, M., 2021. Holistic big data integrated artificial intelligent modeling to improve privacy and security in data management of smart cities. *Microprocessors and Microsystems*, 81, p.103722.

Chen, M., Mao, S. & Liu, Y., 2014. Big data: A survey. *Mobile Networks and Applications*, 19, pp.171-209.

Christou, P.A., 2022. How to use thematic analysis in qualitative research. *Journal of Qualitative Research in Tourism*, 3(2), pp.79-95.

Cilliers, I., 2022. How can governments become data-driven organisations? Available at: https://mg.co.za/article/2022-08-10-how-can-governments-become-data-driven-organisations/ [Accessed 9 August 2023].

City of Tshwane (n.d.). Available at: https://www.tshwane.gov.za [Accessed 9 November 2024].

City of Tshwane, 2023. 2023–2024 Review of the 2022-2026 Integrated Development Plan. Pretoria: City of Tshwane. Available at: https://www.tshwane.gov.za [Accessed 30 October 2024].

Cleland, J.A., 2017. The qualitative orientation in medical education research. *Korean Journal of Medical Education*, 29(2), pp.61-71.

Cohen, D. & Crabtree, B., 2008. Qualitative Research Guidelines Project. Available at: http://www.qualres.org/index.html [Accessed 22 August 2020].

Cohen, L., Manion, L. & Morrison, K., 2007. *Research Methods in Education*. 6th ed. London: Routledge.

Cooper, H.E., Camic, P.M., Long, D.L., Panter, A.T., Rindskopf, D.E. & Sher, K.J., 2012. *APA Handbook of Research Methods in Psychology, Vol 2: Research Designs: Quantitative, Qualitative, Neuropsychological, and Biological*. Washington, DC: American Psychological Association.

Corsi, A., de Souza, F.F., Pagani, R.N. & Kovaleski, J.L., 2021. Big data analytics as a tool for fighting pandemics: A systematic review of literature. *Journal of Ambient Intelligence and Humanized Computing*, 12(10), pp.9163-9180.

Cowley, R., Joss, S. & Dayot, Y., 2018. The smart city and its publics: Insights from across six UK cities. *Urban Research & Practice*, 11(1), pp.53-77.

Cronin, P., Ryan, F. & Coughlan, M., 2008. Undertaking a literature review: A step-by-step approach. *British Journal of Nursing*, 17(1), pp.38-43.

CSIR, 2020. Data revolution: The gold rush of the information age [Online]. Available at: https://www.csir.co.za/data-revolution-gold-rush-information-age [Accessed: 27 September 2022].

Cuthbertson, L.M., Robb, Y.A. & Blair, S., 2020. Theory and application of research principles and philosophical underpinning for a study utilising interpretative phenomenological analysis. *Radiography*, 26(2), pp.e94-e102.

Das, M., Ester, P. & Kaczmirek, L. (eds.), Year. *Social and Behavioural Research and the Internet: Advances in Applied Methods and Research Strategies*. Routledge, pp.105–132.

De Mauro, A., Greco, M. & Grimaldi, M., 2015. What is big data? A consensual definition and a review of key research topics. *AIP Conference Proceedings*, 1644(1), pp.97-104.

De Mauro, A., Greco, M., Grimaldi, M. & Ritala, P., 2018. Human resources for Big Data professions: A systematic classification of job roles and required skill sets. *Information Processing & Management*, 54(5), pp.807-817.

DeJonckheere, M. & Vaughn, L.M., 2019. Semi-structured interviewing in primary care research: A balance of relationship and rigour. *Family Medicine and Community Health*, 7(2), p.e000057.

Department of Cooperative Governance and Traditional Affairs (DCoG) & Council for Scientific and Industrial Research (CSIR), 2021. *A South African Smart Cities Framework: A decision making framework to guide the development of smart cities in South Africa*. Available at: [Provide full link if possible].

Department of Cooperative Governance and Traditional Affairs (n.d.). Local Government Legislation – Department of Cooperative Governance and Traditional Affairs. Available at: [Provide full link if possible].

Department of Home Affairs (n.d.). Available at: DHA - Home [Accessed 9 November 2024].

Dhlamini, M., 2023. Structuration analysis of collaboration in Big Data Analytics work practices in organizations.

Diamantoulakis, P.D., Kapinas, V.M. & Karagiannidis, G.K., 2015. Big data analytics for dynamic energy management in smart grids. *Big Data Research*, 2(3), pp.94-101.

Dlodlo, N., Olwal, T. & Mvelase, P., 2012. The Internet of Things in bridging the gap in municipal service delivery in South Africa. *IST Africa 2012*, Dar es Salaam, Tanzania, 9-11 May 2012.

Duggineni, S., 2023. Impact of controls on data integrity and information systems. *Science and Technology*, 13(2), pp.29-35.

Ede, C.I. & Jili, N.N., 2020. Service Delivery with Wanton Protests in Megalopolises, South Africa. *Indexing & Abstracting*, 1, pp.50-60.

Enaifoghe, A., 2022. Challenges of municipal service delivery and instruments for enhancing South African local government administration. *African Journal of Development Studies*, 12(3), p.105.

Faghmous, J.H., Kumar, V. & Shekhar, S. 2015. Computing and climate. *Computing in Science & Engineering*, 17(6), pp. 6–8.

Farayola, O.A., Olorunfemi, O.L. & Shoetan, P.O. 2024. Data privacy and security in IT: a review of techniques and challenges. *Computer Science & IT Research Journal*, 5(3), pp. 606–615.

Fasel, D. 2014. Potentials of big data for governmental services. *Proceedings of the 2014 First International Conference on eDemocracy & eGovernment (ICEDEG)*, 17–18 April, IEEE, pp. 17–18.

Ferretti, A., Ienca, M., Sheehan, M., Blasimme, A., Dove, E.S., Farsides, B., Friesen, P., Kahn, J., Karlen, W., Kleist, P. & Liao, S.M. 2021. Ethics review of big data research: What should stay and what should be reformed? *BMC Medical Ethics*, 22(1), p. 51.

Flyverbom, M., Deibert, R. & Matten, D. 2019. The governance of digital technology, big data, and the internet: New roles and responsibilities for business. *Business & Society*, 58(1), pp. 3–19.

Fransman, T. & von Fintel, M. 2024. Voting and protest tendencies associated with changes in service delivery. *Development Southern Africa*, 41(1), pp. 71–90.

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), pp. 39–62.

Fylan, F. 2005. Semi-structured interviewing. In J. Miles & P. Gilbert (eds.) *A handbook of research methods for clinical and health psychology*. Oxford: Oxford University Press, pp. 65–78.

Gamage, P. 2016. New development: Leveraging 'big data' analytics in the public sector. *Public Money & Management*, 36(5), pp. 385–390.

Ganesh, S. 2023. Top 10 countries leading the big data adoption in the year 2023. *Analytics Insight*. Available at: https://analyticsinsight.net/top-10-countries-leading-the-big-data-adoption-in-the-year-2023/ (Accessed: 9 August 2023).

Garcia, A. & Adams, J. 2023. Data-driven decision making: Leveraging analytics and AI for strategic advantage. *Research Studies of Business*, 1(2), pp. 77–85.

George, G., Haas, M.R. & Pentland, A. 2014. Big data and management. *Academy of Management Journal*, 57(2), pp. 321–326.

Gerring, J. 2004. What is a case study and what is it good for? *American Political Science Review*, 98(2), pp. 341–354.

Ghaffar, A. 2020. Integration of business intelligence dashboard for enhanced data analytics capabilities. *Unpublished manuscript.*

Giddens, A. 1984. *The constitution of society: Outline of the theory of structuration.* Berkeley: University of California Press.

Ginsberg, J., Mohebbi, M.H., Patel, R.S., Brammer, L., Smolinski, M.S. & Brilliant, L. 2009. Detecting influenza epidemics using search engine query data. *Nature*, 457(7232), pp. 1012–1014.

Guan, S., Zhang, C., Wang, Y. & Liu, W., 2024. Hadoop-based secure storage solution for big data in cloud computing environment. *Digital Communications and Networks*, 10(1), pp.227–236.

Guest, G., Namey, E. & Chen, M., 2020. A simple method to assess and report thematic saturation in qualitative research. *PloS One*, 15(5), p.e0232076.

Gwebityala, Z., Migwalla, R. & Myburgh, J., 2022. The Big Data Opportunity in the South African Public Sector. *Ntiyiso Consulting Group*. Available at: https://www.ntiyisoconsulting.co.za [Accessed 9 August 2023].

Habeeb, R.A.A., Nasaruddin, F., Gani, A., Hashem, I.A.T., Ahmed, E. & Imran, M., 2019. Real-time big data processing for anomaly detection: A survey. *International Journal of Information Management*, 45, pp.289–307.

Hackfort, D. & Schinke, R.J. (eds.), 2020. *The Routledge International Encyclopaedia of Sport and Exercise Psychology: Volume 1: Theoretical and Methodological Concepts*. London: Routledge.

Hajirahimova, M. & Aliyeva, A., 2017. Big data initiatives of developed countries. *Problems of Information Society*, 8(1), pp.10–19.

Hajjaji, Y., Boulila, W., Farah, I.R., Romdhani, I. & Hussain, A., 2021. Big data and IoT-based applications in smart environments: A systematic review. *Computer Science Review*, 39, p.100318.

Hancock, D.R., Algozzine, B. & Lim, J.H., 2021. *Doing case study research: A practical guide for beginning researchers*. London: Routledge.

Haneem, F., Kama, N., Taskin, N., Pauleen, D. & Bakar, N.A.A., 2019. Determinants of master data management adoption by local government organizations: An empirical study. *International Journal of Information Management*, 45, pp.25–43.

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), pp.1–16.

Hasan, M.K., Alkhalifah, A., Islam, S., Babiker, N.B., Habib, A.A., Aman, A.H.M. & Hossain, M.A., 2022. Blockchain technology on smart grid, energy trading, and big data: Security issues, challenges, and recommendations. *Wireless Communications and Mobile Computing*, 2022(1), p.9065768.

Hassa, I., 2020. The democratisation of decision-makers in data-driven decision making in a Big Data environment: The case of a financial services organisation in South Africa. Unpublished dissertation.

Heale, R. & Twycross, A., 2018. What is a case study? *Evidence-Based Nursing*, 21(1), pp.7–8.

Heinze, N. & Hu, Q., 2005. E-government research: A review via the lens of structuration theory. In *International Conference on Intelligent Computing*. Cham: Springer International Publishing, pp.684–697.

Hemlata, C. & Gulia, P., 2016. Big Data Analytics. *Research Journal of Computer and Information Technology Sciences*, 4(2), pp.1–4.

Hilbert, M., 2016. Big data for development: A review of promises and challenges. *Development Policy Review*, 34(1), pp.135–174.

Holloway, I. & Galvin, K. 2023. *Qualitative research in nursing and healthcare.* Chichester: John Wiley & Sons.

Hosseinzadeh, M., Azhir, E., Ahmed, O.H., Ghafour, M.Y., Ahmed, S.H., Rahmani, A.M. & Vo, B. 2023. Data cleansing mechanisms and approaches for big data analytics: a systematic study. *Journal of Ambient Intelligence and Humanized Computing*, pp. 1–13.

Hossin, M.A., Du, J., Mu, L. & Asante, I.O. 2023. Big data-driven public policy decisions: Transformation toward smart governance. *Sage Open*, 13(4), p. 21582440231215123.

Hunziker, S. & Blankenagel, M. 2024. Cross-sectional research design. In S. Hunziker & M. Blankenagel (eds.) *Research design in business and management: A practical guide for students and researchers.* Wiesbaden: Springer Fachmedien Wiesbaden, pp. 187–199.

Huyler, D. & McGill, C.M. 2019. Research design: Qualitative, quantitative, and mixed methods approaches, by John Creswell and J. David Creswell. Thousand Oaks, CA: Sage Publications, Inc., 275 pages, $67.00 (Paperback). *New Horizons in Adult Education & Human Resource Development*, 31(3).

Hwang, K. & Chen, M. 2017. *Big-data analytics for cloud, IoT, and cognitive computing.* Chichester: John Wiley & Sons.

Ikegwu, A.C., Nweke, H.F., Anikwe, C.V., Alo, U.R. & Okonkwo, O.R. 2022. Big data analytics for data-driven industry: A review of data sources, tools, challenges, solutions, and research directions. *Cluster Computing*, 25(5), pp. 3343–3387.

Ikram, M. & Kenayathulla, H.B. 2022. Out of touch: Comparing and contrasting positivism and interpretivism in social science. *Asian Journal of Research in Education and Social Sciences*, 4(2), pp. 39–49.

Ingrams, A. 2019. Public values in the age of big data: A public information perspective. *Policy & Internet*, 11(2), pp. 128–148.

Islam, M. 2020. Data analysis: Types, process, methods, techniques, and tools. *International Journal on Data Science and Technology*, 6(1), pp. 10–15.

Iyamu, T. 2020. Examining e-government enabling of e-health service through the lens of structuration theory. *International Journal of Sociotechnology and Knowledge Development*, 12(3), pp. 26–40.

Jackson, A.Y. & Mazzei, L.A. 2022. *Thinking with theory in qualitative research.* 2nd ed. Abingdon: Routledge.

Jakoet-Salie, A. 2020. E-government strategies in South Africa. *Administratio Publica*, 28(3), pp. 1–22.

Janssen, M., van der Voort, H. & Wahyudi, A. 2017. Factors influencing big data decision making quality. *Journal of Business Research*, 70, pp. 338–345.

Jensen, M.H. & Kadenic, M.D. 2024. Enhancing big data analytics deployment: Uncovering stakeholder dynamics and balancing salience in project roles. *Software Quality Journal*, pp. 1–25.

Jin, X., Wah, B.W., Cheng, X. & Wang, Y. 2015. Significance and challenges of big data research. *Big Data Research*, 2(2), pp. 59–64.

Johnson, A. & Nick, A., 2023. Big data: Security and privacy: Advanced challenges and solutions.

Johnson, J.A., Sanghvi, P. & Mehrotra, S., 2022. Technology-based interventions to improve help-seeking for mental health concerns: A systematic review. *Indian Journal of Psychological Medicine*, 44(4), pp.332–340.

Johnson, M., Jain, R., Brennan-Tonetta, P., Swartz, E., Silver, D., Paolini, J., Mamonov, S. & Hill, C., 2021. Impact of big data and artificial intelligence on industry: Developing a workforce roadmap for a data-driven economy. *Global Journal of Flexible Systems Management*, 22(3), pp.197–217.

Johnson, S.L., Gray, P. & Sarker, S., 2019. Revisiting IS research practice in the era of big data. *Information and Organization*, 29(1), pp.41–56.

Jones, M., 2019. What we talk about when we talk about (big) data. *The Journal of Strategic Information Systems*, 28(1), pp.3–16.

Jones, M.R. & Karsten, H., 2008. Giddens's structuration theory and information systems research. *MIS Quarterly*, 32(1), pp.127–157.

Joseph, J.E. & Williams, R., 2022. A retrospective analysis: ICT for improved municipal service delivery amidst COVID-19. *EUREKA: Social and Humanities*, 2, pp.70–85.

Josphineleela, R., Kaliappan, S., Natrayan, L. & Garg, A., 2023. Big data security through privacy–preserving data mining (PPDM): A decentralization approach. In *2023 Second International Conference on Electronics and Renewable Systems (ICEARS)*, pp.718–721. IEEE.

Joubert, A., Murawski, M. & Bick, M., 2023. Measuring the big data readiness of developing countries–Index development and its application to Africa. *Information Systems Frontiers*, 25(1), pp.327–350.

Kabanda, S. & Brown, I., 2017. A structuration analysis of Small and Medium Enterprise (SME) adoption of E-Commerce: The case of Tanzania. *Telematics and Informatics*, 34(4), pp.118–132.

Kabir, S.M.S., 2016. *Basic guidelines for research: An introductory approach for all disciplines*. Chittagong: Book Zone Publication.

Kaizer, R.M., Ntshangase, B.A. & Msosa, S.K., 2022. Development planning peculiarities in the City of Tshwane, South Africa: A case study. *Entrepreneurship and Sustainability Issues*, 10(1), p.282.

Kalema, B.M. & Mokgadi, M., 2017. Developing countries organizations' readiness for Big Data analytics. *Problems and Perspectives in Management*, 15(1), pp.260–270.

Kandt, J. & Batty, M., 2021. Smart cities, big data and urban policy: Towards urban analytics for the long run. *Cities*, 109, p.102992.

Kang, E. & Hwang, H.J., 2021. Ethical conducts in qualitative research methodology: Participant observation and interview process. *Journal of Research and Publication Ethics*, 2(2), pp.5–10.

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

Kankanhalli, A., Charalabidis, Y. & Mellouli, S. 2019. IoT and AI for smart government: A research agenda. *Government Information Quarterly*, 36(2), pp. 304–309.

Karunarathna, I., Gunasena, P., Hapuarachchi, T. & Gunathilake, S. 2024. The crucial role of data collection in research: Techniques, challenges, and best practices. *Uva Clinical Research*, pp. 1–24.

Kaya, M. & Yildirim, E. 2024. Strategic optimization of high-volume data management: Advanced techniques for enhancing scalability, efficiency, and reliability in large-scale distributed systems. *Journal of Intelligent Connectivity and Emerging Technologies*, 9(9), pp. 16–44.

Kgatle, M.S. 2018. The impact of the Vuwani protests on teaching and learning: Practical theological reflection. *Stellenbosch Theological Journal*, 4(1), pp. 247–266.

Khando, K., Islam, M.S. & Gao, S. 2022. The use of structuration theory in empirical information systems research: A systematic literature review. In *Conference on e-Business, e-Services and e-Society*, Springer, Cham, pp. 327–339.

Khine, P.P. & Shun, W.Z. 2017. Big data in government organizations: A review. In *2017 IEEE 2nd International Conference on Big Data Analysis (ICBDA)*, IEEE, pp. 426–431.

Khoa, B.T., Hung, B.P. & Hejsalem-Brahmi, M. 2023. Qualitative research in social sciences: Data collection, data analysis and report writing. *International Journal of Public Sector Performance Management*, 12(1-2), pp. 187–209.

Kitchin, R. 2021. *The Data Revolution: A critical analysis of big data, open data and data infrastructures.*

Kumari, A. 2022. A review of research process: Data collection and analysis. *Galaxy International Interdisciplinary Research Journal*, 10(5), pp. 771–780.

Laudon, K.C. & Laudon, J.P. 2004. Managing the digital firm. *Managing Information Systems*, pp. 197–200.

Lautenbach, P., Johnston, K. & Adeniran-Ogundipe, T. 2017. Factors influencing business intelligence and analytics usage extent in South African organisations. *South African Journal of Business Management*, 48(3), pp. 23–33.

Lavrov, I. & Koveshnikov, V. 2020. Big data usage by private and public sectors: Reality and prospects. *Journal of Society and the State*, 2(7), pp. 2020–7.

Lee, J.W. 2020. Big data strategies for government, society, and policy-making. *Journal of Asian Finance Economics and Business*, 7(7), pp. 475–487.

Lee, S.M., Hwang, T. & Choi, D. 2012. Open innovation in the public sector of leading countries. *Management Decision*, 50(1), pp. 147–162.

Lester, J.N., Cho, Y. & Lochmiller, C.R. 2020. Learning to do qualitative data analysis: A starting point. *Human Resource Development Review*, 19(1), pp. 94–106.

Li, W., Chai, Y., Khan, F., Jan, S.R.U., Verma, S., Menon, V.G., Kavita, F. & Li, X., 2021. A comprehensive survey on machine learning-based big data analytics for IoT-enabled smart healthcare system. *Mobile Networks and Applications*, 26, pp.234–252.

Li, Y., Yu, X. & Koudas, N., 2021. Data acquisition for improving machine learning models. *arXiv preprint arXiv:2105.14107*.

Liao, G., 2022. *The Evolution of Cloud Data Architectures: Storage, Compute, and Migration* (Doctoral dissertation, University of Maryland, College Park).

Lim, W.M., 2024. What is qualitative research? An overview and guidelines. *Australasian Marketing Journal*, p.14413582241264619.

Local Government: Municipal Structures Act, Act 117 of 1998, 2018. *South African Year Book 2018/2019: Government Systems*. Available from: https://www.gcis.gov.za/south-africa-yearbook-201819 [Accessed 27 September 2020].

Löfgren, K. & Webster, C.W.R., 2020. The value of Big Data in government: The case of 'smart cities'. *Big Data & Society*, 7(1), p.2053951720912775.

Louisa, T., Guicheney, W., Kyarisiima, H. & Zimani, T., 2016. Big Data in the Public Sector. Selected Applications and Lessons Learned. In *Inter-American Development Bank*, pp.345–364.

Lukes, S., 2021. Power and domination. In *Essays on Evolutions in the Study of Political Power*, pp.97–108. Routledge.

Lukomska, S.O., 2020. Integrative metatheoretical perspective of structuration interaction. *Materiały*, 79.

Lunde, T.Å., Sjusdal, A.P. & Pappas, I.O., 2019. Organizational culture challenges of adopting big data: A systematic literature review. In *Digital Transformation for a Sustainable Society in the 21st Century: 18th IFIP WG 6.11 Conference on e-Business, e-Services, and e-Society, I3E 2019*, pp.164–176. Springer International Publishing.

Lv, Z., Song, H., Basanta-Val, P., Steed, A. & Jo, M., 2017. Next-generation big data analytics: State of the art, challenges, and future research topics. *IEEE Transactions on Industrial Informatics*, 13(4), pp.1891–1899.

Maciejewski, M., 2017. To do more, better, faster and more cheaply: Using big data in public administration. *International Review of Administrative Sciences*, 83(1), pp.120–135.

Magagula, D.N., Mukonza, R.M., Manyaka, R.K. & Moeti, K., 2022. The role of district municipalities in service provision in South Africa: Dissecting challenges faced by Ehlanzeni District Municipality. *Africa's Public Service Delivery and Performance Review*, 10(1), p.628.

Maier, C., Thatcher, J.B., Grover, V. & Dwivedi, Y.K., 2023. Cross-sectional research: A critical perspective, use cases, and recommendations for IS research. *International Journal of Information Management*, 70, p.102625.

Malaka, I. & Brown, I., 2015. Challenges to the organisational adoption of big data analytics: A case study in the South African telecommunications industry. In *Proceedings of the September 2015 Annual Research Conference on South African Institute of Computer Scientists and Information Technologists*, pp.1–9.

Mamokhere, J. 2019. An exploration of reasons behind service delivery protests in South Africa: A case of Bolobedu South at the Greater Tzaneen Municipality. In *International Conference on Public Administration and Development Alternatives (IPADA)*.

Mamokhere, J. 2023. Sending a message to the top: the influence of service delivery protests on service delivery planning in South African municipalities. *Insights into Regional Development*, 5(2), pp. 60–71.

Manyika, J., Chui, M., Brown, B., Bughin, J., Dobbs, R., Roxburgh, C. & Hung Byers, A. 2011. *Big data: The next frontier for innovation, competition, and productivity*. McKinsey Global Institute.

Mariani, M.M. & Wamba, S.F. 2020. Exploring how consumer goods companies innovate in the digital age: The role of big data analytics companies. *Journal of Business Research*, 121, pp. 338–352.

Marzullo, K. 2016. Administration Issues Strategic Plan for Big Data Research and Development. Available at: Administration Issues Strategic Plan for Big Data Research and Development whitehouse.gov (Accessed: 9 August 2023).

Masiya, T., Davids, Y.D. & Mangai, M.S. 2019. Assessing service delivery: Public perception of municipal service delivery in South Africa.

Masuku, M.M. & Jili, N.N. 2019. Public service delivery in South Africa: The political influence at local government level. *Journal of Public Affairs*, 19(4), p. e1935.

Matsepe, N.T. & Van der Lingen, E. 2022. Determinants of emerging technologies adoption in the South African financial sector. *South African Journal of Business Management*, 53(1), p. 2493.

Mawela, T., Ochara, N.M. & Twinomurinzi, H. 2017. E-government implementation: A reflection on South African municipalities. *South African Computer Journal*, 29(1), pp. 147–171.

Mbanaso, U.M., Abrahams, L. & Okafor, K.C. 2023. Research philosophy, design and methodology. In *Research Techniques for Computer Science, Information Systems and Cybersecurity*, Springer Nature Switzerland, pp. 81–113.

Mbanyele, S.S. 2018. Marginalization as a source of insecurity: The securitization of service delivery protest in South Africa. *Doctoral dissertation*, University of Pretoria.

McMahon, A., Buyx, A. & Prainsack, B. 2020. Big data governance needs more collective responsibility: The role of harm mitigation in the governance of data use in medicine and beyond. *Med. L. Rev.*, 28, p. 155.

McPhee, R.D., Poole, M.S. & Iverson, J. 2014. Structuration theory. In *The SAGE Handbook of Organizational Communication: Advances in Theory, Research, and Methods*, 3, pp. 75–100.

Meijer, A.J. & Torenvlied, R. 2016. Social media and the new organization of government communications: An empirical analysis of Twitter usage by the Dutch police. *The American Review of Public Administration*, 46(2), pp. 143–161.

Merhi, M.I. & Bregu, K. 2020. Effective and efficient usage of big data analytics in public sector. *Transforming Government: People, Process and Policy*, 14(4), pp. 605–622.

Mikalef, P., Boura, M., Lekakos, G. & Krogstie, J., 2019. Big data analytics and firm performance: Findings from a mixed-method approach. *Journal of Business Research*, 98, pp.261–276.

Mikalef, P., Pappas, I.O., Krogstie, J. & Giannakos, M., 2018. Big data analytics capabilities: A systematic literature review and research agenda. *Information Systems and E-Business Management*, 16, pp.547–578.

Millham, R., Agbehadji, I.E. & Frimpong, S.O., 2021. The paradigm of fog computing with bio-inspired search methods and the "5Vs" of big data. In *Bio-inspired Algorithms for Data Streaming and Visualization, Big Data Management, and Fog Computing*, pp.145–167.

Misra, N.N., Dixit, Y., Al-Mallahi, A., Bhullar, M.S., Upadhyay, R. & Martynenko, A., 2020. IoT, big data, and artificial intelligence in agriculture and food industry. *IEEE Internet of Things Journal*, 9(9), pp.6305–6324.

Mixson, E., 2021. Data Science at Netflix: How Advanced Data & Analytics Helps Netflix Generate Billions. *Why data science is central to Netflix's Business Success*. Available at: Data Science at Netflix [Accessed 9 August 2023].

Mkhomazi, S.S. & Iyamu, T., 2013. A guide to selecting theory to underpin information systems studies. In *International Working Conference on Transfer and Diffusion of IT*, June, pp.525–537. Springer, Berlin, Heidelberg.

Mneney, J. & Van Belle, J.P., 2016. Big data capabilities and readiness of South African retail organisations. In *2016 6th International Conference-Cloud System and Big Data Engineering (Confluence)*, pp.279–286.

Mohajan, H.K., 2020. Quantitative research: A successful investigation in natural and social sciences. *Journal of Economic Development, Environment and People*, 9(4), pp.50–79.

Mohammed, A.F., Humbe, V.T. & Chowhan, S.S., 2016. A review of big data environment and its related technologies. In *February 2016 International Conference on Information Communication and Embedded Systems (ICICES)*, pp.1–5.

Monino, J.L., 2021. Data value, big data analytics, and decision making. *Journal of the Knowledge Economy*, 12, pp.256–267.

Morabito, V. & Morabito, V., 2015. Big data driven business models. In *Big Data and Analytics: Strategic and Organizational Impacts*, pp.65–80.

Morse, J.M., Field, P.A., Morse, J.M. & Field, P.A., 1996. The purpose of qualitative research. In *Nursing Research: The Application of Qualitative Approaches*, pp.1–17.

Motau, M. & Kalema, B.M., 2016. Big data analytics readiness: A South African public sector perspective. In *2016 IEEE International Conference on Emerging Technologies and Innovative Business Practices for the Transformation of Societies (EmergiTech)*, pp.265–271.

Msenge, P. & Nzewi, O., 2021. A proposed citizen participation–public trust model in the context of service delivery protests in South African local government. *Journal of Local Government Research and Innovation*, 2, p.26.

Mukhtarov, I.S., 2023. Methodology of leveraging big data in financial services for enhanced decision making. *Финансовые рынки и банки*, (9), pp.104–115.

Muniswamaiah, M., Agerwala, T. & Tappert, C.C., 2023. Big Data and Data Visualization Challenges. In *2023 IEEE International Conference on Big Data (BigData)*, pp.6227–6229. IEEE.

Munné, R., 2016. Big data in the public sector. In *New Horizons for a Data-driven Economy: A Roadmap for Usage and Exploitation of Big Data in Europe*, pp.195–208.

Munshi, M., 2023. *The Ethics of Artificial Intelligence: Balancing Benefits and Risks*. Muzaffar Munshi.

Murthy, S., Bakar, A.A., Rahim, F.A. & Ramli, R., 2019. A comparative study of data anonymization techniques. In *2019 IEEE 5th Intl Conference on Big Data Security on Cloud (BigDataSecurity), IEEE Intl Conference on High Performance and Smart Computing (HPSC) and IEEE Intl Conference on Intelligent Data and Security (IDS)*, pp.306–309. IEEE.

Naeem, M., Jamal, T., Diaz-Martinez, J., Butt, S.A., Montesano, N., Tariq, M.I., De-la-Hoz-Franco, E. & De-La-Hoz-Valdiris, E., 2022. Trends and future perspective challenges in big data. In *Advances in Intelligent Data Analysis and Applications: Proceeding of the Sixth Euro-China Conference on Intelligent Data Analysis and Applications, 15–18 October 2019, Arad, Romania*, pp.309–325. Springer Singapore.

Naeem, M., Ozuem, W., Howell, K. & Ranfagni, S., 2023. A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods*, 22, p.16094069231205789.

Ngobeni, M.A., 2018. *Factors affecting service delivery in the Tshwane Municipality*. Doctoral dissertation, North-West University.

Nisar, Q.A., Nasir, N., Jamshed, S., Naz, S., Ali, M. & Ali, S., 2021. Big data management and environmental performance: Role of big data decision making capabilities and decision making quality. *Journal of Enterprise Information Management*, 34(4), pp.1061–1096.

Niu, Y., Ying, L., Yang, J., Bao, M. & Sivaparthipan, C.B., 2021. Organizational business intelligence and decision making using big data analytics. *Information Processing & Management*, 58(6), p.102725.

Nkhabu, M.F., 2021. *The role of local government in the implementation of Sustainable Development Goals: A case of Tshwane Municipality*. Master's thesis, University of Pretoria.

Norori, N., Hu, Q., Aellen, F.M., Faraci, F.D. & Tzovara, A., 2021. Addressing bias in big data and AI for health care: A call for open science. *Patterns*, 2(10), p.100347.

Nunu, K., 2019. *A big data framework to improve government service delivery in South Africa*. Doctoral dissertation, Cape Peninsula University of Technology.

O'Loughlin, T. & Bukowitz, R., 2021. A new approach toward social licensing of data analytics in the public sector. *Australian Journal of Social Issues*, 56(2), pp.198–212.

Oláh, J., Karmazin, G., Pető, K. & Popp, J., 2018. Information technology developments of logistics service providers in Hungary. *International Journal of Logistics Research and Applications*, 21(3), pp.332–344.

Olaitan, O.O., Issah, M. & Wayi, N., 2021. A framework to test South Africa's readiness for the fourth industrial revolution. *South African Journal of Information Management*, 23(1), pp.1–10.

Opoku, A., Ahmed, V. & Akotia, J., 2016. Choosing an appropriate research methodology and method. In: Research Methodology in the Built Environment. Routledge, pp. 32-49.

Ormston, R., Spencer, L., Barnard, M. and Snape, D., 2014. The foundations of qualitative research. In: *Qualitative Research Practice: A Guide for Social Science Students and Researchers*. 2nd ed. SAGE Publications, pp. 52-55.

Osman, A.M.S., 2019. A novel big data analytics framework for smart cities. *Future Generation Computer Systems*, 91, pp. 620-633.

Oussous, A., Benjelloun, F.Z., Lahcen, A.A. and Belfkih, S., 2018. Big Data technologies: A survey. *Journal of King Saud University-Computer and Information Sciences*, 30(4), pp. 431-448.

Paudel, P., 2024. Examining Paradigmatic Shifts: Unveiling the Philosophical Foundations Shaping Social Research Methodologies. *Journal of the University of Ruhuna*, 12(1).

Pei, Z. & Wang, Y., 2022. Problems and Countermeasures in the Construction of Intelligent Government Under the Background of Big Data. In: *International Conference on Intelligent Computing*. Cham: Springer International Publishing, pp. 684-697.

Pervin, N. and Mokhtar, M., 2022. The interpretivist research paradigm: A subjective notion of a social context. *International Journal of Academic Research in Progressive Education and Development*, 11(2), pp. 419-428.

Pesce, D., Neirotti, P. and Paolucci, E., 2019. When culture meets digital platforms: value creation and stakeholders' alignment in big data use. *Current Issues in Tourism*, 22(15), pp. 1883-1903.

Pham, H.T., 2019. The application of structuration theory in studying collaboration between librarians and academic staff in universities in Australia and Vietnam. *Information Research: An International Electronic Journal*, 24(3), p. n3.

Pina, E., Ramos, J., Jorge, H., Váz, P., Silva, J., Wanzeller, C., Abbasi, M. and Martins, P., 2024. Data Privacy and Ethical Considerations in Database Management. *Journal of Cybersecurity and Privacy*, 4(3), pp. 494-517.

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, S46-S58.

Qin, X., Luo, Y., Tang, N. and Li, G., 2020. Making data visualization more efficient and effective: a survey. *The VLDB Journal*, 29(1), pp. 93-117.

Qwabe, A., 2020. Big data analytics as a dynamic capability to enhance customer value management for sustainable competitive advantage. *University of Pretoria* (South Africa).

Ragolane, M., 2022. Effects of service delivery protests on political stability in The City of Johannesburg Metropolitan Municipality. Doctoral dissertation, *University of Johannesburg*.

Rainer, R.K., Prince, B., Sánchez-Rodríguez, C., Splettstoesser-Hogeterp, I. & Ebrahimi, S., 2020. *Introduction to Information Systems*. John Wiley & Sons.

Ramruthan, D., 2022. Monetising big data in South African financial services.

Rao, T.R., Mitra, P., Bhatt, R. & Goswami, A., 2019. The big data system, components, tools, and technologies: A survey. *Knowledge and Information Systems*, 60, pp.1165–1245.

Rawahi, K.A., Coombs, C. & Doherty, N., 2016. The realization of public value through e-government: A structuration perspective.

Rawat, D.B., Doku, R. & Garuba, M., 2019. Cybersecurity in big data era: From securing big data to data-driven security. *IEEE Transactions on Services Computing*, 14(6), pp.2055–2072.

Regulwar, G.B., Mahalle, A., Pawar, R., Shamkuwar, S.K., Kakde, P.R. & Tiwari, S., 2024. Big data collection, filtering, and extraction of features. In *Big Data Analytics Techniques for Market Intelligence*, pp.136–158. IGI Global.

Rehman, A., Fahad, M., Ullah, R. & Abdullah, F., 2017. Big data analysis and implementation in different areas using IoT. *International Journal of Hyperconnectivity and the Internet of Things*, 1(2), pp.12–25.

Rehman, A., Naz, S. & Razzak, I., 2022. Leveraging big data analytics in healthcare enhancement: Trends, challenges, and opportunities. *Multimedia Systems*, 28(4), pp.1339–1371.

Riaz, S., Khan, A.H., Haroon, M., Latif, S. & Bhatti, S., 2020. Big data security and privacy: Current challenges and future research perspective in cloud environment. In *2020 International Conference on Information Management and Technology (ICIMTech)*, pp.977–982. IEEE.

Rogge, N., Agasisti, T. & De Witte, K., 2017. Big data and the measurement of public organizations' performance and efficiency: The state-of-the-art. *Public Policy and Administration*, 32(4), pp.263–281.

Roh, Y., Heo, G. & Whang, S.E., 2019. A survey on data collection for machine learning: A big data integration perspective. *IEEE Transactions on Knowledge and Data Engineering*.

Rwelamila, P.D., 2022. Pretoria–Tshwane, South Africa. In *The Future of the City Centre*, pp.83–99. Routledge.

Ryan, G., 2018. Introduction to positivism, interpretivism and critical theory. *Nurse Researcher*, 25(4), pp.41–49.

Saeed, A. & Ebrahim, H., 2024. The intersection of machine learning, artificial intelligence, and big data. In *Big Data Computing*, pp.111–131. CRC Press.

Saliya, C.A., 2023. Research philosophy: Paradigms, world views, perspectives, and theories. In *Social Research Methodology and Publishing Results: A Guide to Non-Native English Speakers*, pp.35–51. IGI Global.

Sandhu, A.K., 2021. Big data with cloud computing: Discussions and challenges. *Big Data Mining and Analytics*, 5(1), pp.32–40.

Saunders, M.N., Saunders, M., Lewis, P. & Thornhill, A., 2009. *Research methods for business students*, 5th ed. India: Pearson Education.

Sazu, M.H. & Akter Jahan, S., 2022. Impact of big data analytics on government organizations. *Management & Datascience*, 6(2).

Schleier-Smith, J., Sreekanti, V., Khandelwal, A., Carreira, J., Yadwadkar, N.J., Popa, R.A., Gonzalez, J.E., Stoica, I. & Patterson, D.A., 2021. What serverless computing is and should become: The next phase of cloud computing. *Communications of the ACM*, 64(5), pp. 76-84.

Schulman, P.R., 2020. Organizational structure and safety culture: Conceptual and practical challenges. *Safety Science*, 126, p. 104669.

Sciberras, M. & Dingli, A., 2023. Research Philosophy—Pragmatic Paradigm. In: *Investigating AI Readiness in the Maltese Public Administration*. Cham: Springer International Publishing, pp. 25-27.

Seenivasan, D., 2021. ETL in a World of Unstructured Data: Advanced Techniques for Data Integration. *Journal Homepage*: http://www.ijmra.us, 11(01).

Segooa, M.A. & Kalema, B.M., 2018. Leveraging big data analytics to improve decision making in South African public universities. In: *March 2018 IEEE 3rd International Conference on Big Data Analysis (ICBDA)*, pp. 9-13.

Seko, L.J., Garbutt, M. & Tsibolane, P., 2022. Stakeholder Readiness for Adopting a Big Data Governance Framework in a South African Metropolitan Municipality.

Selowa, K.T., Ilorah, A.I. and Mokwena, S.N., 2022. Using Big Data analytics tool to influence decision making in higher education: A case of South African Technical and Vocational Education and Training colleges. *South African Journal of Information Management*, 24(1), pp. 1-8.

Setona, P., 2023. The effect of coalition government on municipal service delivery in the City of Tshwane.

Shamim, S., Zeng, J., Shariq, S.M. & Khan, Z., 2019. Role of big data management in enhancing big data decision making capability and quality among Chinese firms: A dynamic capabilities view. *Information & Management*, 56(6), p. 103135.

Shamsudin, M.F., Hassim, A.A. and Abd Manaf, S., 2024. Mastering Probability and Non-Probability Methods for Accurate Research Insights. *Journal of Postgraduate Current Business Research*, 9(1), pp. 38-53.

Shaqiri, B., 2017. Exploring techniques of improving security and privacy in big data. Doctoral dissertation, *University of Information and Technology-Ohrid*.

Shava, E. & Vyas-Doorgapersad, S., 2022. Fostering digital innovations to accelerate service delivery in South African Local Government. *International Journal of Research in Business and Social Science (2147-4478)*, 11(2), pp. 83-91.

Shava, E. and Mazenda, A., 2021. Ethics in South African public administration: a critical review. *International Journal of Management Practice*, 14(3), pp. 306-324.

Shongwe, B.R. and Meyer, D.F., 2023. Service Delivery Challenges within Rural Communities: The Case of the Nkomazi Local Municipal Area. *Administratio Publica*, 31(2), pp. 136-159.

Shukla, S., George, J.P., Tiwari, K. & Kureethara, J.V., 2022. Data security. In *Data Ethics and Challenges*, pp.41–59. Singapore: Springer Singapore.

Singh, D., 2019. Understanding philosophical underpinnings of research with respect to various paradigms: Perspective of a research scholar. In *ANVESH-2019 Doctoral Research Conference in Management*, pp.1–26.

Singh, D., 2020. Towards data privacy and security framework in big data governance. *International Journal of Software Engineering and Computer Systems*, 6(1), pp.41–51.

South Africa., 1996. *Constitution of the Republic of South Africa*. Available at: https://www.gov.za/documents/constitution-republic-south-africa-1996 [Accessed 19 November 2024].

South African Government (n.d.). Available at: Frontpage | South African Government [Accessed 9 November 2024].

South African Local Government Association, n.d. *About Municipalities*. Available at: [Accessed 19 November 2024].

South African Revenue Service (n.d.). Available at: SARS Home | South African Revenue Service [Accessed 9 November 2024].

South African Revenue Service (n.d.). Available at: SARS Home | South African Revenue Service [Accessed 9 November 2024].

Spriggs, M.P. & Gillam, L.H., 2008. Consent in paediatric research: An evaluation of the guidance provided in the 2007 NHMRC National statement on ethical conduct in human research. *Medical Journal of Australia*, 188(6), pp.360.

Steyn, N.R., 2022, September. Legislative responses to the challenge of insufficient data on water service delivery in South African cities. *Urban Forum*, 33(3), pp.349–366.

Stones, R., 2020. 19 Anthony Giddens, Structuration Theory, and Radical Politics.

Subedi, K.R., 2021. Determining the sample in qualitative research. *Online Submission*, 4, pp.1–13. Dordrecht: Springer Netherlands.

Sun, L., Shang, Z., Xia, Y., Bhowmick, S. & Nagarajaiah, S., 2020. Review of bridge structural health monitoring aided by big data and artificial intelligence: From condition assessment to damage detection. *Journal of Structural Engineering*, 146(5), p.04020073.

Taherdoost, H., 2021. Data collection methods and tools for research; a step-by-step guide to choose data collection technique for academic and business research projects. *International Journal of Academic Research in Management (IJARM)*, 10(1), pp.10–38.

Taherdoost, H., 2022. What are different research approaches? Comprehensive review of qualitative, quantitative, and mixed-method research, their applications, types, and limitations. *Journal of Management Science & Engineering Research*, 5(1), pp.53–63.

Technology Salon, 2018. *How Big Data Can Solve South Africa's Biggest Challenges*. Available at: https://technologysalon.org/big-data-solve-south-africa-biggest-challenges [Accessed: 27/09/2020].

Thomas, P.Y., 2010. Research methodology and design. *Research Methodology and Design*, pp.291–334.

Tomar, L., Guicheney, W., Kyarisiima, H., Zimani, T., Roseth, B. & Acevedo, S., 2016. Big Data in the Public Sector. Inter-American Development Bank.

Touriano, D., Sutrisno, S., Kuraesin, A.D., Santosa, S. & Ausat, A.M.A., 2023. The role of information technology in improving the efficiency and effectiveness of talent management processes. *Jurnal Minfo Polgan*, 12(1), pp.539–548.

Trom, L. & Cronje, J., 2019, March. Analysis of data governance implications on big data. In *Future of Information and Communication Conference*, pp.645–654. Cham: Springer.

Twinomurinzi, H. & Visser, W., 2004. E-Government & public service delivery: Enabling ICT to put "People First"–A case study from South Africa. *Understanding data analytics*, n.d., Data Science Hub. Available at: https://www.datasciencehub.com/understanding-data-analytics [Accessed 19 November 2024].

Unsworth, K., 2016. The social contract and big data. *Journal of Information Ethics*, 25(1), pp.83–97.

Vaismoradi, M., Jones, J., Turunen, H. & Snelgrove, S., 2016. Theme development in qualitative content analysis and thematic analysis.

van der Hoogen, A., Fashoro, I., Calitz, A.P. & Luke, L., 2024. A digital transformation framework for smart municipalities. *Sustainability*, 16(3), p.1320.

van Ooijen, C., Ubaldi, B. & Welby, B., 2019. A data-driven public sector: Enabling the strategic use of data for productive, inclusive, and trustworthy governance.

van Veenstra, A.F., Grommé, F. & Djafari, S., 2021. The use of public sector data analytics in the Netherlands. *Transforming Government: People, Process and Policy*, 15(4), pp.396–419.

Visser, D., 2018. The fourth industrial revolution–it's happening but what does it mean? *CSIR Science Scope*, 13(2), pp.54–55.

Wang, J., Xu, C., Zhang, J. & Zhong, R., 2022. Big data analytics for intelligent manufacturing systems: A review. *Journal of Manufacturing Systems*, 62, pp.738–752.

Williamson, B., 2016. Digital education governance: Data visualization, predictive analytics, and 'real-time' policy instruments. *Journal of Education Policy*, 31(2), pp.123–141.

Wiltshire, D. & Alvanides, S., 2022. Ensuring the ethical use of big data: Lessons from secure data access. *Heliyon*, 8(2).

Winkle-Wagner, R., Lee-Johnson, J. & Gaskew, A., eds., 2019. *Critical theory and qualitative data analysis in education*. New York: Routledge.

Wu, Z., Sun, J., Zhang, Y., Wei, Z. & Chanussot, J., 2021. Recent developments in parallel and distributed computing for remotely sensed big data processing. *Proceedings of the IEEE*, 109(8), pp.1282–1305.

Xu, C. & Chen, C.A., 2023. Open government data and smart nation in Singapore. In *Open Government and Freedom of Information: Policy and Practice in Asia and the Middle East*, pp.163–184. Cham: Springer International Publishing.

Yaseen, H.K. & Obaid, A.M., 2020. Big data: Definition, architecture & applications. *JOIV: International Journal on Informatics Visualization*, 4(1), pp.45–51.

Yigzaw, S., 2020. Data-driven e-governance to optimize the performance of public sector decision making processes. *Doctoral dissertation*.

Yin, R.K., 2014. *Case Study Research: Design and Methods*. 4th ed. London, UK: Sage Publications, Inc.

Yoshikuni, A.C., Dwivedi, R., Zhou, D. and Wamba, S.F., 2023. Big data and business analytics enabled innovation and dynamic capabilities in organizations: Developing and validating scale. *International Journal of Information Management Data Insights*, 3(2), p. 100206.

Yu, M., Yang, C. & Li, Y., 2018. Big data in natural disaster management: a review. *Geosciences*, 8(5), p. 165.

Yuniarti, Y., Aziz, M. and Gani, H.A., 2024. The Impact of Creative Content on Digital Marketing Effectiveness: A Comprehensive Analysis. *Valley International Journal Digital Library*, pp. 6179-6193.

Zhang, D., Pee, L.G., Pan, S.L. and Cui, L., 2022. Big data analytics, resource orchestration, and digital sustainability: A case study of smart city development. *Government Information Quarterly*, 39(1), p. 101626.

Žukauskas, P., Vveinhardt, J. & Andriukaitienė, R., 2018. Philosophy and paradigm of scientific research. *Management Culture and Corporate Social Responsibility*, 121(13), pp. 506-518.

 Zemmouchi-Ghomari, L., 2021. Basic Concepts of Information Systems. In: D. Reilly, ed., *Contemporary Issues in Information Systems*, p. Ch. 2. Rijeka: IntechOpen. DOI: 10.5772/intechopen.97644.

APPENDIX A: ETHICAL CLEARANCE CERTIFICATE

UNISA university of south africa

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

2022/05/10

Dear Ms Modjadji Pressinah Moloto

ERC Reference #: 2021/CSET/SOC/058
Name: Modjadji Pressinah Moloto

Student #:51285630
Staff #:

Decision: Ethics Approval from 2022/05/10 to 2025/05/10
Humans involved

Researcher(s): Modjadji Pressinah Moloto
51285630@mylife.unisa.ac.za, 072 319 1341

Supervisor (s): Dr. Mampilo Phahlane
phahlmm@unisa.ac.za, 074 031 3667

Working title of research:

Determining the current status of the use of big data by municipalities in South Africa.

Qualification: Master of Science in Computing.

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 3 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2022/05/10 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The proposed research may now commence with the provisions that:

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

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

Note

The reference number 2021/CSET/SOC/058 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,



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



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



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

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX B: PARTICIPANTS INFORMATION SHEET

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2021/CSET/SOC/058

Research permission reference number:

Date:

Title: Determining the current status of the use of big data by municipalities in South Africa

Dear Prospective Participant

My name is Modjadji Pressinah Kgoale and I am doing research with Dr. Mampilo Phahlane, a senior lecturer in the Department of Science, Engineering and Technology, towards a Master of Science in Computing at the University of South Africa. We are inviting you to participate in a study entitled "Determining the current status of the use of big data by municipalities in South Africa".

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to determine the current status of the use of big data analytics by municipalities in South Africa. This study will determine the type of big data that is produced and interpreted by the municipalities in order to support their decision making, describe how South African municipalities use big data analytics to support their decision making and evaluate the current benefits obtained from using big data analytics South African municipalities. The results of this research study will provide insights on South African municipalities' experiences, perceptions, motivations and behaviours around big data analytics and how these municipalities could use big data analytics as a tool to improve their services.

WHY AM I BEING INVITED TO PARTICIPATE?

All participant's contact details have been provided by City of Tshwane municipality's by requesting for employees who are responsible for data analytics. Approximately 10 participants have been selected to participate in this proposed study.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The study involves interviews where your role as a participant, is to answer truthfully according to your knowledge to the questions which have been provided in this document. The interview will take approximately one hour for each participant. These interviews will be conducted by means of remote digital interaction between myself as a researcher and you as a research participant using video and audio software applications such as Zoom, Skype and Microsoft Teams.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw from participating before or during the interview. You cannot withdraw your answers as soon as the interview is completed, or the research is completed.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

By taking part in this study, you will be assisting in conducting this research to determine the current status of the use of big data analytics by municipalities in South Africa. This study will provide insights on South African municipalities' experiences, perceptions, motivations and behaviours around big data analytics.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There is no possible or reasonably foreseeable risks of harm or side-effects to the potential participants by taking part in this research. The interviews will take place virtually and participants are encouraged to sit at a comfortable space of their choice to mitigate any interruption during the interviews.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

involvement in this research. Your answers will be given a code number, or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

While every effort will be made by the researcher to ensure that you will not be connected to the information that you share during the interview, I also advise you not to disclose personally sensitive information during the interview.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

All data for the recorded interviews will be encrypted and kept securely in password-controlled device. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. When necessary, this information will be permanently deleted from the storage device and through the use of a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

There is no reward offered, financial or otherwise for taking part in this study. All costs incurred during this research will be paid by UNISA in line with the UNISA bursary approval process.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the College of Science, Engineering and Technology Ethics Committee at Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings or should you require any further information or want to contact the researcher about any aspect of this study, please contact Modjadji Pressinah Moloto on 0723191341 or 51285630@mylife.unisa.ac.za or pressinah@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Dr Mampilo Phahlane on 0740313667 or email phahlmm@unisa.ac.za. Contact the research ethics chairperson of the SOC Research Ethics Committee on SocEthics@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.



Pressinah Moloto

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

APPENDIX C: INTERVIEW GUIDELINES

INTERVIEW PROTOCOL

Research Title: **Determining the current status of the use of big data by municipalities in South Africa**
Main Researcher: **Ms MP Kgoale**
Supervisor: **Dr. MM Phahlane**
Name of Institution: **University of South Africa**

1. **What type of big data is currently produced and used by municipalities in South Africa?**

    a) Tell me about big data collection in organisation.
    b) Describe the type of big data this organisation is collecting.
    c) How is this data collected?
    d) Where is the data stored?
    e) Describe the type of technologies that are used in the processing of big data in this organisation?
    f) How important is the use of these technologies?

2. **How are municipalities in South Africa currently using big data?**

    a) Briefly describe the type of services this organisation provide.
    b) Describe your current role in this organisation.
    c) What is your role in the processing of big data in this organisation?
    d) What is the main purpose of using big data analytics in this organisation?
    e) How is big data processed and analysed to make decisions?
    f) Describe the type of technologies that are used in analysing big data in this organisation.
    g) Tell us about the people who are responsible for the collection, analysing, and making decisions about this data and how these responsible people were selected.
    h) Briefly describe the overall knowledge and skills required for the processing and management of big data in this organisation.
    i) Briefly describe the decisions that are made with the help of big data analytics.

3. **What are the current benefits obtained from big data analytics implementation in municipalities in South Africa?**
    a) In your view, please describe how this organisation is benefiting from using big data analytics?
    b) Are there any challenges in the use and management of big data? If yes, give examples
    c) Is the organisation planning on expanding its resources to encourage the use of big data technologies within the organisation and other areas of government?

4. **What are the challenges faced by South African municipalities when using Big data analytics?**
    a) Are there any challenges in the use and management of big data? If yes, give examples
    b) What do you think must be done to overcome these challenges?
    c) Before we conclude this interview, is there anything else you would like to share?

APPENDIX D: CITY OF TSHWANE PERMISSION LETTER

CITY OF
TSHWANE
IGNITING EXCELLENCE

City Strategy and Organisational Performance

Room D2EO01 | 2nd Floor, Block D | Tshwane House | 320 Madiba Street | Pretoria | 0002
PO Box 440 | Pretoria | 0001
Tel: 012 358 4749/0478 | Fax: 086 651 9999
Email: nosiphoh@tshwane.gov.za | www.tshwane.gov.za | www.facebook.com/CityOfTshwane

My Ref:	**Research Permission Letter\ Moloto**	Tel:	(012) 358 4559
Contact Person:	**Pearl Maponya**	Email:	PearlMap3@tshwane.gov.za
Section/Unit:	**Knowledge Management**	Date:	23 March 2022

Ms Modjadji Moloto
Unit 106 Rose Stone Complex
337 Granite Crescent
0157

Dear Ms Moloto

RE: BIG DATA ANALYTICS TO ENABLE CITIZEN SATISFACTION WITH PUBLIC SERVICE

Permission is hereby granted to Ms Modjadji Moloto, Master of Science in Computing candidate at the University of South Africa (UNISA), to conduct research in the City of Tshwane Metropolitan Municipality.

It is noted that the primary aim of the study is to determine how big data analytics can be used to improve service delivery in South African municipalities to enable citizen satisfaction. The City of Tshwane further notes that all ethical aspects of the research will be covered within the provisions of UNISA Research Ethics Policy. You will be required to sign a confidentiality agreement with the City of Tshwane prior to conducting research.

Relevant information required for the purpose of the research project will be made available as per applicable laws and regulations. The City of Tshwane is not liable to cover the costs of the research. Upon completion of the research study, it would be appreciated that the findings in the form of a report and or presentation be shared with the City of Tshwane.

Yours faithfully,

PEARL MAPONYA (Ms.)
DIRECTOR: KNOWLEDGE MANAGEMENT

APPENDIX D: PUBLISHED JOURNAL ARTICLE

South African Journal of Information Management
ISSN: (Online) 1560-683X, (Print) 2078-1865

Structuration theory perspective of Big Data in a typical South African municipality

Authors:
Modjadji P. Kgoale[1]
Mampilo Phahlane[1]

Affiliations:
[1]Department of Information Systems, College of Science, Engineering and Technology, University of South Africa, Pretoria, South Africa

Corresponding author:
Modjadji Kgoale,
pressinah@gmail.com

Dates:
Received: 01 Oct. 2023
Accepted: 16 Feb. 2024
Published: 22 May 2024

How to cite this article:
Kgoale, M.P. & Phahlane, M., 2024, 'Structuration theory perspective of Big Data in a typical South African municipality', *South African Journal of Information Management* 26(1), a1780. https://doi.org/10.4102/sajim.v26i1.1780

Copyright:
© 2024. The Authors. Licensee: AOSIS. This work is licensed under the Creative Commons Attribution License.

Background: Big Data, sourced from various digital sources, offers valuable insights for better decision-making, and organisations are implementing Big Data technologies to improve their services. This article is about how the City of Tshwane (CoT), a South African metropolitan municipality is using data collected from its various information and communication technology (ICT) projects to improve decision-making.

Objectives: The study aims to identify the type of Big Data generated by South African municipalities and to establish ways in which knowledge, expertise and suitable management techniques impact the efficient application of Big Data in these municipalities.

Method: A qualitative approach, a case study method and Semi-structured interviews were deemed fit to collect data while thematic analysis was employed to identify patterns and themes associated with participants' experiences. Structuration Theory was used to analyse existing social structures that govern how Big Data is used in the CoT.

Results: There is a lack of data integration and a Big Data management system in the CoT. However, the CoT is ready to embrace Big Data and it is currently establishing a unit to effectively analyse collected data.

Conclusion: Big Data's potential for developing effective data management systems has garnered significant attention in the public sector and the CoT is also ready to fully adopt and implement these technologies.

Contribution: South African municipalities can effectively utilise Big data by establishing skilled staff, good infrastructure and suitable policies for efficient data generation and interpretation.

Keywords: Big Data; South African municipalities; CoT municipality; structuration theory; Decision making.

Introduction

Big Data refers to enormous datasets with a complex structures that are challenging to manage (Yaseen & Obaid 2020), and the process of analysing these huge data sets is called Big Data Analytics (Hemlata & Gulia 2016). Global corporations and government agencies are currently enforcing and extending big facts technology because they realise the capacity benefits of adopting and using enormous amounts of data (Trom & Cronje 2019). Countries such as Singapore, Malaysia, France, Japan, Great Britain, Australia, China and South Korea are also utilising Big Data projects to provide the government with insights into citizens' needs and priorities (Anna & Nikolay 2015; Hajirahimova & Aliyeva 2017).