Exploring the big data maturity level of a metropolitan municipality in Gauteng Province, South Africa

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ABSTRACT

A recent study by the World Bank highlights the importance of public sector organizations to embark on digital transformation. Public sector organizations that successfully undertake digital transformation journey serve their customers better; become more competitive; and improve their financial performance. Significantly, they also improve their digital maturity levels. Using a case study design, this study explored the big data maturity status quo of the Tshwane metropolitan municipality. Data maturity assessments are needful in the public sector to assist them in digital technology adoption.

Conceptually, the study used the Resource View (RBV) theory to understand the extent to which this city optimizes big data as a strategic resource for decision-making. The study also used the Dynamic Capabilities Theory (DCT) to explore the extent to which big data analytics is leveraged to enhance capabilities of the city to improve service delivery. In this regard, the study focussed on five themes, viz: (a) organizational vision and strategy, (b) customer relations management, (c) data-driven- decision-making, (d) data governance, and (e) deployment of industry 4.0 best practices and/or systems.

Following a qualitative design, the researcher collected data from 20 managers, using two data collection strategies. First, a focus group discussion was used to collect data from 8 managers at operational management level. A purposive sampling method was used. Secondly, structured questionnaires were administered to 12 managers, of which 6 were middle management level, and 6 were top management level incumbents.

The study finds that there is no common understanding regarding the vision and strategy for digital transformation in the city. Big data analytics is not optimally used for purposes of innovation, and operational and strategic decision-making. This study contributes by uncovering some of the challenges faced by public sector organisations as far as using data to drive decision-making is concerned. In this regard, the study also tables some of the remedies and interventions that can be embarked upon to undermine some of the key teething challenges.

KEYWORDS

Digital transformation, digital maturity, smart city, big data, big data analytics, big data maturity, data-driven organization, data governance.

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CHAPTER 1.INTRODUCTION

1.1 Statement of purpose

This research is a case study aimed at exploring the big data maturity level within the City of Tshwane, one of the metropolitan municipalities in Gauteng Province, South Africa. Recognizing the existence of numerous big data maturity tools, this study utilizes five (5) Data Maturity Models (MM) to achieve its objectives. The selected MMs boast a robust academic, theoretical, and conceptual foundation. They are also practical and comprehensive, encapsulating key principles of modern Industry 4.0.

To gather pertinent data, the study focuses on different levels/categories of managers within the City of Tshwane. The unit of analysis comprises individuals with titles such as Foremen, Superintendents, and Functional Heads. Middle management encompasses those with titles of Deputy Directors and Directors. Lastly, top management includes managers with titles of Divisional/Regional Heads. The study emphasizes managers responsible for executive/management support and fundamental service delivery functions/operations, including water, electricity, roads, transport, and community services.

1.2 Background of the study

The adoption of tools and platforms from the fourth industrial revolution in the pursuit of digital transformation has demonstrated positive effects on organizations and countries. Global research reveals how developed economies have utilized digital transformation to significantly impact business strategies and processes across various industries (Benavides et al., 2020). Similarly, many developing economies, including South Africa, are recognizing the positive correlation between digital transformation and growth (Jawad et al., 2021). Several African countries are also acknowledging this reality, evident in the adoption of the *Digital Transformation Strategy for Africa*, a clear indication of

senior leaders in the continent recognizing the value of digital transformation. In Africa, the adoption of digital transformation technologies is driven by compelling reasons such as job creation and efficient delivery of public services (Union, 2020).

An integral component of digital transformation is the incorporation of big data analytics. Numerous private sector industries have embraced this reality, investing significantly in big data analytics and related capabilities. Successful mining companies, for instance, have accelerated their big data capabilities, reshaping the entire mining industry (Qi, 2020). In a recent study on the South African mining industry, Bag et al. (2020) found that effective management of big data analytics can positively impact sustainable supply chain outcomes. The manufacturing industry is also investing in big data analytics, utilizing AI-powered analytics (Bag et al., 2021). Scholars like Mhlanga and Moloi (2020) argue that the COVID-19 pandemic has been a key driver of digital tool adoption in the South African education sector.

In contrast to private sector organizations, public sector entities tend to be slower in adopting digital technologies, as noted by Mbunge (2020) in the case of the health sector. Recent research in the South African private sector by Gaglio et al. (2022) found that the adoption of digital technologies, especially in the manufacturing sector, drives higher performance. A World Bank study underscores the importance of public sector organizations adopting digital technologies (Dener et al., 2021). Digital transformation is essential for all organizations, both public and private, requiring government organizations to reconsider data and its management practices to address socio-economic needs and improve efficient service delivery (Alvarenga et al., 2020). ElMassaha and Mohieldin (2020) suggest that when executed correctly, digital transformation in

the public sector can improve the chances of achieving Sustainable Development Goals (SDGs).

Given the significant role played by the public sector in citizens' lives, it is crucial for public sector organizations to accelerate their adoption of digital transformation strategies. In this study, the focus is on understanding the big data maturity level/status quo of a public sector institution. However, considering the broad scope of the South African public sector, comprising national, provincial, and local government entities, this study concentrates on the local government sphere (municipalities), delving deeper into one metropolitan municipality. Many major South African cities have embraced the concept of smart cities, including the City of Johannesburg under the Johannesburg 2040 Strategy (Balkaran, 2019). This study's specific focus is a metropolitan municipality, one of the capital cities in South Africa, which has declared its intention to be a smart city. Some studies have found that there is a lack of digital leadership and digital hesitancy in this city, contributing to poor service delivery in this capital city (Shava and Vyas-Doorgapersad, 2022).

Globally, the concept of smart cities gained traction in the early 2000s (Söderström et al., 2021). There are concerted efforts among major metros in South Africa to "transform their cities into smart cities" (Das, 2020:1). Smart governance is a goal of smart cities (Oke et al., 2020), and in South Africa, municipalities are leveraging smart digital technologies to address governance challenges (Langa and Thakhathi, 2022). It can be argued that smart cities and big data analytics go hand in hand, as big data analytics is one of the key central themes for smart cities. Smart cities encounter all four Vs of big data (velocity, volume, variety, and veracity). The primary objectives of smart cities include improving citizens' well-being, promoting economic development, and maintaining sustainability (Bassoo et al., 2018).

Smart cities rely on ICTs as enablers for their "smartening." Data-intensive analysis remains a major challenge for smart cities (Tang et al., 2015). In fulfilling their basic mandate, smart cities engage with vast and diverse data, commonly referred to as big data, crucial for delivering services such as health and transport. To handle these diverse and voluminous data sets, smart cities need to employ ICTs, Internet of Things (IoT) technology, and device governance systems. They also require big data analytics techniques to gain better insights and enhance their functionalities. State-of-the-art big data analytics capabilities are essential for several urban planning activities in smart cities (Rathore et al., 2016). For instance, in the roads and transport sector, smart cities use sensors to generate data for traffic monitoring, road speed monitoring, and public transport (Gohar et al., 2018).

Cities are now dealing with more customer data than ever before. Therefore, the ability of cities to collect, store, analyze, and manage larger amounts of data is crucial. Data analyticsaids cities in drawing correlations, gaining new insights, and conducting real-time analytics (Mouchili et al., 2019). Big data analytics supports smart cities in making informed decisions regarding customer needs and problem-solving (Mouchili et al., 2019).

1.3 Research problem

Numerous empirical studies have contributed valuable insights into the application of big data analytics across various industries. For example, Qi (2020) and Bag et al. (2020) conducted studies in the South African mining industry, while Bag et al. (2021) explored the manufacturing sector. Gaglio et al. (2022) recently investigated the adoption of digital technologies in the manufacturing sector, and studies by Mhlanga and Moloi (2020) and Mbunge (2020) focused on the impact of digital transformation in the education and healthsectors, respectively. Public sector organizations achieving successful digital transformation experience improvements in efficient service delivery (Alvarenga et al., 2020) and in meeting Sustainable Development Goals

(SDGs) (ElMassaha and Mohieldin, 2020). The World Bank emphasizes the importance of public sector organizations adopting digital technologies (Dener et al., 2021).

The reality is that major metropolitan areas in South Africa face the challenges posed by the four Vs of big data (velocity, volume, variety, and veracity). Many of these metropolitan areas envision themselves as (aspirant) smart cities (Das, 2020:1). This case study contributes to understanding the big data maturity status of a smart city in South Africa. Specifically, the study is motivated by the under-explored area of big data maturityin the public sector, which warrants further research attention. There is a notable lack of empirical studies on digital transformation in the South African public sector, particularly in the realm of big data analytics. Optimal big data maturity can significantly benefit large cities. In dealing with unprecedented volumes of data, big cities should transition from traditional analytics to big data analytics, enabling them to leverage predictive analytics, data science, and effectively engage with complex data models to draw correlations, gain new insights, and conduct real-time analytics (Mouchili et al., 2019). Big cities require state-of-the-art big data analytics capabilities (Bassoo et al., 2018).

Understanding the big data maturity level/status of big cities and implementing systems and processes for improvement can yield numerous benefits. Improved smart governance, a key goal of smart cities (Oke et al., 2020), can be one such benefit. However, smart citiesface challenges in enhancing their data-intensive analysis (Tang et al., 2015) and successfully conducting urban planning activities (Rathore et al., 2016; Gohar et al., 2018).

1.4 Research objectives

The research objectives were developed in response to the underexplored exploration of big data maturity in South African big cities, as outlined in the research problem. The objectives are grounded in the understanding that, similar to private enterprises benefiting from optimum big data maturity, big cities can derive significant advantages by assessing and enhancing their big data maturity levels.

Five research objectives were identified:

a) To explore the big data maturity level in the City of Tshwane concerning aspects oforganizational vision, strategy, and culture.

- *Rationale:* Understanding how organizational vision, strategy, and culture contribute to big data maturity is essential for comprehensive insights into the Cityof Tshwane's data landscape.

b) To understand the big data maturity level in the City of Tshwane as far as using data for purposes of proactive customer relations management and innovation.

- *Rationale:* Examining the use of data for proactive customer relations management and innovation provides insights into the City of Tshwane's customer-centric and innovative approaches.

c) To evaluate the big data maturity level in the City of Tshwane as far as using data as an asset for decision-making on both day-to-day operational management and long-term strategic decisions.

- *Rationale:* Assessing how data serves as an asset for decision-making across operational and strategic levels enables a holistic understanding of the City of Tshwane’s decision-making processes.

d) **To understand the data governance systems and processes in the City of Tshwane for continuous improvements and efficiency.**

- *Rationale:* Investigating data governance systems and processes is crucial for identifying areas of improvement and ensuring efficiency in managing and utilizingdata within the City of Tshwane.

e) To explore the extent to which the City of Tshwane deploys Industry 4.0 best practices as part of digital transformation.

- *Rationale:* Exploring the adoption of Industry 4.0 best practices sheds light on the City of Tshwane's commitment to digital transformation and aligning with contemporary technological advancements.

These research objectives collectively aim to fill the gap in the exploration of big data maturity in South African big cities, specifically focusing on the City of Tshwane. They provide a structured framework for investigating various dimensions of big data maturity within the context of the identified research problem.

1.5 Rationale

This study is driven by the acknowledgment that big data maturity in the public sector remains underexplored, necessitating more empirical research attention. The primary aim is to contribute to the discourse on understanding the big data maturity status of big cities in South Africa. Given that big cities grapple with unprecedented volumes of data, it is argued that adopting state-of-the-art big data analytics capabilities is essential (Bassoo et al., 2018). The value of big cities transitioning from traditional analytics to big data analytics lies in their ability to conduct predictive analytics.

Another significant benefit is that big cities can scientifically engage with large data sets, navigate complex data models, and derive correlations, new insights, and real-time analytics (Mouchili et al., 2019 Improving data-intensive analysis and smart governance are additional rationales for enhancing big data maturity in big cities (Tang et al., 2015; Oke et al., 2020). Ultimately, a higher level of big data maturity empowers cities to make well-informed decisions (Osman, 2019) and address the needs of their residents

based on factual information rather than subjective or politically motivated considerations. Investors would also be attracted to cities where decision-making is based on facts. This would create an environment of policy stability and/or predictability.

From a theoretical perspective, this study contributes to the Resource-Based Theory (RBT) by exploring how big cities can optimize data as a strategic resource for competitive advantage. Similarly, within the framework of the Dynamic Capabilities Theory (DCT), the study delves into how big cities can leverage big data to enhance their capabilities for improving service delivery through digital transformation tools such as applied data analytics and IoT.

The outcomes of this research, from an institutional capacity-building and knowledge management perspective, are poised to guide big cities in understanding their big data maturity level and considering interventions for improvement. This knowledge can position cities as models or centers of excellence in becoming data-driven organizations within the public sector, potentially setting an example for other municipalities or government spheres to follow suit. Moreover, key stakeholders and institutions in the local government sector, including the South African Local Government Association (SALGA), the South African Cities Network (SACN), the Department of Cooperative Governance (DoCG), South African Council for Planners (SACPLAN), National Treasury, and Development Finance Institutions (DFIs) like the Development Bank of Southern Africa (DBSA), can leverage the big data maturity outcomes to inform decisions related to institutional stability assessments, funding, borrowing, and other strategic considerations.

1.6 Delimitations of the study

This section outlines the delimitations, establishing the specific boundaries and scope of this study. Firstly, the study adopted a case study approach, concentrating on one metro municipality in Gauteng. Consequently, the other eight (8) metros were excluded from this study. Secondly, Secondly, the data

collection was limited to management in departments handling basic service delivery functions (water, electricity, roads/transport, wastes management, and community services). Thus, the study excluded managers in support functions such as Legal, Human Resources, etc.

Thirdly, the reality is that there are many maturity models (Becker et al., 2009; Mettler et al., 2010; Pöppelbuß and Röglinger, 2011; Röglinger et al., 2012; Braun, 2015). Some of the maturity models have been used in the public sector as well (Halper and Stodder, 2014; Okuyucu and Yavuz, 2020). Some of the maturity models are relevant in the age of Industry 4.0 (Felch et al., 2019). In this regard, the study focused on specific factors covered in different big data maturity models, examining the following five areas: (a) organizational vision, strategy, people, and culture; (b) customer engagements; (c) data as an asset; (d) data governance, systems, and processes; and (e) industry 4.0 best practices. From a theoretical perspective, the study was confined to the theoretical frameworks of two theories, viz. the Resource Based Theory, and the Dynamic Capabilities Theory. The conceptual and theoretical frameworks are discussed in Chapter 2.

1.7 Definition of terms

This section provides definitions for key terms used in the study:

(a) Big data. Big data involves holistically managing, processing, and analyzing the five characteristics (i.e., value, velocity, volume, variety, and veracity). The aim is to get insights into the value and improve performance to gain a competitive advantage. This is called Five V's (Wamba et al., 2015). These have been extended to include variability and valence to become seven V's (Janssen et al., 2017). Other scholars highlight the requirement of data connectedness and emphasize the need to transform big data for effective decision-making (Saggi and Jain, 2018).

(b) Big data analytics: involves acquiring information from data by applying different techniques, including simulations, mathematical, statistical,

econometrical, etc to support the process of decision-making in an organization (Arunachalam, et al., 2018). By implication, big data analytics involves the application of advanced competencies and skills using, among others, advanced IT tools to organize and manage data from diverse ICTs. Big data analytics aims to empower organizations to generate information for efficient decision-making to create and enhance value for an organization (Belhadi et al., 2019).

(c) Big data maturity: big data maturity is the level at which an organization utilizes big data analytics and processes for enhanced decision-making. Different factors influence the big data maturity level/degree of an organization. Some of them relate to systems, people, culture, data privacy, data governance, data quality, etc. (Surbakti et al., 2020). Researchers employ different big data maturity models to explore the levels of big data maturity in organizations, including the data maturity levels of public sector organizations (Okuyucu and Yavuz, 2020).

(d) The data-driven organization: a data-driven organization is one where (quality) data forms the basis for all decision-making throughout the organization. So, decisions making based on data science and analytics becomes an engrained culture of the organization (Patil and Mason, 2015). Typically, data-driven organizations purposefully create data-focused management positions, such as Chief Data Officer, whose main task is to lead the digital transformation process (Hupperz et al., 2021). In such organizations, data science is leveraged to make decisions (Berntsson Svensson and Taghavianfar 2020) for competitive advantage over rival organizations (Kayabay et al., 2021).

(e) Data governance: data governance involves developing controls and defining authority over the access and management of data to prudently manage associated risks (Abraham, et al., 2019).

(f) Digital transformation: digital transformation is a deliberate journey that organizations embark on to integrate data into organizational processes based on a well-defined digital transformation strategy (Hupperz et al., 2021).

(g) Smart city: a smart city is a city that leverages high Information and Communications Technologies (ICTs) (Camero and Alba, 2019) for the benefit of citizens, and to ensure inclusivity, intelligent development, and public participation (Dameri, 2013). A smart city is a city that integrates conditions and critical infrastructures to maximize the delivery of public services (Hall et al., 2000). Another name for a smart city is a digital city (Ishida, 2002).

1.8 Assumptions

This section outlines the assumptions made in the study:

I. It is assumed that public sector organizations need to embark on digital transformation.
II. It is assumed that cities opting to be smart cities need to undergo digital transformation and utilize various digital technology tools to achieve smartness goals.
III. It is assumed that there is a gap in the literature for empirical studies on the digital maturity of public sector organizations, with a particular focus on smart cities.
IV. It is assumed that city managers and other stakeholders in the public sector, especially in the local government sector, will find the study's findings useful for reflection and strategic decision-making.

1.9 Chapter Outline

The report is structured into six sections, each serving a specific purpose. Figure 1 below presents a graphic outline of the report from the beginning to the end. Chapter 1 introduces the study and provides background information. This

chapter also outlines the problem statement, rationale, aim, and objectives. Importantly, the chapter also defines main and secondary research objectives. Finally, it justifies the study and articulates the key 'road map.'

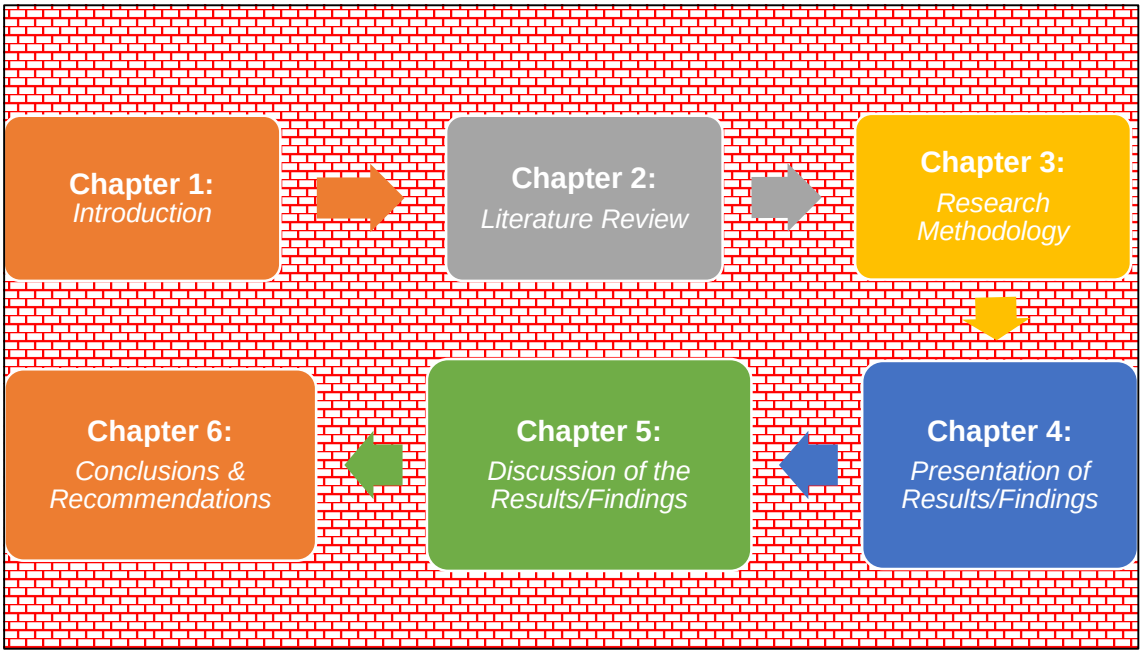

Figure 1: Graphic Presentation of the Dissertation Outline (Author, 2023)

Chapter 2 is the literature review chapter. In this regard, the chapter explores conceptual and theoretical frameworks. It examines related terminologies, principles, and concepts. The chapter also reflects on challenges and opportunities for measuring big data maturity. It also critically reviews different big data maturity tools. Importantly, this chapter also provides a critical review of different big data maturity tools. Finally, this chapter concludes with a summary, synthesizing the key messages.

Having set the scene of the study (background, problem statement, rationale, as well as the aim and objectives) through Chapter 1, and the review of literature through Chapter 2, Chapter 3 outlines research methods, including strategy and tools. This chapter also clarifies aspects such as research design, approach, sampling, and data collection tools. The chapter also describes data analysis

approaches and ethics; d also provides justifications for research choices and concludes with a summary.

Chapter 4 presents answers to primary and secondary research objectives. In the main, the chapter focuses on the five different themes of big data maturity within the city. Essentially, this chapter presents the findings from in-depth interviews and focus group discussions.

Chapter 5 discusses implications of findings within the conceptual and theoretical framework. In this regard, this chapter explores the implications of the resource-based theory and dynamic capabilities theory. The chapter also discusses the practical implications for the public sector in South Africa, specifically big cities. This chapter leads to the final chapter of the study.

Chapter 6 concludes the study by revisiting objectives outlined in Chapter 1. Finally, this chapter proposes some recommendations for the city. This structured approach ensures a comprehensive exploration of the research, from the foundational aspects to empirical findings, analysis, and practical implications.

CHAPTER 2.LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This section presents the literature review of the study as well as the conceptual and theoretical grounding of the research.

2.2 Discussion: Literature Review

Chapter Two delves into the literature review, forming a critical foundation for the study's conceptual and theoretical frameworks. A thorough exploration of existing scholarship is paramount to contextualize the research, identify gaps, and justify the study's significance. The literature review unfolds by elucidating key terminologies, principles, and concepts related to big data maturity. By scrutinizing challenges and opportunities in measuring big data maturity within public sector organizations and smart cities, this chapter lays the groundwork for the subsequent discussion.

Moreover, a meticulous review of diverse big data maturity tools is undertaken, offering insights into existing methodologies and their applicability. Different perspectives, arguments, and point of view are presented below as part of the literature for the study. The literature review is structured in a way that addresses the research objectives of this study, and the themes identified. So, in this regard, it reflects different perspectives on digital transformation and big data analytics in the public sector broadly, but also specific reference to the local government sector. The comprehensive analysis concludes with a synthesis of key findings, providing a roadmap for understanding the current landscape of big data maturity research.

2.2.1. Use of data for vision, strategy, and digital transformation

Objective 1 of the study deals with big data maturity concerning the extent to which the conceptualization and implementation of organizational vision, strategy, and culture are informed by, and aligned to insights generated by big data analysis. Big data maturity can be seen as part of the digital transformation journey. The term digital, in its broadest sense, refers to fields of technological innovation, such as robotics, drones, 3-D printing, etc. In a sense, it can be used synonymously with technological innovation (Armstrong and Lee, 2021). The term maturity can be defined as a state of being fully developed or grown up. In digital maturity scholarship, it refers to an organization's ability to respond adequately to an environment (Talukdar and Das, 2013).

Digital maturity is a 'snapshot' of "how digitalized an organization has become at a point of time in its journey of digital transformation". It is also a "measure of how adept an organization is in responding to technological change, as it progresses on its digital transformation journey (Armstrong and Lee, 2021: 516). Another perspective posits that digital maturity is "the ability of an organization to "adapt to a constantly changing digital business environment, where change is driven by evolving technologies (Eremina, Lace, and Bistrova, 2019). Digital transformation is "the process of responding to perpetual, pervasive, and powerful exogenous technological change (Armstrong and Lee, 2021: 516).

There is some appreciation in the African continent that digital transformation in the public sector, in particular, is no longer a luxury. To this end, the African Union's "Digital Transformation Strategy for Africa 2020- 2030" presents a case for boldly embracing digital transformation as a pervasive force for inclusive and sustainable growth development (African Union, 2020). In South Africa, in the last decade, there has been an accelerated adoption of digital technologies in the quest for digital transformation. This can be evidenced by, among others, the number of internet users, improvements in broadband internet access, etc (Gaglio et al., 2022).

From a policy perspective, there have also been some positive movements in the South African context as well. For instance, the “2020 National Digital and Future Skills Strategy” appreciates the need to ramp up digital skills, for sustainable and inclusive development going forward (South African Department of Telecommunications, 2020). Therefore, the use of digital technologies must be informed by factors such as accessibility, especially to those stakeholders and role players who are small and could be operating in the informal sector le and beneficial to small firms, including those operating informally (Gaglio et al., 2022).

South Africa has embraced the digital transformation agenda (Manda and Backhouse, 2018). COVID-19 has been one of the key triggers for the escalating digital transformation efforts (Mhlanga et al., 2022). Many sectors in the South African economy have seen some form of digital transformation initiatives and efforts. There are many opportunities (Manda and Backhouse, 2017). The education sector has also seen exponential growth in the adoption of digital technologies (Mhlanga and Moloi, 2020).

The retail sector has also seen some of the most prominent digital transformation initiatives, especially in the area of data analytics and cloud technologies (Van Dyk and Van Belle, 2019, 2020). Even the Small Micro, and Medium Enterprises (SMME) sector has seen a good share of digital transformation efforts (Gaglio et al., 2022). The healthcare sector has also embraced the digital transformation challenge in South Africa (Willie and Nkomo, 2019). Modiba and Kekwaletswe (2020) studied digital transformation in the financial sector. So, the South African economy is saturated with digital transformation efforts, with some successful, and others not so much successful.

Public sector organizations must be concerned about the state of their digital transformation and maturity level (Dener et al., 2021). Public sector organizations operating in rural areas in South Africa face more challenges for digital adoption and transformation (Aruleba and 2022). There are many reasons for public sector organizations to adopt digital technologies. South African public sector employees need digital skills to improve service delivery (Nhede et al., 2022).

Masinde and Mkhonto (2019) caution that one of the reasons some e-government efforts fail in South Africa is that they tend to disregard local contexts.

Tabane (2022) developed some conceptual framework for digital skills in the South African Public sector. One area of research interest for digital transformation in the South African public sector is the supply chain (Ambe and Badenhorst-Weiss, 2011). In the area of cyber security, there is more scope for research in the public sector (Patrick, Niekerk, and Fields, 2018). Shibambu and Marutha (2022) explored the digitalizing management of records in the public sector of South Africa. Other scholars indicate that public sector organizations in South Africa also need some knowledge-sharing frameworks (Mkhize, 2015), to foster innovation (Sono and Malan, 2021).

There have been some studies about digital transformation in municipalities in South Africa. Using the technology readiness index (TRI), Seko et al., (2022) concluded that South African municipalities are generally not ready to adopt big data technologies, although some of them are somewhat fairly au fait with what could be required. Other studies have found that municipalities that successfully embark on digital transformation efforts tend to realize positive developmental outcomes in areas such as governance, information management, institutional memory, and access to information (Jacobs et al, 2019). Digital initiatives in cities tend to enhance citizen engagement and better service delivery. However effective execution of digital transformation in South African municipalities is often hampered by a lack of resources (Osah and Pade-Khene, 2020). In this regard, not surprisingly, Sibanda et al. (2019) opine that there need for strengthening IT governance systems in municipalities.

South African municipalities also need to be assisted with the development of big data governance systems (Seko et al., 2022). One of the factors that bedevil the successful implementation of e-municipalities is the issue of digital, and lack of requisite technical skills. So, municipalities do not adequately invest in ICT infrastructure for e-municipality development (Nel-Sanders and Malomane, 2022). Other barriers include poor governance infrastructure, and a lack of ICT

leadership in municipalities (Mawela et al, 2017). In the case of eThekwini Metropolitan Municipality, Reddy and Govender (2019) found that the eThekwini Metropolitan Municipality is not able to compete internationally within the digital economy, owing to, among others, the fact that there is limited application of digitalization systems; and that the digital governance processes are weak. Ncoyini and Cilliers (2016) point out that the organizational culture in South African municipalities does not support knowledge/information sharing. Municipalities' ICT systems are not integrated, and digital transformation initiatives do not fully receive top management support.

Public sector organizations generally struggle with adapting to technological changes (Osborne and Brown, 2011). This often delays these organizations in adopting new practices (De Vries et al., 2019). The same can be said about cities. So, there is a need to understand the linkages between strategy and big data within a smart city ecosystem and context. Data is a strategic asset for modern organizations (Khatri & Brown, 2010). Smart cities embrace diligent data management systems. So, being a smart city can be seen as a strategy, or a strategic goal for many cities (Vanolo, 2014). Data can also be seen as a strategy used by organizations to shape and craft strategic decisions so that decision-making is purely data-led (Mazzei and Noble, 2017).

Some scholars argue that there are several smart city strategies within the smart city concept (Masik et al., 2021). Globally, cities, being a smart city has gained traction (Söderström, et al., 2021). Many 'big' metros in South Africa aim to be smart cities (Das, 2020). The reality is that being a smart city is impossible without big data analytics capabilities. Hence, smart cities not only employ Information Communication Technologies (ICTs) and Internet of Things (IoT) technology, but they also need state-of-the-art big data analytics capabilities (Bassoo, et al., 2018). Many urban planning activities in smart cities require big data analytics capabilities (Rathore et al., 2016). Smart cities use sensors to generate data (Gohar et al., 2018). So, data-intensive analysis remains one of the major imperatives for smart cities (Tang et al., 2015). Merely deploying technology to

source data is not adequate. There is, as a matter of urgency, to understand the strategic implications of data (Wang et al., 2018).

2.2.2. Use of data for proactive customer relations management and innovation

Objective 2 of the study is about how organizations use data to engage their customers, to implement innovative technologies for effective and proactive customer relations management systems and platforms. Some of the key digital MM emphasize the issue of using data as an asset for customer engagements and management. For instance, the Rogers Digital Transformation Playbook Model has five domains, and one of them deals with: customers, competition, data, and innovation (Rogers, 2016). Armstrong and Lee (2021) developed what they call a “Unified Digital Maturity Model”, which has 12 factors and 56 sub-factors (indicators). One of the key sub-factors related to big data maturity is the Customer Orientation and Engagement factor.

With the advent of urbanization, cities are dealing with more volumes of data than ever before about their customers. This has at least two implications. First, the requirements of cities to collect, store, analyze, etc larger amounts of data about their customers are immense. So, a better data maturity level would give cities the benefits of a nuanced understanding of customer needs, thus improving their chances of outsmarting their rivals (Mouchili et al., 2019). With big data analytics on their side, smart cities can make informed decisions regarding solving customer problems (Mouchili et al., 2019).

For cities to use data to understand their customers better, they need to migrate from traditional analytics to predictive analytics and data science. Smart cities employ data analytics to draw correlations, new insights, real-time analytics, etc, rather than merely focusing on causation (Mouchili et al., 2019). Smart cities need to integrate and analyze data flowing from various domains of the city (Osman, 2019). Cities can use data-intensive analysis to run several urban planning activities successfully (Rathore et al., 2016). Big data analytics can assist smart

cities in making informed decisions about urban management problems facing their customers, understanding customer needs, solving customer problems, and ultimately gaining a competitive advantage (Mouchili et al., 2019).

One of the major challenges for smart cities is to improve their data-intensive analysis (Tang et al., 2015). Cities can generate more data about their customers in areas such as traffic monitoring, road speed monitoring, public transport, etc. (Gohar et al., 2018). In essence, a better data maturity level would assist cities in taking decisions that are well-informed (Osman, 2019). In essence, a better big data maturity level would assist cities in taking well-informed decisions (Osman, 2019), based on a nuanced understanding of customer needs, therefore increasing their possibilities of outsmarting their rivals (Mouchili et al., 2019).

Another benefit is that customers/residents can gain more confidence when they know that the decisions taken by their cities are based on facts, rather than on some subjective ('politically correct') grounds. Investors would also be attracted to cities where decision-making is based on facts. This would create an environment of policy stability and/or predictability.

2.2.3. Use of data to inform decision-making

Objective 3 of the study is about how organizations use big data as an asset for decision-making on both day-to-day operational management activities and long-term strategic decisions. The intense use of new technologies has the effect of generating high volumes of data (Braganza et al., 2017). The word "big", is not only about size but also about the complexity of managing the data (Caesarius and Hohenthal, 2018). Thus, there is a need to capture and analyze data to generate and capture value (George et al., 2014). This global phenomenon is called big data.

In South Africa, the South African Revenue Services (SARS) is one of the organizations that have demonstrated the value of using big data science and analytics in the public sector. Motau and Kalema (2016) found that SARS has

managed to build data storage systems that have sufficient flexibility to scale as and when additional data is brought into their data analytical models. SARS is also consistently procuring new ICT systems to keep up with the demands. The top management has been actively supporting big data analytics at SARS (*ibid*). So, SARS is a classic example of a relatively successful data-driven organization in the context of the public sector in South Africa.

Big data are very much part of big cities. However, there is a paucity of empirical literature on how organizations go about building their capabilities to handle big data (Dubey et al., 2019). There is a need to understand the role of different players, especially 'data analysts', within a smart city ecosystem and context. If an organization wants to enhance its big data and digital maturity level, one of the things it has to master is the provision of institutional role clarification and definition to support data science activities.

Smart cities use data analytics as part of their strategy for decision-making. So, data analytics is used to draw correlations, get new insights, and perform real-time analytics (Mouchili et al., 2019). Smart cities integrate and analyze data flowing from various domains of the city, for better decision-making (Osman, 2019). With big data analytics on their side, smart cities can make informed decisions regarding solving customer problems (Mouchili et al., 2019), since smart governance is one of the goals of a smart city (Oke et al., 2020). Conventional data management technologies cannot fully assimilate the management of big data properly. The proper management of big data results in knowledge production and insights that cannot be realized with traditional data management methods such as statistics and archiving (George et al., 2014).

The use of dashboards in smart cities assists in visualizing data sets for decision-making purposes. That also goes a long way in building accountability and transparency, as well as supporting the engagement of citizens, and the interpretation of data. Smart cities can use dashboards to support their policy-making, implementation, and evaluation efforts. One of the characteristics of a good dashboard is that it must be user-centric. The aim of the dashboards should

include empowering citizens to become ‘smarter’ citizens. The introduction of dashboards must be accompanied by organizational changes, and the dashboards themselves must be properly designed. Poorly designed dashboards can lead to misunderstanding of data, thus potentially affecting public confidence in the city government (Matheus et al., 2020).

The use of dashboards in smart cities assists local governments in connecting devices with large data using cloud-computing technologies. This has been happening globally in the last decade, to anchor smart cities, and even smart homes, etc. (Patel and Chauhan, 2019). So the effective deployment of cloud technologies is very much part and parcel of smart cities because they enhance the capabilities and abilities of cities to engage in big data analytics as part of their digital transformation processes and strategies. Some scholars, e.g. Nashrulloh et al., (2019) have found that the use of dashboards can allow organizations to improve performance on their strategic business goals, but also position organizations towards enviable positions of digital maturity and leadership. As such, public organizations, in this context cities, must be encouraged to invest in the deployment of dashboards to effectively improve the accuracy of their decision-making, to enhance service delivery for the benefit of their communities.

Dameri and Dameri (2017) found that the performance of smart cities can be enhanced through the use of dashboards, thus creating value for communities. It has also been found that when smart dashboards are used, urban management services for functions such as water treatment plants can be improved significantly (Kiyan, et al., 2023). In addition, Suakanto et al. (2013) found that smart cities can effectively use digital dashboards to integrate different data sensor networks and improve decision-making in the process. Other scholars such as Kourtit and Nijkamp (2018) posit that the use of big data dashboards can be beneficial in integrating operational requirements and choices of different stakeholders in smart cities. Significantly, the use of digital dashboards in the context of smart cities assists urban managers in collecting, analyzing, and

visualizing the performance of different regions within a city, to support sustainable development (Farmanbar and Rong, 2020).

2.2.4. Data governance systems and processes

Objective 4 of the study deals with the data governance systems and processes for continuous improvements and efficiency gains. Data governance is about who has control and authority over the management of data. Data governance also sets out the policies, formalities, and procedures about how data can be accessed, used, etc (Korhonen et al., 2013). Another aspect of governance deals with monitoring conformance to policies, procedures, and formalities, and ensuring enforcement (Loshin, 2008). It can also deal with enforcing conformance with regulatory requirements and SLAs (Al-Ruithe et al., 2018). Another aspect deals with who has the mandate for certain data-related activities (Otto, 2011). Governance also deals with data policies within an organization. This aspect deals with rules and guidelines for managing the creation, storing, and determining permissible use of data (e.g., Alhassan et al., 2019). Importantly, data governance also deals with data processes.

Data processes are a necessity for effective data governance systems (Alhassan et al., 2019). Data processes outline documented, standardized, and repeatable methods that are part of the data governance eco-system (Al-Ruithe, et al., 2018). Data processes also include the rules for documenting the lifecycle of data (Kim and Cho, 2018). The capability to structure and manage big data to get insights is imperative to ensure success in the organization's performance (Wang et al., 2018).

Through proper data governance, the risks associated with the data can be minimized, while the value of the data can be maximized (Abraham, et al., 2019). Data governance creates an environment where risk-mitigating measures are put in place to ensure compliance (Khatri & Brown, 2010). Risks may be caused by non-conformance to standards (Loshin, 2008). Other risks may be caused by privacy and security breaches (Rifaie et al., 2009).

2.2.5. Deployment of industry 4.0 best practices

Objective 5 of the study deals with the deployment of industry 4.0 best practices as part of the digital transformation journey. Deployment of big data analytics seems to be one of the major challenges facing public sector organizations (Margetts and Sutcliffe, 2013). Yet, some empirical studies show that the deployment of big data analytics can transform the operations of public sector organizations (Joseph and Johnson, 2013), improve efficiency (Milakovich, 2012), and lead to informed decision-making (Janssen and Kuk 2016). The reality is that public sector organizations generate vast quantities of data through activities such as issuing official documents, tax collection, health systems, traffic data, etc. However, in comparison with other sectors, the public sector is generally low on using data analytics capabilities (Mullich, 2013). Some scholars posit that the concept of big data analytics is still relatively new in the public sector (Al-Sai and Abualigah, 2017).

One of the reasons for the poor account of data analytics in the public sector is that there is no sufficient supply of skilled data-oriented employees in the public sector, who can use big data analytics to address service delivery challenges and develop frameworks for big data solutions (Munné, 2016). Some public sector organizations do not even have properly qualified Chief Information Officers (CIOs). Public sector organizations need to take the issue of CIOs very seriously (Anna and Nikolay, 2015). In some cases, although public sector organizations do have some technical skills to handle big data, however, there are some misalignments between big data applications and organizational goals and their legislated/statutory tasks or mandates (Klievink et al., 2017). As such, a good appreciation of big data analytics requirements is generally low in this sector, although there are some pockets of excellence (Desouza and Jacob, 2017).

There is a need for executives in the public sector to create incentives for sharing data and acquiring the appropriate skills (Gamage, 2016). Public sector organizations stand to benefit immensely from big data analytics, both from operational efficiency and strategic management perspective (Fredriksson et al.,

2017). One area where public sector organizations can benefit from the deployment of big data analytics is transparency and accountability (Merhi and Bregu, 2020), especially in cases where being citizen-centric is one of the goals of government (Aggarwal, 2019). In South Africa, the Batho Pele Policy commits government across all spheres to be citizen-centric.

In the Society 5.0 era, effective deployment of big data analytics can assist government agencies to make intelligent decisions (Anna and Nikolay, 2015), and develop policies that are informed by actual reality on the ground (Rahmanto et al, 2021). Some scholars insist that the deployment of big data analytics can assist public sector organizations to do more cheaply, faster, and better (Maciejewski, 2017). Interestingly, in South Africa, the Batho Pele White paper, and both the Public Finance Management Act (PFMA) and the Municipal Finance Management Act (MFMA) embrace the principles of cost efficiency and quick turnaround on service delivery. Public sector organizations need to invest in developing integrated data systems to avoid siloed approaches to managing data (Malomo and Sena, 2017). Kim et al (2014) and Khtira et al (2017) also show that the deployment of big data analytics can empower public sector organizations with predictive analytics for proper decision-making and anticipating eventualities.

2.3 ANALYTICAL FRAMEWORKS

The analytical framework provides an integrated overview of this study's theoretical and empirical concepts. This study is based on two theories. These are the Resource Based theory and the Dynamic Capabilities Theory.

2.3.1. The Resource-Based View (RBV) theory

Previous studies have used the Resource-Based View (RBV) theory to understand how organizations use big data as a resource for competitive advantage. The resource-based view theory of the firm is also one of the strategic

management theories that has been extensively used to understand the role of resources in building organizational capabilities as well as building big data culture, whilst improving operational performance (Dubey et al., 2019). The RBV theory can be used as one of the theoretical lenses to understand how organizations need to develop capabilities to deal with big data can be used as a dynamic resource (Braganza et al., 2017).

Big data, as an organizational resource, can be harnessed to realize competitive advantage. Big data can be a source of creativity and innovation. Creative organizations can outsmart their competitors. Big data have the characteristics of large volumes, extensive variety, and high speed, or velocity (Günther et al., 2017). So, it is also advantageous if the big data is not imitable; and not easy to substitute either (Barney, 1991). However, the reality is that big data may not always be rare, because often, competitors do access data.

2.3.2. Dynamic Capabilities Theory

The Dynamic Capabilities (DC) theory has been used by previous studies to understand how organizations need to develop capabilities to deal with big data as a dynamic resource (Braganza et al., 2017). In the 21st Century, organizations should develop the capability to manage huge volumes of data. Such capabilities would put organizations in a better position to gain a competitive advantage and improve organizational performance (Dubey et al., 2019). Organizations need to have a proper appreciation of the capabilities they need to be able to translate big data insights into meaningful results that bring improved organizational performance. In addition, organizations need to understand the threats or risks that they need to overcome so that they can convert insights from big data analytics into tangible positive outcomes for the organization (Walls and Barnard, 2020).

The insights emanating from big data analytics can be a useful source of efficiency for operations, strategic delivery, and financial performance (Caesarius and Hohenthal, 2018). According to scholars such as Braganza et al., (2017), the

problem is that sometimes management doesn't always set aside resources to develop big data capabilities. Yet, organizations such as Amazon, LinkedIn, Facebook, Zara, Google, Netflix, eBay, and Walmart have successfully used big data analytics to gain a competitive advantage and build new markets (Caesarius and Hohenthal, 2018).

2.3.3. Conceptual Framework

Figure 2 provides a pictorial conceptual framework for the study.

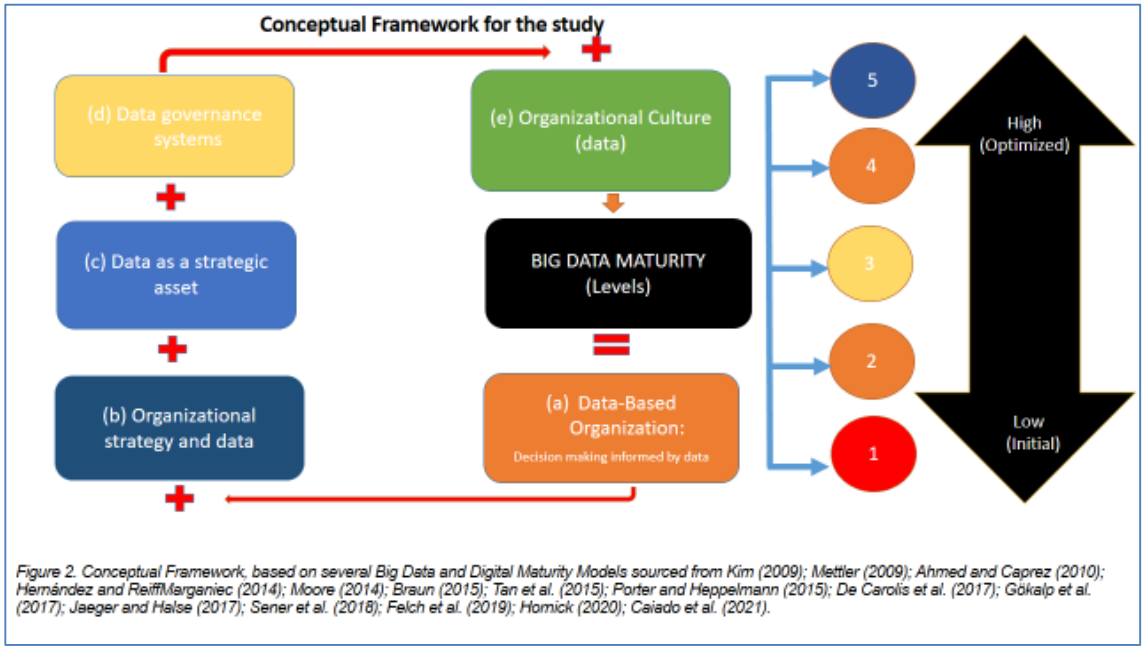

Figure 2. Conceptual Framework, based on several Big Data and Digital Maturity Models sourced from Kim (2009); Mettler (2009); Ahmed and Caprez (2010); Hernández and ReiffMarganiec (2014); Moore (2014); Braun (2015); Tan et al. (2015); Porter and Heppelmann (2015); De Carolis et al. (2017); Gökalp et al. (2017); Jaeger and Halse (2017); Sener et al. (2018); Felch et al. (2019); Homick (2020); Caiado et al. (2021).

2.3.3.1. Data Maturity Levels

The Capability Maturity Model Integration (CMMI) is one of the most famous data maturity models developed so far (Mettler, 2009; Ahmed & Caprez, 2010). The model provides five (5) data maturity levels (Braun, 2015):

- Level 1 is called *Initial Stage*. This is where nothing is done, or done haphazardly.
- Level 2 is called *Managed Stage*. This is where things are done, but they are generally reactive instead of being proactive.

- Level 3 is called *Defined Stage*. This is where there is evidence of documentation and standardization in an organization.
- Level 4, is *Quantitatively Managed.* In addition to proper documentation and standardized, there is clear measurement and control.
- Level 5, called the *Optimized stage*. This is where continuous improvement is part of the organizational way of doing things (Moore, 2014; Braun, 2015).

2.3.3.2. Elements of the conceptual framework

One of the key features of a data-driven organization is that decision-making is primarily informed by data (Park and Datnow, 2009; Chatterjee et al., 2022). This is where data influences, and shapes all the strategic elements of the organizational strategy (Yu Chung Wang, et al., 2022). From this perspective, big data management is part of the organizational strategy (Fisher, 2009). In a data-driven organization, data management is an essential element of organizational strategy (Martínez-Caro et al., 2020). This is so because big data is viewed as a strategic asset (Harris, 2010). This perspective is in line with the Resource Based Theory/perspective, wherein data is seen as a strategic resource for competitive advantage.

For big data to be handled as a strategic asset, organizations need to consciously and deliberately construct and develop data governance systems (Singh, 2020). Data governance is about setting out processes, 'protocols', and procedures for handling and managing data (Janssen et al., 2020) as a critical resource for competitive advantage (Cheong, et al., 2007; Al-Ruithe et al., 2019). This is in line with the dynamic capabilities theory (Rialti et al., 2019; Shamim et al., 2019; Chen, et al., 2022). Data analytics can support an organization in developing and enhancing strategic capabilities such as agility, quality, dependability, flexibility, and cost advantage (Ageron et al., 2020).

Finally, if an organization envisions and aspires to reach high(er) levels of big data maturity, there must be a shift in the organizational culture as far as handling (big) data is concerned. So, an enterprise-wide culture that embraces the

strategic essence and value of data across the entire organization must be built (Berndtsson et al., 2018). Admittedly, it takes time to build a data-driven organizational culture (Kamble and Gunasekaran, 2020).

2.4. Conclusion of Literature Review

Public sector organizations generate vast quantities of data. However, in comparison with other sectors, this sector is generally low on using data analytics capabilities (Mullich, 2013). In the last decade, there has been an accelerated adoption of digital technologies in the quest for digital transformation in South Africa (Gaglio et al., 2022). COVID-19 has been one of the key triggers for the escalating digital transformation efforts (Mhlanga et al., 2022). Notwithstanding, the effective deployment of big data analytics seems to be one of the major challenges facing public sector organizations (Margetts and Sutcliffe, 2013).

Cities have big data. However, there is a paucity of empirical literature on how organizations go about handling big data (Dubey et al., 2019). Some scholars posit that the concept of big data analytics is still new in the public sector (Al-Sai and Abualigah, 2017); and that South African cities are generally not ready to adopt big data technologies. So, they need assistance, e.g. with governance systems (Seko et al., 2022) because conventional systems cannot help manage big data properly (George et al., 2014).

3. RESEARCH METHODOLOGY

3.1. Introduction

The preceding literature review has delved into the challenges faced by public sector organizations in effectively implementing digital transformation strategies. Specifically, this study focuses on the application of big data analytics within public sector entities, witha particular emphasis on major urban centers. It has been asserted that these organizations stand to gain significant advantages through the application of big data analytics. However, a prevalent issue is that many organizations embark on digital transformation initiatives without a clear understanding of their digital maturity levels. Addressing this gap constitutes the primary objective of this study.

From a theoretical standpoint, two frameworks will guide this study. Firstly, the Resource- Based View (RBV) theory will be employed to elucidate how major cities in South Africa can leverage big data as a valuable resource for competitive advantage. The RBV theory will also contribute to comprehending how these cities can cultivate capabilities to adeptly handle big data as a dynamic resource. This study contends that achieving higher levels of big data maturity necessitates South African cities to showcase their ability to manage data as a strategic resource, aligning with RBV principles.

The second theoretical framework is the Dynamic Capabilities (DC) Theory. Previous research has successfully utilized the DC theory to comprehend how organizations can develop the necessary capabilities to navigate big data as a dynamic resource. These capabilities position cities favorably to attain a competitive edge and enhance overall organizational performance. Viewing the landscape through the lens of the DC theory, South African cities can gain valuable insights into how to mitigate threats and risks, facilitating the conversion of big data analytics into tangible positive outcomes for operational efficiency and strategic delivery. This study argues that advancing digital maturity requires

South African cities to cultivate capabilities in dealing with big data, in accordance with the principles of the DC theory.

3.2. Research approach

This research focuses on exploring the big data maturity level in the City of Tshwane. For this purpose, a constructivist approach was employed. The understanding of digital maturity was derived by engaging managers, allowing the construction of meanings (subjective truths or perceptions) related to big data maturity in the metropolitan municipality based primarily on their perspectives. The constructivist approach aids in comprehending the contextual aspects of the world in which people work or live (Mohajan and Mohajan, 2022), recognizing that there is no single reality. This is why researchers seek the views of participants (Teherani et al., 2015). Thus, a new body of knowledge concerning the big data maturity level in the city was constructed based on the primary data collected from managers in the metropolitan municipality.

3.3. Research design

This research adopted a case study design to explore the big data maturity level in the City of Tshwane, South Africa. The City of Tshwane is among the prominent cities in South Africa that has declared itself a smart city. The choice of a case study design is deemed appropriate as the research questions and objectives are specifically focused on this city.

3.4. Data collection methods

This study employed two data collection methods, as discussed below:

3.4.1. Focus Group Discussion (FGD) with operational management

A focus group discussion (FGD) serves as an effective means to bring together individuals with similar backgrounds or experiences to delve into a specific topic of interest. Guided by a moderator (or group facilitator), participants engage in lively and natural discussions (Mishra, 2016). Focus groups integrate group interactions, discussions, and participant observation (Plummer-D'Amato, 2008). Regardless of the size of the focus group, participants may experience fatigue if discussions extend for extended periods. Typically, sessions last between 1 to 2 hours, depending on the complexity of the subject under investigation (Nyumba, Wilson, Derrick, and Mukherjee, 2018).

The size of a focus group is influenced by factors such as allocated time, session duration, the number of questions, and the session format. Importantly, the size should align with research aims and objectives (Tang and Davis, 1995). Generally, a focus group comprises a small group, with recommendations ranging from 4 to 8 participants (Greenwood, Ellmers, Holley, 2014). Others suggest 8 participants (Fern, 1982), while some propose any number between 8 to 12 (Chaleunvong, 2009). In this study, the focus group consisted of 8 officials at the operational management level (i.e., managers with titles such as Foremen, Superintendents, Functional Heads, and Deputy Directors). The rationale for limiting the number to eight was to ensure manageable discussions within a period of 1 to 2 hours.

Additionally, the number aligns with the discussion questions related to the five themes identified in this study: (a) vision, strategy, people, and culture, (b) customer engagements, competition analysis, and innovation, (c) data as an asset, (d) data governance, systems, and processes, and (e) the use/application of Industry 4.0 best practices. If a larger number of participants could have been used, this could have rendered the discussions practically difficult to manage.

3.4.2. In-Depth Questionnaires with middle and top management

Adhering to a qualitative design, the researcher administered a structured in-depth questionnaire to 12 managers in the city to comprehend their perceptions and views regarding the utilization of big data maturity level in the City of Tshwane. In this exploratory study, the structured questionnaire was distributed via email communication. The 12 managers comprised 6 middle-management level managers (holding titles of Deputy Directors and Directors) and 6 top-management level managers (holding titles of Regional/Divisional Heads).

3.5. Population and sample

The population and sample strategy for this study is stated below.

3.5.1. Population

This study targeted managers responsible for various service delivery functions within the metropolitan municipality in the City of Tshwane. The study included a total of 20 managers – 12 managers at middle and top management levels and 8 managers at the operational level. The selection of only managers, as opposed to all staff, is justified by the study's focus on data-driven decision-making, and the chosen managers hold decision- making responsibilities in the city. This population choice aims to provide a macro-level perspective on management challenges and opportunities related to the use of big data (and analytics) for decision-making in the South African local government sector.

3.5.2. Sample and sampling method

A purposive or selective sampling approach, a form of non-probability sampling, was employed. Judgment played a crucial role in selecting population members relevant to this study. Specifically, managers responsible for basic service delivery functions/operations such as water, electricity, roads, transport,

community services, and executive/management were chosen for participation. Primary data was collected from these managers using two data collection methods/strategies, as discussed above. The summary tables outline the profiles of the middle and top management level managers who participated in the structured in-depth questionnaire and the operational managers who took part in the focus group discussion:

Participant	Title	Management Level	Pseudo Name	Work experience: No of years	Service Delivery Sector
1	Director	Middle Management	Perli	> 10 years	Strategy and Performance
2	Director (Acting)	Middle Management	Lola	> 20 years	Community Services
3	Director	Middle Management	Lera	> 15 years	Executive Support
4	Director	Middle Management	Thatisto	> 5 years	Research and Innovation
5	Director	Middle Management	Mindlos	> 15 years	Electricity
6	Director	Middle Management	Mokwenaite	> 10 years	Transport & Roads
7	Divisional Head	Top Management	Mpule	> 10 years	Executive Governance
8	Divisional Head	Top Management	Mankwi	> 10 years	Finance: Billing and Levies
9	Divisional Head	Top Management	Milanto	> 10 years	Customer Relations
10	Divisional Head	Top Management	Faithicious	> 15 years	Customer Relations

11	Divisional Head	Top Management	Mgodene	> 15 years	Service Delivery Operations
12	Divisional Head	Top Management	Spume	> 5 years	City Strategy & Performance

The table below outlines a summary of the profiles of the eight (8) operational managers who participated in the focus group discussion of the study:

Participant	Title	Management Level	Service Delivery Sector
1	Deputy Director	Operations	Water and Sanitation Operations
2	Functional Head	Operations	Electricity Operations
3	Deputy Director	Operations	Management Support: Operations
4	Deputy Director	Operations	Strategy Development
5	Deputy Director	Operations	Management Support: Operations
6	Deputy Director	Operations	Management Support: Operations
7	Deputy Director	Operations	Management Support: Operations
8	Deputy Director	Operations	Electricity Operations

3.6. Methods used for data collection

Two data collection methods were utilized in this study: Focus Group Discussion (FGD) and structured in-depth questionnaires. The FGD involved

discussions on the topic with agroup of operational managers, guided by a moderator.

3.7. The Research Instruments

Since the 1970s, numerous digital maturity tools have been developed in the information systems field alone (Braun et al., 2015). These tools serve diagnostic, normative, and prescriptive purposes. In this study, a data collection tool integrating aspects of various big data and digital maturity model was developed for comprehensiveness and rigor, drawing from five maturity models: Capability Maturity Model Integration (CMMI), advisory firm perspectives and business literature models, the Digital Readiness Assessment Maturity Model (DREAMY), the Industry 4.0 Maturity Model, and the IoT Technological Maturity Model.

3.7.1. Capability Maturity Model Integration (CMMI)

The Capability Maturity Model Integration (CMMI) remains one of the most famous data maturity models developed so far (Mettler, 2009). This model guides organizations to look at their maturity levels and develop solutions to improve (Ahmed & Caprez, 2010). The model has five (5) levels (Braun, 2015). The levels are as follows: Level 1 is called *Initial Stage*. This is a stage where the internal data management processes are neither controlled nor predictable. Level 2 is called *Managed Stage*. This is where internal data management processes exist but are generally reactive instead of proactive. Level 3 is called *Defined Stage*. This is where processes are typically documented and standardized. Then there is level 4, which is *Quantitatively Managed.* In this stage, processes are not only documented and standardized but they are also measured and controlled. The final stage is level 5, called *Optimized stage*. This is where processes have a focus on continuous improvement (Moore, 2014; Braun, 2015).

3.7.2. Advisory firm's perspectives and business literature models

The work by global advisory firms such as Bain and Company, Accenture, KPMG, Pricewaterhouse Coopers, and many others highlights some of the factors that are important to consider when looking at digital transformation and the digital maturity of organizations. Some of the key factors include strategy, culture, governance, harnessing data and an asset, etc. (Armstrong and Lee, 2021). The literature from the business sector also sheds some light on the subject. For instance, Westerman's 'Leading Digital Model" focusses on 'digital capabilities' and 'leadership capabilities'. The first one relates mostly to processes, whereas the latter addresses issues like vision and enabling governance structures within an organization (Westerman et al., 2014).

The Rogers Digital Transformation Playbook Model deals with five domains: customer, competition, data, and innovation and value domains (Rogers, 2016). The data domain is particularly important for this study as it relates to the question of (big) data maturity. Evan's Mastering Digital Business Model focuses on vision, people and culture, processes and governance, and technologies and capabilities (Evans, 2017). In their book, *Exponential Organizations (ExO's),* Ismail, et al (2014) emphasize that we are living in an information-based world, which is exponentially evolving, thus requiring organizations to, among others, appreciate the significance of data. This means that organizations and communities generate a huge amount of data; so that decisions are data-driven. According to Ismail et al. (2014), ExO's use automated dashboards, which provide a real-time view of what is happening both internally and externally to the organization.

In their *The Technology Falacy*, Kane et al. (2019) bring to the fore a perspective that emphasizes people and leadership in the discourse of digital maturity and digital transformation. They further posit that one of the core leadership capabilities required includes 'good business insight' to navigate ambiguity and complexity. This is where big data analytics and big data maturity come in. Meanwhile, Armstrong and Lee (2021) developed what they call a "Unified Digital

Maturity Model", which has 12 factors and 56 sub-factors (indicators). It can be argued that among the key sub-factors related to big data maturity are: data governance (under 'Organization and Governance' factor); use of data as a strategic asset (under the 'New Value Streams and Business Models' factor); use of data analytics (under 'Customer Orientation and Engagement' factor), and use of dashboards (under 'Core Processes Innovation and Digitalization' factor).

Whilst good in terms of providing some useful business content, the MM developed by advisory firms and business literature models do not always have sound theoretical founding. Secondly, they tend to be more relevant to the private sector because they tend to be focussed on their profit orientation, and not public service. As such, the models developed by advisory firms are not found apt for empirical data collection in this study. The elements embodied in the MM below are thus seen as more relevant to the study.

3.7.3. The Digital Readiness Assessment Maturity Model

The Digital Readiness Assessment Maturity Model (DREAMY) addresses issues of data and digital maturity in the manufacturing sector. This model is designed to assist organizations in dealing with data maturity challenges in the Age of Industry 4.0. The model consists of five levels of maturity; and also has four distinct dimensions, which deal with the process, monitoring, control of technology, and organization (Felch et al., 2019).

In terms of the five maturity levels, the first level is called *Initial*. At this level, there is poor, or no data management/process coordination. If it happens, it is only reactionary. There are also no technological tools to manage data at this level. The second level is called *Managed*. At this level, there are processes developed, but they are poorly conceptualized and implemented. There are also no enabling technologies at this level. The third level is called *Defined*. This is where the implementation of good process management practices is thwarted by a lack of clearly defined organizational responsibilities and a lack of enabling technologies. The fourth level is called *Integrated and Interoperable*. At this level, based on

common standards and best practices, there are attempts to introduce integration and interoperability of applications within the organization, to manage data and information flow and exchange. The final stage is called *Digital Oriented*. At this level, there is solid technological infrastructure to support data maturity efforts. Aspects of speed, security, and robust information exchange and flow are given priority, and decision-making is informed by data (De Carolis et al., 2017).

3.7.4. The Industry 4.0 Maturity Model

There is a need to look at some Maturity Models (MM) in the context of Industry 4.0. MMs can be used by organizations to guide digitalization and also track the progress of their 4.0 initiatives (Caiado et al., 2021). The *Industry 4.0 Maturity Model* is one of the relevant models in this regard. This model consists of 6 levels/stages of maturity in its Capability Dimension. The first is called *Level 0: Incomplete*. At this level, neither best practices nor basic business operations of digitization are applied. The second level is called *Level 1: Performed*. Here, some best practices are applied, although at a minimal scale. There is hope that the organization can transition to Industry 4.0. The third level is *Level 2: Managed*. The essence of this level is that there is the installation of smart technologies; and there is a migration of physical items to the virtual world (Gökalp et al., 2017; Sener et al., 2018).

The fourth level is called *Level 3: Established*. At this level, the organization starts to embark on vertical integration of systems and standard data management processes are being implemented. The fifth level is called *Level 4: Predictable*. Here the organization begins to do vertical integration, there are controlled processes and operations. Big data analytics, AI, and machine learning are introduced and applied in the organization. The final (sixth) level is called Level 5: Optimizing. At this level, there is end-to-end integration of digital tools and platforms. Continuous adaptation of the organization takes place, and there are innovative business processes (Gökalp *et al.,* 2017; Sener et al., 2018).

3.7.5. The IoT Technological Maturity Model

The IoT Technological Maturity Model has eight (8) levels. The first is called *Level 1: 3.0* Maturity. At this level, the organizations implement some technologies, but the functionality is very limited. In addition, the organization collects and interprets data from its business operations. Another characteristic of this level is the elementary automation of some processes within an organization. The second Level is called *Initial (on the path to 4.0 Maturity).* This is where an organization has at least a single IoT-enabled process. This means things connected to the Internet. The third level is about *Connectivity*. It relates to the use of Cloud computing, use of robotics, etc, and the ability to communicate through the internet. At this level, the organization can use Cloud computing to access files, including 3rd party services via a 3rd party (Kim, 2009). The four Level (*Enhanced*) entails the IoT processes that can communicate through Cloud Computing or the Internet. At this level, there is enhanced automation of both outbound and outbound processes, and more use of robotics (Jaeger and Halse, 2017).

Level five (*Innovating)* includes the application of at least ten (10) IoT-enabled processes, with more additional features, including communication of wireless technologies. Interoperability is established across different parts of the organization. Level 6 (*Integrated*) includes a scenario where IoT objects within the organization can communicate with human beings within the organization. The use of IoT to improve operations is normalized (Hernández and Reiff Marganiec 2014). Connected machines and robots exchange information with each other at this level. There is a clear data management strategy within the organization. Level 7 *(Extensive)* includes the use of IoT to communicate with external role players. There are high levels of automation, replacing manual work operations. The organization migrates from Data Management to Big data analytics to get business insights (Tan et al., 2015). The use of sensors, networks, etc to take decisions is naturalized. Level 8 (*Maturity)*, represents the fourth industrial revolution ideals. With the optimal use of IoT technology,

everything is seamlessly integrated and connected to the internet. There is continuous business improvement, and real-time data can be produced. Manual work is only done to a limited extent (Jaeger and Halse, 2017). At this level, raw data is transformed into meaningful information (Porter and Heppelmann, 2015).

3.7.6. Data Science Maturity Model

The Data Science Maturity Model for Enterprise Assessment tool was recently updated (2022) by Mark Hornic, Senior Director at Oracle Data Science and Machine Learning. The model has a sound academic, theoretical, and conceptual foundation. This model is also practical and comprehensive, consisting of 10 dimensions. The ten dimensions (or Key Performance Areas) are all relevant to big data science are (1) big data and organizational strategy; (2) big data roles, (3) big data collaboration, (4) big data science methodology, (5) big data awareness, (6) big data access, (7) big data scalability, (8) big data asset management, (9), big data tools, and (10) big data deployment. On each dimension, an organization can be scored: where 1= the least mature, and 5 = is the most mature (Hornick, 2020).

3.8. Summarising key aspects from the five (5) Maturity Models (MMs)

It is crucial to provide a summary of the key aspects discussed in the five Maturity Models (MMs) above. None of the models stands alone as perfect or comprehensive. Figure 3 below attempts to highlight these key aspects.

Digital Maturity Levels/Stages								
MATURITY MODELS	1	2	3	4	5	6	7	8
Capability Maturity Model Integration	Initial	Managed	Defined	Quantitatively Managed	Optimized			
Digital Readiness Assessment Maturity Model	Initial	Managed	Defined	Integrated and Interoperable	Digital Oriented			
The Industry 4.0 Maturity Model	Incomplete	Performed	Managed	Established	Predictable	Optimizing		
The IoT Technological Maturity Model	3.0 maturity	Initial to 4.0 maturity	Connected	Enhanced	Innovating	Integrated	Extensive	4.0 maturity
Data Science Maturity Model	01. Least Mature							10. Most Mature

Fig 3. A summary of Big Data and Digital Maturity Models: Sourced from Kim (2009); Mettler (2009); Ahmed and Caprez (2010); Hernández and ReiffMarganiec (2014); Moore (2014); Braun (2015); Tan et al. (2015); Porter and Heppelmann (2015); De Carolis et al. (2017); Gökalp et al. (2017); Jaeger and Halse (2017); Sener et al. (2018); Felch et al. (2019); Hornick (2020); Caiado et al. (2021).

There is significant convergence between the Capability Maturity Model Integration and the Digital Readiness Assessment Maturity Model concerning stages 1 to 3. The Industrial 4.0 MM and the IoT Technological MM address pertinent issues of the Internet of Things in the context of the pervasive Fourth Industrial Revolution. Additionally, the Data Science Maturity Model encompasses ten (10) factors, each rated from the least to the most mature level.

3.9. Key considerations when using data maturity MMs

A literature review suggests that certain characteristics distinguish good maturity models. A good MM should assist an organization in realizing a competitive advantage, reducing costs and time, and enhancing quality (Mettler et al., 2010). A good big data maturity tool should contribute to quality improvement (De Bruin et al, 2005). Furthermore, a good model or tool should aid an organization in

realizing economic efficiency and organizational IT performance (Becker et al, 2009). In addition, a good data maturity tool should support an organization in knowledge management and digital government (Poppelbub & Roglinger, 2011). Lastly, the tool should be user-friendly, enabling organizations to use them independently (Boughzala and de Vreede, 2012).

MMs should also have sound theoretical grounding (Mettler et al., 2010) and a robust conceptual basis (De Bruin et al, 2005). The models should provide adequate detail on how they were developed conceptually and practically (Becker et al, 2009). Furthermore, the models must be pragmatic, offering practical guidelines on corrective/improvement actions (Mettler, 2009). The MM must have been tested with real-world organizations (Marco Comuzzi Anit Patel, 2016). In essence, they must prove helpful for organizations and managers for decision-making purposes (Kohlegger et al. 2009). However, managers must appreciate that the MM does not guarantee success (Mettler, 2009).

3.10. Themes for data collection in this study

Given that there is no perfect big data and/or digital maturity tool, the researcher has developed integrated themes based on insights from the five (5) maturity models.

THEME	DATA MATURITY MODELS
1. Vision, Strategy, People, and Culture	• Models by Advisory Firms (e.g. Bain and Company, Accenture, KPMG, Pricewaterhouse Coopers, etc) • Mastering Digital Business Model (Evans, 2017), • The Technology Falacy (Kane et al., 2019) • Westerman's 'Leading Digital Model" (Westerman et al., 2014). • Unified Digital Maturity Model" (Armstrong and Lee, 2021). • Data Science Maturity Model for Enterprise Assessment (Hornick, 2020).

2. Customer Engagements, Competition Analysis, and Innovation	• Unified Digital Maturity Model" (Armstrong and Lee, 2021). • Digital Transformation Playbook Model (Rogers, 2016)
3. Data as an asset	• Exponential Organizations (ExO's) (Ismail et al., 2014) • The Capability Maturity Model Integration, (Mettler, 2009, Ahmed & Caprez, 2010, Braun, 2015). • Digital Readiness Assessment Maturity Model (Felch et al., 2019).
4. Data Governance, Systems, and Processes	• Data Science Maturity Model for Enterprise Assessment (Hornick, 2020). • Digital Readiness Assessment Maturity Model (Felch et al., 2019).
5. Industry 4.0. Best Practices	• The Industry 4.0 Maturity Model (Caiado et al., 2021). • The IoT Technological Maturity Model (Kim, 2009; Jaeger and Halse, 2017).

The actual data collection tools to gather primary data on these five themes are attached in Appendix C

3.11. Procedure for data collection

Primary data for this qualitative study was collected directly from the managers who participated in the study. The in-depth questionnaire was emailed to the participants, and they were returned to the researcher by email. Meanwhile, the focus group discussion strategy was used to gather data from managers at the operational level.

3.12. Trustworthiness, Rigour, and Credibility

Trustworthiness and credibility are crucial in qualitative studies (Creswell, 2013). To address these aspects, this research integrated five MM tools, collected primary data from operational management through focus group

discussion, and middle and top management through structured interview methods. Triangulating results from these three management levels enhances the credibility and trustworthiness of the study outcomes. The research process is clearly outlined for potential replication in different settings.

3.13. Data analysis strategies and interpretation

Data analysis was done using thematic analysis. The themes were drawn from the different data maturity aspects covered in the five Maturity Models. Different scholars outline the critical steps necessary in using thematic analysis. This include Braun and Clarke, (2021); and Braun, et al (2023). Thematic analysis usually entails familiarisation, coding, generating themes, reviewing themes, defining and naming themes and write-up. In this regard, the following phases were followed:

The first phase/step was familiarising with data: The researcher immersed himself in the data. This was done by actively engaging with the data as it was gathered, from a critical and analytical perspective. This was possible because the data was collected by the researcher himself, without using third party agents, or research assistants. During the interviews about the use of data in the city, the researcher actively took notes, to create the initial analytical interest. This enabled the researcher to pick up raw patterns of responses. Secondly, the researcher repeatedly read the responses of the participants, thereby getting more familiar with the data and consolidating the understanding of the patterns and trends. With each iteration, the researcher was able to get richer insights and understanding of the responses from both operational, middle and top level management within the city. Some themes which were originally missed were picked up during this repetition process. In addition, the researcher familiarised himself with the data by doing the transcribing of the data himself. This created further opportunity to be intimate with the data more.

The second step was generating initial codes. The researcher was able to code the data by assigning the data label's that summarised what was being said by the respondents by way of sentences and paragraphs. In this way, the researcher was able to break down and reduce the information into chunks that are digestible and manageable. The initial codes were organised into groups, and subsequently developed into themes. Some patterns were noticed in the process, and these were further analysed.

The third step was searching and reviewing themes. Different themes were developed by grouping codes together. For instance, theme about vision, culture, systems, processes, decision making, etc emerged as the respondents were giving their feedback. The themes were linked to the research objectives, and an interpretive analysis was adopted, to answer research questions. All themes were developed into concepts that assist the researcher to answer the research questions posed in chapter 1. A mind map approach was also used to develop and consolidate the themes, based on the analysis of the data as it was coming through.

The fourth step was to review, define and naming themes. This process was followed by establishing a master description sheet, and the main themes and sub-themes were developed and described appropriately. The sub themes were related to the main themes to ensure congruence and alignment.

The final step was to do report production. The writing part was enabled by the detailed steps followed above. In some instances, direct quotes from the participants were provided to show the originality and authenticity of the findings. The direct quotes is one of the authentic way of presenting the results, and ensure objectivity of findings. In addition, the meanings were discussed, from an analytical perspective. Where some of the quotes were in sync with quotes by other respondents, such meeting of minds were highlighted. Equally, contrasting views were highlighted, as part of the analytical discussion.

The thematic analysis approach was followed with a view to validate the results by triangulating the views of managers at three (3) different levels: top management, middle management, and operational level management. The analysis was also supplemented with a review of the current literature in areas such as big data, big data analytics, digital transformation, digitalization, data-driven organization, etc.

3.14. Limitations and challenges of the study

This research project had limitations, such as the inclusion of only managers, leaving room for future studies to include external stakeholders for triangulation. The study's focus on one out of eight metropolitan municipalities in Gauteng limits broad generalization, suggesting a potential area for future research.

3.15. Ethical considerations

The study received ethics clearance on August 28, 2023 (protocol number: WBS/DB2330748/254). Classified as a low-risk study, it maintained privacy and confidentiality during the administration of in-depth questionnaires and focused discussions. Respondents remained anonymous, and all participants consented to the study.The researcher completed an international course on "Introduction to Research Ethics" as part of the TREEEE training program. The certificate is attached as APPENDIX E.

4. PRESENTATION OF RESULTS/FINDINGS

4.1. Introduction

This chapter aims to unveil the empirical findings of the study, derived from the administration of in-depth questionnaires and focus group discussions with managers in thereal-world setting of the municipal environment. The overarching goal is to delve into the perspectives of managers concerning the big data maturity level in the City of Tshwane. The presentation of results and findings is structured thematically, emphasizing the five (5) key themes that form the focal points of the study:

a) Theme 1: digital transformation, vision, and strategy.
b) Theme 2: customer relations management, competition analysis, and innovation.
c) Theme 3: data as a strategic asset for decision-making.
d) Theme 4: data governance, systems, and processes.
e) Theme 5: industry 4.0 best practices.

While the primary focus centres on exploring the big data maturity level in the City of Tshwane through an exploratory approach, the study has been organized to address these five overarching themes. The findings are presented both at an aggregate theme level and at an individual question level. In some instances, direct quotations are incorporated, and extracted directly from the raw data provided by the research participants. The subsequent sections sequentially unveil the findings for each of these themes.

4.2. Presentation of the results and findings from Focus Group Discussions with operational level managers

This section of the report presents the findings from the Focus Group Discussion (FGD) that was with 8 managers at the operational management level within the

City of Tshwane. The FGD took place through a recorded MS online meeting platform. The participants are referred to as discussants.

4.2.1. Vision and strategy for digital transformation

A majority (7 out of 8) managers at the operational level believes that the city does not have a clear vision and strategy for digital transformation. The discussants indicate if the digital transformation and vision does exist, unfortunately, they have never come across it. They also indicate that if the strategy and vision does exist, they need to be aware of it to enable them to understand it.

The discussants also bemoan the fact that the City is still not having artisans who are using gadgets to receive and attend to service delivery queries. They argue that at an operational level, the continued reliance and use of manual job card system does not show that the City is gearing itself up for digital transformation.

The discussants further indicate that even though the IDP documents indicate that city is moving towards modernization and digitalization of the city processes, there is no practical ways to show how this is implemented in reality.

Most of the operational processes are found to be manually run, e.g. the timesheet, etc. The discussants are further disappointed by the fact that a city such as theirs, with 24 departments, does not have digital systems in place for performance information.

The discussants point a need to integrate the operational processes too. Currently, it is difficult to tell if the city is progressing or moving towards in terms of digitising

Some of the operations managers in the electricity sector speak highly about electricity metering project which is currently been rolled out. Other examples include smart fleet management, and digital document management initiative. Example and the document management. However, questions are being asked

about how such projects gets implemented without an overarching digital strategy and vision on the city. There are also concerns that there is lack of coordinated efforts to ensure that digital transformation efforts coordinated in such a way that no one (staff and stakeholders) is left behind.

The City does seem to be seeking to take the direction of insisting on the deployment of IT solutions for the last five to 10 years, but such efforts are bedevilled by, among others, lack of synchronising all the systems into one integrated systems. Some operational sections such as water and sanitation, insist on using certain systems. Other sections of the city use other systems for information or data processing. So there is a little bit of confusion in terms of strategy.

The Focus Group Discussants believe that even though the strategy document and vision document does not exist, in time past, such a document use to exist. This discussant believes that there was a vision that and strategy to indicating that the city invests in an infrastructure that will provide free Wi-Fi to the residents, as an example. Other discussants believe that one of the challenges is the duplication of systems in the city. They argue that this suggest inefficiencies.

4.2.2. Culture of digital transformation

All the Focus Group Discussant managers at the operational level believe that there is no culture of digital transformation in the city. One of the examples cited by discussants is the lack of a culture of paperless environment. They argue that this not embedded in the people yet.

The discussants argue that the lack of digital culture is demonstrated by absence of capable digital tools, such as hardware, laptops and software. They posits that employee support for digital culture is also at its lowest, thus not creating a conducive environment for the digital culture to emerge and flourish.

Communication to empower the digital culture is also apparently lacking in this city.

The operational managers also assert that there is lack of effective change management efforts to undergird a digital culture in the City of Tshwane. Some of the operational managers believe that the culture has now reached a ceiling; meaning that some more radical changes are now needed.

A digital culture needs to be resourced as well. Not all employees of the city are able to work off site now. So, a digital culture is still at infancy level. Not everyone can use a gadgets, and a digital culture is yet to be inculcated. The discussants also believe that the lack of digital strategy results is the poor state of digital culture in the city.

One of the discussants opines that a digital culture can result in cost savings in the fact that most of the people don't really need an office space, if they could use digital tools and platforms. Some of the department, like City Strategies, don't need the space which they are using.

Microsoft Teams meetings can go a long way to be used to save money for the city, instead of paying for physical space for staff. The discussant cites the City of Johannesburg, where employees can be in the office only two days of the week. It makes no sense for the city to buy laptops and pay for data for the staff, and still require all of them to be at the office every day. According to the discussants, this culture needs to be changed.

4.2.3. Use of data for customer engagements

The overwhelming view among the discussants is that the current administration seems to be effectively using social media a lot, so they collect data from surveys, and other sources to analyse customer feedback. Such information is used to also understand the needs of the residents; what they like and what they dislike

about the city, services and infrastructure. So that is enabling the city to make informed improvements.

One of the discussants recalls listening to a radio show on Power FM, wherein it was indicated that the City of Tshwane cannot be matched on how it responds to residents' complaints, emanating from various social media platforms. So, there is a strategy of allocating media specialists to pick up all issues that relates to the city, to inform how the city responds.

However, some of the discussants hasten to point out that even word of mouth is an important source of information. This is because there is appreciation of the fact that not everybody has got access to the social media. Nonetheless, the discussants do accept that social media remains a growing media of communication and is spreading the word faster.

One discussant posit that the City of Tshwane has innovated an after call service where after being helped, a resident has the choice of staying on the line to access other services; and in the process, more data is actually collected about the customer. Even more, the old method of the filling in a physical questionnaire is also still in use, to complement digital methods. All the older citizens wouldn't necessarily get information from social media, but they their first point of contact is the Customer Care Centre. So, both the old and the new methods are being used to have a grip of what customer needs are.

The city has also made available E services for customers, e.g. E procurement and E recruitment that customers can use. However, one of the criticisms of such platforms is that they are not always very interactive; they're more form based or, just about customers answering questions, but they not they do not necessarily get to the answers that they're looking for. Another discussant refers to the use of AI systems used by companies such as Vodacom, which use automated machine algorithms, with the machine being able to answer real questions, real time, because they have access to lots of data about a customer. So, the city has not yet reached a level where there is intense investment in AI.

4.2.4. Leveraging data to inform innovation and creativity.

The discussion reveals a consensus among participants that the City of Tshwane falls short in effectively utilizing data for innovation. Although an innovation department exists, its functionality is limited. External initiatives, like university hackathons, are recognized as positive contributors to fostering an innovative culture. Suggestions include incentivizing data-driven innovation programs and establishing a centralized system for processing and evaluating ideas. Some participants express concerns about the Innovation Department's insufficient collaboration with other departments.

Another discussant raises the point that an external programme like the university hackathons, which involve students in competitions is a useful initiative to ground a culture of innovation and creativity. Yet, another discussant suggests that if the City can develop programmes that offer incentives for the use of data to inform innovation and creativity, the results could improve for the better.

Another discussant suggest that the City needs to develop a system where ideas to innovate about service delivery can be banked, processed and evaluated. It is felt that the city is not maximising on what is available in terms of generating ideas. There are some discussants who believe that the Innovation Department is not adequately consulting, and/or engaging meaningfully with line departments to generate novel ideas to solve service delivery linked problems.

The issue of gadgets does come up again. In this context, it is argued that if the teams on the ground were using some gadgets, they can just send data to a central point whereby the information can be validated. This will also go a long way to ensure that technicians do complete jobs on site, thus being able to creatively solve problems. In addition, the officials on the ground would be empowered to meaningfully engage the relevant stakeholders. There is emphasis that the city need to actually start actually improving such systems.

Some discussants appreciate the fact that there is a lot of innovations which are happening in the city. However, there is no consensus on whether such innovations are informed by data. It is also reported that there is a lot of data which is sitting on IBS and other systems. However, the lack of dedicated capacity in terms of data analytics is raised as one of the key concerns for this city. There is a need to improve on the issue of data and how it links to, and/or feed innovation in this city.

4.2.5. Integrating data to inform day-to-day operations in the city

Discussants express scepticism about the extent to which data informs day-to-day operational decisions. Performance scorecards and target-setting are perceived as disconnected from data. Inefficiencies arise in responding to service delivery issues due to misalignment between plans and actual data. Operational managers identify structural issues in data systems, hindering effective utilization for daily decision-making. The absence of data scientists is noted as a contributing factor.

So, there is disjuncture between the plans and the data, ultimately resulting in teams literally going out on the depots to attend to call outs and complaints rather haphazardly. The discussants suggest that it seems like political priorities and mandates and aspirations take precedents over what the actual data could be indicating as problem areas.

The discussants indicate that the city has primary source documents like timesheets, which has a lot of day-to-day information or data that can be very useful for planning operations work. However, the inefficiencies in terms of people attending to call outs and the resources are also prevalent. Sometimes, the workers can idle in terms of not responding to service delivery queries, even when the data is availed to show where the problems are. Often, workers do this to generate overtime benefits.

Operational managers also suggest that the way in which the data systems are structured does not always allow for effective use of data as a source of decision making. There is an argument that there exist serious misalignment to ensure that there is a day-to-day operational dependency on data, to inform efficient flow of operations. Another point raised is that there is no substantive reliance on data processing to make decision that affects day-to-day operations. So, some data still requires some bit of processing before it can be usable for operational management decisions. The also seem to be paucity of trends and patterns analysis to inform decision making in the city. This may be somewhat related to the lack of data scientists in the organisation.

4.2.6. Using data to inform strategic management decisions in the city

Operational managers believe that strategic decisions in the city are predominantly influenced by political priorities rather than systematically leveraging data. Participants argue that better use of data could have prevented past errors, especially in sectors like electricity. Challenges include political and administrative will, skills gaps, and insufficient utilization of available data for strategic planning. Political instability and blurred lines between administrative and political offices are identified as obstacles to data-driven decision-making.

Even where data exist, the city leaders seem to ignore such data for decision making. An example is decisions on replacement of old and aged infrastructure in key services such as water and electricity. So, basically, the absence of data is not the major problem, but the political and administrative will, skills, and appetite to use the data seem to be where problems are. It is argued that if long term strategic decisions were based on data, the city would save a lot of money and avoid some of unnecessary catastrophies. Other discussants posit that there is lack of synergy between the administrative office run by the City Manager and the political office run by the Executive Mayor. This seems to lead to inconsistencies in terms of placement and removal of management, which

compromises the probability of data to be used for strategic decision making in the city.

It would have been expected that the IDP would be informed by the data rightfully so that remains irrespective of change in new political leadership. It is argued by discussants, that five years is a very short time for strategic planning, and the fact that there is no political stability caused by coalition governments in local government is seen as a threat to using data as a source of strategic decision making in cities. So, the constant change in leadership is a course for concern. The apparent blurring of lines between the administrative and political offices is coming strong as one of the obstacles for data driven decision making in local government sphere broadly.

4.2.7. Standard, documented procedure for controlling access to data.

Discussants express concern over the absence of guidelines or standard operating procedures for controlling access to data. The decentralized nature of data sharing leaves the city vulnerable to cybersecurity threats. Participants emphasize the urgent need for central data control measures. None of the operations managers are aware of the existence of a Standard Operating Procedure (SoP) for data access control. The discussants believe that the data is lying all over the city, and there is no central “data control centre”. It is literally up to employees to decide which data to share, to whom, how, and when. This status quo leaves the city open for serious cyber security threats and attacked. There is an urgent need for the city to develop controls in this regard.

4.2.8. Standard, documented procedure for sharing and exchanging data

The operations managers detest the lack of formal standardised procedures and systems to coordinate and guide the sharing of data in this organisation. All the discussants are not aware of the existence of such policies, systems and/or

procedures. The general picture is that employees can share and exchange data and information with whoever they want to, at any given point in time. The employees point out that the information is stored on Q drive, but can be accessed by anybody. The data on the Q drive can be accessed by anyone.

And the information on the Q drive can be created by anyone. So the Q drive is owned by the IT department, but anyone can create a folder in the Q drive and choose whoever they want to have access to the information. That is how the Q drive works. So if the originator does not put control measures for access and sharing the information, anybody within the organisation can easily access the folder, irrespective of the level and/or degree of sensitivity of the data or information therein contained. If the originator or creator of the folder does not share a link, anybody seeking to access the data must approach the initiator for access rights to the folder. The reality is that many folders do not have access control measures in the city. In the main, the folders created by the Office of the City manager and political offices tend to have access control measures; the rest are easily accessible by anyone.

However, the city is currently in a process to move away from the Q drive data strategy. The city is busy creating the E filing system where everybody will have a password to access certain files. So, the new system will allow a central storage of information and access will be controlled. Already, employees have been given deadlines to start learning the new ways and to work on the new E filing system because the Q drive will be phased out completely. One challenge would be that there are majority of employees who don't have access to such resources in the city. So, there is a need for management to share and inform general workers that report to them.

4.2.9. Automating of systems, replacing manual systems

Operational managers unanimously assert that the city lags in automating its systems. The need for workforce involvement, capability building, and mindset shifts during automation processes is emphasized. Participants stress the importance of providing resources, including gadgets, to facilitate employee adaptation to automation.

With the wave of the fourth industrial revolution being disruptive in the private and public sectors alike, the discussants are of the view that there is a need for this city to explore automation much more strongly. There is a need for management to involve the employees when automation, otherwise there would be needless resistance from the employees. There is a need to build workforce capability and also shifting mind-sets to embrace automation, as part of change management processes. This process must equip employees, including, but not limited to providing them with certain gadgets so that they can learn and unlearn, and relearn some of the new skills to be able to optimally automate.

4.2.10. Use of cloud computing

All the discussants believe that the city is lagging behind in terms of using cloud computing technologies. This, according to the discussants, is one of the causes of poor service delivery in the city. If the city could invest more in cloud computing technologies, it would allow residents to access more services wherever they are. There is confidence among the discussants that the city can and should invest in cloud computing technologies. In this way, employees would be in a position to access data and information even if they are outside the boarders of the city.

Given that the city of Tshwane is a Category A metropolitan municipality, the discussants are of the view that there is an urgency to adopt new technologies in terms of cloud computing. Discussants are not sure if there is political for this. However, there is a strong inclination to move away from traditional systems of using memorial sticks. These managers want to access information they are.

Importantly, the discussants are aware of some of the risks associated with cloud computing from a cyber-security perspective. To this end, they point out that there is a need for the city management to strengthen cyber security systems to avert cyber security threats and attacks. The discussants urge the city to consider innovations such as OneDrive. This should be able to allow multiple users to work on one document at the same time.

4.2.11. Use of wireless technologies

The discussants believe that the city is not exploiting the use is wireless technologies to advance certain objectives. One of these is asset verification. However, they point out another critical matter, which is the availability of the budget. There is a strong believe that when it comes to asset verification, a wireless way would be better than a manual way of verifying assets. The manual system is said to be leaving lot of room to error. There is also a good appreciation of the fact that the city's infrastructure is ageing. Another challenge facing the infrastructure is vandalism, and thefts. So, the asset register itself or the value of our assets and the condition of the assets is not properly done due to heavy reliance on non-wireless technologies in the city.

The discussants posit that there is an opportunity for the city to adopt genius wireless gadgets that are available in the market to address the issue of asset accounting. This issue is often raised by the Office of the Auditor General as one of the governance weaknesses in the city. There are a lot of discrepancies that result from manual verification.

The discussants indicate that the city has done a good job in terms of introducing the Wi-Fi programme, which is wireless. However, in terms of wireless of Internet of Things, there is still lack in terms of communication with one another. Another area of opportunity is the management of attendance registers. The current system of attendance register is easy to manipulate it. So, the discussants conclude that on wireless technologies, the city is not doing well currently, meanwhile there is a definite need.

4.2.12. Major obstacles for using data to inform decision making in this city

The discussants were asked to identify some of the major obstacles working against the use of data to inform decisions in the city. A whole range of issues were mentioned. Some of the key ones include the fact that political considerations play a big role in managing a municipality. The other issue relets to the fact that the IT systems have outdated configurations; and these tend to lead to unreliable data. Some discussants point to the lack of seamless integration of systems. Even more, lack of digital strategy, and lack culture come up strongly.

Some of the discussants argue that the city needs to establish a central data centre to coordinate the management of organisation wide data management processes. Other discussants posit that there is less engagement with end users, resulting in rushed implementation of programmes. The inability to interpret data from a right skills perspective is also seen as one of the major challenges.

4.2.13. Addressing the threats/obstacles

The discussants also shared some insightful views about how the challenges can be addressed. Firstly, they argue that the city needs to put systems to ensure that information is shared broadly. Monthly or quarterly engagements with staff on data and its management is also recommended. It is also suggested that the city needs to procure new IT systems or reconfigure the current systems. There are also strong views that the city needs to move towards seamless integration of systems. There is a need to develop a strategy, to drive it, and to ensure that all behaviour is aligned to the right culture.

4.2.14. Seizing opportunities for using data in the city

The discussants believe that the city can use data for strategy development. When that happens, there is also opportunities for culture realignment. Use of data can also assist the city to stop nuisance electricity trips. Even more, data can be used to set performance targets better, as well as for better resources allocation.

4.3. Presentation of the results and findings from the administration of in-depth Questionnaires with middle and top management officials

This section of the report presents the findings from the administration of in-depth questionnaires with middle and top management officials. The researcher administered a structured in-depth questionnaire to a total of 12 managers in the city. The 12 managers consisted of 6 middle management level managers (holding titles of Deputy Directors and Directors) and 6 top management level managers (holding titles of Regional/Divisional Heads). The presentation of the findings is organized according to themes.

Theme 1: Digital transformation, vision, and strategy

4.3.1. Understanding of the concept of digital transformation

The scientific literature reveals that data-driven organizations embrace digital transformation, and ensure that employees understand what constitutes digital transformation. In this regard, the study sought to understand the extent to which managers have a comprehension and understanding of the term *"digital transformation",* and what it means for the city. It can be indicated that there is some good understanding among managers, regarding the different nuances of the term digital transformation. Some emphasize aspects related to the increased use of technologies, with the end goal being improving outputs. For instance, Mankwi describes digital transformation as using technology to improve, change or transform how things are done, using technology to aid in the delivery of

services. Similarly, Mpule posits that digital transformation relates to the conversion of an area of delivery (or of communication) from manual to computer-assisted or generated platforms. Perli highlights the benefits of digital transformation to external stakeholders. In this regard, she defines digital transformation as:

"*It is the adoption and use of technologies that get to be embedded in the normal business processes, services, and strategies of an organization to better serve customers, stakeholders, suppliers, and the entire workforce"*

Similarly, Spume adds that digital transformation is about leveraging the capabilities and efficiencies that technology provides: He indicates as follows:

"The deployment and the use of digital technologies to transform or improve the processes of conducting business operations by leveraging the capabilities and efficiencies that technology provides"

Other managers emphasize aspects such as acceleration/faster realization of results. In this regard, Lola defines digital transformation as embracing new technologies and integrating them into every area of the business, with a particular emphasis on the departure from manual processes to automation of systems, to make life easy and faster, and accelerate productivity. This view is shared by Mgodene, who indicates that digital transformation entails the use of technology in all business operations e.g., automation of manual processes to digital by embracing technology. Similarly, Milanto concurs that digital transformation involves the enabling of digitally based processes and operations as opposed to manual processing i.e. paper, physical presence, etc.

Other managers view digital transformation as a process. For instance, Lera argues that digital transformation is a process in which an organization implements technology to change the way they operate and do business. This view is augmented by Mindlos, who sees digital transformation as the process of

using digital technology in an organization, including the alignment of the business model to processes and products to improve efficiency. Faithicious seems to concur, by indicating that digital transformation involves the integration of all digital technologies to achieve integrated business processes and move towards big data management and usage.

Some managers see digital transformation as a way of working. For instance, Mokwenaite defines it as the way of working with a digital system or advanced digital technology for a more effective and innovative way to achieve an organization's deliverable. Similarly, Thatisto views digital transformation as entailing the integration of business service processes with digital technology to improve service offerings to customers. The diverse perspectives highlight the multifaceted nature of digital transformation.

4.3.2. The necessity for digital transformation

The necessity for digital transformation is generally appreciated in the context of the fourth industrial revolution and smart cities. So, this study sought to understand the extent to which managers in this city see digital transformation as a necessity in the current dispensation. Encouragingly, all managers see the necessity of cities to adopt digital transformation. For Mankwi, cities will profit from digital transformation efforts because:

"It will improve processes, time, and costs of doing business; ultimately improving how services are provided".

Sphume highlights the impact of digital transformation on revenue and service delivery in a city. He says:

"Yes, digital transformation is a critical enabler of competitiveness, and efficiencies and improves the experience of the client or customer. Therefore, if the city needs to improve its offerings and impact its customers or service

beneficiaries positively, especially given its challenges on revenue and effectiveness in service delivery, digital transformation should be one of its flagship projects".

Mpule adds that the world is gradually transforming into a digital planet and soon enough many of what is considered basic needs will be delivered using digital equipment. He makes a profound statement about the need for cities to embrace digital transformation so that they are not "left behind":

"If the city does not transform, it will be left behind by the world and will find it difficult to interact with its stakeholders, such as service providers, residents, other spheres of government and business among others. That will make service delivery almost impossible. As we speak, normal mail is becoming extinct and the delivery of municipal bills is already a challenge due to the slow adoption of digital transformation"

Additionally, Perli suggests that cities that adopt digital transformation stand chances of automating business processes that can promote transparency by automatically notifying residents/stakeholders/customers, etc. as each step or transaction (be it service, processing payments/invoices) of a municipal process is completed. She adds that the residents will benefit by getting notified and informed throughout a particular transaction or process. Consequently, this will prevent residents or customers from calling the customer care center to track and trace their requests, etc.

She then makes a crucial remark on investor confidence and economic growth:

"The City of Tshwane needs to take a bold decision and invest in the digital transformation initiative and actively embrace digital technologies. If this is not taken seriously, the City will still experience customer complaints, poor customer satisfaction, service protests and ultimately lose big investors to drive economic growth".

For Lola, digital transformation adoption is a necessity for cities because it will assist cities in eliminating paperwork and queues for its customers to do online service. Lera points out that COVID-19 has forced cities to adopt platforms like Microsoft Teams. However, she points out that there is still a long way to go, especially in using technology to run operations like logging and closing service requests immediately, instead of waiting for a foreman to give manual job cards to data the capturers back at the office. In the same vein, Mgodene posits that cities need to adopt digital transformation in their operations to minimize human interventions that are costly, time-consuming, and susceptible to manipulation.

Faithicious seems to argue that when cities adopt digital transformation, they are more likely to take better decisions. In the same vein, Mokwenaite posits that a manual way of addressing pothole complaints by creating works orders issued to supervisors and timesheets written by hand can be done away with if cities adopt digital technologies. He argues that cities should, for instance, have digital devices that can properly record the data on the system from the implementation stage until the final stage of addressing complaints. For Mindlos, the adoption of digital transformation by cities will assist in ensuring the alignment of business processes, thus avoiding a silo mentality and using available data to improve service delivery to the end consumer. According to Thatisto, such a move will enable cities to offer convenient services to communities and transform cities into organizations that are fit for the future. However, Milanto cautions that cities need to ensure that their digital transformation efforts accommodate older people, whilst endeavoring to ensure that the cities do become learning organizations so that cost benefits are leveraged where necessary.

In sum, managers acknowledge the necessity for cities to adopt digital transformation, citing improvements in processes, time, costs, and service delivery. The consensus is that digital transformation is a critical enabler for competitiveness, efficiency, and positive customer experiences. The potential for economic growth, transparency, and improved service offerings are also emphasized.

4.3.3. Vision and strategy for digital transformation

Digital transformation requires a clear vision and strategy, which must be understood and permeate through all levels of staff. So, having captured the understanding of managers on the concept of digital transformation and the necessity of digital transformation efforts by cities, it is also vital to understand the views of managers regarding whether, to their knowledge, the City of Tshwane has a vision and strategy for digital transformation.

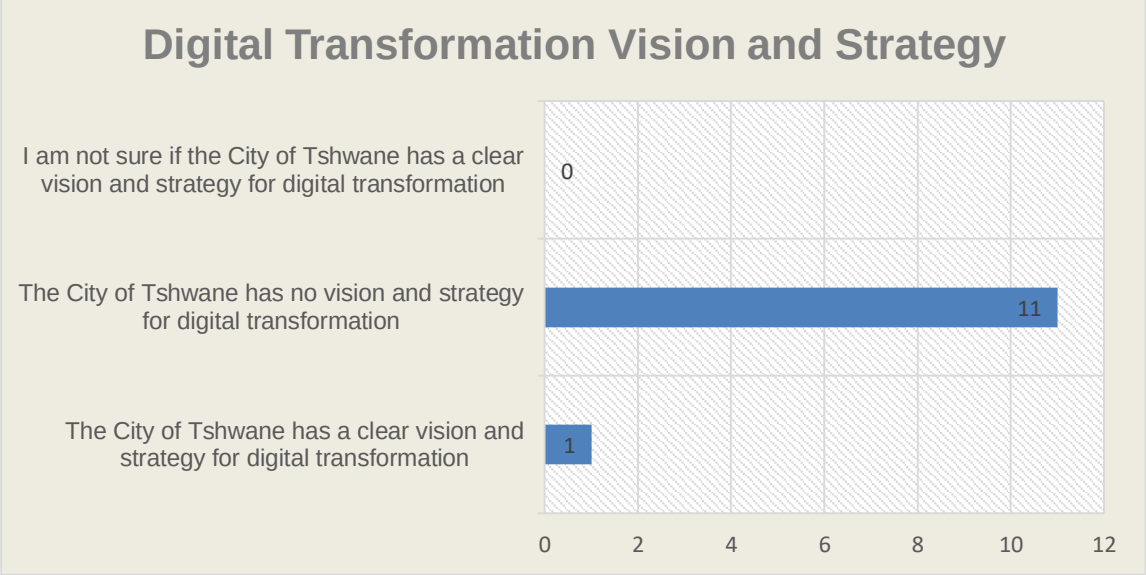

Figure 4: Understanding digital transformation vision and strategy in the CoT

On this one, there are two predominant schools of thought/perspectives. On one hand, only one manager believe that the City of Tshwane has a vision and implementation strategy for digital transformation. On the other hand, other managers (a majority) believe the city does not have it. Mpule puts it like this:

"The City [of Tshwane] is aware of the need for digital transformation. However, a cogent view has not been adopted on how the City can achieve digital transformation, therefore there is no vision nor strategy at this stage. The City has only managed to identify digital transformation as an imperative"

Perli seems to agree with Mpule. She indicates that according to her knowledge, whilst the City of Tshwane has been working towards a “Smart Cities Strategy” together with the Development Bank of Southern Africa (DBSA) and World Bank, the strategic document is still a work in progress and it is not certain when the City will have the strategy in place. However, she indicates that part of the previous commitments (2022/2023 financial year) from the political administration was to have a “Data-driven City”. She adds that progress towards this might not be tangible, or there is no progress towards this commitment at all.

Similarly, other managers, including Mindlos, Milanto, and Sphume argue that in practical terms, the city does not have a strategy for digital transformation. Mgodene argues that if at all such a strategy exists, it is not generally known by many stakeholders in the city. Faithicious and Thatisto reflect on the smart city strategy of the City of Tshwane in this regard. So, Faithicious asserts that whereas the city speaks a lot about smart city (and there is a steering committee for that too), it is impossible to reach a smart city if digital transformation is not considered. However, she indicates that she cannot refer to any of the documentation for the smart city vision; neither can she vouch with surety that there is a strategy. In the same breath, Thatisto confirms that the city is indeed working on a smart city strategy, which touches on digital transformation. She also believes that the approved innovation strategy of the city indicates the city’s intent to digitize and decentralize the innovation management system.

Mankwi also seems to believe that the strategy exists, but that it is not clearly articulated so everyone is aware of it. Similarly, Lola believes that the deterring factor to implementation is political instability and budget constraints within the city. Lera believes the City of Tshwane does have a digital transformation vision and/or strategy, however, the implementation is delayed and/or thwarted by a lack of finances. She also indicates that it is quite difficult to introduce technology in government because it is seen as replacing the labor force. Mokwenaite recommends that the Research and Innovation Department of the City of

Tshwane should look into digital platforms to assist various departments to ensure their work is more efficient and effective.

It can be concluded that digital transformation requires a clear vision and strategy permeating all staff levels. The majority of managers express uncertainty about whether the City of Tshwane has a clear vision and strategy for digital transformation. While some believe it exists but lacks articulation, others argue that the city does not have a concrete strategy in place. Political instability, budget constraints, and lack of finances are identified as potential barriers to implementation.

4.3.4. Using big data to enable organization-wide strategy implementation

Data-driven organizations use data as part of their key strategies to drive digital transformation. So, the study sought to understand the views of managers regarding the current status quo in terms of big data being used for implementation vision and strategy in this city. The overwhelming view among managers is that the city does not meaningfully use big data for strategy implementation.

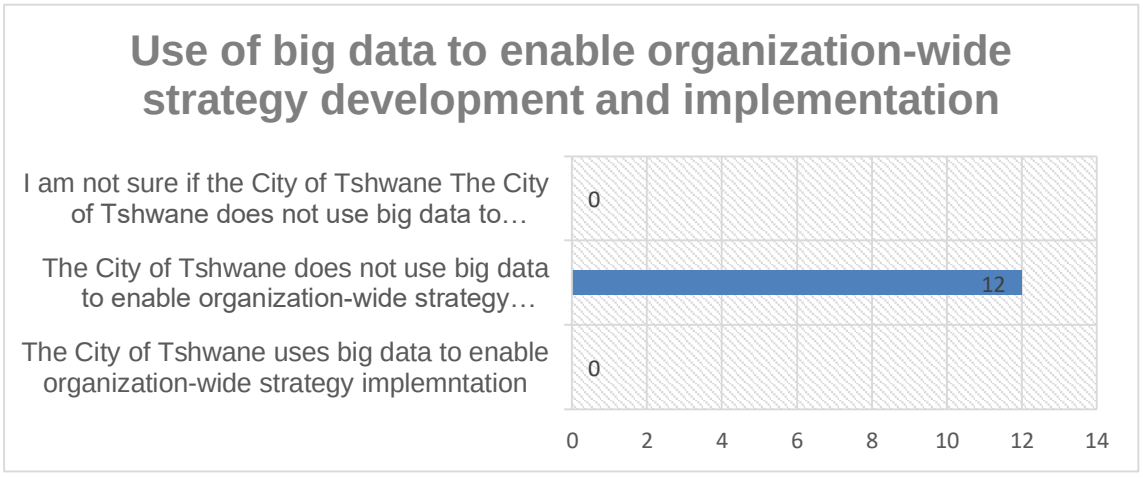

Figure 5: Use of big data to enable organization-wide strategy development in the CoT

Managers such as Mankwi do not believe that the city relies on big data to drive strategy implementation. She believes that if big data were used by the city, different types of customer queries would inform decision making and improvement plans would focus on areas with more complaints and the ones that take longer to resolve.

Similarly, Mgodene is of the view that the use of data in the city in the implementation of its vision and strategy is still at an elementary stage but there is an appetite to do so as evidenced by the service delivery data analytics forums to evaluate the performance of the city in different disciplines using data. Mpule also shares the same sentiment, by indicating that the City hardly considers big data for decision making. She puts it this way:

"In fact, most decisions are made on the personal observations of senior managers and politicians as opposed to the information contained in our digital archives. Data collection is a standard practice, however, the conversion of such data (analytics) into usable information is still wanting."

Perli suggests that one of the reasons the city is not able to use big data is that the City of Tshwane lacks an integrated approach towards "big data utilization", and this is exemplified by the existence of many systems in use which are not integrated. Some of the systems are too manual. Lola agrees that systems are still manually operated (e.g. facilities and services bookings), with only a small fraction being automated.

Lera suggests that in the past years, the city has not been able to improve or introduce technologies to improve operations. Faithicious makes a point that the city does not have one platform for customer profiles; there are multiple profiles per service which sometimes contradict each other and affect the service delivery negatively within the same city. Mokwenaite adds that the City does not have one

digital system to avoid audit findings and quarries. Faithicious seems to suggest that in the City of Tshwane, the use of big data analytics does not exist at all:

"The term big data is still a dream"

Milanto seems to agree with the view shared by Faithicious:

"…the City is not within the realms of how big data is being harvested in global Institutions. As an example If you look at google and how Google harnesses Big data to earmark its next innovation, it is said at any given one time Google puts a budget aside to run 100 projects, accounts for the 100 as a write-off before anything is done simply to see what can be generated from the 100, the data is used for lessons that can be learned…"

Mindlos indicates that one of the reasons to support the notion that the city does not use big data to make decisions is that departments that contribute high value to the revenue generation in the city are not getting a proportional chuck of the Opex budget to make sure that income generation is not hindered. In this regard, Thatisto agrees, when he points out that the city does not fully exploit the use of big data to make or assist with management decision-making. He argues that, instead, service providers take advantage of the evident gap.

In sum, managers express skepticism about the meaningful use of big data for strategy implementation in the city. Challenges include a lack of integrated approaches, manual systems, and a need for more efficient data utilization. The city's use of big data is perceived as elementary, with concerns about the absence of a comprehensive strategy and system integration.

Theme 2: Customer engagements, completion analysis, and innovation

Data-driven organizations use data tactfully to engage customers, analyze competition, and innovate for better delivery. So, the managers were also asked

to offer their views on the use of big data to inform the city's engagements with its customers. Most managers are not optimistic that the city is using big data analytics to tactfully engage its customers. For instance, Mankwi indicates that the city is poor in using data to communicate with is customers. Similarly, Mpule cites an example that laments the fact that so far, data is not being used to guide how different categories of customers are engaged. Thatisto argues that it is very frustrating because the data is readily available. However, he points out that one of the major problems is that the city does not have a dedicated unit to analyze data and feed the information up to management. Lola also indicates that big data systems are not used to engage customers in the City of Tshwane. Lera adds:

"I am not aware of any data being used to engage customers".

Faithicious argues that one of the challenges facing the city is that the city manages data in very departmentalized and misaligned ways; for example, housing data, spatial planning data, finance/revenue management data, health and social development data, and customer care data are used separately and in many cases contradict and confuses customers.

Sphume argues that the use of data is not consistent in the City of Tshwane:

"Sporadic and reactionary use of data for crisis management instead of drawing intelligence for proactive and deliberate planning of responsive interventions as may be suggested by the analysis of the available data"

In a similar vein, Mindlos posits that:

"To my understanding, the city is engaging with customers in generic terms, they are not using data to coin specific messaging".

Few managers believe that the city is trying its best to use data for purposes of customer engagement. For instance, Mgodene argues that to a larger extent, the

city’s customer care centers use data to analyze the quantity, quality, frequency, and mode of interactions the city has with its customers. He also argues that most customers engage the city through social media platforms and the city also uses social media platforms to communicate with customers on issues of service delivery.

Similarly, Mokwenaite posits that the current system used does inform the customers of their complaints details, and generates unique reference numbers for customers; and the system automatically sends or informs customers of the status after completion via sms or email. However, he laments the fact that the system doesn’t track progress in the process to keep customers abreast of the status quo.

Milanto suggests that the city is currently in the process of understanding data. She argues that the Customer Relations Management (CRM) unit generates the data to show levels of query, inquiry, and complaint resolution. However, she hastens to indicate that not much is done to understand the needs of the customers on the ground; which is where there are plentiful missed opportunities.

In sum, managers express skepticism about the meaningful use of big data for strategy implementation in the city. Challenges include a lack of integrated approaches, manual systems, and a need for more efficient data utilization. The city's use of big data is perceived as elementary, with concerns about the absence of a comprehensive strategy and system integration.

4.3.5. Use of big data analytics for customer relations management

Data-driven organizations embrace big data analytics in their quests for understanding customer needs, so that they can proactively address them. Hence the researcher also sought to explore the views of managers on the use of data analytics for purposes of customer relations management. The major

finding is that most managers are not optimistic about how big data analytics are used for customer relations management in this city.

Sphume shares some useful insights:

"There is no systematic engagement of available data produced either internally (within the city) or produced by external data houses to glean anything of a substance that motivates or compels the city to initiate targeted customer engagements as informed by the synthesis of the data available. The city does not have a mechanism for data analytics to draw intelligence from any data. Customer engagements are always reactionary instead of being proactive as informed by intelligence drawn from the data available".

Mankwi puts it this way:

"Customer engagement is still done in a traditional way in the city, we still rely heavily on walk-in centers to engage customers"

Perli offers more insights:

"There is a lot of work that needs to happen in-house across all departments to have an understanding of "big data" and how that could be used to inform "planning, evidence-based decision-making, and strategy development. It is important to build capacity and provide support in various departments on "business intelligence/big data/data science" and ensure the skills gaps are addressed and have dedicated "Business Intelligence (BI Specialists) and Data Analysts that will provide service at different levels of management and operations"

Faithicious also agrees that there is no use of big data. She points out that as a result of that gap, the city is often unable to use data-based intelligence to pick up fraudulent cases by customers. Mokwenaite adds that the fact that the city only does customer satisfaction surveys once a year causes some delays in satisfying the emerging needs of the customers. Mindlos cautions that the fact

that customers are addressed with bulk messages is indicative of how less data is used for effective customer relations management. He points out that there is no focus on individual customers who often have unique challenges specific to their needs.

Mgodene points out that even though data trends show that most people engage the city through social media platforms, the city has not fully embraced and maximized the use of its social media platforms as a customer interface system that can be automated to understand customer needs accurately. In a similar vein, Thatisto posits that whereas there is increasing acknowledgment that customers do use digital technology platforms, the challenge is that the city does not optimally use the platforms to improve service delivery as it should. Mpule argues that the city should do more to use data for accurate billing of customers.

In sum, managers express mixed views on the city's use of big data for customer engagement. While some believe the city is making efforts to use data for customer care centers and social media interactions, others emphasize challenges such as departmentalized data management, lack of dedicated units for data analysis, and sporadic use of data for crisis management.

4.3.6. Use of data for strategic competitor analysis and management

Data can be very useful for understanding threats from the markets competitors and rivals. So, management was asked to share their views on how data is being used in the city to understand competition from private sector service providers who offer similar services that could compete with municipalities. The overall finding is that managers believe that the city does not use data to conduct competitor analysis; if done, it is at a very basic level. In this regard, Mankwi the city does not use data to study completion, even at the detriment of revenue collection. She adds that:

"…with waste collection, more households are moving to private service providers due to unreliability of city services".

Faithicious also suggests that even though the city is facing strong competition from the private waste management service providers, the city is not doing enough to use data to inform its strategy and tactics. As a result, this tends to negatively affect municipal revenue. In sum, she puts it this way:

"It is my view that the data in this regard is not used at all".

Mpule concurs that data is hardly used for competitor analysis in this city. Other managers such as Perli, Lera, Milanto, and Lola also agree. Mgodene posits that the city does use data to understand competition, but to a very small extent, or at most, on an ad hoc basis. He argues that efforts to understand competition are not something that is ingrained in the operations of the city, to inform decision-making. This view is similarly shared by Mindlos, who points out that the municipality is not been run on a commercial basis; where competitive advantage is being used to leverage customer satisfaction. In the same vein, Mokwenaite argues that the city is not pushing to be a competitive organization to improve the way it conducts business. Thatisto sees this as one of the reasons why there is a huge appetite by private players to provide services that are normally offered by municipalities.

Equally, Sphume believes that the city can do more:

"With the proliferation of small-scale embedded generation of energy, the city has not used any available data to assess the extent of threat which that may have to its critical revenue stream and devise means to mitigate any negative impact of such. This is despite a clear indication that the city needs to protect and expand its revenue streams"

4.3.7. Use of data for innovation and creativity

Data is a critical input to formulate innovative interventions. So, the researcher was also interested in understanding the views of managers regarding how data is used in the city to inform innovation and creativity for improving or bettering service delivery programs/efforts. There is an overwhelming consensus among managers that data is used very minimally, if any, to anchor creativity and innovation in this city. For instance, Mankwi suggests that in areas such as meter reading, although there are opportunities for innovation based on actual data, not much is explored by the city. Mpule posits that in the areas of supply chain management processes and land use applications systems, data could be used to develop creative and innovative solutions.

Some managers go as far as identifying some of the projects/programs which the city could use to improve the situation. For instance, Perli points out that the city's Innovation Maturity Index study conducted by the Innovation Centre can be used more optimally to inform innovation programs relevant to the municipality. Similarly, Lera highlights that in 2022, there was an initiative where different stakeholders, including Non-Governmental Organizations (NGOs) and young people, were coordinated to use their creativity to develop solutions to help address some of the identified challenges in the city.

In agreeing that data is used minimally to inform innovation and creativity in the city, Lola and Mgodene emphasize their observation that most decisions are mainly based on satisfying the view held by the constituency that is aligned to the governing party or coalition government that is in place at the time of decision making. This suggests that innovation is done to appease political support in some respects in this city. Faithicious gives a practical example of how the city is handling service requests. She argues that whereas the data shows that the city in many cases does not offer services in line with the approved service delivery norms and standards, the city management is not putting necessary measures to address this big deficiency, regardless of whet the available data points to.

Mindlos cites an example in the electricity sector. He points out that within this electricity environment, there is minimal use of data to inform the necessary upgrades for purposes of refurbishing equipment, and/or brining on board newer technology to allow for speed in clearing electricity operational faults. This is yet another missed opportunity. Thatisto suggests that lack of departmental coordination and synergy (managing interdependencies) is one of the factors that prohibits the effective use of data to develop new exciting products and/or services within this city. He argues, for instance, that the department which is responsible for innovation does rely on the different departments of the city to provide it with data to run service delivery innovation challenges, and such data is more often than not, not forthcoming.

In sum, managers unanimously believe that the city does not effectively use data for competitor analysis. Concerns include a lack of systematic engagement of available data and insufficient utilization for targeted customer engagements. The absence of a mechanism fordata analytics is highlighted as a barrier to proactive and intelligent planning

4.3.8. Use of big data analytics for innovation management

It is one thing to innovate. It is another to manage innovation. Data analytics can be very handy in managing innovation interventions. In this regard, the views of managers regarding the use of big data to innovative in this city provided further interesting insights. The general feeling among managers is that there is a dearth of innovation in this city. Mankwi had this to say:

"There seems to be minimal innovation currently in the city, we are in many areas still doing things the way they were done years ago".

Mpule shares the sentiment of Mankwi:

"There has not been a single innovation in the operations of the municipality that came about as a result of gleaning big data and that, in the main, is an outcome of failure to analyze the data in the City's possession"

In agreeing to the views of Mpule and Mankwi, Mindlos adds that:

"The city is using the same old techniques which were used 30 years ago to solve problems which have changed overtime due to the advancement of technology and the newer customer who is agile".

Mgodene appreciates the fact that there is room for improvement in using data to inform innovation in the city. He cites an example regarding the use of data analytics that could have ensured that the Bus Rapid Transport (BRT) uses routes with high demand to ensure Return on Investment (ROI) for the city. He argues that the busses continue to run empty or with fewer passengers because the identified routes don't have the numbers that are needed to run a profitable transport service.

Similarly, Lola and Lera do not believe that innovation is prioritized and emphasized as one of the core values in this city. Some managers can suggest some of the stumbling blocks for the lack of innovative culture in the city. For example, Mokwenaite suggests that delayed innovation due to a lack of dedicated funding (budgetary constraints). Meanwhile, for Thatisto, the non-exploitation of data will remain until dedicated personnel are employed to use big data to the city's benefit. Perli seems to suggest that one of the challenges facing the city is silos. She argues that:

"I don't think that the data that is sitting in various systems is often used or leveraged to drive innovation in the municipality. Various information sources are used to assess the current challenges that the City of Tshwane is facing. However, having reliable and centralized data systems and ensuring that certain data reports are pushed to levels of management was going to add

value. The other issue to look at is, whether officials at different levels have "interest" and the "competencies" to be able to use data for effective delivery and improvement of services and programs"

Other managers were able to point out areas of opportunity. For instance, Faithicious suggests that in the past 10 years, the city has been delaying to introduction of innovative mobile applications for customers. Another area of opportunity is to have a fault reporting functionality on the website, and to synchronize processes to allow an overview of customers and many more.

Theme 3: Data as a strategic asset for decision-making

4.3.9. Data as a strategic asset

Data-driven organizations see, use, treat, and apply data as a strategic asset. So, one of the significant objectives of this study was to understand the extent to which data is used as a strategic asset in this city. Overwhelmingly, the managers believe that the city has not yet reached a maturity level where data is viewed as a strategic asset. Mankwi puts it bluntly:

"I do not think that the city view data as a strategic asset at all, especially because it's not being used for the benefit of the city".

Mpule also agrees that data is not necessarily treated as an asset in this city. She adds that one would hardly find a document that considers data an asset. Lola argues that the city has not fully unlocked its full potential it terms of strategically enhancing data efficiency. Mgodene attempts to provide one of the reasons, i.e. that the city doesn't have a centrally managed Management Information System (MIS) that is easily accessible with real-time information. In the view of Faithicious, the very fact that data is not seen as an asset in the city explains why there is a low response towards digital transformation.

Some managers provided examples of areas where treating data as an asset could potentially benefit the city if well handled. For instance, Mokwenaite says that many of the negative audit findings made by the Office of the Auditor General (AG) could be avoided if data was used as an asset. Another example is that the city could develop a credible Asset Register if data was properly managed. The poorly managed Pavement Management System keeps data that is very old. Mindlos argues that the electricity metering data could be used by the city to identify non-paying customers to focus revenue protection actions in specific areas. In addition, illegally electricity-connected customers can go for many years without being detected because the city hardly pays attention to data as an asset. Thatisto points out that in the area of contract management, more could be done to ensure that data is treated as an asset in this city. He cites an example that service providers refuse at times to release data back to the city when contracts end because the city does not make that a requirement. In [some] instances, the city is forced to consider contract extensions because the city has no clauses on ownership/management of data in its contracts. Milanto suggests a need for the city to have organisation-wide cohesive discussions about the significance of data as an asset. Perli points out some of the departments which need to urgently consider data as an asset. These include the Economic Intelligence Unit, City Sustainability Unit, Health Department, Strategy Development and Implementation, Organisational Performance Management, Continuous Improvement Section, and Customer Relations Management (CRM), just to name a few.

Sphume suggests that some of the challenges experienced by the city (e.g. financial crisis) will ultimately be the drivers pushing for a data-driven orientation or culture in the city. It is then that data will be treated as a critical strategic asset. Then the city will invest (time and resources) accordingly in this asset.

4.3.10. Data used to inform long-term strategic decision-making

In data-driven organizations, long-term strategic decisions are taken based on what the data indicates. In this regard, managers were asked to share their views and perspectives regarding the extent to which they think data is being used for making long-term strategic decisions in their city. Mpule and Mankwi opine that if data is used to inform long-term decision-making in this city, it is done to a very little extent or very limited extent. However, most managers believe that long-term decisions are not taken based on what data shows in this city. Mgodene seems to suggest that the lack of stability in the local government sector broadly does not stimulate or encourage long-term planning. To quote him verbatim:

"… The nature of local government doesn't allow for long-term strategic planning due to constant changes informed by the short-term narure of political office. This has even been made worse by the advent of coalition governments, long-term strategic decisions are not carried forward due to the instability caused by the constant changes".

Faithicious concurs as well:

"In the context of the Integrated Development Plan (IDP) as the long-term plan for the municipality, I think data is hardly used, hence the new development mushroom without infrastructure expansion plans".

Mindlos suggests that decisions are taken based on political point scoring rather than what the data says:

"Business decisions taken by the city seem to be for political expediency rather than to be supported by data. For example, a decision to implement a shift system was approved by the council a few years ago without proper consultation and costing".

Sphume suggests that there are no deliberate and targeted ways through which data is made to feature strategically in the critical decision-making platforms in the city. He says:

"Budget decisions and allocations are not informed by any analysis of any data. They are based on other things other than data indicators as that relates to each of the business areas that require informed budget allocation decisions".

Mokwenaite opines that one of the reasons why long-term decision-making is not informed by data is because a lot of the data is outdated. Thatisto laments the fact that the city has not built predictive tools for long-term decisions. Perli shares that from a long-term workforce planning perspective, there is data that indicates that by 2026, no less than 1 240 employees would have exited the employ of the city. However, she laments that at the top management level, there are no strategic decisions taken to address this proactively from a business continuity point of view. So data is not effectively being used to address the risk of losing institutional knowledge.

4.3.11. Use of big data analytics for strategic management

Data analytics can assist executive managers to look at the organization from a long-term horizon lens. So, the views of managers were also collected, regarding the extent to which big data analytics are being strategically used for decision-making in the city, for strategic purposes. As observed from the responses of managers, there is almost none, or at best modest use of data analytics in this city. In this regard, Mankwi believes that even with the information available, very little gets used to make decisions. Thus, the city is not fully realizing the intelligence that the data provides. Mpule indicates that there is no data analytic in the city at all.

For Perli, the real challenge is that even though some useful management and operations data gets gathered through the public consultation and the planning

process, the reports generated still depict a picture of how the city is performing; and in cases where there is poor performance, decisions need to be taken to come up with corrective action plans and service delivery improvement plans. Lola shares that even though data analytics can help the city to make strategically guided decisions; the problem is that this is not fully applied in the city. Lera laments that data is not used for decision-making simply because most things have not improved or changed in the last 10 years.

Mgodene advises that the nature of decision-making in the city is mainly informed by the popular sentiment of the governing party's constituency. The failure by the governing party to adhere to the sentiment of its constituency, even if the data analytics prove otherwise may compromise its standing in the community and lead to the loss of voters.

Mokwenaite suggests that the delay in the city to upgrade its information management systems has led to the current low usage of data analytics. Mindlos: shares that he is not aware of any use of data analytics in the city, to mine and analyze the data. However, Thatisto indicates that although there is war room to discuss service delivery data, she is not sure about the extent to which data analytics are used for purposes of informing decision-making.

4.3.12. Data used to inform day-to-day operations decisions and choices

Not only is data and its analysis useful for strategic decision-making, but it is also found useful for operations decision-making in data-driven organizations. So, the researcher also sought to understand the views of managers as to the extent to which they think data is being used for making day-to-day operational decisions in their city. Similar to strategic decision-making, the predominant view from managers is that there is very little evidence to suggest that day-to-day operational decisions are data-driven. Mankwi suggests that data could be used, although to a limited extent, concerning handling daily customer complaints.

Perli suggests that many management units in the city do not possess requisite capabilities for using data as the basis for operational decision-making. Lola adds that information management systems are not robust and credible enough to be utilized for day-to-day decision-making. Lera points out that the problem is that even though data is collected, there are no interventions to enforce that such data is used for decisions to improve day-to-day operations. Similarly, Mgodene sees an opportunity for the city to use data emanating from customer complaints from the customer relations management systems on repairs and maintenance to be used for operational decision-making.

Thatisto adds that for day-to-day decisions, the city can use platforms such as SAP, to harvest data and use it for decision-making. Data can also be used to make operational decisions concerning debt collection, rationing of water and electricity, etc. Sphume argues that there are no deliberate mechanisms for the uptake of available data in the decisions taken operationally. Milanto opines that there are various platforms where data is shared with top management and the executives, e.g. Service Delivery War room of the Executive Mayor, the Mayoral Committee (MAYCO), and the Operational Performance Task Teams platform. Accordingly, Milanto implies that these platforms should be enforcing the need for such data to be used as the basis for operational and tactical decision-making.

Faithicious laments the fact that some few departments seem to show efforts in using data, whereas many departments don't demonstrate zeal. So, the culture of using data is not evenly embedded in the city. For Mokwenaite, data could be communicated internally, but it is largely not used to address the needs of the customers externally. In this regard, Mindlos adds that the city could be using data monitoring systems to ensure that the operations and maintenance stores are fully supplied with stock so that the repairs stock is available at all times. Because this is not done, there are situations where maintenance teams, especially within electricity, end up using lower-rated materials just to make means to reconnect customers. The consequence is that this often results in a

sub-standard grid/network which could cause frequent electricity nuisance trips to paying customers.

4.3.13. Use of big data automated dashboards

The use of automated dashboards has become standard in data-driven organizations. So, managers were asked to reflect on the extent to which big data automated dashboards are used in their city. The findings show mixed results. Some managers believe that some dashboards is being used in the city, while others believe that more could be done. Mankwi argues that meter reading and billing is automated, and it makes it easier to determine areas where meter readings were obtained. So, managers can pick up if billing has taken place or not.

Mgodene indicates that the CRM also has some form of big data automated dashboard that aggregates data according to Regions. This dashboard system assists the city to see when complaints are reported and when complaints are dispatched and completed. In addition, Faithicious indicates that there is a councillor's dashboard which is integrated with customer care data, and a call center management dashboard which integrates workforce data from the Human Resources division from a compliance perspective. E-health is another automated dashboard implemented in the city.

Mindlos also indicates that the city also has the Quality Program Reports (QPR) system as one of the dashboards used in the city. This dashboard system is used to address performance management data. In addition, Thatisto points to the Enterprise Resource Management (ERM) dashboard system used by the Project Management Unit (PMU) to plan and monitor the implementation of projects. There is also a dashboard system used by Indigent Management Section to monitor the applications for the indigent program. Mokwenaite also highlights that there are dashboards used to report financial data in the city. In addition, Milanto

also suggests that the Client Relations Management also have some dashboard systems.

Perli, Lera, Sphume, and Lola indicate that they are not aware of any automated data dashboard. Lola goes to the extent of saying manual systems for tendering should be replaced with online tendering or job applications to name a few Mpule argues that changes in political leadership could have frustrated the process of using automated dashboards in the city.

4.3.14. Use of other big data analytics tools

Data-driven organizations also make use of various data analytics tools to assist them in understanding the different nuances of their data. So, the researcher was also interested in understanding the deployment of big data analytics tools in the city. Most managers are not aware of the deployment of big data analytical tools in the city. Mankwi says:

"In the space where I operate, we use excel to analyze data, although its time consuming it is effective in that it provides the information required".

Mpule, Mindlos, and Lera are not aware of the use of big data analytics tools in the city. Perli cites Power BI, and SAP BI. Lola cites Ibis. Faithicious points to power business intelligence pro. Mokwenaite indicates awareness of BI or Business Workshop analysis software. Thatisto: Water and Electricity departments have their own tools to analyze water and electricity consumption patterns in the city. Milanto talks about the Microsoft Dynamics system. Meanwhile, Mgodene argues that the data analytics are done ad-hoc basis in this city.

4.3.15. Use of data for performance management

Data is an important ingredient for performance management systems in any organization. So this study sought to understand the extent to which is being used effectively for performance management in this city. By and large, managers are not impressed with how data is being used for purposes of performance management in this city.

Mpule indicates that:

"Performance management is manual in the City, therefore data is not used at all for that purpose. However, in instances where the performance of the municipality as a whole is being measured or the performance of the municipal manager, then the Service Delivery Business Implementation Plan (SDBIP), which can only be affirmed through data, enjoins the assessors to demand data-driven performance evidence"

Sphume indicates that:

"The city has not yet institutionalized a systematic performance management system at the both organisational and individual levels. Therefore, the use of data in performance management is at its rudimentary stages. Therefore, it can be argued that data is used to a limited extent."

Mankwi and Mgodene believe that data is used to a lesser extent since there are no intelligence reports that arise out of performance management reviews that are used to give insight and guide the operations of the city. However, Lola indicates that performance evaluation sessions are a valuable source of data that can help to align the workforce and identify gaps and opportunities that need to be exploited in the city.

Perli shares that the custodian division for performance management does analyze and audit performance data generated by departments regularly so they can produce performance reports for legislative compliance. In departments, performance targets are assessed against what has been achieved and committed. Similarly, Lera indicates that data is collected on departmental performance and the reasons for not achieving departmental Key Performance Indicators (KPIs) are indicated.

Mokwenaite opines that the integration of the system is not effective in terms of performance management. Mindlos adds that the performance measures set are not aligned with the realities on the ground (e.g. the shortage of material, personnel, and vehicles). Meanwhile, Thatisto indicates that the performance management systems are largely manually driven, posing threats of inaccuracies and inconsistencies.

Milanto laments the fact that data is not used to hold managers accountable:

"I have to answer to a Service Level Agreement (SLA) of 80 percent of calls answers within 20 seconds in the Call Centre – and I am measured on this quarterly and so is the Department – I don't think this necessarily filters down effectively and adequately towards remuneration".

4.3.16. Use of data for risk management

Integrated risk management relies on credible data management systems. So, the study also sought to understand the extent to which data is used effectively for risk management purposes in the city. Overwhelmingly, managers believe that risk management efforts are not informed by credible use of data in the city. Sphume indicates that there is no proper coordinated risk management modality in the city. Therefore, it can be argued that the use of data in risk management if limited or to a limited extent. Mankwi, Lola, and Mpule don't agree that data is used to inform risk management interventions. Perli opines that the Group Audit

and Risk (GAR) Department should be doing this exercise.

Lera believes that data is used to develop risk registers that are monitored quarterly and presented to top management. She posits that:

"To my knowledge, the reports are used to come up with strategies to address the risks however I am not sure if those are effective. For example, we have a risk of theft and vandalism which is costing the city a lot of money but we are not actively managing this risk even when the city has data on the hot spots, etc. I see the review of the risks quarterly as a compliance issue not necessarily yielding results".

Mgodene suggests that data is being used, but to a lesser extent. He cites an example of the city's revenue data, which indicates that the city collects less revenue in townships for water and electricity services but still, there are no focussed interventions that are tailored to address this culture of non-payment for services in townships as informed by data.

Faithicious hints that if data is used, the level of usage is very low, and hence the city is mostly operating from a crisis management perspective. Mokwenaite adds that data is not effectively and properly used to management the risk of data loss. He indicates that the current system being used doesn't have support services. Mindlos also does not believe that the city is doing enough to use data to inform risk management strategies:

"The city has been experiencing disasters, major power failures, due to burning of electricity sub stations and it would seem no root cause analysis is performed to avoid/mitigate the risks/incidents from recurring".

Thatisto adds:

"The city currently uses excel spreadsheet for their risk register"

Milanto also agrees that there is vast room for improvement for the city to employ data as part of its risk management strategy.

Theme 4: Data governance, systems and processes

4.3.17. Processes and procedures for data access control

Data-driven organisations deliberately establish procedures and systems to control access to data. So, this study sought to investigate the extent to which there are standard, documented procedures for controlling access to data in the city. For Mankwi, the city does have standard procedures for data access control. However, the disappointment is that not all employees are aware of the procedures. Mpule also agrees; and points out that data governance is managed through the use of policies and standard operating procedures in the municipality. She also points out that such procedures and policies are audited by the Auditor General annually for their compliance.

Perli refers to a document called a *"Data Governance Framework"*, which is meant to serve as a blueprint for guiding how data access should be handled in the city. However, she ventilates that there is a huge gap in terms of data governance and Information Management in the city. Significantly, she indicates that in the 2018/2019 Knowledge and Information Management Capability Assessment that was conducted, it has been revealed that there are no proper guidelines in place to control access to data and information. As a result, some confidential information gets leaked in the city.

On one hand, Lola, Lera, Thatisto, Faithicious, and Mgodene argue that there is no prescribed standard for controlling access to data in the city. Their view is that anyone can have access to data as long as the Head of Department (HoD) or the person who access is willing to make it available. On the other hand, Mokwenaite posits that there are many systems used for data governance; different departments seem to have various process flows and standard operating procedures. In this regard, Mindlos cites the fact that when logging onto the computers, there is a message popping up directing all employees to the city

policy regarding access and usage distribution. Hence Milanto argues that the data governance systems may not be adequately synergised across the city.

4.3.18. Processes and procedures for management of data sharing

Systems, processes, and procedures for sharing data are some of the key aspects found in data-driven organizations. So, managers were asked to share their views on the extent to which there are standard, documented procedures for sharing data in this city. The results are mixed, with most managers believing that the city does not have explicit standard procedures, guidelines, and policies to govern how data should be shared in the city.

Mankwi, Milanto, and Mokwenaite believe that such procedures do exist, but not all employees are aware of them. Mindlos shares the same view, i.e. that if the document is available, it is not shared broadly with all employees. Mpule, Lola, Thatisto, Lera, Mgodene, Faithicious, and Perli believe that such procedures don't exist at all. Sphume shares this sentiment, indicating that:

> *"The fact that the city does not have a data management policy and strategy renders the related efforts less robust or weak. Also, the city has never systematically institutionalized data management as part of its operating model. Therefore, data governance is not guided by any instrument deliberately and purposefully developed in the city. There are not instruments that support proper data governance".*

However, Perli indicates that in some departments there are "sector-specific" guidelines and procedures. The International Organization for Standardization (ISO) 9001: 2015 to a certain extent guides in terms of "control of data". Whether departments adhere to ISO 9001 clauses still needs to be investigated. Some

managers argue that the governance framework provided by the Protection of Personal Information Act (POPIA) is sufficient.

4.3.19. Robustness of data governance systems

One of the requirements of a data-driven organization is robust data governance systems. So, managers were asked to express their views regarding the robustness of data governance systems and processes in the city. Most managers are not confident about the integrity of the data governance systems. For instance, Mankwi laments that the fact that confidential information leaks in the city points to the reality that the data governance systems are not robust.

Mpule indicates that whilst the systems and processes for data governance are continuously being improved in the city; however, their current robustness could be found wanting. She cites the fact that circa 2019, the city was hit by a cyber-attack that led to the loss of money, showing the weaknesses of the control environment. Lola adds that the city has not managed to drive and manage the setting of internal governance of systems and processes. Lera is not even aware of the existing data governance system.

Mokwenaite argues that the data governance systems do exist, but the city does not have sufficient internal capabilities and capacity to manage them. Mgodene argues that the data governance system is weak, to a degree that if one asks the question about the number of employees that the city has in its books, one is likely to go to get different answers or numbers, depending on who is answering the question. Similarly, Mindlos points out that in some cases, employees who have resigned from the city have been found to still be able to illegally access the e-mail system of the city from outside. This is one of the major cyber security risks facing the city, and it needs to be addressed. Thatisto asserts that there is some form of a data governance system in the city, but it is not sufficiently institutionalized, nor assimilated throughout the entire fabric of the organization.

Theme 5: Industry 4.0 best practices

4.3.20. Automation of systems and processes

Data-driven organizations do automate systems, to the extent possible. In this regard, managers in this city were asked to express their views regarding the extent to which the city is automating systems and processes, replacing manual ones. Most managers are of the view that the city could do more to automate systems and processes. Mankwi argues that automation is happening to a lesser extent, whilst

Sphume argues that the city is very slow or has taken a very conservative approach to automating its key business processes. Perli is also of the view that the city is showing very minimal efforts to automate processes and systems. Lola seems to agree, indicating that:

"The process to automate systems is unhurried, most systems are still manually operated or on the old systems"

Citing an example in the electricity sector, Mindlos is of the view that the city does not prioritize automation. He argues that, for example, electricity reliance on the manual system called Power Map creates multiple calls and reference numbers to be issued to customers with clogs the system. Mokwenaite seems to share the view of Mindlos:

"We still have many departments who work manually"

Even more worrying, Faithicious has this to say:

"The city is reverting to the manual system even in some cases where systems were automated before".

However, some managers are more positive about the level of automation in the city. For instance, Mpule believes that:

"There is a gradual movement towards that end, however, it is at a snail's pace"

Lera cites that she is aware of some efforts to automate the process of closing service requests relating to Energy and Electricity and Water and Sanitation. However, it seems that the process did not go ahead because the automation system was not compatible with other systems that are currently being used like Powermap. Similarly, Mgodene believes that there is an appetite from departments to replace manual systems with automated systems even though the process is still at an elementary stage. Even Thatisto believes that there is a desire to automate [some of the], but progress is slow. Milanto shares that there is some traction, however, more traction is needed.

4.3.21. Use of cloud computing technologies

Data-driven organizations do use cloud computing technologies. In this regard, managers in this city were asked to express their views regarding the extent to which the city is using cloud computing technologies. Some of the managers are positive about the extent to which the city is using cloud computing technologies. For instance, Mankwi cites the issue of one-drive. Lola also agrees that the City is using cloud computing such as emails, and WhatsApp calendars to name a few. Also, Mgodene indicates:

"The city uses cloud computing for network hosting and storage to minimize the risk of corruption in the network and loss of information".

Sphume says that he is aware of the use of cloud computing in the city, but it is used to a very limited extent and very few city employees who should be aware and derive benefits from this are aware.

However, Mpule argues that:

"I believe that the City of using cloud computing because I have heard, in various meetings, presenters asserting the use of cloud computing in their environment".

Some of the managers (e.g. Thatisto) are not positive about the extent to which the city is using cloud computing technologies.

For instance, Perli says:

"Not that I am aware of"

Equally, Lera has this to say:

"I am not aware of any".

Faithicious also agrees:

"The city is not using cloud computing at this stage, even in cases were cloud storage was introduced, the city had to revert to on-site servers due to network capacity".

Some managers, like Milanto, are not aware of the use of cloud computing in this city. This includes Mokwenaite and Mindlos, who indicate that system back-ups for the server are done only by the Information technologies department, but he is not privy to where back-ups are kept.

4.3.22. Use of wireless technologies

Data-driven organizations do use wireless technologies. In this regard, managers in this city were asked to express their views regarding the extent to which the city is using wireless technologies. Most managers are positive about the use of wireless technologies in this city. For instance, Mpule indicates that the city does use wireless technologies because many laptop users have Wi-Fi connectivity and work remotely on work-related matters. Lola agrees that the city has

implemented various wireless technologies for communication and connectivity purposes such as Wi-Fi hotspots, wireless networks, and communication systems for emergency services.

Mankwi and Lera cite the fact the city is using Wi-Fi in all its buildings, we connect daily to Wi-Fi instead of Local Area Network (LAN). Similarly, Mgodene agrees that the city has the largest footprint of Wi-Fi network of all the metros in Gauteng and that is made available and accessible to communities at no cost. Similarly, Faithicious and Mokwenaite posit that in some cases, most of the municipal buildings are on wireless connectivity. In agreement, Mindlos indicates that most of the offices in the city have free Wi-Fi connectivity and most managers and supervisors have lap tops with 3g connectivity to the server. Even Thatisto believes that the City has made strides to make sure that the offices and associated facilities allow employees and communities to access [free] Wi-Fi. Finally, Milanto and Perli are not sure about the use of wireless technologies in this city.

4.3.23. Implementation of Industry 4.0 best practices

Managers were asked to indicate their views regarding the extent to which the city is implementing Industry 4.0 (Fourth Industrial Revolution) best practices. The poor level of understanding industry 4.0 among managers in the City of Tshwane is a cause for concern.

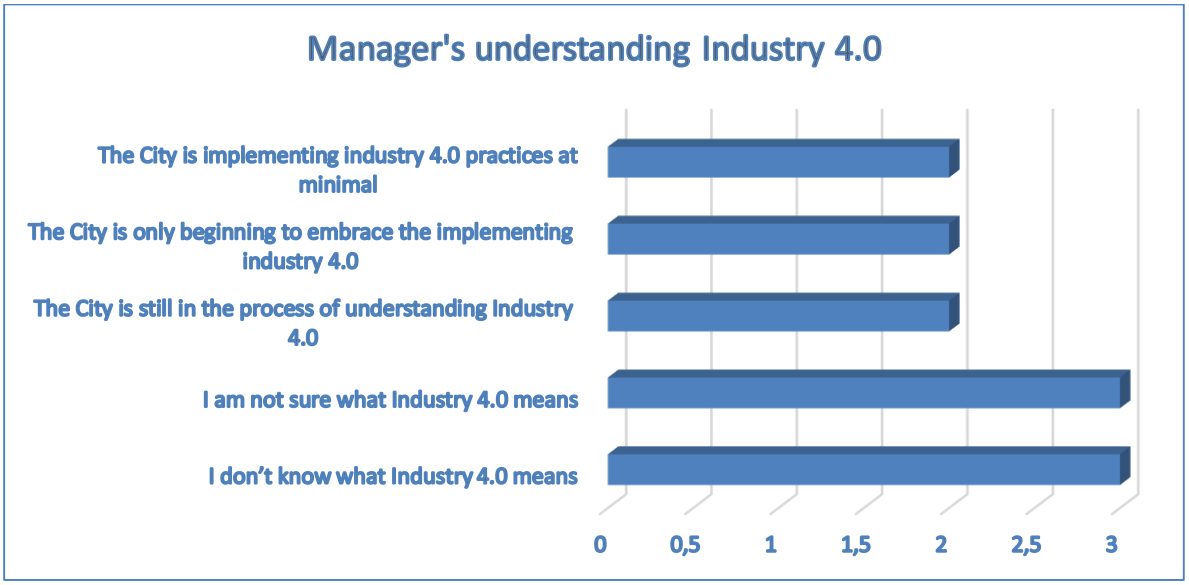

Figure 6: Manager's understanding of Industry 4.0 in the CoT

Some managers, e.g. Mpule indicate that they don't know what Industry 4.0 means. In addition, Lera indicates that she is not sure if there are such best practices. Lola indicates that the city still needs to create a strategic plan that defines its technology assessment of infrastructure and capabilities to identify gaps. Mindlos indicates that the city should consider moving to technologies of issuing job cards via hand held devises to technicians to reduce delays caused by manual processes.

Thatisto shares that though the progress of implementing Industry 4.0 (Fourth Industrial Revolution) best practices in this city is not moving at light speed, the city is embracing 4IR. Similarly, Mankwi believes that the use of Industry 4.0 (Fourth Industrial Revolution) best practices is done at a minimum; and not integrated into how the organisation functions and the extent to which the city is implementing. Perli indicates that based on his limited knowledge of what is happening in departments and across the city, there is little implementation of Industry 4.0 best practices in this city. For Mgodene, slowly but surely the city is beginning to embrace the industry 4.0 practices as evidenced by the appetite and the automation of some manual operational processes. According to

Mokwenaite, there are a lot of things to be improved to maintain consistency of practices and data management.

Threats and opportunities for using data as an asset for strategic management

4.3.24. Threats and obstacles for big data analytics and management

Managers were also asked to reflect on the major threats/obstacles to using data for decision-making in this city. Managers were able to offer diverse views on the obstacles. For example, Mankwi believes that the city needs to work on its organizational culture for culture. In addition, Mpule suggests that the political environment for municipalities does not allow it to use data mainly as the key decision-making reference point. This is mainly due to political priorities. Mpule also suggests that limited financial resources in the city impede the investment in data analytics to enable the use of data for decision-making. Mokwenaite agrees with this point as well. Mpule further adds that the city's priorities are mainly focussed on finding a way to address basic service delivery targets.

Similarly, Mgodene suggests that the nature of local government business is dictated by many external factors that must be considered and satisfied before decisions are made. So decision-making is not entirely dependent on data but also on the views that are popular with the public or rate payers. For Perli, one of the challenges is that most data in the city is unreliable and not valid enough to enable quality decision-making. So, most data cannot be trusted, partly due to a lack of controls in place.

Sphume raises a few insightful factors. Firstly, he argues that the culture of data-driven decision-making has not yet been embraced. Secondly, the management style adopted in the city which is a style that reacts to crisis instead of proactive and deliberate planning for the results aspired to is the most dominant. This is to the detriment of data-informed managerial decision making. Thirdly, the city has

not institutionalized data analytics as a management practice and does not have capabilities for data analytics capacitated with practitioners that will play advocacy and drum-up interest in using credible data for decision making. Lastly, there is no championing of data-driven decision-making in the city

Mindlos seems to agree that the data available is not reliable as it is generally coming from manual systems, which are often not integrated. Another challenge is duplication and under reporting of data. Thatisto: also believes that the issue of lack of data integrity is one of the major obstacles. The capability of employees to integrate and analyse data, using analytical techniques is also seen as one of the major obstacles in the city.

In addition, Lola adds that insufficient and outdated systems result in inaccurate data, as well as duplication of data. Faithicious hints that one of the challenges is that technology systems in the city are fragmented. She also adds that the lack of transformation resulted in departmentalized/silo working mentality in this city. As far as Milanto is concerned, another challenge is that there are people who have vested interests, which makes it difficult to use data to make decisions. This issue of conflict of interest is very important for the city to look at more deeply.

4.3.25. Addressing the threats and obstacles for big data analytics and management

Managers provided some insights on how some of the challenges and obstacles raised above can be addressed. For Mankwi, there is a need for a change management process to be initiated in this city. Mpule suggests that if evidence of the benefits (efficiency and effectiveness) can be presented, this would go a long way towards removing the obstacles towards data usage. In addition, Perli suggests that the city needs to develop a formal Data Governance Framework, as well as a reliable Data Architecture Framework or Enterprise Architecture Program.

Lola believes that addressing the threats and obstacles indicated requires a comprehensive approach involving data governance, capacity building, and technological investment. For Mgodene, the obstacles can be addressed when the clear separation of roles between the executive and the administration can be observed and adhered to without compromise. If officials can be allowed space to operate in their respective disciplines without interference/influence from the politicians then the ideals of using data for decision-making can be realized. In a similar vein, Faithicious suggests that there is a need for leadership that can provide a clear vision that should be shared by all stakeholders.

Sphume believes that the city should institutionalize data analytics as an inherent management practice linked to other mutually supportive business practices in the city i.e., link data analytics to the current planning, budgeting, monitoring, evaluation, and reporting practices. Mokwenaite adds that the city needs to allocate a sufficient budget for digital transformation; and prioritize it to improve innovation in order for the city to conduct its business more effectively and efficiently. Mindlos posits that some of the challenges can be solved by streamlining and reducing systems/data systems and using only one system (SAP) to manage and control the flow of data. Importantly, Thatisto highlights the need for training and awareness of the importance of data and data use.

4.3.26. Opportunities for big data analytics and management

In conclusion, managers were also asked to reflect on some of the opportunities for implementing big data management systems in the city. Mankwi suggests that using big data analytics can assist the city in improving service delivery, reduce costs, improve turnaround times, and introduce a different way of doing business. Importantly, Mpule posits that the current challenges that the municipality is having with revenue collection presents an opportunity to introduce data management systems, especially if that data is used to make decisions on

revenue collection that works. He adds that the city should invest in data analytics as a starting point for the use of data as a decision-making tool

Perli indicates that the city needs to set aside financial resources as well as a dedicated function or capability called Enterprise Data/Information Management Division/Unit. She further adds that there are opportunities to start capacity building and appoint experienced data analysts. She also adds that the city must seize an opportunity to develop policy documents on “Digital Transformation” and Data Governance, whilst simultaneously running a series of workshops and webinars on to obtain inputs and buy-in from various stakeholders.

Lola adds that there are opportunities for improved governance and strategic decision-making. Lera indicates that there are opportunities for management of operational risks, and improved and faster customer interaction. In addition, savings can be made on expenditure items like overtime and employee costs.

For Mgodene, big data analytics can assist the city in making decisions on where to make the necessary infrastructure investments, including how to maximize the use of personnel to influence production and also identify, minimize, and limit leakages in expenditure or procurement of goods and services. He argues that cities must start embracing the 4IR and also ensure that decision-making in the municipalities is informed by science and not just popular sentiments that cannot be backed by data.

Faithicious adds that data-driven municipalities can realize proactive communication to customers and reputation. In addition, Mokwenaite opines that cities need to look into upgrading their data systems. For Mindlos, cities can streamline systems so that they can have reliable, and trustworthy data which would be usable in taking business decisions grounded on factual data. This could further assist the city to be a learning organization and learn from its mistakes. Finally, Thatisto adds that using big data analytics can assist cities in

discovering new revenue streams and realize cross-pollination of data and knowledge.

Sphume argues that the current financial crisis and poor performance on key mandate issues in the city present itself as an opportunity for the city to look at the data management system and its outputs (outputs of the system) for solutions to many of its challenges bedevilling the realization of its service delivery, growth, and development objectives set out its planning instruments (long term strategy, IDP, etc).

4.4. Summary of the results/findings

This chapter has provided a presentation of the perspectives and views of the management regarding the different areas of data maturity within the City of Tshwane, according to the themes identified in this study. As a start, it can be said that the managers in this city seem do not only have a fairly good understanding of the concept of digital transformation but also have a proper appreciation of the need (and urgency) for the city to undergo a process of digital transformation. However, the city needs to develop and cast a clear vision and implementation strategy for digital transformation; so the city can be able to meaningfully use big data for decision making, engaging its customers, competitor analysis, creativity and innovation management, performance management, and risk management. These would require the city to develop governance systems, procedures, systems, guidelines, policies, standards, etc to manage data.

Having said that, there are some findings which are a cause for concern. The first one is that most managers say they need to know if there is a digital transformation strategy and vision in the City of Tshwane. The implications of this

shortcoming is that the City leadership does not take digital transformation serious. The strategies, and allocations of resources, financially, intellectually and in terms of human resource development are not informed by an existing digital strategy.

Even though the City of Tshwane refers to herself as a smart city, talking about concepts such as digital modernization etc, the application and implementation is not grounded on any vision, nor strategy. This will provide a breeding ground for further confusion in the organization.

The second area of concern is that in the long run, when managers are not clear about the existence of a strategy, the operations would continue going in the wrong direction. With Tshwane being one of the capital City in South Africa, this would send a wrong message to investors, not only about the city itself, but about the readiness and willingness of this country to embrace digital transformation in the public sector. International Organizations such as the World Bank and the International Monetary Fund (IMF) may also look at South Africa differently.

Thirdly, from a governance and systems perspective, the lethargy of the city in adopting digital technologies might send a message that the city is not serious about setting systems o detect and deal decisively with corruption. In the context of the State Capture Report, continual use and reliance on manual systems of governance and oversight, especially for financial management is no good news at all. The repeat findings of the Auditor General about weak controls in municipalities provides good grounds for cities to move towards digital transformation, especially the use of data for both operational and strategic decision making.

Fourthly, continued politicisation of decision making will deter attraction of foreign direct investments in the city, and by implication the entire local government

sector in South Africa. Politicians should leave space for technocrats to operate without fear and favour. Decisions must be taken on the basis of facts, transparently, openly and in an objective manner. Bureaucrats must also take their space, knowing the Constitution is behind them in terms of professionalization of the public service.

The fifth, last point, is about training, skilling and reskilling. Digital transformation will not take place if people are not trained, and developed with new ways of doing things. Cities need to set aside resources for human capital development. Digital transformation is not merely about technologies, it is also about culture, mind-set change and embracing the industry 4.0 best practices. Investment in IT systems without corollary development of human capital will not assist the city to move forward progressively, in a sustainable manner.

5. DISCUSSION OF RESULTS/FINDINGS

5.1. Introduction

The findings concerning the perspectives and views of management in the different areas of data maturity within the City of Tshwane are now discussed. Whereas the presentation of the findings in the previous chapter was done both at an aggregate theme level as well as at an individual question level, in this chapter, the focus of the discussions will be limited to the theme level and not the individual question level. In some instances, there are direct quotations and/or citations from the participants. These have been directly drawn from the raw data derived from the research participants themselves, to emphasize particular (outstanding) points, where necessary. The following sections present the findings of each of these themes sequentially.

5.2. Discussion of Results/Findings

The perspectives and views of management in different areas of data maturity within theCity of Tshwane are discussed based on the identified themes in this study.

5.2.1. Theme 1: digital transformation, vision, and strategy

As a start, the managers in this city seem to have a fairly good understanding of the concept of digital transformation. In addition, managers also seem to have a proper appreciation of the need (and urgency) for the city to undergo a process of digital transformation. Part of the digital transformation process is to set out a journey that mainstream data into organizational processes (Hupperz et al., 2021). In the case of the City of Tshwane, the study finds that some managers believe that the City of Tshwane has a vision and implementation strategy for digital transformation; whilst other managers (a majority) believe the city does not have it. This kind of uncertainty among senior managers needs to be avoided.

Therefore, this study asserts that one of the key interventions needed in the city is the crafting of a deliberate journey or path to mainstream data into the organizational processes. Parallel to this, the city needs to consider developing a clear vision of digitizing the organization, based on a well-defined digital transformation strategy. This view is consistent with propositions by scholars such as Hupperz et al. (2021). These efforts would go a long way to deepen the operationalization of the concept of a smart city within the Tshwane metropolitan municipality. Cities that implement such innovations can meaningfully use high ICTs (Camero and Alba, 2019) for the benefit of citizens, and to ensure inclusivity, intelligent development (Dameri, 2013), maximize the delivery of public services (Hall et al., 2000), and move towards being digital cities (Ishida, 2002).

5.2.2. Theme 2: customer engagements, competition analysis, and innovation

Scholars such as Rogers (2016) emphasize the issue of using data as an asset for customer engagements and management. The “Unified Digital Maturity Model” by Armstrong and Lee (2021) also emphasises the Customer Orientation and Engagement factor. Through the use of big data analytics, cities can make informed decisions about engaging customers and finding solutions to diverse customer problems (Mouchili et al., 2019).

In this study, the general view among managers is that the city is not optimally using big data analytics to tactfully engage its customers. In the same vein, managers do not believe that the city does not optimally use available data for purposes of competitor analysis. So, the organization is missing an opportunity to use big data analytics to collect, store, analyze, etc data. When this happens, this means that the city is missing the benefits of not only understanding the needs of its customers better but also missing opportunities to outsmart its rivals (Mouchili et al., 2019). This can disempower cities from making informed decisions regarding solving the customer care management-related challenges of their clients (Mouchili et al., 2019). So,

As opined by scholars such as Mouchili et al. (2019), this study suggests that the city needs to explore the use of data analytics to help it draw new insights about its customers. It would be useful if the city could set up systems to integrate and analyze data flowing from various domains of the city (Osman, 2019). As argued by scholars such as Mouchili et al. (2019), this might give the city a better chance of gaining a competitive advantage against its rival municipalities. The reality is that cities do generate data from their customers (Gohar et al., 2018).

5.2.3. Theme 3: data as a strategic asset for decision-making.

So, the managers believe that the city has not yet reached a maturity level where data is viewed as a strategic asset. Most managers believe that both day-to-day operational and long-term decisions are not taken based on what data shows in this city.

5.2.4. Theme 4: customer engagements, completion analysis, and innovation

When organizations develop the capabilities to capture and analyze data, they stand a chance to generate and capture value (George et al., 2014). One of the benefits is having that can be used as an asset for decision-making. Generally, there is a paucity of empirical literature on how public sector organizations go about building their capabilities to handle big data (Dubey et al., 2019). In South Africa, there are few public sector organizations (e.g. the South African Revenue Services (SARS)) that have managed to demonstrate the value of using data for decision-making (Motau and Kalema, 2016).

In this study, it is found that managers generally believe that the city has not yet reached a maturity level where data is viewed as a strategic asset. Most managers believe that both day-to-day operational and long-term decisions are not taken based on what data shows in this city. This is disappointing, because

smart cities use data analytics as part of their strategy for decision-making (Mouchili et al., 2019).

As argued by participants such as Mpule, Lola, Mindlos and Mgodene, decision-making in the city is less informed by data, but rather by personal convictions of senior managers and politicians, and the political expediency arising out of coalition governance arrangements/agreements. As Mpule opines, changes and/or instability in political leadership in cities have the potential of bedeviling the process of using data as an objective asset for decision-making. It seems that most important decisions are based on political priorities, which are not necessarily backed by factual data.

The view that decisions tend to be taken based on populist sentiments in the city is not good for a city that professes to be (working on being) a smart city; one that embraces digital transformation. In addition, the impression that most data in the city is unreliable (lacks integrity) to enable quality decision-making, coupled with concerns around the perceived lack of systems of data controls is worrisome also. Even more worrying is the impression that data is not being used because some people (possibly senior officials and politicians) have vested interests in decision making suggesting the possibility of a deliberate desire to suppress digital transformation in the municipal environment.

5.2.5. Theme 5: data governance, systems and processes

Smart cities aim to achieve smart governance (Oke et al., 2020). Indeed, research has found that the use of smart digital technologies can enhance the capabilities of municipalities to address a range of governance challenges (Langa and Thakhathi, 2022). In this study, it is found that there are mixed views from managers about the extent to which the city has established procedures and systems to control access to data. Most managers believe that the city does not have explicit standard procedures, guidelines, and policies to govern how data should be shared in the city. The general view is that the data governance

systems are weak, if not nonexistent. Most managers are of the view that the city could do more to automate systems and processes.

Data governance issues such as data privacy, data quality, etc. are important (Surbakti et al., 2020). Organizations need to develop controls to govern the access and management of data so that the risks related to data can be prudently managed (Abraham, et al., 2019). In this regard, it is suggested that the City of Tshwane explore ways of strengthening its data management systems, processes, and infrastructure. This comment goes not only for the City of Tshwane, because scholars such as Seko et al. (2022) suggest that South African municipalities are not doing well as far as developing big data governance systems is concerned. Scholars such as Ncoyini and Cilliers (2016), Mawela et al (2017), and Reddy and Govender (2019) have also cautioned that most South African municipalities do face poor governance infrastructure and a lack of ICT leadership in municipalities.

In this regard, it is apt to refer to two (disturbing) points raised by Mindlos. The first one is that illegally electricity-connected customers can go for many years without being detected shows that the city does not pay adequate attention to strengthening its control environment. The second disturbing point raised by Mindlos is that in some cases, employees who have resigned from the city have been found to still be able to illegally access the e-mail system of the city from outside. As argued earlier, this is one of the major cyber security risks facing the city, and it needs to be addressed. Borrowing from the views of scholars such as Jacobs et al (2019), access to information and preservation of an organization's institutional memory is very key. The City of Tshwane needs to consider these matters carefully.

One more critical aspect of governance deals with monitoring conformance to policies, procedures, and formalities, and ensuring enforcement (Loshin, 2008). In this regard, it is not clear if the city has robust procedures to regulate tight access to data systems. Yet, enforcing conformance with regulatory requirements is very important (Al-Ruithe et al., 2018). The issue of delegating

authority for managing the creation, storing, and determining permissible use of data is important (Alhassan et al., 2019). The city needs to carefully think about these matters. There would be a need for the city to have documented, standardized methods for the entire data governance eco-system (Al-Ruithe, et al., 2018), including setting out rules for documenting the lifecycle of data (Kim and Cho, 2018). Such measures can be part of the enterprise-wide integrated risk management strategy. The risks related to privacy and security breaches are a great concern that the city needs to pay close attention to.

5.2.6. Theme 5: industry 4.0 best practices.

Deployment of industry 4.0 best practices constitutes an integral part of the digital transformation journey for organizations. Even though empirical studies show that the deployment of big data analytics can transform public sector organizations (Joseph and Johnson, 2013), and lead to informed decision-making (Janssen and Kuk 2016), this study, however, confirms that in the public sector, the deployment of big data analytics seems to be one of the major challenges organizations (Margetts and Sutcliffe, 2013).

In this study, it is found that managers do appreciate the fact that some cloud computing technologies and wireless technologies are being used in the city, although they indicate that more can still be done. The progress of implementing Industry 4.0 (Fourth Industrial Revolution) best practices in this city is moving rather slowly. And; managers can identify threats and opportunities for the use of big data analytics in this city. Some of the suggested interventions tabled by the participants include developing a comprehensive approach involving data governance, capacity building, and technological investment.

In addition, the issue of appointing properly qualified and skilled officers such as Chief Information Officers (CIOs) needs to be taken seriously in public sector organizations (Anna and Nikolay, 2015). There is also a need to explore the role of incentives for sharing data and acquiring the appropriate skills (Gamage, 2016). With appropriate skills and an enabling environment, the implementation

of industry 4.0 best practices can be enhanced in South African cities and municipalities. Some of the benefits would include allowing public sector organizations to make intelligent decisions (Anna and Nikolay, 2015), and delivery services in faster, and better ways (Maciejewski, 2017). The Batho Pele White Paper, and the Municipal Finance Management Act (MFMA) embrace the principles of cost efficiency and quick turnaround on service delivery. Avoiding siloed approaches to managing data by developing integrated data systems is also important in this context (Malomo and Sena, 2017). Public sector organizations cannot ignore the need to develop predictive analytics for proper decision-making and anticipating eventualities (Kim et al., 2014; Khtira et al., 2017).

5.3. Conclusion

It is clear that the City of Tshwane still has not yet reached a digital maturity level where data and big data analytical tools are used as primary and/or key basis for both operational day-to-day and strategic long-term decision-making. The City leaders need to first make up their mind if they want to take the city through a journey of digital transformation. If there is consensus on the journey, a digital transformation vision and strategy needs to be crafted. Change Agents/Leadership for such a strategy will be important, and the strategy needs to be properly resourced as well.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Introduction

This chapter offers conclusions and recommendations based on the findings of the study, also touching on the theoretical implications. The research aimed to contribute insights intovarious facets of big data maturity within a specific South African city. Recognizing the World Bank's call for digital technology adoption in the public sector, this study aligns with the global shift toward digital transformation (Dener et al., 2021). South African citiesaspire to be smart cities, navigating the challenges posed by the substantial volume of data, known as the four Vs (Das, 2020:1).

The study advocates for the City of Tshwane to transition from traditional analytics to big data analytics, emphasizing the benefits of predictive analytics, data science, and proficient engagement with large and complex datasets (Mouchili et al., 2019). It underscores the necessity for cities to enhance their big data analytics capabilities, engage in data-intensiveanalysis, and elevate smart governance (Bassoo et al., 2018; Tang et al., 2015; Oke et al., 2020).

6.2. Revisiting Key Literature on Maturity Models

Recall that the study gleaned different aspects of big data maturity from different big data maturity models. As such, it is important to reflect on the implications of the maturity models for this study. Scholars such as Armstrong and Lee (2021) and Evan’s Mastering Digital Business Model (Evans, 2017) extensively deal with factors such as vision/strategy, culture, governance, using data as an asset for decision-making, etc. These aspects were considered in this study. The study also investigated the perspective of managers on aspects like vision and enabling governance structures within an organization. These aspects are emphasized in Westerman’s ‘Leading Digital Model” which focusses on ‘digital capabilities’ and

issues (Westerman et al., 2014). Additionally, the study explored the views of managers on aspects such as customer relations management, competition, data, and innovation. The Rogers Digital Transformation Playbook Model addresses these issues (Rogers, 2016). Ismail, et al (2014) emphasize the significance of handling huge amounts of data so that decisions are data-driven, and the use of automated dashboards. Armstrong and Lee (2021) have a “Unified Digital Maturity Model”, which deals with big data maturity such as data governance; the use of data as a strategic asset; the use of data analytics; and the use of dashboards and innovation.

6.3. Conclusions on the big data maturity level in the City of Tshwane

In assessing the big data maturity level of the City of Tshwane, key conclusions are drawn:

6.3.1. Big data, organizational vision, strategy, people, and culture.

The study emphasizes the necessity for a shared understanding of the vision and strategy for digital transformation within the city's management. There exists a level of confusion in these areas, requiring clear communication across the organization.

Using the lenses of the Capability Maturity Model Integration (CMMI), it could be argued that the City of Tshwane is at Level 1, called *Initial stage*. This is because currently, there is no alignment between strategy, culture, vision. From the perspective of the Digital Readiness Assessment Maturity Model (DREAMY), it can be argued that the City of Tshwane is at the very first level called *Initial*. The City still needs to draw a digital strategy, which currently does not exist. When one analyses the situation from the perspective of the Industry 4.0 Maturity Model, it can be argued that the City of Tshwane is at the first is called *Level 0: Incomplete*. This conclusion is based on the fact that currently, there is incomplete understanding among managers of what digital strategy is about.

From the lenses of the IoT Technological Maturity Model, it can equally be argued that the City of Tshwane is at the first level, called *Level 1: 3.0 Maturity.* This is a level where an organization does not have a digital strategy, even though some digital tools and platforms have been created. From the perspective of the Data Science Maturity Model, the City of Tshwane can be scored as "*Least Mature",* because the city is still using traditional strategy methods, and the culture of initiating a digital transformation is yet to be started.

6.3.2. Big data and customer relations management/innovation

There seem to be consensus by the respondents that the current administration seems to be effectively using social media and other digital tools, surveys, and other sources to collect and analyse data related to customer relations management and feedback. Using the lenses of the Capability Maturity Model Integration (CMMI), it could be argued that as far as using data for customer engagements is concerned, the City of Tshwane is at Level 5, called Optimized stage. This is where processes are not only put in place, but they are optimally used to ensure that there is deliberate focus on continuous improvement. The reason for this argument is that discussants point out that the data from the customer surveys and social media analysis is used by the city to drive continuous improvements efforts to satisfy customer needs. From the perspective of the Digital Readiness Assessment Maturity Model (DREAMY), it can be argued that as far as using data for customer engagements is concerned, the City of Tshwane is at stage is called Digital Oriented. This is where there is solid use of technological infrastructure to support data maturity efforts, and using data from surveys to inform decision-making with respect to customer engagements.

When one analyses the situation from the perspective of the Industry 4.0 Maturity Model, it can be argued that as far as using data for customer engagements is concerned, the City of Tshwane is at Level 5, called Optimizing. This is because it is apparently clear that the city is deliberately deploying end-to-end integration of digital tools and platforms for continuous adaptation with how its customers are

using social media technologies. From the perspective of the Data Science Maturity Model, the City of Tshwane can be scored as “most mature”, because the city is using innovative business processes to harness information emerging from such platforms to proactively respond to customer needs.

The study finds that data is not a key determining factor for decision-making in this city. Using the lenses of the Capability Maturity Model Integration (CMMI), it could be argued that as far as using data for decision making, the City of Tshwane is at Level 1, called *Initial stage*. This is because currently, there are no internal data management processes in place to “force” decision makers to use the data to take decisions. From the perspective of the Digital Readiness Assessment Maturity Model (DREAMY), it can be argued that as far as using data for decision making is concerned, the City of Tshwane is at the very first level called *Initial*. This is because there is no data management/process coordination to ensure that decision making is only made on the basis of factual data.

When one analyses the situation from the perspective of the Industry 4.0 Maturity Model, it can be argued that the City of Tshwane is at the first is called *Level 0: Incomplete*. This conclusion is based on the fact that currently, there are no best practices to ensure that decision making is based on data. From the lenses of the IoT Technological Maturity Model, it can equally be argued that the City of Tshwane is at the first level, called *Level 1: 3.0 Maturity.* This is a level where an organization does not use, interpret and analyse the data it has to inform its business operations and strategic decisions. From the perspective of the Data Science Maturity Model, the City of Tshwane can be scored as “*Least Mature”,* because the city is primarily relying on political considerations for both operational and strategic decision making.

So, the city scores very low on this aspect. The city needs to move to a place where data becomes the basis for all decision-making, across the board. In this regard, building strong data science and analytics becomes an important step for the city to embark on. Scholars such as Patil and Mason (2015) show how organizations can go about doing this. The city may also need to purposefully

create data-focused management positions, such as Chief Data Officer. Scholars such as Berntsson Svensson and Taghavianfar (2020), Hupperz et al. (2021), and Kayabay et al. (2021) demonstrate the benefits of organizations going that route. In South Africa, cities can learn from public sector organizations such as SARS. Motau and Kalema (2016) have explored this matter. The city also needs to build data storage systems and data analytical models. In addition, the city also needs to consciously and deliberately construct and develop data governance systems. Scholars such as Singh (2020) ventilate the benefits of strong data governance systems to allow data-based decision-making in organizations.

In conclusion, the City of Tshwane is well-positioned in using modern digital technologies to engage digitally savvy customers. However, the dynamic nature of this environment necessitates vigilance and an ongoing commitment to keeping pace with developments. Big data as an asset for decision-making in the city

6.3.3. Data management and governance

As far as data management processes, the study found that the city is in a stage where the internal data management processes are neither controlled nor predictable. According to the Capability Maturity Model Integration (CMMI), this is Level 1, and it is called *Initial Stage*. The city needs to desire and intentionally plan to move towards a place where processes are documented and standardized. This is called the *Defined Stage*, in terms of the CMMI.

In terms of the Digital Readiness Assessment Maturity Model (DREAMY), it can be concluded that the city is at the first level of maturity levels, which is called *Initial level*. At this level, there is poor, or no data management/process coordination. The city needs to desire and intentionally plan to move towards a place where the processes are gradually developed, documented, and standardized. In terms of the DREAMY, this level is called *Managed*.

When one analyses the situation from the perspective of the Industry 4.0 Maturity Model, it can be argued that the City of Tshwane is at the first is called *Level 0: Incomplete*. This conclusion is based on the fact that currently, there are no best practices to ensure that there are robust data management and governance systems. From the lenses of the IoT Technological Maturity Model, it can equally be argued that the City of Tshwane is at the first level, called *Level 1: 3.0 Maturity.* The City does not have data governance to regulate access control even to critical and strategic data. From the perspective of the Data Science Maturity Model, the City of Tshwane can be scored as "*Least Mature",* because there is still minimum level of automation of systems and processes in this city; and this can compromise the capability, speed, and agility of the city to ensure good governance.

6.3.4. Use of industry 4.0 technologies.

The study finds that in this city, there is minimal application of industry 4.0. best practices and technologies. According to the Capability Maturity Model Integration (CMMI), this is Level 1, and it is called *Initial Stage*. The city has not yet optimised the use of digital technologies. Respondents argue that a lot of systems and processes are still manually run. In terms of the Digital Readiness Assessment Maturity Model (DREAMY), it can be concluded that the city is at the first level of maturity levels, which is called *Initial level*. At this point, there less automation and use of digitally driven document management systems which are standardized.

When one analyses the situation from the perspective of the Industry 4.0 Maturity Model, it can be argued that the City of Tshwane is at the first is called *Level 0: Incomplete*. This conclusion is based on the fact that currently; the use of industry 4.0 best practices is very limited. The city needs to plan and strategize to move to the second level, which is called *Level 1: Performed, where there will be more* installation of smart technologies and swift migration of physical items to the virtual world. Scholars such as Gökalp et al. (2017) and Sener et al. (2018)

advocate that organizations need to migrate to the virtual world of doing things. According to the *Industry 4.0 Maturity Model*, this level is *Level 2: Managed*.

From the lenses of the IoT Technological Maturity Model, it can equally be argued that the City of Tshwane is at the first level, called *Level 1: 3.0 Maturity.* This is because the city is currently implementing some technologies, but the functionality is very limited. Some of the managers are not even aware of what industry 4.0 technologies are. The city needs to set systems and strategies to move towards the second Level, called *Initial (on the path to 4.0 Maturity).* In this regard, the city will need to have at least a single IoT-enabled process; and move towards connecting other things to the Internet, which is the third level dealing with increased use of cloud computing, use of robotics, etc, and the ability to communicate through the internet. Scholars such as Kim (2009) advocate for such interventions.

From the perspective of the Data Science Maturity Model, the City of Tshwane can be scored as "*Least Mature",* because there is still minimum level of automation of systems and processes in this city; and this can compromise the capability, speed, and agility of the city to ensure good governance.

6.4. Implications for theory

Recall that from a theoretical perspective, this study is framed around two theories, viz. the Resource Based Theory, and the Dynamic Capabilities Theory.

6.4.1. Resource Based View (RBV) perspective

The study's theoretical underpinning incorporates the Resource-Based View (RBV) and Dynamic Capabilities Theory (DCT). From the RBV perspective, the study employs the theory to elucidate how cities can leverage big data as a strategic resource for competitive advantage. RBV provides strategic insights into organizational data capabilities and cultivating a big data culture. On the other hand, DCT is employed to underscore the significance of cities developing

dynamic capabilities to effectively utilize big data as a strategic asset. This involves the construction of robust data governance systems and fostering a culture embracing the strategic value of data.Dynamic Capabilities Theory perspective

Secondly, Dynamic Capabilities Theory (DCT) was used to interrogate how cities can leverage big data to enhance their capabilities to improve service delivery offerings to communities, employing digital transformation tools such as applied data analytics, IoT, etc. Data analytics can support cities to develop and enhance strategic capabilities such as agility, quality, dependability, flexibility, and cost advantage. So, from this vantage point, it can be argued that cities need to develop dynamic capabilities so that they can handle data as a strategic asset. To do that, the cities need to consciously and deliberately construct and develop data governance systems. The data governance systems must include setting out processes, 'protocols', and procedures for handling and managing data. Significantly, if cities envision and aspire to reach high(er) levels of big data maturity, they must work on shifting the organizational culture as a dynamic capability for handling big data. So, a city-wide culture that embraces the strategic essence and value of data across the entire organization must be built by cities.

6.5. Recommendations of the study

a) It is recommended that the city develop a clear vision of digitizing the organization, based on a well-defined digital transformation strategy. This would deepen the operationalization of the concept of a smart city
b) It is also recommended that the city invest in data governance infrastructure to improve the protection of data privacy, data quality, etc. In this regard, priority must be placed on developing robust systems of data controls so that cyber-attack and other related risks can be prudently managed.
c) It is also recommended that the city review and/or redesign its customer relations management strategy to be based on data. The main objective of the review and reconfiguration of the customer relations management

strategy should be to ensure that big data analytics is optimally used for customer relations management in this city.

d) It is also recommended that the city develop a culture, and systems that would enable data-based decision making, both at a strategic and operational level. This includes building data management and analytical capability/skills. The appointment of properly qualified and skilled officials such as Chief Information Officers (CIOs) needs to be considered.

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APPENDIX A: THE PARTICIPANT INFORMATION SHEET

Dear Sir/Madam

PARTICIPANT INFORMATION SHEET

My name is Phillemon Mathane and I am a Master of Management (Digital Business) at the University of the Witwatersrand (Wits Business School), Johannesburg. As part of my studies, I have to undertake a research project, Titled: **Exploring the big data maturity level of a metropolitan municipality in Gauteng Province, South Africa,** under the supervision of Dr. Thembekile Mayayise. This research aims to understand the views and perspectives of managers regarding the data maturity level within your organization.

As part of this project, I would like to invite you to take part in an interview, following a structured guide/schedule. This activity will take around 20-30 minutes. With your permission, I would also like to audio record the interview using a digital device. This recording will be stored in a password-protected computer, and only the researcher will have access to this recording. Further, all identifying features will be removed; data will be deleted after 5 years.

There will be no personal costs to you if you participate in this project. You will not receive any direct benefits from participation, but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not wish to. The interview will be completely confidential and anonymous as I will not be asking for your name or any identifying information, and the information you give to me will be held securely and not disclosed to anyone else. I will use a pseudonym (false name) to represent your participation in my final research report. If you experience any distress or discomfort during this process, we will stop the interview or resume at another time.

If you have any questions during or afterward about this research, feel free to contact me at the details listed below. This study will be written up as a research report which will be available online through the university library website. If you wish to receive a summary of this report, I will gladly send it to you (optional). With your permission, the data collected from this research project may be used by other researchers.

If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Yours Sincerely

Researcher: Phillemon Mathane phillemonmathane@gmail.com (Tel: 076 376 9032)

APPENDIX B: PARTICIPANT CONSENT FORM

Title of project: Exploring the big data maturity level of a metropolitan municipality in Gauteng Province, South Africa

Name of researcher: Tlou Phillemon Mathane

I, ……., agree to participate in this research project.

I agree to the following:

(Please circle the relevant options below)

The research study was explained to me. I understand what this study is about.	YES	NO
I understand that I can volunteer to take part in the study	YES	NO
I agree that the interview/focus group/other activity may be audio-recorded	YES	NO
I agree that direct quotations from my interview/focus group/other activity may be used by the researcher in their research report/ manuscript/book chapter	YES	NO
I agree that my participation will remain anonymous (my name or other identifying data will not be used by the researcher in their research report/manuscript/book chapter)	YES	NO
I agree that other researchers may use the information I provide in my interview/focus group/other activity (depending on their own ethics clearance being obtained) but my name and any personal information will not be used or passed on	YES	NO

…… (signature)
…… (name of participant)
…… (date)
…… (signature)
…… (name of researcher/person seeking consent)
…… (date)

APPENDIX C: DATA COLLECTION TOOLS

Data Collection Tool 1: In-Depth Interview (IDI) Schedule

Name of Researcher	Tlou Phillemon Mathane
Name of University	Wits (Wits Business School)
Name of the Research Project	*Exploring the big data maturity level of a metropolitan municipality in Gauteng Province: South Africa.*

A. BRIEF PROFILE OF THE RESPONDENT

Department/Division/Section					
Rank/Position operation					
(Tick appropriate box) →	Deputy Director	Director	Divisional Head	Group Head	Above Group Head
Total Nr of years working in this City	Less than 5 years	Between 5-10 years	Between 10-15 years	Between 15-20 years	20 plus years
(Tick appropriate box) →					
Briefly summarize your role:					

QUESTIONS

Kindly answer the following questions with deep consideration and honesty:

B. VISION, STRATEGY, PEOPLE, AND CULTURE

1. What is your understanding of the **term "digital transformation"?**

_____

_____

2. Is there a need for this **city to embark on digital transformation**? Please elaborate on your answer below:

_____

_____

3. In your view, does this city have a **vision and strategy** for digital transformation?

_____

_____

4. On a scale of 1-5, what is your view regarding the current status quo in terms of big data being used for implementation vision and strategy in this city? [Where 1 is **LOW** and 5 is **HIGH**]

1	2	3	4	5

5. Please motivate your answer above

C. CUSTOMER ENGAGEMENTS, COMPETITION ANALYSIS, AND INNOVATION

6. To what extent do you think data is being used to inform how this city is **engaging its customers**?

_____

_____

7. To what extent do you think data is being used to inform how this city understands **competition** from private sector service providers who are competing with municipalities?

_____

_____

8. To what extent do you think data is being used in this city to inform **innovation, and creativity** for improving or bettering service delivery programs/efforts?

_____

_____

9. On a scale of 1-5, what is your view regarding the current status quo in terms of big data being used to engage customers in this organization? [Where 1: **LOW,** 5: **HIGH**]

1	2	3	4	5

10. Please motivate your answer above

---

11. On a scale of 1-5, what is your view regarding the current status quo in terms of big data being used to innovate in this organization? [Where 1: **LOW,** 5: **HIGH**]

1	2	3	4	5

12. Please motivate your answer above

_____

D. DATA AS AN ASSET

13. To what extent do you think data is being treated as a **strategic asset** in this city?

_____
_____
_____

14. To what extent do you think data is being used for making **long-term strategic decisions** in this city?

_____
_____
_____

15. To what extent do you think data is being used for making **day-to-day operational decisions** in this city?

_____
_____
_____

16. Are you aware of the use of **big data automated dashboards** in this city? Please give one or two examples, and express your view about how effective they are:

_____
_____
_____

17. Are you aware of the use of **big data analytics tools** in this city? Please give one or two examples, and express your view about how effective they are:

_____
_____
_____

18. To what extent has data been used effectively for **performance management** in this city?

_____
_____
_____

19. To what extent has data been used effectively for **risk management** purposes in this city?

_____
_____
_____

20. On a scale of 1-5, what is your view regarding the extent to which big data analytics are being strategically used for decision-making in this organization? [Where 1: **LOW,** 5: **HIGH**]

1	2	3	4	5

21. Please motivate your answer above

_____

E. DATA GOVERNANCE, SYSTEMS, AND PROCESSES

22. In your view, is there a standard, documented procedure for **controlling access to data** in this city?

_____
_____

23. In your view, is there a standard, documented procedure for **sharing** data in this city?

_____
_____

24. In your view, is there a standard, documented procedure for **sharing and exchanging** data in this city?

_____
_____

25. On a scale of 1-5, what is your view regarding the robustness of data governance systems and processes in this organization? [Where 1 is **LOW** and 5 is **HIGH**]

1	2	3	4	5

26. Please motivate your answer above

_____

F. INDUSTRY 4.0 BEST PRACTICES

27. In your view, to what extent is the city **automating** systems, replacing manual systems?

_____
_____

28. Are you aware if the City is using **cloud computing** technologies? Please express your views.

_____

_____

29. Are you aware that the City is using **wireless** technologies? Please express your views

_____

_____

30. On a scale of 1-5, what is your view regarding the extent to which Industry 4.0 best practices are being implemented in this organization? [Where 1: **LOW** and 5: **HIGH**]

1	2	3	4	5

31. Please motivate your answer above

_____

G. CONCLUSION: THREATS AND OPPORTUNITIES

32. What are the **major threats/obstacles** to using data for decision-making in this city?

_____

_____

33. How can these threats/obstacles **be addressed**?

_____

_____

34. What are some of the **opportunities** for implementing big data management systems in this city?

_____

_____

CLOSING REMARKS (any comment on the study is welcome)

_____

THANK YOU FOR YOUR PARTICIPATION IN THE STUDY

Data Collection Tool 2: Focus Discussion Group (FDG) Questions

Name of Researcher	Tlou Phillemon Mathane
Name of University	Wits (Wits Business School)
Name of the Research Project	*Exploring the big data maturity level of a metropolitan municipality in Gauteng Province: South Africa.*

QUESTIONS

Let us discuss the following questions with deep consideration and honesty:

A. VISION, STRATEGY, PEOPLE, AND CULTURE

1. In your view, does this city have a **vision and strategy** for digital transformation?
2. What is your view about the **culture of digital transformation** in this City?

B. CUSTOMER ENGAGEMENTS, COMPETITION ANALYSIS, AND INNOVATION

3. To what extent do you think data is being used to inform how this city is **engaging its customers?**
4. To what extent do you think data is being used in this city to inform **innovation and creativity** for improving service delivery programs/efforts?

C. DATA AS AN ASSET

5. To what extent do you think data is being used for making **day-to-day operational decisions** in this city?
6. To what extent do you think data is being used for making **long-term strategic decisions** in this city?

D. DATA GOVERNANCE, SYSTEMS, AND PROCESSES

7. In your view, is there a standard, documented procedure **for controlling access to data** in this city?

8. In your view, is there a standard, documented procedure for **storing, sharing, and exchanging data** in this city?

E. INDUSTRY 4.0 BEST PRACTICES

9. In your view, is the city optimally **automating** some of its systems, replacing manual systems?
10. Is the city optimally using **cloud computing technologies**?
11. Is the city optimally using **wireless technologies**?

F. CONCLUSION: THREATS AND OPPORTUNITIES

12. What are the major **obstacles** to using data to inform decision-making in this city?
13. How can these threats/obstacles be **addressed**?
14. What are some of the **opportunities for using data** in this city?

CLOSING REMARKS (any comment on the study is welcome)

THANK YOU FOR YOUR PARTICIPATION IN THE STUDY

APPENDIX D: ETHICS CLEARANCE CERTIFICATE

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB2330748/254
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below)

Project title	Exploring the big data maturity level of a metropolitan municipality in Gauteng, South Africa
Investigator / Researcher	Mr Tlou Phillemon Mathane
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are advised that anonymity and confidentiality cannot be guaranteed.
Issue Date of Certificate	28 08 2023
Expiry date	Date of submission of the project / research report
Chairperson	Dr Pius Oba ☎ +27 11 717 3976 +27 82 733 6587 pius.oba@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

31/08/2023
Date:

APPENDIX E: RESEARCH ETHICS TRAINING CERTIFICATE”

TRREE

Zertifikat

Certificat

Certificado

Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Clinical Trials Centre
The University of Hong Kong

Tlou Phillemon Mathane

a complété avec succès - has successfully completed

Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2023/06/29

CID : byQPJ7RcFg

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

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[REV : 20220217]

APPENDIX F: PERMISSION LETTER FROM THE METROPOLITAN MUNICIPALITY

CITY OF TSHWANE
IGNITING EXCELLENCE

City Strategy and Organizational Performance

Room RD 17 | Ground Floor, West Wing, Block D | Tshwane House | 320 Madiba Street | Pretoria | 0002
PO Box 440 | Pretoria | 0001
Tel: 012 358 4209
Email: IsaiahE@tshwane.gov.za | www.tshwane.gov.za | www.facebook.com/CityOf Tshwane

My ref:	**Research Permission/ Mathane**	Tel:	012 358 4559
Contact person:	**Pearl Maponya**	Email:	PearlMap3@tshwane.gov.za
Section/Unit:	**Knowledge Management**	Date	29 June 2023

Mr Phillemon Mathane
1316 Magaliesberg Country Estate
Brits Avenue
Amandasig
0182

Dear Mr Mathane,

RE: ASSESSING THE BIG DATA MATURITY LEVEL OF A METROPOLITAN MUNICIPALITY IN GAUTENG PROVINCE, SOUTH AFRICA

Permission is hereby granted to Mr Phillemon Mathane, Master of Management Degree candidate at the University of Witwatersrand (WITS), to conduct research in the City of Tshwane Metropolitan Municipality.

It is noted that the primary research objective is to assess the big data maturity level in municipalities, with specific reference to the City of Tshwane Metropolitan Municipality in Gauteng Province, South Africa. The City of Tshwane approves the use of its name in the title of the study and further notes that all ethical aspects of the research will be covered within the provisions of WITS 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 availalble as per applicable laws and regulations. The City of Tshwane is not liable to cover the costs of the research. Upon completion of the research study, it would be appreciated that the findings in the form of a report and or presentation be shared with the City of Tshwane.

Yours faithfully,

PEARL MAPONYA (Ms.)
DIRECTOR: KNOWLEDGE MANAGEMENT

City Strategy and Organisational Performance • Stadstrategie en Organisatoriese Prestasie • [illegible]

APPENDIX G: CERTIFICATE OF PROOFREADING AND EDITING

CERTIFICATE OF PROOFREADING AND EDITING

THIS CERTIFICATE HAS BEEN ISSUED BY ***ACADEMIC PUBLISHING SPECIALISTS*** AND SERVES AS PROOF THAT

TLOU PHILLEMON MATHANE

HAS DULY BEEN PROVIDED A COMPREHENSIVE EDITORS AND PROOFREADERS REPORT

TO MAKE AND EFFECT ALL NECESSARY CHANGES TO THE MASTERS DISSERTATION

Exploring the big data maturity level of a metropolitan municipality in Gauteng Province, South Africa

STUDENT NUMBER: 2330748

2330748@students.wits.ac.za / +27 76 376 9032

Supervisor: Dr Thembekile Mayayise

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

ALL RECOMMENDATIONS AND SUGGESTED CHANGES FOR THE ENHANCEMENT OF CLARITY, CONCISENESS AND READABILITY HAS BEEN INFORMED ON THE PROOFREADERS AND EDITORS REPORT

ONCE ALL CHANGES HAVE BEEN MADE, THE SUBMISSION OF THE FINAL TEXT IS ENCOURAGED

PERCENTAGE OF CHANGE REQUIRED: 22%

PLAGIARISM DETECTED: LOW

READABILITY OF TEXT: 92%

26/11/2023

DATE OF ISSUE

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