



**Enhancing the effectiveness of data management
to improve data quality for evidence-based decision-making:
A case study of Pelonomi Tertiary Hospital**

by
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Abstract

We are currently living in an era where effective data management has become a critical process for improving data quality and informing rational management decision-making across organisations. New technologies show promising results globally for managing data. The healthcare sector produces heterogenous data daily and big data solutions are used internationally to manage voluminous data as traditional data management systems cannot keep up.

In the healthcare sector, the need for effective decision-making is high and the consequences of ill-informed decisions could lead to loss of life; this compels the decision-makers to have real-time data, sound data management policies and other essential resources to manage and improve the quality of data produced and used to inform such decisions. Good data management practices can assist in minimising potential errors by establishing efficient processes and policies for usage and building confidence in the data being used to make rational decisions about patient care and health outcomes across healthcare institutions.

The study aims to enhance the effectiveness of data management practices at Pelonomi Tertiary Hospital to improve data quality for evidence-based decision-making. A qualitative case study approach is utilised. Self-administered questionnaires and semi-structured interviews have been deployed as data collection methods, purposeful sampling was done and an appropriate sample size was selected.

The findings of the study revealed that gradual adoption of new technologies can assist in overcoming the system fragmentation and harmonise data management practices for improved data quality that can be used confidently for evidence-based decision-making. Management support is key to achieving data of high quality and there is a need to comply with data management human resource requirements as stipulated in the District Health Information Management Systems policy. The placement of data management personnel on the organogram needs urgent management attention if the hospital is to maintain high data quality and enhance data management practices. This will also assist in role clarification in

data management activities and improve levels of accountability and ownership of data produced.

Keywords: health data management, data quality, data, decision-making, effectiveness

Opsomming

Ons leef tans in 'n era waar effektiewe databestuur 'n kritieke proses geword het om datakwaliteit en inligting oor rasonale bestuursbesluitneming oor organisasies heen te verbeter. Nuwe tegnologieë lewer wêreldwyd belowende resultate vir die bestuur van data. Die gesondheidsorgsektor produseer daaglik heterogene data en grootdata-oplossings word internasionaal gebruik om lywige data te bestuur aangesien tradisionele databestuurstelsels nie kan byhou nie.

Daar is 'n groot behoefte aan doeltreffende besluitneming in die gesondheidsorgsektor en die gevolge van oningeligte besluite kan tot lewensverlies lei; dit dwing die besluitnemers om intydse data, gesonde databestuursbeleide en ander noodsaaklike hulpbronne te hê om die kwaliteit van data wat geproduseer en gebruik word om sulke besluite te beïnvloed, te bestuur en te verbeter. Goeie databestuurspraktyke kan help om potensiële foute te minimaliseer deur doeltreffende prosesse en beleide vir gebruik daar te stel en vertroue te bou in die data wat gebruik word om rasonale besluite oor pasiëntsorg en gesondheidsuitkomste oor gesondheidsorginstellings heen te neem.

Die studie het ten doel om die doeltreffendheid van databestuurspraktyke by Pelonomi Tersiêre Hospitaal (PTH) te verbeter om datakwaliteit vir bewysgebaseerde besluitneming te verbeter. 'n Kwalitatiewe gevallestudie benadering word gebruik. Self-gedadministreerde vraelyste en semi-gestruktureerde onderhoude is ontplooi as data-insamelingsmetodes en doelgerigte steekproefneming is gedoen en 'n toepaslike steekproefgrootte is gekies.

Die bevindinge van die studie het aan die lig gebring dat geleidelike aanvaarding van nuwe tegnologieë kan help om die stelsel fragmentasie te voorkom en databestuurspraktyke te harmoniseer vir verbeterde datakwaliteit wat met selfvertroue gebruik kan word vir bewysgebaseerde besluitneming. Bestuursondersteuning is die sleutel tot die verkryging van data van hoë gehalte en daar is 'n behoefte om te voldoen aan databestuur menslike hulpbronne vereistes soos uiteengesit in die Distriksgesondheid Bestuursinligtingstelsel beleid. Die plasing van databestuurpersoneel op die organogram verg dringende bestuursaandag as

die hospitaal hoë datakwaliteit sou handhaaf en databestuurspraktyke sou verbeter. Dit sal ook help met rolverduideliking in databestuuraktiwiteite, en vlakke van aanspreeklikheid en eienaarskap van data wat geproduseer word, verbeter.

Sleutelwoorde: databestuur, datakwaliteit, data, besluitneming, doeltreffendheid

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List of Abbreviations and Acronyms

AGSA	Auditor-General South Africa	IBUR	Inpatient Bed Utilisation Rate
AI	Artificial Intelligence	ICT	Information and Communication Technology
ALOS	Average Length of Stay	IT	Information Technology
BAS	Basic Accounting System	MMM	Mangaung Metro Municipality
BDA	Big Data Analytics	M&E	Monitoring and Evaluation
COVID-19	Coronavirus Disease of 2019	NCVHS	National Committee on Vital and Health Statistics
DHIS	District Health Information System	NDoH	National Department of Health
DHMIS	District Health Management Information Systems	NDHS	National Digital Health Strategy
DLC	Data Life Cycle	NHI	National health Insurance
DOH	Department of Health	NHISSA	National Health Information Systems South Africa
DQ	Data Quality	PFMA	Public Finance Management Act
EBDM	Evidence-based Decision-making	PHC	Primary Healthcare
FIO	Facility Information Officer	POPI	Protection of Personal Information
FS	Free State	PPP	Public Private Partnership
FS DoH	Free State Department of Health	PTH	Pelonomi Tertiary Hospital
FMPI	Framework for Managing Performance Information	SA	South Africa
GWM&E	Government-wide Monitoring and Evaluation	SASQAF	South African Statistical Quality Assurance Framework
HGSA	Health System Governance and Accountability Model	SITA	State Information Technology Agency
HII	Health Information Infrastructure	Stats SA	Statistics South Africa
HIS	Health Information System	SU	Stellenbosch University
HIV and AIDS	Human Immunodeficiency Virus and Acquired Immune Deficiency Syndrome	TB	Tuberculosis
HNSF	Health Normative Standards Framework	UN	United Nations
HPRS	Health Patient Registration System	WHO	World Health Organisation

Chapter 1: Introduction

This chapter discusses the rationale, research objectives, and scope of this study and research design. It also outlines the sampling approach, data collection and analysis and the ethical standards with which the research was conducted.

1.1 The growing importance of ensuring health data quality

Globally, reliance on the use of data for decision-making has gained momentum. According to Nyamtema (2010:11), data is “a representation of facts, concepts or instructions in a formalised manner suitable for communication, interpretation, or processing by humans or by automatic means.” To derive the intrinsic meaning out of data, proper data management processes are crucial. Health systems are increasingly relying on this intangible asset to create value. Good data management is a prerequisite to improving data quality in the health sector for informing administrative and clinical decisions which are all patient-centred. Statistics South Africa (Stats SA) (2008) defines data quality in terms of “fitness for use”. Data of good quality has been proven to have numerous valuable attributes in planning and informing policies, not just in the health sector but in organisations across the world.

District Health Management Information System policy (DHMIS) defines data management as “up-to-date and easy-to-use data collection procedures” and this includes all aspects of data planning, handling, analysis, documentation and storage (Boone and Heywood, 2015:17). Data management is a fundamental process that is prerequisite to improving data quality.

The agony of climate change on human lives has increased pandemics and the burden of diseases globally. It has also placed an onerous burden on the resource requirements for the provision of quality healthcare services. This requires proper resource planning and need for data quality that will create real value for health systems globally. From as early as the 18th century, high-quality data was delivered to users as information which played an important role in health planning, management and decision-making (Pearlson and Saunders, 2013:11). Nsubuga *et al.* (2002:197) define information as facts provided or learned about something or someone.

Worldwide pandemics have demonstrated the importance of data management and data use as a product. In London during the cholera outbreak in the mid-1800s that left many devastated, Dunnigan (2003:30) demonstrates how the use of health data helped the officials to trace the number of deaths using local mortality registers. Similarly, constant outbreaks such as Ebola in some parts of Africa are notified and monitored through the use of data. This is an indication of how far back the systematic collection and analysis of public health data has been important.

In 2020, the world was grappling with the coronavirus disease of 2019 (COVID-19). This has unearthed most countries' economic differences and inequalities between the rich and the poor, testing the resilience and sustainability of health systems. The pandemic has eroded the already ailing South African health system, leaving the marginalised more vulnerable with uncertainties. It is during this period that real-time reliable data has proven to be a need in disease surveillance. "Real-time" is defined as data that is continuously up to date to allow users to make immediate decisions (Mackay, 2006:25).

Real-time data played a pivotal role in making decisive decisions to save human lives and mitigate the social and economic effects of the pandemic. In their study, Van Schalkwyk *et al.* (2020:3) emphasise that for policymakers to have made informed decisions on how to address either direct or indirect health-related and economic challenges during the pandemic, it was of critical importance that they had current and accurate information because it would support rapid decision and ability of health systems to be more responsive. Their analysis demonstrates that there was a decline in the utilisation of healthcare services in the entire country.

Information is processed data. According to Choo (2002:xv-xvi) data is needed for information, and information is data which has been made relevant, purposeful, useful and added meaning to help in making decisions. Health information is a basis for resource allocation, e.g., personnel, infrastructure, medical consumables, funding, decisions on whether to expand or reduce health services. Effective data management plays an important role in strengthening the health information system (HIS) to make decisions regarding health services. The word "system" points to an inter-connectedness and organisation of the health process (AbouZahr & Boerma, 2005:20). This also has the potential to strengthen

organisational intelligence through innovative data management strategies. HIS has the potential to improve performance as it collects, stores and encourages the use of information and provides feedback to the decision-makers.

Properly designed data management systems should assist in the management and planning of health programmes, within the overall national HIS that integrates data collection, processing, reporting and use of information to improve health service effectiveness and efficiency through better management at all levels, for all actors and institutions (WHO, 1993). Data needs are different at each level of care within the health system. The health sector produces voluminous and diverse amounts of data daily but the ability to use and analyse these data is complex due to vertical programmes in the health system with each operating their information system to fulfil their needs. Ibrahim *et al.* (2012: 300-304) argue that there is a need for a paradigm shift from the traditional data management systems approaches because they are frustrating and exacerbating the entire process.

The public health sector is characterised by a complex bureaucratic structure, however, in recent years, advancements in information and communication technology (ICT) have proven to assist organisational alignment and use of information to improve operational and organisational efficiency. For instance, improve resource allocation, inform policy decisions and improve access to data use. Research has shown that artificial intelligence (AI) can be used in various fields such as healthcare and finance. Dayyala *et al.* (2021:180) define “AI” as “the simulation of human intelligence that is programmed to think and learn like humans ... involves the creation of algorithms and computer programs ... such as visual perception, speech recognition, language translation and decision-making.”

AI has prospects to improve the management of data in the healthcare sector. According to Davenport and Redman (2020:12), AI is quietly improving the management of data, including its quality, accessibility, and security. In today’s world, efficient data management systems are assembled in different data management platforms which include databases, data warehouses, big data analytics, and more. Hiba *et al.* (2017) state that traditional databases are no longer satisfactory due to the large amount of data generated in different sectors daily including the health sector. All these data management platforms can deliver more effective

data management solutions to address both immediate and long-term organisational data needs.

To improve the quality of data in public healthcare, more innovative ways of data management processes and data-intensive techniques are required. This will assist in the integration of all data from fragmented data management sources. A current relational system like HIS is being flooded with large amounts of data daily and it cannot handle all healthcare data. The introduction of big data analytics can help in improving management decisions. Jayashree and Abirami (2018:27) point out that big data analytics is the new approach used for analysing large amounts of data and it has gained traction from both academia and the ICT industry. The researchers Jayashree and Abirami (2018:28) continue to mention that big data can perform the following functions, process massive amounts of data more simply and safely, and securely store data by utilising different software tools – this improves business intelligence and encourages the use of data by authorities.

This study aims to enhance the effectiveness of data management practices at Pelonomi Tertiary Hospital to improve data quality for evidence-based decision-making. Technology alone cannot improve data management processes for desired data quality and evidence-based decision-making, but a systematic approach to ensure more innovative ways such as complimenting recent technology with data governance strategies and policies, adequate resource allocation, clear outline of responsibilities and data structures should be in place.

The next section of this chapter will deal with the background and rationale of the study, purpose, potential value, research question and objectives, including the design and methodology. The last part will provide an outline of all chapters.

1.2 Background and rationale of the study

The District Health Management Information System Policy (DHMIS) provides an official regulatory framework in terms of the National Health Act (RSA Act 61 of 2003) which empowers the Minister to establish the legal framework for health information systems. It presents in detail what the National Department of Health (NDoH) expects from users of the DHMIS at all levels of the health system, i.e., national, provincial, district, sub-district, and health establishments. The benefits of the policy include harmonisation of information across

the country, as well as formalisation of the resources required for effective implementation of a well-functioning DHMIS. The policy clarifies the roles of different users in ensuring the production of comprehensive, timely, reliable, and good-quality data; converting data into meaningful information, and using such information for decision-making, planning, and performance monitoring in the public health sector.

The policy outlines the prospects to contribute significantly to improving the availability, quality and use of health information for efficient and effective planning and management of health programmes, as well as enhancing the coverage and quality of health services to improve health outcomes. The policy further sketches out the envisioned effective and good data management processes which could translate into producing “timeous, reliable and good quality data”. The establishment of effective functional HIS is vested upon the responsible Minister. It is the responsibility of public health authorities to ensure that policy implementation takes place accordingly, such as providing relevant resources, a conducive environment for effective data management practices and use of information and products.

According to the World Health Organization (WHO, 2008),

“...the goal of a health information system is often narrowly defined as the production of good-quality data. However, the ultimate goal is more than this – it is to produce relevant information that health system stakeholders can use for making transparent and evidence-based decisions for health system interventions. Health information system performance should therefore be measured not only on the quality of data produced, but on evidence of the continued use of data to improve health system performance, to respond to emergent threats, and to improve health.”

In addition, the National Health Act (RSA Act 61 of 2003) states that improving health information systems in terms of data availability, quality and use often requires interventions that address a wide range of possible determinants of performance.

To measure performance and health outcomes, the Free State Department of Health (FS DoH) has set targets to reach envisioned health outcomes over the medium term, whereby outcome indicators are used to measure performance. WHO (2006) defines a “health indicator” as a variable that can be measured directly to reflect the state of health of people

within a community. The health information contains demographic statistics that are crucial for measuring and analysing the health needs of the population within a specified community. Furthermore, in a hospital setting, data collected includes patient information, diagnosis, medical history and treatments. This implies that the quality of data is essential in this regard. As a prerequisite, effective data management procedures are crucial for the production of good quality data to form the basis for evidence-based management decisions regarding the health needs of the community and providing quality care.

FS DoH (2023:59) states that there have been some challenges in data management in the department but there have also been a few gains such as the standardisation of data collection tools in all public health facilities to improve data quality. Other notable achievements include the implementation of electronic data collection systems for some data sets to continuously eliminate the use of multiple paper-based registers. The health services in FS DoH are offered through the decentralisation of district health services following the legislated demarcated geographic settings.

On the contrary, FS DoH (2023:56) cites that despite the strides made in improving data management, data completeness and validity continue to be a challenge due to resource challenges and poor alignment of services. ICT infrastructure which includes connectivity and fragmented information systems is a challenge in advancing effective data management. Data collection tools are still mostly paper-based in points of collection and this affects the integrity and quality of data collected and recorded.

The official web-based district health information system (DHIS) which was adopted by the National Department of Health (NDoH) in 2000 still relies on paper-based registers at health establishments, which leaves huge room for error during data capturing and processing. According to Heeks (2013:74-84), data errors occur during the following stages in data handling: capturing, input, processing, storage and output phases, and this can either be human or technical. This implies that some of the causes of poor data quality could emanate from human and technical errors and it can affect decision-making at any level of healthcare.

While technology is not promising to eliminate all data management problems, it can help to address some of the technical and human errors in data handling in health facilities. PTH in the FS is one of the big hospitals that offers tertiary services and it is also a platform for learning, and this makes effective data management practices crucial to justify both clinical and administrative decisions. New technologies can enable data management repositories to work together, creating a platform for organisations to rapidly analyse data from multiple sources using advanced analytics for better business decisions (Akter & Haque, 2022:27). Use of data can also promote more innovative solutions to managing and accessing organisational information.

The inherent complexity of healthcare structure is on one hand promoting multiple sources of information systems for managing data and each is linked to certain programmes, e.g., human resource information system linked to human resource manager, infrastructure information system attached to infrastructure manager. Strategic alignment of healthcare IT should be managed and operated in a way that mirrors the management and structure of the organisation to eliminate fragmented HIS, instead strengthening it. This can also promote a culture of information use by the authorities.

The ultimate goal of the study is to enhance the effectiveness of data management practices at PTH for improved data quality and evidence-based decision-making. To realise change, FS DoH will need to invest more in recent technologies which provide a wide range of powerful techniques and tools that can assist in managing the voluminous amount of data produced in the sector daily. This includes the allocation of adequate relevant resources and the capacity to use data and data products to continuously inform authorities in the healthcare sector to improve programme performance and health outcomes.

To conclude the section, effective data management processes are crucial for improving data quality which is critical for informed decision-making and essential for developing appropriate interventions and strengthening health information systems. Planning, monitoring and evaluation are key to continuously improving HIS performance and striving for better health outcomes. Data that are of poor quality can lead to ill-informed decision-making which can affect patient care and overall performance on health outcomes.

1.3 Study purpose

The general purpose of the study is to enhance the effectiveness of data management processes at PTH in the FS DoH to ensure that they add value to the quality of data produced for evidence-based decision-making and inform other key policy mandates. This was done using questionnaires, and semi-structured interviews with relevant hospital personnel to assess their experience on data management processes in PTH and to make recommendations towards enhanced effectiveness.

1.4 Potential value of the study

The study will contribute significant insights into data management practices or processes that can assist in improving data quality in hospitals that are similar to the one under study. It can also identify the data management challenges which can be specific or generalised and offer some valuable solutions. Lastly, the study can also raise awareness among authorities and decision-makers of the importance of effective data management processes in hospitals.

1.5 Research question and objectives

The problem and primary objectives of this study are outlined below.

1.6 Research question

To what extent do the data management practices at Pelonomi Tertiary Hospital (PTH) ensure data quality as outlined in the District Health Management Information Systems Policy (DHMIS) and how can they be improved to inform evidence-based decision-making?

1.7 Research objectives

The primary objectives of this study were to:

1. Develop a conceptual framework drawn from the academic literature and policy for assessing the impact of data management processes and controls on data quality at a South African tertiary hospital;

2. Assess data management processes at PTH and their influence on data quality concerning the conceptual framework;
3. Identify barriers to good quality data and their impact on evidence-based decision-making in PTH; and
4. Make recommendations on strategies that can enhance the effectiveness of data management processes to improve data quality in PTH.

1.8 Scope of the study

The study aims to assess the effectiveness of data management PTH in the FS Province and make recommendations to improve data quality for informed decision-making. Data management is seen in this study as a prerequisite to improving the quality of data and it is used as a basis for achieving quality data, addressing barriers to quality data, and recommending strategies to PTH for enhancing their data management practices. One of the key themes of the study is data quality but it is important to mention that the study will not include any algorithms to measure data quality.

It is also important to mention that consent forms were issued to all willing participants and a level of confidentiality was maintained throughout the study. It is a very low-risk study as it did not review any patient information or any medical records.

1.9 Possible study limitations

The results of the study might be compromised because the study was conducted in a familiar environment and sometimes respondents can be hesitant to give their real views, especially in semi-structured interviews even though findings will be reported anonymously and the confidentiality of all responses will be safeguarded. In addition to this, contextual factors in data management might be dependent on the type of data and technical capacity of the unit of study. Because of the purposive non-random sampling and the focus on a single hospital, the findings may not necessarily be generalised to other tertiary hospitals in the FS or SA more broadly.

1.10 Research design and methodology

Rowley (2002:18) defines “research design” as the logic that links data to be collected and conclusions to be drawn to the initial questions of a study and it ensures logical coherence (Gomm *et al.*, 2000; Hamel, 1993; Yin, 1994:13). To achieve the objectives of this study, a descriptive case study research method was selected. According to Yin (1994:23), case studies provide an empirical enquiry that examines the contemporary phenomenon in their real-life environment and Hamel (1993) and Rowley (2002:16) are useful in providing answers to “How?” and “Why?” questions and this can be done in an exploratory, descriptive or explanatory manner of research.

This assessment assisted in providing an in-depth systematic description to answer the research question. Creswell (2013) adds that qualitative approaches allow for complexity in understanding a problem and context. This allowed the researcher to investigate and examine data at a micro level and explore detailed contextual in-depth analysis and description of smaller groups, conditions or events and their relationships (Flyvbjerg, 2011:310). Creswell (2002:101) adds that one of the advantages of the qualitative approach is that it provides for maximum data collection, especially during interviews, where personal perspectives and opinions could be included. As mentioned earlier, purposeful sampling was deployed to identify and select key subjects that are of interest and relevant to the phenomenon under investigation.

1.11 The unit of analysis

The unit of analysis serves as a basis for the case (Rowley, 2002:24). The unit of analysis may be a person or an event (such as a decision, a programme, an implementation process or organisational change) Yin (1994) or an organisation or team or department within the organisation (Rowley, 2002:19). In this case the unit of analysis is Pelonomi Tertiary Hospital. The hospital offers tertiary services in the Free State province, situated in Mangaung Metro (MM). More details are provided in chapter 5. The hospital offers highly specialised services and it is also a centre of excellence. There are several speciality divisions within the hospital and it operates with a cost-centres model and each has a manager.

The hospital produces voluminous amounts of data daily and it is exported to the next level of care. It is the responsibility of the head of the institution to sign off data to the next level. By so doing, they are committing to having reviewed and checked the data. The next level does the same, validations, and performs other relevant data quality checks before the district manager can also sign off, till it reaches the highest level. The data is captured in a system/s. The data quality checks are also done up to the provincial level, where the head of the department is also expected to sign off all the departmental data to NDoH. Due to the processes entailed in data management, the study aims to enhance the effectiveness of such processes in PTH for improved data quality, which can inform evidence-based decision-making. A more detailed picture of the unit of analysis is provided in Chapter 5. The next paragraphs will discuss, data collection and analysis, sampling design and ethics of the research.

1.12 Data collection and analysis

Case studies draw on various sources of evidence (Rowley, 2002:16; Yin,1994:9). According to Rowley (2002:16), Saunders *et al.* (2000) and Yin (1994:9), typically, case study research makes use of a variety of evidence from different sources, such as artefacts, documents, observations and interviews (Flyvbjerg, 2011:309) and this can go beyond evidence from a range of sources that might be accessible in historical studies.

In this study, data was collected using self-administered questionnaires and semi-structured interviews. Both imperial and non-empirical data are used in the study. Semi-structured interviews assisted in exploring the thoughts and beliefs of the participants on the topic of study and diverged into the individual feelings about the subject. Thematic coding for analysis of the results was done and the researcher used pseudonyms to identify respondents for confidentiality. The other data analysis encapsulated the objectives and key themes of the study, which have been shaped by the data collection.

Non-empirical data was collected from reports and other sources that provided sufficient valuable information, such as policies, frameworks and regulated standards on data management and data quality. The researcher made an appointment to be part of the management meeting where all key personnel were present to explain the details of the

study, how it will benefit the institution and increase participation and response rate. The researcher administered all questionnaires to the information personnel and arrangements for the collection of the completed questionnaires were made. The semi-structured interviews were conducted with senior management of the institution and cost centre operational managers. Arrangements with each respondent were made in advance for interviews.

1.13 Sampling design

As mentioned earlier, purposeful sampling was done as it serves the purpose of the study. This allowed the researcher to select informants according to their familiarity with the subject, the position they hold in the institution and their experience. Case studies aim to examine one or several smaller cases in depth (Huberman & Miles, 1994:27; Yin, 2003:41) primarily targeting “analytic” rather than “statistical” validity. This increases the transparency of the findings Yin (2003:32) as well as provides an organised collection of the evidence base.

The informants in this study were executive management of the hospital, different cost-centre operational managers and personnel handling data such as data clerks, information and monitoring and evaluation (M&E) personnel (information personnel). This has also shed light on their perspectives on data management and data quality. Executive managers were selected because they are the key drivers in decision-making and there was a need to hear their perspective on data management processes and quality of data at the hospital. DHMIS policy gives a clear mandate to the heads of health institutions in terms of signing off data from their institutions to the next level of care (NDoH, 2011:23). This compels the executive management to take direct responsibility for data produced in their health institutions.

The cost-centre operational managers are also another option because they are at the point of data generation; it was also important to hear their views about the themes of interest of the study. And they also form part of decision-making within individual-specific programmes. The last group was the personnel vested with handling data of the hospital: information officers, Monitoring and Evaluation (M&E) officials and data clerks. Both operational managers and information personnel provided an insider’s view of the actual processes of

data management, whether negative or positive, and they were also in a good position to give valuable information on the quality of data produced at the point of generation.

1.14 Research ethics

Application for ethical clearance was done through the ethics committee of the Stellenbosch University (SU) before conducting this research. The ethical clearance was also granted by SU, project number 28682. The ethical clearance from SU was submitted to the FS DoH Research Committee before conducting the research. The permission was also granted by FS DoH at the institution level.

Informed consent was obtained from all the participants and all the details about the study were explained to them. The researcher further explained that the study was voluntary and all participants have the right to excuse themselves from the study at any point in time should they feel they no longer want to take part due to personal reasons. They can do so even if they have signed the consent forms. Further details regarding the confidentiality and anonymity of the respondents have been provided on the consent forms including the sharing of data collected, it was only shared with my research supervisor. The audio recordings done during the semi-structured interviews and hard copies of self-administered questionnaires will be discarded after use. The data collected did not have anyone's personal information. The study complied with the Protection of Personal Information Act (RSA Act 4 of 2013) which requires the protection of personal information.

1.15 Outline of chapters

The section provides each chapter's outline and organisation of the study.

Chapter 1: Introduction

The chapter provides an introduction to the data management processes and outlines the need for quality data that can be derived from effective data management for evidence-based decision-making. The chapter further highlights the policy prospects (DHMIS policy) on data management and quality including strengthening HIS under the background and rationale of

the study. Research questions, study objectives, design and methodology are also discussed in this chapter.

Chapter 2: Conceptual framework for enhancing data quality through data management

It provides a conceptual framework drawn from the academic literature related to assessing the impact of the data management process on data quality and controls to ensure data quality. Key concepts of data management, and data quality concerning the global rise in the use of data for evidence-based decision-making will be explored.

Chapter 3: Barriers to data quality and redress strategies

This chapter discusses possible barriers to data quality and the literature around it. Strategies to address data quality are also discussed.

Chapter 4: Legislative framework

This chapter outlines the relevant South African legislative framework and how it denotes the concept of data management and quality, security and protection of personal information and data use.

Chapter 5: Profile of Pelonomi Tertiary Hospital: A case study

The chapter details the profile of Pelonomi Hospital as the case study. It describes its mandate and services rendered so that there is a linkage with the topic of the study.

Chapter 6: Data collection and analysis

This chapter furthers discussions on research design, methodology and data collection and analysis.

Chapter 7: Results interpretation and findings

In this chapter, the findings of the study are presented based on the research question, objectives of the study and envisioned potential value of the study.

Chapter 8: Conclusion and recommendations

A conclusion is drawn from the study findings and recommendations are made based on such.

1.16 Chapter summary

The research aims to assess the effectiveness of data management processes to improve data quality to inform decision-making. Recent technology is promising to improve data management practices which will then advance the quality of data produced. However, efforts need to be made at each stage of data handling to meet organisational data demands. Strategies for improving data management processes need to be clearly outlined in line with the organisation's capacity. This will also include implementation and constant monitoring of relevant policies.

Errors in data management may not be eliminated at once, but gradual improvements in data management practices can minimise translational errors, improve data quality and build confidence in the data used for decision-making by authorities. Big data technologies can improve data handling, processing, analysis and use because they make use of different tools to integrate data from different sources for more meaningful analysis. Evidence based in the healthcare sector is very important as it does not only affect poor performance of targeted health outcomes but it also directly impacts human lives. The next chapter discusses the impact of data management processes on data quality and controls to produce data of high-quality in healthcare.

Chapter 2: A conceptual framework for enhancing data quality through data management

This chapter discusses the impact of data management processes on data quality and controls to produce high-quality healthcare data. The discussions are drawn from the academic literature and developed conceptual framework.

2.1 Introduction

The process of data management is crucial in improving the quality of data generated at public health institutions, especially hospitals. The study aims to enhance the effectiveness of data management practices at Pelonomi Tertiary Hospital to improve data quality for evidence-based decision-making. Evidence-based decisions are crucial in healthcare. The emergence of new technology is promising to improve data management in healthcare due to the exponential growth of data produced in the sector daily.

As mentioned in the previous chapter, DHMIS policy outlines the prospects for improving data quality in the public health sector for various significant reasons mandated to the sector. The scope of this research is guided by the conceptual framework developed through the analysis of relevant literature. The study objectives guided the thematic approach in the organisation of this study. It is also important to mention that there is limited specific literature on similar studies relating to the unit of study under investigation.

To gain an in-depth understanding of enhancing the effectiveness of data management processes for improved data quality for EBDM, DHMIS policy will be used as a point of reference, and other supporting legislation and policy frameworks used within the SA government sphere to justify some of the literature findings. Chapter 1 provided a background rationale of the study and the objectives of the study. This chapter will build on the objectives of the study while trying to answer the research question.

2.2 Data management in healthcare

Most literature reviewed depicts different approaches to data management which are country-specific in healthcare because challenges are dynamic. Senthilkumar *et al.* (2018:62) describe data management in healthcare as organising, cleaning, retrieval, data mining and data governance. This is not limited to data validations to rule out any inconsistencies in the data generated (Archenaa and Anita, 2015). Data management involves all processes and procedures that warrant data quality and encourage its use.

This means data management processes take a systematic approach to data handling such as collection, aggregation, resources, clearly defined procedures for handling data and periodic ways to verify data sources (Reddy, 2009) which include ongoing activity monitoring (Kaduruwane, 2012). Additionally, Heeks (2013:17) summarises data management as a way in which data is controlled and structured in an organisation. Effective data management involves both structured and unstructured data. To cope with the mounting data, government, and other large organisations use big data management solutions because traditional data management systems and relational database platforms cannot keep up with the demands.

Requirements for effective data management include both hardware and software, policies and protocols that guide the entire system, and processes for standardisation and consistency. For organisations to gain a more competitive advantage, proper management of data is crucial. According to Kerr *et al.* (2008:260), the management of data in healthcare has become increasingly complex due to the emergence of technology. The use of technologies is best suited for storing and processing non-transactional forms of data (Pierce, 2004). Mathews (2015) highlights that the management of data and analytics is critical in HIS, and according to the researcher Mathews (2015), analytics means techniques used for analysis and acquiring intelligence (Gandomi & Haider, 2015).

Currently, it is not clear how many hospitals in healthcare have implemented big data analytics (BDA) Lismont *et al.* (2017) due to resource challenges and adoption. The exponential growth of data requires efforts for continuous investment in BDA to ensure

integrated care of patients in hospitals and strengthen HIS for the efficiency of services (Carvalho *et al.*, 2018). The voluminous data generated do not only come from hospitalisations but from other sources in medicine including healthy people (Roesems-Kerremans, 2016). The evolution of disease prevalence and advancement in medicine also contributed to an increase in clinical data.

Sanders *et al.* (2016) highlight the three most common stages in data management in hospitals: data collection, sharing and analysis, of which the latter is still a challenge due to fragmented systems in many hospitals, generally in healthcare. Roesems-Kerremans (2016) adds that data collection and storage, including analysis of health data, “have been, are and will remain fundamental procedures” for the efficiency of healthcare services.

2.3 Conceptualising new technologies in healthcare

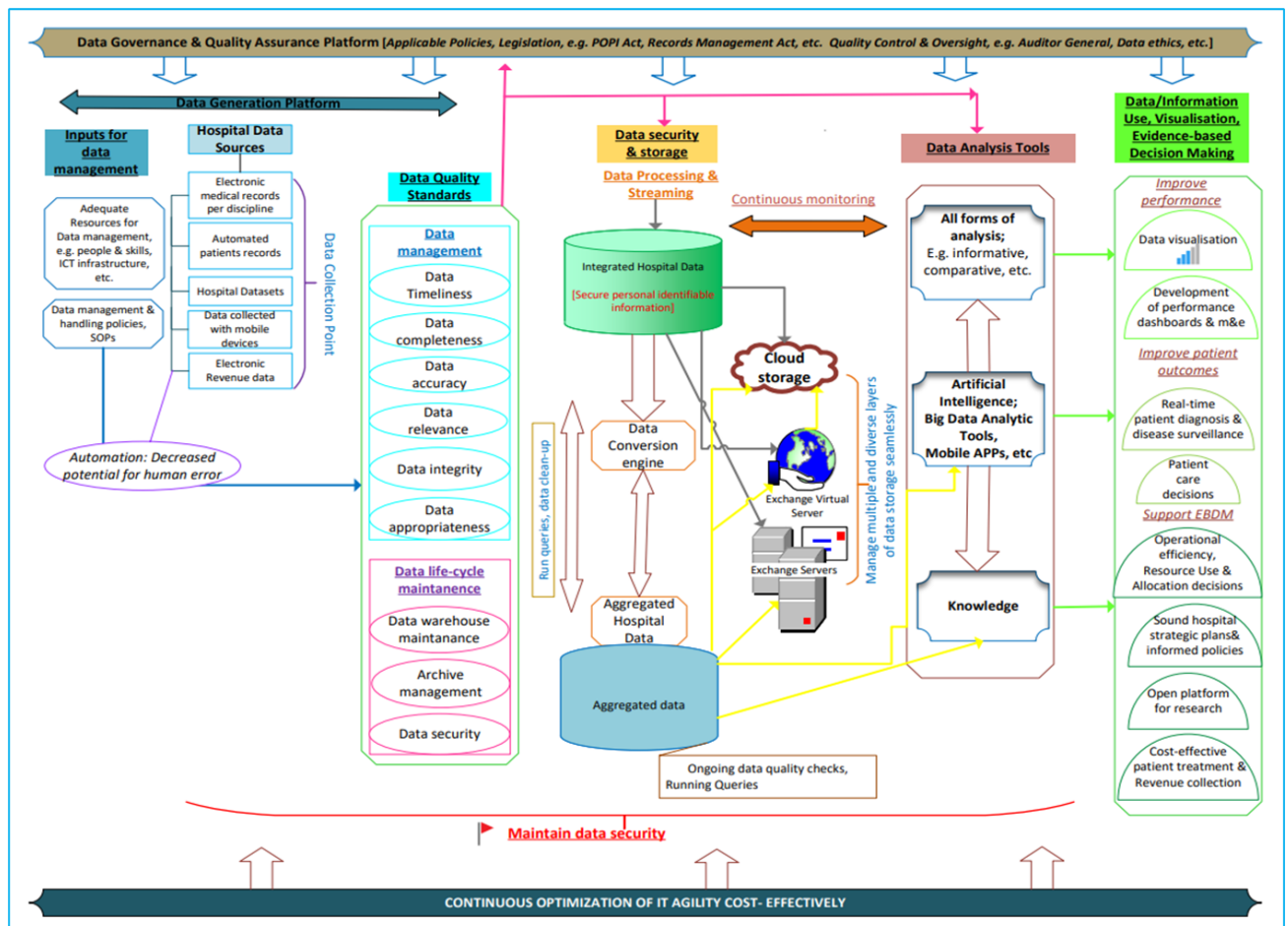
In sub-Saharan Africa, findings of poor data management ranged from lack of resources, organisational data vision and unclear roles and responsibilities of health information personnel Mutale *et al.* (2013), lack of management support, Mapatano and Piripiri (2005) and indicators that are often too many and becoming a daunting task to collect in health facility (Nsubuga *et al.*, 2002; Odhiambo-Otieno, 2005). The health facility in this case means hospitals and other health institutions, like primary healthcare (PHC) facilities.

Many data management challenges have been observed across the health sector worldwide. The current state is regarded as inadequate although there are several benefits and potential to revolutionise how data is managed (Garcia *et al.*, 2022; Epizitone *et al.*, 2022). The constraints in data management are not new – they are persistent due to the resistance to technology use Epizitone *et al.* (2022) and many limitations are stated across the literature such as inadequate resources and technological convergence in healthcare, to name a few.

The conceptual framework which envisions the solution to many data management challenges in the sector at least reducing. Many scholars identified a unique disposition of reliable data management but the perspectives are marred with ever-present barriers (Garcia *et al.*, 2022; Walcott-Bryant *et al.*, 2021).

The researcher’s conceptual framework for data management is presented below. It highlights data automation and integration at least to reduce the level of fragmentation, harmonise data flow and reliably handle heaps of health data generated every day. Different layers can perform different tasks at speed and minimise potential human errors.

Figure 1: Conceptual Framework for Adopting New Technology in Hospitals



Source: Researcher’s concept

2.3.1 Data generation platform

The above concept identifies stages for data management and implementation of BDA. The first stage is resources or inputs for data management processes. According to Wang *et al.* (2016), resources and sources in data management are important as they support both structured and unstructured data collection, internally and externally. The use of autonomous systems can either be medical or patient records from various sources, eliminating human

errors and gathering data from different sources. The data can be collected from any source with any format, smart phones, x-ray results, and so on. Aceto *et al.* (2020) state that health authorities must be aware of all data available to realise the effectiveness of BDA.

There are also systems or databases (and other sources) that collect specific minimum prescribed hospital datasets. Policies and other data handling documentation guide the entire stages of the data management process and maintain control.

According to the Storage Networking Industry Association (2009:2), inputs for data generation level align business information value most appropriately and cost-effectively. Data quality standards measure the quality of both systematic and data which will then translate into information satisfaction for users.

2.3.2 Data integration and aggregation level

Data integration and aggregation levels securely store data. This is the layer where all the hospital data with crucial personal information is integrated. Data is not only protected from artificial threats and human intruders but from natural disasters as well. This will be further discussed under factors affecting data quality later in the chapter. Data security and privacy are very important in this regard. Data is integrated in any format and the data life cycle (DLC) can be managed effectively.

DLC can be defined as the management of data throughout all stages (Wang *et al.*, 2016) from entry, archiving, and warehousing to data destruction (Carvalho *et al.*, 2018). Researchers (Bryant, 2008; Wang *et al.*, 2016) mention that this layer can be a bit complicated due to volumes of data coming in using different formats and sources, and data varies considerably.

Three things happening at this level are data integration, conversion and aggregation. Data conversion happens in each direction to maintain quality standards after running queries and quality checks. Data queries and clean-up are ongoing to ensure quality standards are maintained. Shang and Seddon (2002) maintain that conversion engines in data management must be able to do the following: translation, merging, Wang *et al.* (2016) sorting, data

cleaning and validation. Wang *et al.* (2016) describe converged databases as those with native support for all modern data types and can develop models into a product. Effective converged databases can run many different workloads, such as graph and machine learning.

The aggregation level of data allows for the standardisation of data across the entire hospital and the data are then uploaded to a standardised source. To maintain an ongoing backup of the raw and processed data before and after aggregation, the data can either be stored in exchange servers or cloud storage for easy reference and access.

Cloud storage is defined by Aceto *et al.* (2020) as “a network-based infrastructure capable of storing large scale of virtualized spaces” and Wang *et al.* (2016) add that it performs complex computing in real-time. According to Aceto *et al.* (2020), the world today is being transformed by the availability of “anywhere-and-anytime connectivity” regarding cloud computing. Cloud storage is offering cost-effective, powerful and timely handling and analysis of data and is therefore ideal for cloud computing and eradicates costs for hardware, software and dedicated space in computing (Senthilkumar *et al.*, 2018:61). Wang *et al.* (2016) argue that most hospitals often struggle with the cost for data storage and the increased demands for data-intensive requirements pose challenges, hence they opt for affordable storage.

However, Sahoo *et al.* (2014) raise concerns about storing public health data in the cloud, citing issues of security and privacy to patient information despite its affordability. But Aceto *et al.* (2020) and Wang *et al.* (2016) shed light on the use of a private cloud which provides a secure environment and keeps critical patient data in-house despite a slight increase in cost. The researchers urge hospital managers to maintain a balance between cost-effectiveness and choices of cloud storage for patient information during the adoption of BDA.

To maintain data security discovery must be used to address issues of compliance. These new data management tools make use of data discovery for reviewing data and identifying connections that require detection, tracking and monitoring for multijurisdictional compliance (Aceto *et al.*, 2020). Globally, issues of compliance demands are on the rise and to gain this capacity is crucial for security and risk.

2.3.3 Use of Big Data Analytics tools

In this study, the history and origins of BDA will not be discussed but its benefits will be discussed concerning improving healthcare efficiency. This will also apply to the use of extreme data science terminology in data management to ensure simplicity. Different scholars provide several definitions of BDA depending on the use but the common ground is its capability to manage huge volumes of data to enable users to easily perform data analysis and make reactions (Hurwitz *et al.*, 2013). Aceto *et al.* (2020) highlight its usefulness in maximising business value with its capability to transform raw data into usable information, and Lalalle *et al.* (2011) categorise BDA into three levels – transformed, experienced and aspirational – due to its ability to perform certain tasks which could not have been imagined possible at a cost-effective manner while optimising organisation operations. Other scholars like Simon (2013) include the idea of supporting decision-making in their definition and Aceto *et al.* (2020) describe it as an extraction of value from challenging voluminous and heterogeneous data.

However, Wang *et al.* (2016) define “BDA” through the lens of data management life-cycle in healthcare as “the ability to acquire, store, process and analyse large amounts of health data in various forms and deliver meaningful information to users that allows them to discover business values and insights in a timely fashion”. The unit of analysis in this study is the hospital which offers highly specialised services and a training platform for health professionals which means that fragmented data collection systems might not support EBDM and use of modern technologies like the BDA can be beneficial in this regard. In Chapter 5, further details will be provided regarding the unit of analysis.

Figure 1 demonstrates the concept of using BDA tools to perform all kinds of data analysis and the use of AI in different forms such as predictive, prescriptive, and interoperability comparative, to name a few. Predictive data analysis is the capacity of available data to detect correlations in trends and patterns and use extrapolation to predict the likelihood of future occurrences. Negash (2004), Hurwitz *et al.* (2013) and Kaisler *et al.* (2013) add that prescriptive data analysis is more powerful as it provides advice on possible outcomes before

the actual decisions; it prescribes the “what should we do, what is the best outcome, how can we make it?”

In the dawn of poor governance in the country, mirrored by fraud and corrupt activities, Wang *et al.* (2016) write that with the use of stream computing, which is possible through BDA, fraudulent activities can be predicted when there is a misuse of customers’ accounts for transactions as this can be analysed in real-time. This can be prevented in all healthcare sectors. On the one hand, interoperability involves data integration to support management, collaboration and dissemination of data across all levels of healthcare departments (Sadeghi *et al.*, 2012). This kind of analysis can benefit the larger hospitals by integrating all data generated thus improving responsiveness and creating seamless synchronisation for easier access and use.

With the benefits of BDA, researchers Cozzoli *et al.* (2022) maintain the limitless benefits of using BDA in the healthcare sector. It signals managers to react to stimuli in real-time and identify workable strategies to address challenges and increase programme-specific performance and provides support for preventative care, pharmaceutical management and evidence-based decision-making in medical practices. The level will provide reports and analysis at high speed and maintain real-time analysis to support decision-making in hospitals of this magnitude. Development of strategic plans and other crucial plans happens at ease since data is readily available.

2.3.4 Potential benefits of Big Data Analytics

The potential benefits of big data analytics are multi-dimensional and they include IT infrastructure, operational, organisational, managerial, and strategic (Esteves, 2009; Gefen & Ragowsky, 2005; Mueller *et al.*, 2010; Shang & Seddon, 2002).

Table 1: Potential Benefits Driven by Big Data Analytics in Healthcare

Potential benefits of big data analytics	Elements
IT infrastructure benefits	<ul style="list-style-type: none">▪ Reduce system redundancy.▪ Avoid unnecessary IT costs.

Potential benefits of big data analytics	Elements
	<ul style="list-style-type: none"> ▪ Transfer data quickly among healthcare IT systems. ▪ Better use of healthcare systems. ▪ Process standardisation among various healthcare IT systems. ▪ Reduce IT maintenance costs regarding data storage.
Operational benefits	<ul style="list-style-type: none"> ▪ Improve the quality and accuracy of clinical decisions. ▪ Process many health records in seconds. ▪ Reduce time for patient travel. ▪ Immediate access to clinical data to analyse and shorten the time of diagnostic tests. ▪ Reductions in surgery-related hospitalisations. ▪ Explore inconceivable new research avenues.
Organisational benefits	<ul style="list-style-type: none"> ▪ Detect interoperability problems much more quickly than traditional manual methods. ▪ Improve cross-functional communication and collaboration among administrative staff, researchers, clinicians and IT staff. ▪ Enable the sharing of data with other institutions and add new services, content sources and research partners.
Managerial benefits	<ul style="list-style-type: none"> ▪ Gain insights quickly about changing healthcare trends in the market. ▪ Provide members of the board and heads of department with sound decision-support information on the daily clinical setting. ▪ Optimisation of business growth-related decisions.
Strategic benefits	<ul style="list-style-type: none"> ▪ Provide a big-picture view of treatment delivery for meeting future needs. ▪ Create highly competitive healthcare services.

Source: Wang *et al.* (2016:5)

2.3.5 Knowledge generation

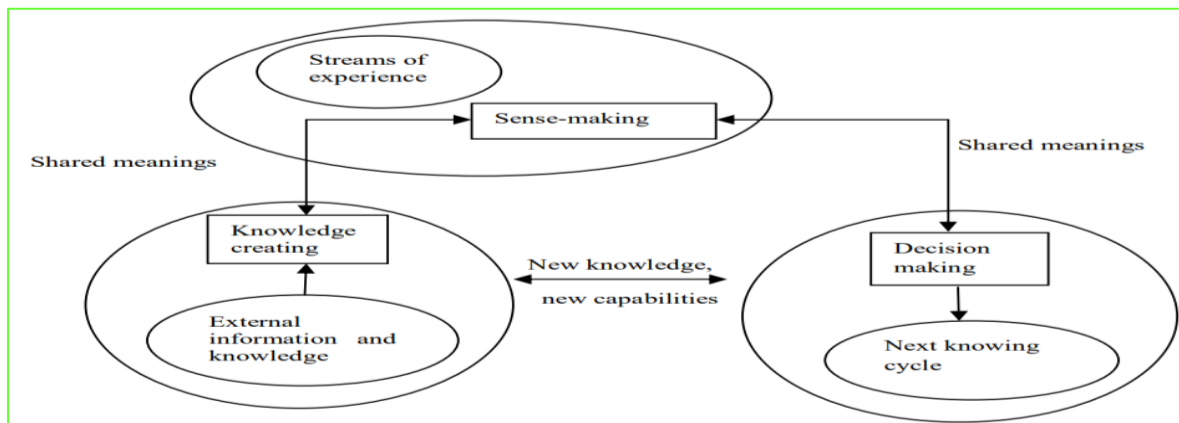
Data are raw unprocessed facts. According to Bell *et al.* (2018), data can be translated into knowledge through interpretation, provision of relevant context and identification of correlations. It can create information that over time can be used to test assumptions and solve problems and result in knowledge that drives decision-making over time. Data, information and knowledge have a strong link, one as a product of another. Barclay (2000) states that in 1597, a well-known father of empiricism Francis Bacon wrote that “Knowledge is power” and it becomes more powerful when it is shared. From this premise, it is imperative

that the interpretative nature of data management and use processes encourage cognitive structural change that transforms people's knowledge.

Researchers Vick *et al.* (2015) add that data as an input is the origin of the creation and innovation of conceptual foundations in organisations and individuals which later encourage and promote knowledge to both. Intelligent organisations use the knowledge gained to have a competitive advantage over their competitors (Choo, 2002; Kumar & Singhal, 2012; Mohajan, 2017:12). According to Choo (2002), an intelligent organisation is a learning one that is capable of creating, acquiring, organising, sharing knowledge and applying it to design its behaviour.

According to Choo (2002), "... in organisational learning, individuals use information to create knowledge, not just in the sense of data and facts but in the form of representations that provide meaning and context for purposeful action". Flexibility in information representation is crucial in accelerating its use for meaning creation and promotion of understanding on how to solve problems.

Figure 2: Knowledge Synthesis



Source: Choo, C.W. (1998:86)

Neto *et al.* (2009) emphasise that organisations practice information for the sense-making of their environment, to generate new knowledge and make informed decisions. The three (sense-making, decision-making and knowledge creation) are interconnected processes that play a highly strategic role in unfolding the organisational knowledge vision. According to Mohajan (2017:12), modern technology is driving a need for many organisations to equip

themselves with knowledge for decision-making and driving organisational competitiveness. Kerr (2007) adds that to create organisation knowledge, high-quality data and derived information are a necessity.

2.3.6 Data/information use level

The information and/or data use level of the framework allows for real-time usage of outputs. The users can produce different types of visualisation per their needs. There are varying reasons why information use can be utilised in a hospital setting, for improving patient outcomes and experience of care. The early discussions have highlighted the need for knowledge in healthcare which can improve how the business or institutional activities are carried out.

Reliable analysed quality data can be used for immediate patient diagnosis and disease surveillance. One of the important factors of the real-time availability of quality data is the support for operational efficiency and resource allocation, producing sound plans and informed hospital policies, providing an open platform for further learning and research to improve hospital revenue collection and realise cost-effective ways of patient treatment and in some instances, guide strategic purchasing in healthcare.

2.3.7 Data governance and quality assurance platforms

Data governance and quality assurance control are crucial in data management. This is applicable across the entire data life-cycle management to maintain compliance. This is done through the implementation of relevant pieces of legislation, applicable policies and standardised quality-controlled measures. The applicable legislation is discussed in Chapter 4. What is data governance? Ibrahim *et al.* (2012) defines “data governance” as organisational standards, strategies, plans, well-defined indicators, information systems, the hierarchy of reporting and accountability shed in ensuring effective data management and high-quality data.

In addition to this, Gorgens & Kusek (2009) simplify data governance as a strategy deployed enterprise-wide for effective data management and to keep checks and balances on organisational operations through compliance (Chellah & Kunda, 2020). Wang *et al.* (2016) add that data governance is an extension of IT governance because it leverages enterprise-wide data resources and creates business value. The level of data governance and quality assurance plays a role in oversight to realise compliance with health standards.

Data governance in success should have a mission, clearly defined goals, execution procedures, metrics and performance measures. This implies that sound data governance protocols should be clearly defined to provide clear guidelines for data availability, criticality, authenticity, sharing and retention that enable healthcare organisations to harness data effectively from time acquired, stored, analysed and used. Quality control processes during the data management phase seek to identify and mitigate errors not prevented in earlier phases (Needham *et al.*, 2009:147).

According to Roos (2013), data governance plans become successful if they are underpinned by strong leadership to provide support and encourage participation. Institutionalisation of data builds capacity and its stabilising benefits can contribute towards nurturing the culture of organisational knowledge sharing (Ndjave-Ndjoy, Twum-Darko & Harker, 2016). In hospitals, healthcare workers are encouraged to review data at the point of collection so that they can realise its value and create a culture of use.

Wang *et al.* (2016) cite the establishment of a data governance committee at the University of Kansas Hospital as one of the good practices in developing a sound data governance ecosystem. The aim is to manage the usability, availability, security and integrity of the institution's data. The committee is composed of three groups (executive, advisory and support groups) with specified responsibilities. First, the executive group has the responsibility of improving data quality by overseeing the development of vision and strategy. Secondly, the advisory group is tasked with establishing the execution of plans and procedures for data quality and creating working groups.

Thirdly, the support group which consists of technology, clinical and process improvement experts to support the two former groups. With the premise for best practice, the committee provides a secure commitment to the users from senior management, initiates data-sharing platforms and offers technological expertise that data consumers can rely on by providing outputs from disparate systems and sources, pointing out data gaps and any interruptions in reporting. Lastly, concerning sound data governance, Kansas Hospital has gained 70 standardised enterprise-wide data definition authorisations and created a successful multi-year data governance roadmap.

2.3.8 Agile IT solutions and support

The full potential of IT is enjoyed when there is alignment with the organisational strategy. Business value in IT is linked to three core dimensions namely, people, process and IT itself (Melville *et al.*, 2004). Alignment is a more powerful approach, as it strives to (re)configure the organisation to synthesise IT processes and the organisation's business strategy, structure, and management. Most organisations have ICT strategies that are not linked to the organisation strategy, not just in healthcare.

According to Wang *et al.* (2016), one of the benefits of agile IT governance is its ability to leverage enterprise-wide resources and create organisational value cost-effectively. Keeping IT systems updated helps to gain full potential and ensures that systems are tailored to the specific needs of an organisation. It also prevents hard problems such as equipment malfunctions, maintaining reliable backups and storage to prevent data loss during natural disasters, and general maintenance of the systems against cybersecurity and software errors. Wang *et al.* (2016) highlight the usual lags in IT adoption in healthcare, however, the potential to create sustainable and agile IT systems will add far-reaching benefits.

2.4 e-Government

Technology is rapidly changing the world and services are delivered by the government to citizens. Technological development offers a great contribution to the enhancement of e-governance. E-government or electronic government can be described as the use of ICT in the

provision of government services to increase efficiency, accessibility, transparency, citizen involvement and participation.

For the sake of simplicity, e-government can be considered as the use of ICT in the public sector. Aldemir and Şen (2021) state that the implementation of ICT in government operations is to achieve public ends by digital means. The e-government means electronic communication between the government itself and from the government to citizens and vice versa and this includes electronic information communication between businesses and the government. With e-government, the government hopes to improve service delivery coverage, transparency in government operations and accountability and restore citizens' trust.

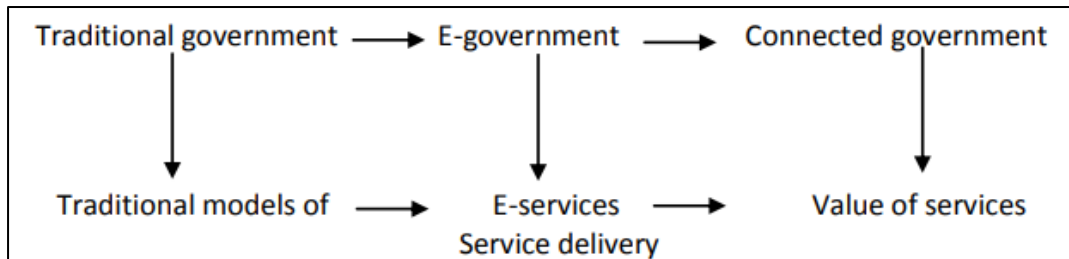
2.4.1 Potential benefits of e-government

The introduction of e-government is a government's strategy to reduce costs while improving the effectiveness and efficiency of service delivery to the citizens. E-governance has the potential to change the landscape of public service delivery (Bannister and Connolly, 2012). With its ability, ICT facilitates information flow between governments and the public. According to Aldemir and Şen (2021), the power of communication and connection technologies, and innovative applications, promote unified knowledge exchange, technical co-operation and capacity-building for sustainable development. The UN (2023) states that e-government can also improve public participation in policy-making decisions.

The concept of e-strategy is concentrated on economic, political and social features. It allows business-to-business transactions and brings customers closer to the businesses (Gordon, 2002; Signore *et al.*, 2005). An institutional e-governance framework is effective in improving the internal mechanisms in the public sector cost-effectively, increasing integration for better workflow and effective utilisation of resources for sustainable solutions. Innovation in the use of e-government can make governments around the world more efficient and responsive to service delivery and the needs of communities (UN, 2023).

The e-government should change how government relates to citizens (Signore *et al.*, 2005) and the e-governance embodies citizenship relating to the needs and responsibilities of the citizens. Below is the evolution continuum of government service delivery.

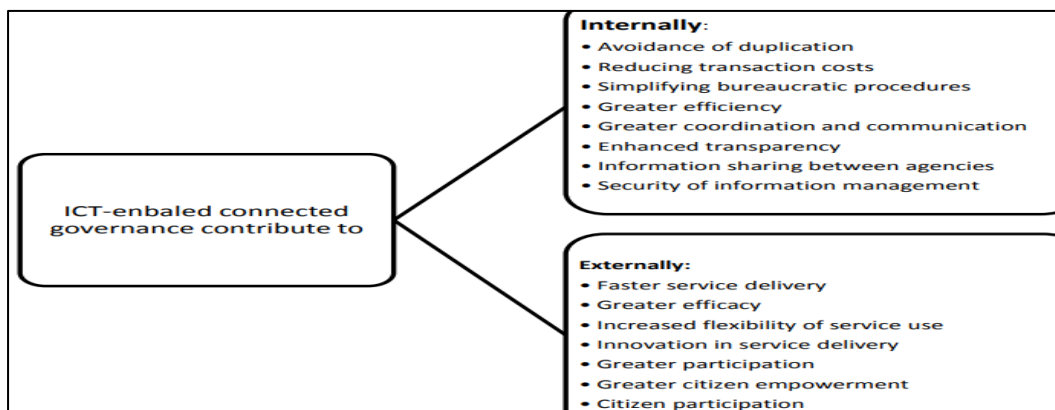
Figure 3: The Evolution Continuum of Government Service Delivery



Source: Iyad (2019:3)

To implement a successful e-government strategy, Iyad (2019) highlights the need for an e-governance framework, citizen database, connectivity framework, interoperability standards and a secure delivery framework. Iyad (2019) and Kettani and Moulin (2014) provide a summary of the key advantages of ICT for governance.

Figure 4: ICT Advantages for Government ICT advantages for governance



Source: Iyad (2019:6)

E-government is generally about the use of ICT in the public sector to improve service delivery and citizen-connectedness. Technology has brought about a lot of transformation and innovation in how the government ushers service delivery to the people and enables the modernisation of the public sector. Different government departments are developing

specific strategies to accelerate service delivery on e-government. The DHMIS policy envisions connected health through technology to improve service delivery and save lives. Below are discussions on e-health.

2.5 e-Health

One of the objectives of this study is to assess data management processes at PTH and their influence on data quality concerning the conceptual framework. Data quality remains a big challenge in healthcare but investment in modern technology across the globe promises to remedy the situation. Traditional data management implementations have proven not to be sufficient (Senthikumar *et al.*, 2018:57).

ICT can meet and exceed the expectations in health data management (Feldman *et al.*, 2015; Senthikumar *et al.*, 2018:57). The WHO (2020:40) defines “e-health” as “cost-effective and secure use of information and communication technologies in support of health and health-related fields, including healthcare services, health surveillance, health literature, health education, knowledge and research”. Rodriguez *et al.* (2010) and Maheu *et al.* (2001) explain that e-health is like e-learning and e-business but the last is specific to the health sector.

Digital technology transforms the landscape in which the health sector conducts business worldwide. This plays a critical role in strengthening health systems in many countries. The WHO (2020) states that chronic pathologies are recently contributing to more diseases worldwide. These diseases are expensive to treat and require specific specialised care. ICT improvements in healthcare aid in better quality of care to nations across the world cost-effectively.

The adoption and implementation of these e-health strategies are guided by legislation, standards and policies of different countries for good governance and ensure that people’s rights are protected. For instance, the use of personal information must always remain secure and confidential. Digital health is considered an integral part of health priorities and should benefit people in a way that is considered ethical, secure, safe, equitable, reliable and sustainable. Its development must be done with principles of transparency, privacy,

confidentiality, security, scalability, accessibility replicability and interoperability (WHO, 2020:8; UN, 2019).

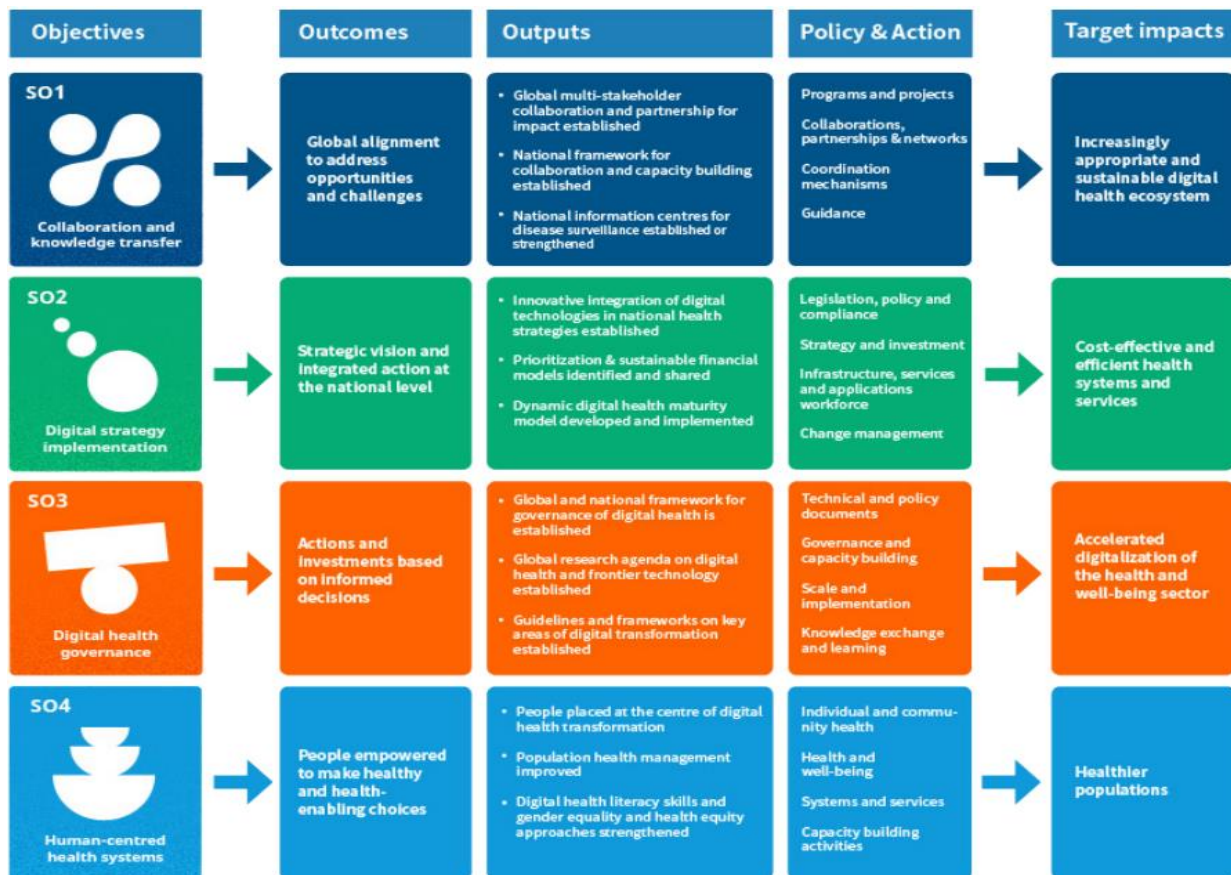
According to the WHO (2020:8):

“Digital transformation of healthcare can be disruptive; however, technologies such as the internet of things, virtual care, remote monitoring, artificial intelligence, big data analytics, blockchain, smart wearables, platforms, tools enabling data exchange and storage and tools enabling remote data capture and the exchange of data and sharing of relevant information across the health ecosystem creating a continuum of care have proven potential to enhance health outcomes by improving medical diagnosis, data-based treatment decisions, digital therapeutics, clinical trials, self-management of care and person-centred care as well as creating more evidence-based knowledge, skills and competence for professionals to support healthcare.”

Despite strides made in the adoption and use of digital health, numerous developing countries still do not enjoy the benefits. According to the WHO (2020), there is a need to support efforts for investment in ICT and overcome impediments in developing countries to accessing modern digital health technologies. Governments and leadership in such countries need to provide a conducive environment, adequate resources and capacity, infrastructure to support the digital transformation, education, capital investment to set up all requirements, technology ownership, security, privacy, foster adoption and implementation of global standards and technology flows.

The Global Strategy on Digital Health 2020-2025 of the WHO (2020:32) provides a summary of strategic objectives and implementation of action plans for digital health to support countries and bridge the digital divide.

Figure 5: Global Strategy on Digital Health 2020-2025



Source: Global Strategy on Digital Health 2020-2025 (WHO, 2020:32)

2.5.1 The National Digital Health Strategy for South Africa 2019- 2024

In SA, the National Digital Health Strategy (NDHS) for South Africa 2019- 2024 envisions "better health for all South Africans enabled by person-centred Digital Health". This strategy proposes some strategic interventions to be achieved by 2024. The strategy aims to "establish an integrated information architecture for interoperability and effective, safe sharing of health information across health systems and services" in SA (NDoH, 2019).

Section 74 (1) of the National Health Act, 2003 (RSA Act 61 of 2003) compels the minister to facilitate the establishment, implementation and maintenance of a national health information system across all tiers of government. This is also mandated in the DHMIS policy. The development of the Health Normative Standards Framework 2022 (HNSF) is a key enabler

guiding the realisation of a fully functional interoperable South African digital healthcare. The White Paper for NHI Policy (2017) advocates for an integrated and modernised national health information repository and data system for the effective management of the NHI.

The SA National Digital Health Strategy has also been translated into an implementation plan as a response to the National Development Plan 2030, the SA government's Medium-term Strategic Framework and integrated into the Medium-term Expenditure Framework and annual operational plans (NDoH, 2019). The strategy delivers interventions that captures milestones towards achieving its vision. Relevant regulatory frameworks, policies and legislation will ensure strengthening of digital health in the country for transparency and accountability when handling personal information. This will also strengthen health systems in the country.

According to the NDoH (2019), a situational analysis was conducted to mark progress on e-health in SA. Challenges and gains were noted. Some of the gains attributed to digital health include the development of the Ministerial Advisory Committee on e-health, the health patient registration system (HPRS) and the rationalisation of PHC registers for data collection which resulted in a reduction in the number of PHC registers from more than 50 registers to six standardised registers.

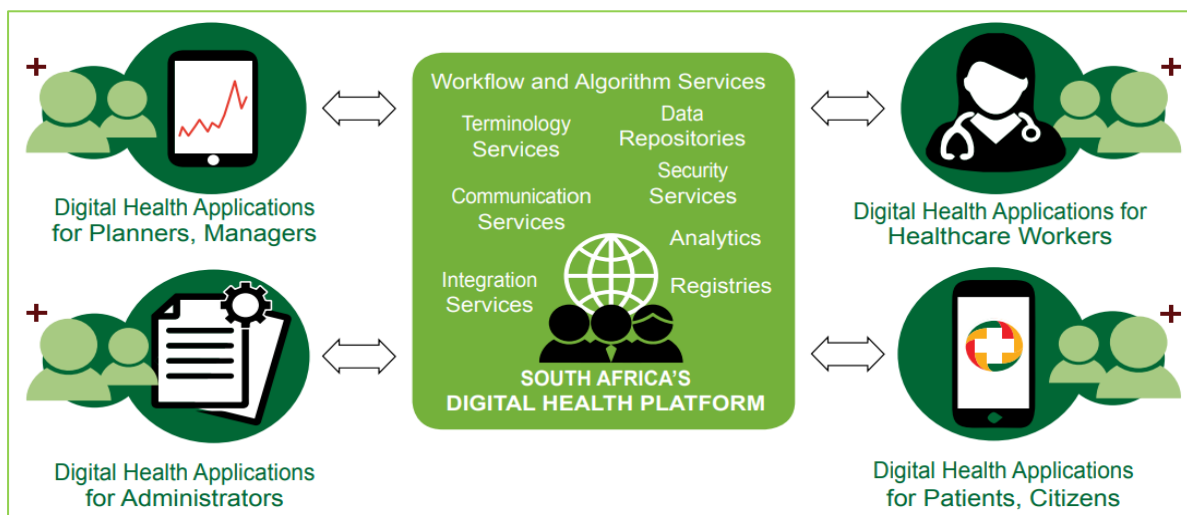
Significantly, this has reduced the capturing workload in health facilities and improved the standardisation of data collection tools. mHealth has also been implemented to support priority health programmes and one of them is Mom Connect which has proven useful in women's health, encouraging women to make use of free antenatal and post-natal services during and after childbirth.

Clinics and hospitals around the country are also benefiting from the mHealth application Stock Visibility System. This is an electronic stock management system implemented to increase access to accurate, timely medicine availability information from health facilities and telemedicine. Digital learning, also known as eLearning, is offered and according to NDoH (2019) modules have been developed focusing on data quality, DHIS and NIDS.

While gains are significant, there are challenges which also include internet connectivity, the digital divide in certain rural areas, budgetary issues and load shedding, which has brought the country's economy to its knees.

The NDHS 2019-2024 identifies nine strategic objectives. One of the strategic objectives is to “Establish an integrated information architecture for interoperability and effective, safe sharing of health information across health systems and services” (NDoH, 2019). This will democratise the health information system spaces and incorporate all data sources to harness data management in the sector. This can only be possible through the robust application of modern technologies. Below is the envisioned concept of SA's digital health platform.

Figure 6: Conceptual Overview of SA's Digital Health Platform



Source: NDoH (2019:22)

2.5.2 Managing digital health risks

As mentioned earlier in the chapter, the use of digital health comes with risks that need to be mitigated and safeguarded by personal information. SA legislation requires the protection of personal information and this must comply with relevant legislation. Cyber security threats are real and there is a need to establish policies around them to build effective threat assessment and assign decision structures to mitigation risks. Technology has proven to have

many benefits in health care, but resistance to implement compliance technological standards has harmed the progress made in health information management across many countries and exposes such countries to potential digital health risks (Epizitone *et al.*, 2022).

Implementation of proper change management strategies is a necessary move to overcome the hesitancy in the adoption of technology. The public health sector also has limited resources including funding, especially for the procurement of digital health solutions. However, exploring funding mechanisms to invest in technology is worthwhile.

Modern solutions to data management promise to provide efficient ways to manage data across a diverse environment in a unified manner. The conceptual framework developed for enhancing data management provides a broader picture which can be utilised not only in hospitals but also in healthcare. The need for standardisation in data management cannot be explained, data protection laws to provide security and control of personal information are a necessity. This will assist in communities gaining control and turning into stakeholders when healthcare organisations cannot comply with standards or provide poor control on data use.

2.6 Health Information Systems (HIS)

Health management information systems (HIS) are processes for recording, storing and processing health data. According to Lippeveld (2001), "HIS" is defined as an "integrated effort to collect, process, report and use health information and knowledge to influence policy-making, programme action and research". This definition was further adopted by the WHO (AbouZahr & Boerma, 2005; Bagayoko & Abdrahamane, 2021; Haule *et al.*, 2022). The purpose of HIS is mostly to align fragmented systems and in a way modernise and integrate health functions for improved healthcare delivery (Berrueta *et al.*, 2021; English *et al.*, 2011; Sahay *et al.*, 2018).

HIS has seen a lot of transformation over time due to a significant increase in role players and the introduction of modern technology (Almunawar & Anshari, 2012) and other factors that can change the healthcare service landscape for quality health. The definition harnesses the concept of unifying, imparting knowledge and support for EBDM in healthcare. Several

scholars proclaim HIS disposition by referring to its capabilities in offering seamless healthcare (Almunawar & Anshari, 2012; Epizitone *et al.*, 2022). Malaquias and Filho (2021) emphasise the importance of HIS, highlighting its ability to be optimised for enhancing services that support decision-making, storing and processing of health data. In this light, HIS has the potential to improve the quality of healthcare services for the benefit of the communities.

As mentioned earlier, HIS is important for EBDM across all levels of the health system. Since the beginning of the discourse on the concept of enhancing healthcare applications, HIS was regarded as the foundation (Almunawar & Anshari, 2012) which theorises that the integration of information systems with business processes presents better healthcare services (Tossy, 2014). HIS is entrenched with several features which include technologies. In his study, Panerai (2014) emphasised the notion and theorised HIS as broad, mentioning its contextual definition as relevant. According to the researcher Panerai (2014), HIS was restated as any “structured repository of data, information, or knowledge” that supports healthcare delivery.

This has led to misconceptions over the years that the development of HIS was solely computer technology. It has contributed to the lack of peculiarity between the conceptual structure and implementation of HIS technology. According to Panerai (2014), the literature on the origins of HIS dates back to the 18th century. In their study, Namageyo-Funa *et al.* (2018) applauded the advancement in technology in the health sector, paying attention to the digitisation and revolutionisation of health data. In another study, Venkateswaran (2019) highlighted the transition in HIS from paper-based to the digitalisation of records which can enable streamlined workflow and transform applications in the health sector.

Tummers *et al.* (2021) acknowledged HIS innovation in digital solutions and indicated that current trends in healthcare have been extended with the inclusion of modern technologies. Malik and Hussain (2021) also assessed HIS adoption in terms of organisational, human, technological and environmental determinants and different degrees of utilisation variation were reported. Despite the findings on HIS, the existing literature advocates for resilient and sustainable HIS applications across all levels of healthcare.

2.6.1 Potential benefits of HIS

Literature indicates the interrelatedness of HIS as a system because it accommodates several core processes and departments in healthcare and thus affords many benefits. Easy access to medical and patient records, cost-effectiveness and time-saving, and evidence-based, health-informed policies and interventions are some of the benefits of HIS (Almunawar & Anshari, 2012; Ker *et al.*, 2018; Swartz *et al.*, 2018:28).

Several scholars revealed HIS to be widely known and influential (Ker *et al.*, 2018) and health sectors globally are drawn to these benefits. Moreover, Alahmar *et al.* (2022), Dunn *et al.* (2021) and Swartz *et al.* (2018:31) state that investment in HIS has been beneficial in effectively providing real-time comprehensive health information for quality healthcare applications, decision-making, strengthened monitoring and evaluation, health innovations and resource planning, scaled-up surveillance services, and enhanced governance and accountability. It is also considered pertinent for data, information and knowledge sharing and its incorporation with various technologies is valued.

2.6.2 HIS SA

DHMIS Policy outlines the need for HIS strengthening. It identifies seven priority areas: health information coordination and leadership, indicators, data management, data security, data analysis and information products, data dissemination and use and health information system resources (NDoH, 2011). One of the key aspects of strengthening HIS is through adequate resources to gain full potential (Almunawar & Anshari, 2012).

HIS is regarded as the foundation for the generation of good-quality data and it is one of the building blocks for health systems (English *et al.*, 2011). While progress has been made in the country, strategies to mitigate HIS risks and plans to augment its benefit in enhancing healthcare need to be strengthened.

2.6.3 Developments for strengthening HIS in SA

High-level committees such as the National Health Information Systems Committee of South Africa (NHISSA) which is a sub-committee of the Technical Advisory Committee chaired by the Director-general (DG) of the Department of Health need to be established. NHISSA is tasked to oversee the general data governance mandates in SA including harmonising the use of technology across the sector to improve data management and use. This is well documented in the DHMIS policy itself. The development of DHMIS policy and establishment of NHISSA are meant to create homogeneity in data management standards across SA and similar structures have been replicated across all nine provinces (NDoH, 2011).

The use of web-based DHIS for data collection at all health facilities, standardisation of several service registers and use of technology at certain service points and specific health programmes is also seen as a gain (NDoH, 2022). A unique patient identifier needs to be implemented to enable registration of all patients on a National Patient Registry which is currently running in all health establishments (NDoH, 2019). Data quality clean-up workshops should happen often to ensure consistency across all levels of healthcare.

The discussed literature emphasises the need for high-quality data for evidence-based decision-making. However, there are persistent data quality errors (Kerr, 2007) and they require intentional development of strategic data quality management to improve HIS adoption for informed decision-making – informed decisions are evidence-based.

2.7 Evidence-based decision-making (EBDM) in healthcare

The interest in using evidence-based decisions in public health policy-making is gaining momentum globally (Nutbeam & Boxall, 2008; Rychetnik *et al.*, 2012). Complexity and diversity in public health systems are some of the challenges faced by policymakers in the healthcare sector Rychetnik *et al.* (2012) to develop and implement policies and programmes that necessitate efficiency in the sector (Brownson *et al.*, 2009). Scientific evidence is regarded as effective for use in decision-making processes (Brownson *et al.*, 2009; WHO, 2008).

In developing countries like South Africa (SA), the lack of adequate resources in the healthcare sector is proving that use of EBDM is crucial for rational resource allocation, cost optimisation (Shafaghat *et al.* 2022:3; Majdzadeh *et al.*, 2012) and to prevent negative consequences of poor health outcomes to the communities (WHO 2008). According to Zhang *et al.* (2020), EBDM is a representative of objectivity in policy processes instead of dependence on the personal experiences of policy-makers or their interests. EBDM emanates from the medical domain where evidence is regarded as factual information explaining the validity of beliefs and propositions (Browson *et al.*, 2009; Zhang *et al.*, 2020).

Scholars like Bouchard *et al.* (2013) found that health systems worldwide that failed to properly exploit evidence use resulted in inefficiencies which led to reduced quality of healthcare services, death of citizens and decline in the provision of healthcare services. Oxman *et al.* (2009) support the notion that without attention to evidence, decision-making in the health sector may consequently lead to a lack of efficiency, effectiveness and fairness in health systems. Adopting the use of EBDM has proven to be advantageous, which includes the optimal use of scarce resources, support for cost-effective interventions (Armstrong *et al.*, 2013; Waters *et al.*, 2011), improving customer satisfaction and the quality of care, and achieving better health outcomes for society and the sector at large, including increasing the efficiency and effectiveness of public health programmes (Imani-Nasab *et al.*, 2017).

However, health systems policy-makers are faced with challenges in many developed and developing countries when it comes to EBDM (Shafaghat *et al.*, 2022:2), especially since many health systems in these countries are in rapid transition (El-Jardali *et al.*, 2012; Ettelt & Mays, 2011:48). Shafaghat *et al.* (2022:3) and Oxman *et al.* (2009) found that globally, fewer organisations support the use of research evidence in health-related decisions. This is due to limited access to relevant data and in some instances inadequate use of data due to their inaccuracy, lack of transparency and consistency in the implementation of EBDM in management rather than in medicine (Riley *et al.*, 2012).

According to Rousseau (2012:12), EBDM requires capacity for application, and many practitioners have insufficient capacity to apply in healthcare. There is a gap between theory and practice in EBDM and Zhang *et al.* (2020) describe it as “easier said than done”, calling for

empowering managers other than in the medical field on EBDM in the healthcare environment to save human lives. Jenicek's (1997) argument is that explicit and judicious use of best evidence in decision-making by all healthcare managers can protect the health of communities, prevent diseases and improve health outcomes. In their case study research in Pueblo City-County in Colorado, Hardy *et al.* (2015) found that training on EBDM would encourage utilisation by staff members.

Despite the tangible accomplishments in public health globally, more attention is required on evidence-based strategies. The concept and discourse of EBDM in both medicine and public health emerged a couple of decades ago and it is gaining momentum (Brownson *et al.*, 2013). In both public health and medicine, components of EBDM consider the best scientific evidence available, use of systematic data and information, application of planning frameworks for programmes, community engagement for making decisions, conducting sound evaluations and disseminating information on learnt lessons.

According to the WHO (2008), low to middle-income countries have limited resources to efficiently improve their public health outcomes and quality evidence can assist in mirroring the available resources. This is despite such countries having seen a gain in life expectancy (Brownson *et al.*, 2013). The researchers Brownson *et al.* (2013) add that this is attributed to a certain extent increase in addressing certain social determinants of health such as improved access to clean water, and wide scale of immunisation coverage of children to prevent vaccine-preventable diseases.

Increased use of EBDM has several benefits to the health of the communities, both direct and indirect (Rynes and Bartunek, 2017). Firstly, improved access to scientific quality data on what works and what does not. According to Brownson *et al.* (2013), this has a greater influence on health programme implementation and objectivity in policy decisions and is a more cost-effective way of using private and public resources. Secondly, synthesising processes that drive EBDM becomes more explicit and interdisciplinary in addressing public health challenges. This leads to the use of evaluation research to investigate the intended and unintended benefits of certain implemented health programmes, e.g., health promotion and

medicinal decisions which can lead to rigorous evidence that can be used further in healthcare.

Shafaghat *et al.* (2022:3) indicate that stakeholders have a significant interest in supporting evidence-based projects that can swiftly prioritise funding ring-fenced for health sectors to warrant the effective usage of their monetary resources (Riley *et al.*, 2012; Jacobs *et al.*, 2012). Shafaghat *et al.* (2022:3) identify public health specialists at both executive and managerial levels as key in driving EBDM in healthcare and mention that the majority have thus seen gains despite slow implementation. In addition, new technologies boost healthcare EBDM, from the management of resources to improving performance in hospitals (Benzidia *et al.*, 2021; Kumar *et al.*, 2021; Maglaveras *et al.*, 2016).

Bradt (2009) as quoted by Zhang *et al.* (2020) indicates the importance of EBDM in risk management regarding public health, highlighting that the first point of departure is in the use of evidence-based decisions established through data acquisition. This was evident during the COVID-19 pandemic where EBDM saved many lives in China through epidemiological findings that led to effective countermeasures despite failures to communicate honest risks and collaboration with multiple stakeholders worldwide to contain the outbreak (Zhang *et al.*, 2020). However, Zhang *et al.* (2020) warn of EBDM that can be manipulated to satisfy political gains, social stability and economic factors.

Decision support capability is emphasised more on BDA, the ability to produce reports on daily healthcare activities and services to assist managers in decisions and actions required. Generally, this capability encourages sharing of information and knowledge translation on issues such as descriptive analytics, drilling down to queries, statistical analyses, executive summaries and time series comparisons (Wang *et al.*, 2016:6). Such information can be utilised to provide a comprehensive view in support of the implementation of evidence-based decision-making in medicine, for diagnostic analytics purposes, the detection of advanced warnings on disease surveillance and prescriptive analytics for the development of personalised individual patient care (Senthilkumar *et al.*, 2018:63).

Evidence-based management healthcare systems can only be strengthened if they are meticulously monitored and evaluated by using relevant frameworks and tools that provide reliable indicators of change and progress in terms of all the system components (inputs, processes, outputs, outcomes and impact) (WHO 2007:20). In this regard, health information and M&E systems, as sub-systems of healthcare systems, need to be strengthened to identify best practices and potential shortcomings in each component of the healthcare system.

The government's Medium-term Strategic Framework 2019-2024 outlines the priorities of the government over the medium term and this requires population-based data to track progress. To achieve these envisaged national objectives, especially those tracking improvements in the health of a population, the adoption of evidence-based strategies is necessary (Browson *et al.*, 2013:6). The SA health sector has over the past five years aligned with priorities to eliminate avoidable and preventable deaths (*survive*); promoting wellness and preventing and managing illness (*thrive*); and transforming health systems, the patient experience of care, and mitigating social factors determining ill health (*thrive*) in line with the United Nation's three broad objectives of the Sustainable Development Goals (SDGs) for health.

2.8 Chapter summary

Enhancing data management processes to improve data quality in the healthcare sector is critical for facilitating evidence-based decision-making, improving healthcare delivery and ensuring optimal patient outcomes. This literature review has highlighted several approaches to enhancing data management processes, including the implementation of data governance frameworks, the adoption of interoperable health information systems and the use of healthcare data analytics.

The conceptual framework emphasises the need to harmonise data collection at the point of collection from different sources by means of automation. This will assist in improving the quality of data as it will minimise translation errors. Reliable data storage and ongoing running of data queries can improve both data quality and accessibility. This also requires safeguarding of health data as it contains crucial personal patient information and it requires quality assurance and compliance to regulated safety standards such as policies. The use of

BDA promises to seamlessly manage data from different sources, in different formats in an agile way and this can improve reliability of data used by different data consumers. Clouding computing has been proven to improve access to data anywhere and crucial patient decisions and other important decisions can be made using real-time data.

Findings from the literature indicate crucial benefits of EBDM. However, data quality problems negatively affect the intentions of EBDM in healthcare organisations. The next chapter will discuss barriers to data quality and suggest strategies to overcome poor data quality. DQ is important in healthcare as it supports decision-making in the sector that are crucial for saving patient lives. The next chapter reviews barriers to data quality and suggests strategies that can improve quality of data in healthcare.

Chapter 3: Barriers to data quality and redress strategies

The chapter discusses barriers to data quality concerning evidence-based decision-making. However, before delving into data quality barriers, it is important to understand that data quality issues arise from various causes, including human errors, system limitations, inconsistent formats and disparate data sources to name a few. The chapter will further focus on the strategies to improve data quality.

3.1 Introduction

Data is a critical element in healthcare that contributes significantly to informed decision-making. However, despite the increasing adoption of modern healthcare technologies, data quality remains a persistent challenge. Although modern technology is promising to improve data management and quality in the health sector, alone it is inadequate. DQ challenges can also harm EBDM in healthcare and affect the intentions of the organisation itself.

There is a common belief that data quality problems emanate from technology and this needs further investigation. In their research, Rodriguez *et al.* (2010) found that it was important to find the root causes of data quality problems before attempting the solutions. According to Heeks (2013), the DQ problems range from hard which are technical and soft, caused by humans. Technical problems can include the following, environmental hazards, electrical problems, equipment malfunction and software errors (Heeks, 2013; Rodriguez *et al.*, 2010). Factors propelling poor data quality can happen consciously or unconsciously due to a certain degree of human behaviours.

In this chapter, factors affecting data quality for evidence-based decision-making will be discussed. One of the objectives of the study is to identify barriers to good-quality data and their impact on evidence-based decision-making. The barriers will be structured according to both hard and soft and in line with the literature reviewed.

3.2 Hard problems

Hard problems with data quality are mainly technological (Heeks, 2013) and are easily introduced.

3.2.1 Health Information Infrastructure (HII)

Health information infrastructure (HII) is a necessity across healthcare domains to correct the shortcomings contributing to data quality. According to NCVHS (2000:24), HII is “the set of technologies, standards, applications, systems, values and laws that support all facets of individual health, healthcare and public health. The broad goal of the HII is to deliver information to individuals - consumers, patients, and professionals – when and where they need it, so they can use this information to make informed decisions about health and healthcare”.

Generally, health sector data challenges emanate from the lagging demand for digitalisation and technological transformation (Dunn *et al.*, 2021; Ronveaux *et al.*, 2003). To address these shortcomings, there is a need to strengthen HII to support the latter and decisions at all levels of healthcare (Detmer, 2003). According to Detmer (2003), standards play a crucial role as the backbone of technological progress. They are key enablers in the integration of data from different sources and creating value from raw data through analysis.

Currently, information infrastructure is unevenly developed, incomplete and not designed to synergise across all domains of healthcare, leading to compromised data security and persistent inconsistencies. Detmer (2003) argues that, so far, HII could be the only way by which the exponential growth of health data, information and knowledge can be managed.

Ageing data infrastructure is one of the key factors impeding progress in improving the quality of data. Mutale *et al.* (2013) have noted a shortage of equipment such as computers and increased computer theft in health facilities (FS DoH, 2023) as gripping factors affecting availability, consistency and quality of data produced.

Some of the challenges identified require a rigorous response from the government to invest more in HII (English *et al.*, 2011). Effective data management processes in the South African public health sector are still plagued by poor information infrastructure in most health facilities and the high cost of broadband connectivity or complete lack of connectivity, causing delays towards achieving data that is fit for use English *et al.*, 2011).

3.2.2 Technical challenges

Technical challenges do not mean computer technology only but include among others environmental hazards and natural disasters, electrical challenges, equipment malfunctions and software challenges (Heeks, 2007). According to Ledikwe *et al.* (2014), the lack of IT support for health workers frustrates them because of their low level of computer literacy. In this particular study, respondents cited some of the reasons for poor quality data as viruses, computer crashes, old computer software and loss of data due to a lack of regular backups (Ledikwe *et al.*, 2014).

Cyber security and privacy concerns are also barriers to the quality of data. Healthcare organisations must comply with various regulated standards and policies. However, these regulations can limit data sharing and collaboration, hindering the ability to access and use data to inform decision-making.

In a study by Kaduruwane (2012) which investigated systems failure in Sri Lanka, the researcher found that the systems failed due to a lack of poor technical infrastructure and the country did not have any plans documented for data in the studied region. Kerr (2004) argues that data governance strategies in some countries are system-focused, leaving behind other critical parts of HIS such as long-term transformation plans.

3.3 Soft problems

Soft problems are behavioural and normally difficult to implement solutions because they deal with human motivations and perceptions. They are people-oriented.

3.3.1 Human resources capacity and shortages

Human capacity and lack of the ability to analyse and use data for decision-making are typical challenges to data quality (Mavimbe *et al.*, 2005; Reddy, 2009). Poor understanding of the importance of data itself even before one can understand data quality poses a huge challenge. Garrib *et al.* (2008), Ledikwe *et al.* (2014), Reddy (2009) and Ronveaux *et al.* (2003) cited a lack of understanding of indicator definitions as another challenge in much of the literature reviewed around this subject. There is generally a lack of informatics as a career and critical skill (Garrib *et al.*, 2008; Kerr; 2004; Rotich *et al.*, 2003; Sauerborn, 2000). This leads to wrong manipulation of data and input errors (Rodriguez *et al.*, 2010).

In Botswana, a study by Ledikwe *et al.* (2014) found that staff shortages in performing HIS functions triggered negative staff attitudes towards data management. The findings of this study indicated that poor quality of data is affected by the attitudes of professional health workers reluctant to perform data management activities, citing their role as patient care not the latter. But Gribben *et al.* (2001) argue that professional healthcare workers have a role to care for patients, and data management distracts them from playing their main role, instead information officers should be accountable for data collection, quality and analysis.

Other behavioural barriers are cited in the literature of Asiimwe (2015), Nsubuga *et al.* (2002), Odhiambo-Otieno (2005) and Rotich *et al.* (2003) who argue that a lack of management support, especially in distressed situations where there is a shortage of resources such as human resources, equipment such as computers (Lippeveld *et al.*, 2000), internet connectivity and other resources that contribute to DQ, could be labelled as organisational barriers other than behavioural.

3.3.2 Poor data curation

Poor data curation is one of the most often cited reasons for the low quality of data. In a study conducted in New Zealand by Kerr (2004), the culture of information use was found to be important because it links organisational strategies (Ronveaux *et al.*, 2003) while maintaining healthy information ecosystems throughout the organisation and improving learning.

Promotion of data utilisation and information use in management is key to making rational decision-making. In SA, prospects of NHI implementation rely on information used to map service needs and resource allocation to achieve the much-envisioned universal health coverage. Bell *et al.* (2018) maintain that a limited culture of data use causes more problems because at the point of generation, data becomes neglected and when an ad hoc need to use data arises, data cleaning can be costly and the most time-consuming part of the data analysis process.

Data usage and providing feedback are interrelated. They encourage constant good data management practices. In their studies, AbouZahr and Boerma (2005) and Gibulskins (2002) argued that a lack of feedback from the higher to the lower levels contributed to poor quality of data because the “how” part remains unknown. The assumption is that everybody understands what they are doing and therefore there is no need for feedback.

3.3.3 Lack of standardisation

The lack of standardisation in healthcare data is another significant barrier to good-quality data. The absence of standard data models, codes and vocabularies contributes to data inconsistencies, making it difficult to compare and aggregate data across different healthcare settings. The literature reviewed from sub-Saharan Africa implies that reliance on paper-based data collection tools, which are predominant in this region, contributes immensely to poor DQ (Heeks, 2013; Garrib *et al.*, 2008; Makombe *et al.*, 2008; WHO, 2008). The studies are substantiated by the findings of Garrib *et al.* (2008) who referenced Auditor-general findings in South Africa which identified inconsistencies in data reported, from lack of integrity and incompleteness to low comparability. Lack of standardisation on the roles and responsibilities of health information personnel especially in health facilities leads to data personnel being tasked with non-data-related duties (English *et al.*, 2011:85).

Furthermore, in Malawi, Makombe *et al.* (2008) stated that “... this has led to under reporting which impacts on both planning and decision-making”. In South Africa, Garrib *et al.* (2008) add that the level of incompleteness in data reported decreased the level of precision and usability of health data. Mutale *et al.* (2013) believe that these kinds of problems are more

prevalent in low and middle-income countries due to a lack of resources or other factors that require deeper investigation.

3.3.4 Fragmented systems

Healthcare data fragmentation is a challenge (English *et al.*, 2011:85). Despite the increasing adoption of a big-data environment, data quality management in health services is still fragmented across the data production cycle (Khatri *et al.*, 2010:53). Healthcare data is often scattered across various platforms and systems, including paper-based patient registers, electronic health records, billing systems and other clinical systems.

The lack of integration across systems contributes to data fragmentation, making it more challenging to improve the quality of data and most importantly access accurate patient information as it is scattered in different systems (Gibulskins, 2002; AbouZahr & Boerma, 2005:579) with the use of many data collection tools and increasing duplication (Lippeveld *et al.*, 2000).

Reporting in parallel systems could mean more indicators reported, duplication and the integrity remains questionable. According to English *et al.* (2011:85), some challenges to strengthening HIS in SA include governance and leadership. This emanates from poor alignment of health system processes and inputs, outcome or impact indicators and the sector-envisioned outcomes. Secondly, the number of indicators collected is too many and often not well thought out by relevant managers compromising measurability for outcomes over time. Thirdly, there is generally low commitment from managers on issues of data management.

According to NDoH (2019), as of 2018, SA was reported to have about 42 health information systems. There are no existing platforms for data exchange between these systems (English *et al.*, 2011:85). This causes challenges to effective stewardship and integration of health systems. FS DOH (2023) cites that some of the challenges in data quality are fragmented health information systems and these cannot be easily regulated, managed and outputs justified. Hospitals are a bigger challenge due to their structural nature and level of activity.

In summary, significant to all data challenges are the sluggish adoption of BDA in healthcare, data privacy and security, and efficient data curation especially large volumes of data generated in healthcare which result in fragmented information systems. According to Bellazzi (2014:10), some challenges in DQ include failure to securely maintain the confidentiality of healthcare data and inability to comprehend unstructured clinical notes which result in the omission of highly useful information which can be detrimental not only to DQ but to the health of patients.

3.4 Data Quality (DQ)

Many scholars have different views on what DQ means. According to the literature, there is no single explanation that is acceptable to all. Kerr (2008:260) argues that data is regarded as contextual because the intended user defines high-quality data based on the context of use (Strong *et al.*, 1997; Pringle *et al.*, 2002). According to these researchers (Kerr, 2008; Pringle *et al.*, 2002 and Strong *et al.*, 1997) data quality is a measure of how well data meets the requirements of its intended use.

In the health arena, data quality is critical to maintaining optimal patient outcomes, efficient healthcare delivery and informed decision-making. Poor data quality can lead to inaccurate diagnoses, delayed interventions, may lead to loss of lives (Hausvik, 2017) and increased healthcare costs. DQ is a considerable high risk in healthcare worth consistent monitoring.

Data quality is a key concept in both the fields of information technology and data management. It refers to the accuracy, completeness, relevance, timeliness, and appropriateness of the data that organisations use for decision-making and analysis. Ensuring high data quality is essential for making informed decisions, improving operational effectiveness and maintaining a high level of customer trust.

DQ is assessed based on quality dimensions and these are standards qualified fit for measurability. The notion of DQ has led to the development of quality models and frameworks for guiding the assessment of data quality in different platforms.

3.4.1 SA Statistical Quality Assessment Framework (SASQAF)

SASQAF guides criteria for assessing and endorsing statistics produced by government and non-government institutions. It enables assessment of the quality of statistics and provides assessors on how to determine and achieve quality (Statistics South Africa, 2008). The SASQAF identifies eight data quality dimensions and these are also widely used in SA for data quality assurance across public sector and these are, timeliness, interpretability, coherence, accuracy, relevance, coherence, accessibility and integrity for measuring the quality of data produced. One of the intentions of SASQAF was to ensure that official statistics producers' data products are meaningful and suitable for monitoring and evaluation processes.

The government-wide monitoring and evaluation framework (GWM&E) institutionalises SASQAF and it is regarded as the key reference for the evaluation of performance data across all SA public services. DHMIS policy has also adopted the data quality dimensions in SASQAF largely due to the nature of routine data handled by the District Health Information System (DHIS).

Interestingly, in all data quality dimension frameworks and models, e.g., (Weiskopf and Weng, DQAF, 2013; Canadian Institute for Health Information model (CIHI), 2009; SASQAF, Stats SA, 2008; and the International Monetary Fund, DQAF, 2006) to name a few, quality dimensions overlap to give surety and warrant for data quality assessment. All these data quality frameworks cover quality dimensions from point of data collection to use and they can be applied differently but with the common goal of improving data quality. While the data quality definitions may differ contextually to fit the purpose, quality dimensions remain standard and resolute in the process of assessing data quality and ensuring the quality of the end product. Below, the CARTA framework will be discussed.

3.4.2 CARTA framework

The CARTA framework assumes that causes of low quality are, among others, incompleteness, data requiring regular updates and data that generally have lots of errors. As highlighted earlier in the chapter under barriers to data quality, it is evident that various factors such as

technical, human or soft have an impact to data quality. However, Heeks (2013) believes that most data problems are human-induced, and over 80 per cent can be traced to human beings. Below quality dimensions used for data collection for this research will be discussed focusing on completeness, accuracy, relevance, timeliness and appropriateness and these are also key measures for data quality used in CARTA framework.

Completeness: It is a fundamental dimension of data quality, indicating whether all required data elements are present in the dataset. In the literature, completeness is often described as the degree to which data contains all the expected parts or attributes. Wang and Strong (1996) suggested that complete data should contain all the necessary attributes, including mandatory and optional fields, without any missing values or entries. In their work, Pipino *et al.* (2002) also highlighted the importance of completeness by emphasising that missing data can lead to inaccurate analysis and decision-making.

Furthermore, several studies have discussed the challenges and techniques for assessing and improving completeness. Redman (1996:304) suggested that data profiling techniques, such as statistical analysis and pattern recognition, can be used to identify missing data and assess completeness. This includes making use of data validation rules and automated data collection processes which are commonly recommended to enhance completeness (Batini *et al.*, 2009).

Accuracy: This is another critical dimension of data quality, referring to the degree to which the data correctly represents the real-world objects or events being described. Literature has extensively studied the concept of accuracy in the context of data cleansing, integration and validation processes. Redman (1996:303) pointed out that inaccurate data can lead to costly errors and misunderstandings, making accuracy a crucial aspect of data quality.

To maintain acceptable data accuracy, Doms and Schroeder (2005) suggested the use of data profiling and data cleansing tools to identify and correct inaccurate data. Moreover, Wang and Strong (1996) emphasised the use of data quality metrics and statistical methods, such as mean absolute error and standard deviation, which are widely used to quantify and measure the accuracy of data.

Relevance: This is a data quality dimension that deals with the extent to which the data is applicable and useful for a specific purpose or task. The discourse around this data quality dimension mostly focuses on its contextual usability and its appropriateness for decision-making. According to Batini *et al.* (2009), relevant data should be aligned with the information needs of the users and the objectives of the organisation.

The literature reviewed indicated that to improve the relevance of data, governance frameworks and user involvement in the data quality assessment processes should be considered (Batini *et al.*, 2009). Wang and Strong (1996) stressed the importance of collaborative efforts between data stewards and internal organisation users to ensure that the data remains relevant and valuable. Furthermore, Doms and Schroeder (2005) advocate for the utilisation of metadata management and data profiling techniques because they are commonly recommended to maintain data relevance in organisations.

Timeliness: This is a critical dimension of data quality that indicates the degree to which the data is available within an acceptable timeframe for use in decision-making and analysis. Timeliness has been identified as a key factor in leveraging data for real-time or near-real-time applications. According to Redman (1996:307), outdated or late data can result in missed opportunities and incorrect insights.

Researchers such as Doms and Schroeder (2005) have explored various approaches to address timeliness challenges in data management and quality. Real-time data integration and processing technologies, such as data streaming processes and event-driven architectures, have been proposed to ensure the timeliness of data (Doms and Schroeder, 2005). Moreover, the development and decisive implementation of data governance frameworks are endorsed for the establishment of clear expectations for data delivery timelines (Batini *et al.*, 2009).

Appropriateness: This assesses whether the data requested is suitable and applicable for its intended purpose. Appropriateness is often discussed in the context of legal and ethical compliance, as well as the alignment of data with specific organisational requirements. According to Pipino *et al.* (2002), inappropriate data can result in compliance violations and reputational damage to organisations.

According to Redman (1996:304), to address issues of appropriateness researchers proposed the implementation of data quality standards and data governance policies. Redman (1996) encouraged the development of data quality frameworks that address legal and ethical considerations to ensure that data remains appropriate for its intended use. Moreover, data lineage and documentation practices are also commonly recommended to maintain the appropriateness of data (Wang and Strong, 1996).

Furthermore, the CARTA framework presents the need to understand the actual causes of low data quality so that targeted quality improvement plans can be developed to address the root causes. In so doing, organisations are able to analyse risks and develop mitigating strategies in order to produce reliable quality data that can be used across the organisation for decision-making. CARTA framework also assists organisations to prioritise data quality initiatives to enhance the trustworthiness and usability of data produced. To measure the fitness of the data produced at Pelonomi Tertiary Hospital, CARTA framework stands for; **Completeness, Accuracy, Reliability, Timeliness and Appropriateness**. Strategies for improving data quality will be discussed below.

3.5 Strategies for improving data quality

According to Redman (1996:303) as quoted in Kerr (2008:260), between one to five per cent of data found in many organisations is of poor quality. Improving DQ in healthcare requires concerted management efforts. From the previous literature, it is evident that poor data quality impacts negatively on management decisions which are meant to improve quality of care and save lives.

In the previous sections, literature has proven that effective data management practices improve the quality of data in healthcare. This means addressing data management through viable solutions requires comprehensive and well-thought-out strategies. Health information systems (HIS) promise to eradicate the disjointed information across healthcare and modernise the sector through the integration of services (Epizitone *et al.*, 2022; Sahay *et al.*, 2018). This involves deploying different strategies. One of the objectives of this study is to

recommend strategies that can enhance the effectiveness of current data management processes for improved data quality. This will be discussed below.

3.5.1 Use of modern technologies

One of the critical aspects in improving data quality is the adoption of BDA, leveraging its potential in the sector. Its ability to solve many critical data management and quality shortcomings cannot be overstated.

3.5.1.1 Healthcare data analytics

As highlighted in the first chapter, healthcare data analytics involves the use of sophisticated data analytics techniques such as machine learning and data mining to extract meaningful insights from healthcare data. By analysing large volumes of healthcare data, healthcare organisations can identify patterns and trends that would otherwise be difficult to recognise and use the insights to inform evidence-based decision-making. A study by Ahmadian *et al.* (2018:33) found that the use of healthcare data analytics significantly improved data quality in a large academic hospital by identifying and correcting errors in data entry (Benneyan *et al.*, 2014) enhancing completeness and accuracy and providing timely insights for evidence-based decision-making (Aceto *et al.*, 2020).

DBA has revolutionised e-health and its entire ecosystem due to its ability to shift from mere datasets which could not be handled by general computers to technologies that economically handle large volumes of a wide variety of data (Aceto *et al.*, 2020) enabling high-velocity capture, analysis or discovery (Gantz & Reinsel, 2011). BDA is characterised by the “5 Vs” which are its ability to handle volume (a large amount of data), velocity (analysis and collection subjectivity to time bounds), variety (ability to handle unstructured, semi-structured and structured data), veracity (understanding varying degrees of trustworthiness, following provenance, management, and processing), and value (economical architecture and extraction value) (Aceto *et al.*, 2020; Gantz & Reinsel, 2011; Hu *et al.*, 2014).

3.5.1.2 Interoperable health information systems

Another approach to improving data quality is through the adoption of interoperable health information systems. Interoperability refers to the ability of different health information systems to communicate and exchange data seamlessly. The use of interoperable systems eliminates the need for manual data entry, reduces translational errors, and improves data completeness and accuracy of data. Heeks (2013) states that 83 per cent of these errors are human-made. Gawande and Bates (2010) suggested that the adoption of interoperable health information systems can also significantly contribute to the continuity of patient care.

The use of autonomous technology uses AI capabilities to rigorously monitor databases and run queries in real-time. These will solve the issues of fragmented data sources and improve both data management and quality.

In the SA health sector, several policy papers and frameworks have been developed in a need to harness data interoperability and reduce fragmentation in health systems. One such is the White Paper for the Transformation of the Health System in South Africa in 1997. It presents a set of policy objectives and principles upon which the unified National Health System of South Africa will be based. Its premise on high-quality data is to inform disease prevention and surveillance and promote opportunities for research in the public health sector.

The Health Normative Standards Framework (HNSF) is an enabler of the South African interoperability efforts and supersedes the 2014 HNSF version (NDoH, 2022). The HNSF is the cornerstone in enabling the efficient and secure flow of healthcare-related people-centred information across all health institutions and provincial boundaries. The framework views interoperability as the capacity to disparate and diversify institutions and organisations, open doors for interaction towards a common goal and mutually benefit all citizens. It aims to extend and include the sharing of information and harness knowledge between organisations through the business processes that they support. This will be done through a seamless exchange of data between their ICT systems respective and securely. The ultimate aim is to facilitate interoperability of system-wide information across South African healthcare environments for easy treatment of patients. According to NDoH (2022), HNSF promises to

be a key enabler for the efficiency and secure flow of health-related people-centred information across South Africa.

The framework aligns well with some of the objectives of this research, even though it is centred across a small scale (one health facility). This operationalises the use of modern technology for efficiency, secure and seamless flow of patient information across systems, encourages flexibility, portability and reusability and reduced time for patient treatment (Akter and Haque, 2022:27). It also encourages collaboration at a national level consensus to prompt high-level standards for management and use of data. Below are the guiding principles for the 2021 HNSF implementation towards a fully interoperable South African healthcare environment.

Table 2: Interoperability Development Principles

Principle Name	Principle Statement
Incremental Approach	Take the incremental approach towards the development of a fully interoperable South African digital healthcare environment.
Manage initiative through governed evolution	The NDoH is to assess all interoperability initiatives extensively for alignment with the HNSF.
National coordination and collaboration	Establish and maintain a national digital health interoperability community to improve the adoption and development of a fully interoperable South African digital healthcare environment. Adopt a governance approach that includes the digital health community in decision-making and management implementation.
Security, confidentiality and patient privacy	Protect information security, confidentiality and patient privacy at all times.
Open source	Consider the available open-source solutions for cost-effectiveness and use internationally accepted standards that promise interoperability for data, workflows and technology.

Principle Name	Principle Statement
Intellectual property	Ensure that the intellectual property ownership of public sector e-health initiatives is vested in the government.
Data availability	Ensure that data is available to digital health information systems (within the bounds of confidentiality).
Policy and governance adherence	Follow established national policies, as well as specific governance policies defined by the South African Government.
Data quality and integrity	Follow the accepted data standards and create measures to uphold the integrity and reliability of data processed or stored.
Patient centricity	Patient journeys are at the core of health system interoperability and should be represented in all aspects of the digital health information system.

Source: National Department of Health (2022:9)

This shares the vision of the research for reducing paper-based records and harnessing the use of modern technology in augmenting service standards in the health sector through enhanced data management processes for improved data quality which will then give confidence to users for evidence-based decision-making.

According to the NDoH (2022), the NHI Bill requires reliable and quality data to enable informed decision-making on population health needs assessment, purchasing, financing, patient registration, service contracting and reimbursement, utilisation patterns, performance management, setting the parameters for the procurement of health goods, and fraud and risk management.

3.5.2 Strengthening HIS

According to Epizitone *et al.* (2022), HIS is an enabler of health sector information products and provides much-needed knowledge management and evidence-based decision-making. The definition of “HIS” relates to reflecting proper data management practices. These support health system unification across countries to support timely access to data, maintain data

integrity and data security and encourage data curation. High data quality assimilation and dissemination influence positive healthcare service delivery. The concept of HIS translates data into information for knowledge exchange amongst all stakeholders Epizitone *et al.* (2022) and these are beneficial for strengthening data curation and influential to positive clinical patient outcomes (Garcia *et al.*, 2022).

Despite HIS challenges worldwide that affect its optimisation, health information systems integration remains crucial. Access to quality data can assist in disease surveillance during pandemics (Epizitone *et al.*, 2022). This was evident when the world was plagued by COVID-19. The use of real-time quality data was crucial, and the lack of HIS strengthening in developing countries left many devastated. Strengthening HIS coupled with the use of modern technologies allows countries to share health data seamlessly to save lives.

One of the greatest COVID-19 lessons was that our neighbours' health is our concern too because the pandemic spread like wildfire and with a lack of transparency and limited data-sharing platforms in the beginning, it left many devastated. Many developing countries still don't have accurate mortality data and remain vulnerable. HIS encourages transparency in data use because of the data quality confidence it can achieve if all systems are in place.

3.5.3 Data governance

Several studies have suggested various approaches to enhance data management processes in the healthcare sector for improved data quality. One such approach is the development and implementation of a data governance framework. Data governance involves the establishment of policies, standards and procedures for managing data effectively, ensuring data quality and promoting data-driven decision-making.

Implementation of the organisation-wide data governance provides a clear direction in terms of the processes, policies and resource requirements for data management activities and flow. Wang (2001) and Olson (2003) add that the data governance framework should clarify the bigger data intent of the organisation and provide a holistic approach to improving the quality of data needs.

Well-designed data governance models encourage positive data quality environment and should delineate clear strategy which underpins broader organisational intent. It delivers guidelines for the exploitation of potential value for data in the quest to realise organisational objectives, within the premise that good management of data produces well-versed decisions (Ogundaini & Achieng, 2022), optimises healthcare systems and minimises risks associated with data ethics breaches, especially patient information which the sector predominantly is dealing with. Data ethics need to connect organically with other broader policies, tools and mechanisms to synergise the intentions of the entire organisation on conception and application.

According to OECD (2020:11), ethics in data are holistic and require integrity in the management of data. This calls for trustworthy data management processes across the data life cycle which is not limited to the point of its generation up to the usage stage to maintain quality standards and strengthen public trust. Data governance should encapsulate all the characteristics and more to maintain stability and confidence for data management and quality within an organisation.

Jones *et al.* (2022) maintain that to execute good data governance framework, leadership and management buy-in and support are crucial. Before delving into the data governance frameworks, it is necessary to understand the data quality challenges within an organisation. Data quality issues can arise from various sources such as system limitations and involvement of all stakeholders is important to ensure a common goal in data quality expectations.

The development of sound policies and procedures for data quality should be based on legislation and acceptable standards. Wang *et al.* (1998) add that staff should also have access to copies of relevant legislation, standards and guidelines for data quality. Benneyan *et al.* (2014) add to assist with issues of compliance, a process of monitoring adherence to policies and procedures should be in place.

Maintaining effective use of local innovation for standardisation and practical local support becomes easy to implement (Kerr, 2007). Locally standardised procedures for data collection, development of datasets and flow are bound to receive acceptance because they create

ownership. According to Ledikwe *et al.* (2014), data and indicator definitions improve the quality of data as health personnel can identify errors if they understand the meaning of indicators. This means that data elements and indicator definitions should form an annexure in the plan to ensure that everybody understands what is being collected and how it is collected.

Data governance should accommodate the training needs of personnel including documentation of IT support processes. Effective IT support is also crucial for healthcare workers due to their varying abilities to navigate computers and other IT equipment (Ledikwe *et al.*, 2014). The institutionalisation of data is also beneficial to the organisation because it contributes immensely to capacity building and enhances knowledge-sharing efforts (Ndjave-Ndjoy *et al.*, 2016). However, Davenport (1997) draws attention to the fact that if the staff that carry most of the burden of collecting and reporting data cannot analyse and identify data inconsistencies, institutionalising data will not be beneficial to the organisation (Ledikwe *et al.*, 2014).

In addition to capacitating personnel, regularly conducting data quality audits not only assists in the acknowledgement of good practices but it assists in identifying reliable sources of data (Kerr, 2007). The involvement of senior staff in conducting audits will encourage feedback and lead to the development of quality improvement plans which need to be monitored regularly to address progress. Conducting a data quality audit involves the assessment of data quality dimensions (Ogundaini & Achieng, 2022).

Data governance can encourage the correct use of data in organisations because of regular reviews (Batini *et al.*, 2015). OECD (2020) highlights that ethical use of data, especially in the public sector, calls for entrenching ex-ante and ex-post in the management of risky approaches to mitigate dangers and trade-offs. It also facilitates evidence in the improvement of the quality of services provided (Kerr, 2007). The organisation should create a culture of data use with the appropriate information governance safeguards in place.

This is not an ICT or HIS strategy even though there is an element of inter-connectedness that may assist in improving DQ but it simply means data governance and other sector governance

frameworks can intersect at their own strategic point to strengthen compliance. Lee *et al.* (2004) describe the holistic approach to data governance as a simple application of the theory of total data quality management which incorporates the DQ dimensions and invites consideration of internal organisational change and innovation.

In summary, effective data governance plays a critical role in addressing data quality challenges across different organisations including healthcare by providing a structured approach to data management. Establishing clear policies, standards and processes for capacitating staff, availing appropriate infrastructural technology, risk assessment and mitigation, ongoing audits and monitoring compliance issues within the sector can improve data quality and enhance decision-making (Jones *et al.*, 2022). Implementation of best practices and leveraging technology can help the health sector maximise the effectiveness of its data governance efforts, ultimately realising the benefits of high-quality, reliable data products.

3.5.4 Understanding limitations

Understanding limitations means sourcing local solutions to some data quality challenges. Kerr (2007) mentions that the implementation of local innovations through locally designed data quality strategies can improve the quality of data. Institutionalised activities to DQ solutions can add value and be easier to implement due to familiarity. According to Gordon (2007), management must be able to identify and manage complexities innovatively. English (1999) and Wang (2001) add that to avoid complex situations, management should choose desirable data quality features when the systems are being upgraded or changed to relate to the changes.

3.6 Organisational factors

Organisational factors are linked directly to the organisation and can be performed from within. These include development of internal organisational norms for data life-cycle.

Developing a data warehouse will address multiple data reporting systems, eradicate duplication and redundancy of data reported and eliminates multiple reporting systems that

run parallel; this means a high level of duplication. Heeks (2013) cites that the problem of parallel running systems is worldwide. Total data quality management advocates for data quality models that can solve most data quality problems for management quality purposes. According to Reddy (2009), an integrated data warehouse will improve collaborative efforts with relevant stakeholders in the reduction of unnecessary expenses of duplicated efforts and resources in the already resource-constrained health sector.

According to Curtis and Cobham (2002), Kerr (2004) and Nyamtema (2010) data warehouse should provide effective integration of data management systems for increased awareness and build capacity. It needs participation from the national to local levels to come up with unified health information systems that provide timely, reliable, good-quality evidence-based information for policy development, programme implementation, monitoring and evaluation and decision-making for local, national and international health stakeholders. Well-maintained data warehouse will not only solve data quality problems but it will also resolve human resource challenges. It is also an enabler to achieving implementation of e-health for interoperability of health data.

3.7 Identifying risks

Identify possible risks and have a plan to mitigate them so that complexities within the organisation do not stand in the way of improving quality data such as having a backup in case of computer theft and crashes. English (1999) and Wang (2001) believe that data models and systems should be profiled to identify problems of data quality. However, the researchers substantiate that the quality of data should not be blamed on technological problems alone, but people should understand that information technology is just an enabler; the common causes and errors of low-quality data are often process errors run by human beings.

To minimise some of the human errors, English (1999), Gibulskins (2002), Ledikwe *et al.* (2014) and Bell *et al.* (2018) agree that data collection and entry should be based on clear protocols and ongoing training and monitoring. It should also be integrated into everyday work routines. Human errors form part of the high-risk threats to data quality in the absence of newer technologies. Heeks (2013) advises running regular back-ups and investing in good

anti-viruses to avoid loss of data. In chapter 2, the conceptual framework encourages continuous data security as cyber security is a necessity as the world adopts use of modern technology. Security risks in technology are high and internal controls need to be monitored on regular basis and assessment on who access information systems needs to be monitored regularly and high security compliance imposed through policies and other quality assurance norms and standards to ensure safety of data.

3.8 Strengthening Monitoring and Evaluation Systems

Monitoring and evaluation has shifted its intent of upward reporting to using information for programme improvement in the public health sector and holding authorities accountable. M&E is part of the management process and an important management function of each healthcare provider and manager at each level of the healthcare system. Monitoring, evaluation and reporting form the basis for effective healthcare system management and service delivery.

The Presidency (2007:4) defines a “monitoring and evaluation system” as “... a set of organisational structures, management processes, standards, strategies, plans, indicators, information systems, reporting lines and accountability relationships, which enables national and provincial departments, municipalities and other institutions to discharge their M&E functions effectively”.

The importance of creating, implementing and strengthening a unified and coherent monitoring and evaluation system at national and all other levels of the healthcare system cannot be overemphasised (The Global Fund, 2006:8). An organisation’s failure to align information and M&E systems with their strategies and objectives can result in wasted resources and poor performance. In the wake of citizens demanding accountability, it is crucial to institutionalise M&E to improve data quality for reliable performance reporting. This can also assist in identifying inefficiencies, gaps in service delivery and highlight areas that require additional resources for improving service delivery.

One of the key aspects of the monitoring and evaluation system is the establishment of clear data management standards. This includes the collection, analysis and reporting of performance information across various government departments and agencies. A well-defined data management framework ensures that accurate and reliable data are collected, consolidated and disseminated to relevant stakeholders for use. This not only enhances the government's capacity to make informed decisions but also fosters a culture of accountability and transparency. The establishment of the Department of Planning, Monitoring and Evaluation (DPME) reflects the government's commitment to promoting a culture of performance management and accountability. The DPME plays a central role in coordinating the monitoring and evaluation efforts across government departments and agencies, while also providing guidance on data management and performance information standards.

The institutionalisation of M&E is linked to “broad public-sector reforms geared towards results-based management, performance-based budgeting and evidence-based policy making” (Plaatjie & Porter, 2006). Often, institutionalisation is used in the “pursuit of good governance and meaningful programme implementation, as well as contributes to building institutional capacity, increasing skills, development of processes, structures and systems” (May *et al.*, 2006). In essence, the institutionalisation of M&E facilitates the creation of a support system that produces monitoring information and evaluation of findings which are judged by valuable key stakeholders.

According to Mackay (2006), the institutionalisation of M&E in the public sector needs key drivers and should be driven by substantive demands from certain key departments within the government. Sivagnanasothy (2007) acknowledges the fact that when M&E is institutionalised, “it becomes an integral part of the development programme, it leads to improved planning, policy making and achievement of objectives”. The term “institutionalisation” is the “...creation of an M&E system, which produces monitoring information and evaluation findings, which are judged by valuable key stakeholders, which are used in the pursuit of good governance, and where there is sufficient demand for the M&E function to ensure its funding and its sustainability for the foreseeable future” (Mackay, 2006).

Institutionalising M&E does not only decentralise and expand services but it helps in building capacity for assessing data quality at lower levels and it also builds confidence in the data being used for programme performance assessment and decision-making. It is very important to build M&E capacity at all levels of healthcare.

Both the GWM&E and Framework for Managing Performance Information (FMPI) outline the need to build monitoring and evaluation capacity to be able to handle performance information and ensure a high level of performance across all levels of government. To ensure effective and participative M&E, information management skills, including skills for data collection, statistical analysis and data quality assurance are important. Organisations have to recruit appropriately, train existing staff and facilitate skills transfers from academics and consultants (Presidency, 2007:16).

The GWM&E provides a comprehensive framework for data management, including protocols for data collection, storage, analysis, and reporting. It promotes data quality and reliability by setting standards for data collection methods, ensuring that data is accurate, timely and relevant.

The Framework for Managing Performance Information (FMPI) emphasises the responsibility of accounting officers in managing performance information which is stated as “... accountable for establishing and maintaining the systems to manage performance information. Their performance agreements should reflect these responsibilities” (National Treasury, 2007:13). This is also encapsulated in the DHMIS policy and together with GWM&E give effect to the Constitution and keep track of programme performance, implementation and over time require evaluation to review value for money at different stages for accountability, knowledge and decision-making purposes.

The success of institutionalisation is mostly dependent on the availability of good-quality M&E data. Such data must be accessible and utilised accordingly throughout the entire organisation to derive value and capacity building and achieve a sustainable systematic culture of usage (Mackay, 2007:23).

In conclusion, the role of a government-wide monitoring and evaluation system is paramount for managing performance information, data management and accountability standards in South Africa. By establishing clear data management standards, building institutional monitoring and evaluation capacity, promoting accountability and fostering a culture of evidence-based decision-making, such system can significantly enhance the government's efforts to deliver effective and efficient public services. As South Africa continues to strive for good governance and sustainable development, the continued strengthening of its monitoring and evaluation system will be essential in driving performance improvement and achieving better outcomes for all citizens.

3.9 Behavioural factors

Behavioural factors are people-oriented and can be changed to improve data quality and minimise inconsistencies. This can be done through capacity building of personnel handling data.

Aqil *et al.* (2009) believe that if the confidence level of HIS personnel is high, their behaviour will change too. PRISM framework demonstrates how training will change behaviour and build confidence and skills, which can later improve knowledge and minimise data inconsistencies. AbouZahr and Boerma (2014) emphasise that if there is ongoing capacity building at all levels, it will be easy to analyse and synthesise data from multiple sources that exist in the sector.

This will enhance knowledge capabilities, build data quality check skills, analysis, and presentation and propel data use. If the subject knowledge improves, there will be regular data clean-ups, and ongoing performance monitoring using data of good quality. Wang (2001) and Olson (2003) concur that data quality assessments should be done regularly and require subjectivity of metrics of data quality. The researchers add that if there is capacity, assessment of data quality should not be done on an ad hoc basis for a “quick fix” but should be done routinely.

3.10 Chapter summary

These approaches offer significant potential for improving data quality in healthcare and should be considered by healthcare organisations seeking to improve the quality and reliability of their data for informed decision-making. However, technology alone cannot solve data quality challenges – equipping people with the necessary skills and availing relevant resources are also of great importance. There are different data quality barriers identified in the chapter. These can be conquered through strengthening internal organisation controls and ensuring that adequate interventions are implemented to improve quality of data generated in health care. The DHMIS policy identifies resource requirements for data management to improve quality of data.

Strategies identified for improving data management efficiencies and quality require management support and buy-in from other data consumers or stakeholders. Different data quality frameworks can be adopted to assess data quality in an organisation. However, in South Africa, SASQAF from Stats SA is mostly used to assess data quality in public sector. In chapter 2, conceptual framework demonstrates that the use of modern technologies can assist in solving many data management and quality challenges.

Investing in modern technologies in a cost-effective manner can address some barriers to data quality challenges. Use of BDA such as algorithms will assist to analyse and identify patterns and anomalies to maintain accuracy, consistency and more importantly achieve standardisation. However, internal controls are necessary to instil compliance on data handling policies and ethics to ensure security, privacy and integrity.

Chapter 4 discusses the relevant legislation regarding data management, use, storage, security and most importantly, protection of personal information as the sector deals with confidential patient information.

Chapter 4: Legislative framework for health data management practices

This chapter discusses the relevant legislative mandates in line with data management, use, storage, security and most importantly, protection of personal information. This highlights the importance of compliance with relevant legislation in the handling of data or information products. While the chapter references framework for health data management practices, most of legislation cuts across and some can affect the sector directly or indirectly. Health data is very sensitive as it contains personal information that needs to be protected at all times.

4.1 Introduction

The previous chapter has extensively discussed the conceptual framework relating to the data management processes in hospitals relating to the South African context and detailed the importance of data quality in healthcare settings for evidence-based decision-making. The chapter further looked at the risks of using data of poor quality for decision-making and mitigating strategies that can be implemented to improve the quality of data used in evidence-based management decision-making to improve the quality of health services and outcomes.

This chapter will reference some of the guiding legislatures that compel management in public healthcare to follow to improve the quality of health services. In line with the DHIS policy, reference will be made to some guiding legislative mandates to improve health systems' inter-connectedness for data management and data use for shaping the public health sector in South Africa.

4.2 Legislative Framework

Below are some of the key legislated acts, frameworks, policies and standards that are binding, either directly or indirectly to improve the quality of data used not only in the health

sector but as part of improving government service delivery mandates. The national legislative and policy mandates relevant to the study are listed below.

4.2.1 *The Constitution of the Republic of South Africa*

The Constitution of the Republic of South Africa, Act no. 108 of 1996, places obligations on the state to progressively realise socio-economic rights, including access to (*affordable and quality*) healthcare. The section further states that public services must promote the economic, efficient and effective use of resources, and prompt and accurate information, including accessibility of services. Schedule 4 of the Constitution reflects health services as a concurrent national and provincial legislative competence. Section 9 of the Constitution states that everyone has the right to equality, including access to healthcare services. This means that individuals should not be unfairly excluded in the provision of healthcare.

- People also have the right to access information if it is required for the exercise or protection of a right.

This may arise concerning accessing one's medical records from a health facility to complain or to give consent for medical treatment.

4.2.2 *The National Health Act (Act 61 of 2003)*

Section 74(1) of the Act stipulates that the national Department of Health shall facilitate and coordinate the establishment, implementation and maintenance of the information systems by provincial departments, district health councils, municipalities and the private health sector at national, provincial and local levels to create a comprehensive national health information system.

This serves to harness the flow of information across the health sector and other stakeholders for comprehensive use of information. Section 74(2) of the Act stipulates that the Minister may, to create, maintain or adapt databases within the national health information system contemplated in subsection (1), prescribe categories or kinds of data for submission and collection and the manner and format in which and by whom the data must be compiled or collated and must be submitted to the national department.

In terms of the section, future developments of the National Health Management Information System should include the incorporation and integration of health information from the private sector, to depict a holistic picture of the performance of the entire health system, as it does not exist currently. The promulgation of Chapter 9 of the National Health Act of 2003 will provide the legal framework for this process. The development of DHIS software had this in prospect.

Currently, some private health facilities, including some private hospitals and a few general practitioners and pharmacies with nursing services, have been accommodated in the DHIS using the standard NDoH naming convention for health establishments.

4.2.3 The Public Finance Management Act (Act 1 of 1999)

The Public Finance Management Act (Act 1 of 1999) as issued by the National Treasury stipulates the accountability of the Accounting Officer in reporting the correct data for quarterly reporting that represents the activities that took place, hence the regulations are relevant to producing data quality within the sector. The Accounting Officer is further responsible for effective monitoring, evaluation and corrective actions, whereby data can be used to monitor programme performance in the health sector.

Section 40 (1) (d) of the PFMA 1999 of this Act is also relevant because it talks about financial accountability in the public sector through the submission of activities that are in line with the financial statements. Such activities in this department can be justified through data recorded and collected and through performance information.

Some of the key frameworks in operationalisation of PFMA across all government sectors include the introduction of GM&E and the FPMI. The two documents emphasise the need for managing performance information and accountability in the government. In South Africa, the role of a government-wide monitoring and evaluation system and framework is crucial for managing performance information, data management and accountability standards. Such a system serves as a foundation for ensuring transparency, accountability and efficiency in the delivery of public services. The establishment of a comprehensive monitoring and

evaluation system enables the government to track the performance of various programmes and policies, assess their impact to make data-driven decisions to improve public service delivery.

The GWM&E was introduced in 2007 as part of the broader efforts to improve governance and accountability in South Africa. This system aims to enhance the effectiveness and efficiency of government programs and policies by monitoring and evaluating their impact. The GWM&ES establishes a standardized approach to collect, manage, analyse and report data on across government initiatives. It ensures that key performance indicators are defined and data is gathered consistently across all government departments. This unified system enables the government to track progress, identify areas of improvement and make informed decisions based on evidence (National Treasury, 2007).

Furthermore, the monitoring and evaluation system plays a pivotal role in promoting accountability standards within government. By setting clear performance targets and regularly assessing progress towards these targets, this holds government officials accountable for the effective implementation of policies and programmes meant to improve services to the citizens. This also reinforces public trust and confidence in the government's ability to deliver essential services and meet the needs of its citizens.

The FMPI was also introduced in 2007 as a supportive initiative to the GWM&ES. It aims to improve the management of performance information within government departments, encouraging a culture of accountability and evidence-based decision-making. The FMPI provides guidelines for government departments to manage their performance information systematically. It outlines all the processes from setting performance targets, collecting data and reporting on these targets. The framework emphasises the importance of aligning departmental objectives with national priorities, ensuring that performance indicators are relevant, realistic and measurable. By implementing the FMPI, government departments are required to establish robust data management systems, including the development of data collection tools, databases and reporting mechanisms. This ensures that performance data is collected consistently, stored

securely and regularly analysed to evaluate the effectiveness of government programmes (The Presidency, 2007).

Both the government-wide monitoring and evaluation system and the framework for managing performance information play a vital role in data management and accountability standards in South Africa. These initiatives provide a unified approach to data collection, storage, analysis and reporting, enabling the government to make evidence-based decisions and improve the effectiveness of its programmes and policies.

4.2.4 *The Public Audit Act of 2004*

Section 20(1) (c) of the Act requires reporting of the relevant performance information against the predetermined objects. This means for the department to get a clean audit, data management systems need to be in place to produce reliable data for the government departments and other entities to remain accountable for the use of state resources for obtaining a clean audit outcome. The auditor general South Africa uses FMPI as a guide for conducting audits across all government departments and agencies. This compels all to ensure compliance in implementation of FMPI and monitoring thereof.

4.2.5 *The Statistics Act (Act 6 of 1999)*

The Statistics Act (Act 6 of 1999) details the role of the Statistician-general in formulating the criteria and establishing standards, classifications and procedures for statistics in South Africa.

The Act states that:

- The Statistician-general shall promote coordination among producers of official statistics to advance quality.
- Consistency, comparability and optimum use of produced statistics.

This compels the Department of Health to inherently work together with Statistics South Africa and other relevant stakeholders to develop acceptable norms and standards to produce quality data for use and sharing to improve decision-making for the benefit of all citizens.

4.2.6 Promotion of Access to Information Act (Act 2 of 2000)

This Act (Act 2 of 2000) gives the constitutional right to access data and information held by the State that is required for the exercise or protection of any rights and it provides a framework for requesting such data and information. The Act aims to promote a culture of transparency and accountability in both the public and private sectors. The Act strengthens the need for access to information and responsible use of personal or any other state information. It also allows for access to information by citizens for them to fully exercise their rights.

4.2.7 The Protection of Personal Information (POPI) Act (Act 4 of 2013)

The POPI Act (Act 4 of 2013) sets out the minimum standards regarding accessing and “processing” any personal information belonging to another. The Act defines “processing” as collecting, receiving, recording, organising, retrieving, or the use, distribution or sharing of any such information. This Act mandates the protection of personal information and responsible use of any person who has access to personal information to request permission from the owner before sharing such information. Section 32 of the Act strengthens the need for personal data security by both public and private institutions, processing of patient health records/information by relevant clinicians requires the patient’s concern.

The Act is meant to aims to regulate the processing of personal information across organisations and it aligns well with international privacy standards. However, there has been notable grey areas when it comes implementation. There is lack of enforcement to implement and comply with the Act across the country and implementation has been slow despite the years of enactment. Compliance must be enforced across all sectors to ensure safety and security of personal information. Secondly, ambiguities and special exemptions of the Act are not clear-cut, leading to inconsistencies in interpretation. Additionally, certain sectors such as journalists are granted exemptions from certain obligations. These exemptions may be prone to misuse and need clearer guidelines.

4.2.8 *The National Archives and Record Service of South Africa Act (Act 43 of 1996)*

The National Archives and Record Service of South Africa Act (Act 43 of 1996) seeks to guide a National Archives and Record Service. The Act guides the proper management and care of the records of governmental bodies (*which includes patients' records*) and the preservation and use of national archival heritage; and to provide for matters connected therewith. In the health sector, proper management of patient records has proven important in patient treatment and management of diseases thereof.

4.2.9 *The Public Service Act (Act 103 of 1999)*

The following sections of the Public Service Act (Act 103 of 1999) sections 3(1)(g) and 3(2) mandate the Department of Public Service and Administration to establish e-government services to improve government-wide service delivery. The Act seeks to improve and integrate government services through the use of technology.

4.2.10 *The State Information Technology Act (Act 38 of 2002)*

The amended State Information Technology Act (Act 38 of 2002) outlines the operations of the State Information Technology Agency (SITA) which operates under the Department of Public Service and Administration (DPSA) in the provision of mandatory e-government and electronic area network (WAN) services and maintenance to all government departments including all citizens. This is not limited to harmonising government businesses and improving communication with one another through technology and management of other important transversal information services in government and other government entities. Through this Act, SITA is tasked to coordinate and manage all ICT needs and infrastructure government-wide and conclude all ICT-related business agreements on its behalf. According to RSA (2000a), while the government is gearing up for universal Health Coverage, SITA should play a critical role in the implementation of an e-health service strategy.

4.3 Legislation and Policies through the lens of Data and Information Management

Data and information management are crucial aspects of effective healthcare delivery in public health care in country as it caters for the uninsured majority. This bears in mind the strengths and weaknesses of legislation and policies governing data and information management in the public health sector. However, as mentioned earlier, the content might be most direct to the health sector but most of the legislation here cuts across. From the previous chapters, it is eminent that SA has notably acknowledged the innovation in technology and importance of protecting personal data, promotion of transparency and security in information management.

In addition to POPIA, South Africa also has the Promotion of Access to Information Act (PAIA) (RSA Act 2 of 2000). It promotes transparency and access to information held by public and private bodies. PAIA gives individuals the right to access information held by public and private bodies, however, this is subject to certain limitations and is crucial in promoting accountability and openness in information management.

Furthermore, the Electronic Communications and Transactions Act (ECTA) (RSA Act 25 of 2002) is another important piece of legislation in South Africa that addresses data and information management in the context of electronic communications. ECTA aims to facilitate electronic transactions and communications while ensuring the security and integrity of data transmitted electronically. The Act covers a wide range of issues related to electronic communications, such as electronic signatures, data messages, and the liability of network service providers, all of which have significant implications for data and information management in the digital age. However, in the wake of growing utilisation and demand for modern technology, cyber security is crucial in this regard.

One critical aspect is the need for effective implementation and enforcement of legislation governing use of technology. While South Africa has made significant strides in establishing comprehensive legislation for data and information management, the effectiveness of policies and pieces of legislation are sorely dependent on their enforcement and the capacity of regulatory authorities to monitor and enforce compliance.

Another consideration is the impact of these legislative frameworks on organisations and businesses operating in South Africa. Compliance with data protection laws requires significant investment and resources pertaining implementation of robust data security measures in order to maintain ongoing compliance legislation. This can be particularly challenging for small and medium-sized businesses, which may face difficulties in meeting the regulatory requirements while continuing to operate effectively.

Additionally, the evolving nature of technology and data management presents an ongoing challenge for legislative frameworks. The rapid pace of technological innovation requires legislative frameworks to be agile and adaptable to new developments in data management Kohler *et al.* (2018), such as the rise of artificial intelligence, big data analytics, and the Internet of Things. As such, there is a need for continuous review and updating of legislation to ensure that it remains relevant and effective in addressing emerging challenges in data and information management.

Despite these challenges, South Africa's legislative frameworks for data and information management also present opportunities for promoting a culture of accountability, transparency and data protection. By establishing clear standards for data management and protection, these obligations can contribute to building trust and confidence among consumers and stakeholders, ultimately benefiting all citizens equally.

Moreover, the legislative frameworks can also serve as a catalyst for innovation and best practices in data management. By setting clear expectations and requirements for data protection and management, these pieces of legislation and policies can encourage organisations to adopt best practices in data security, governance, privacy and ultimately contributing to a more robust and resilient data ecosystem in the entire country.

As mentioned earlier, quality and accuracy in data management are crucial aspects of effective healthcare delivery, particularly in the context of public health care in South Africa. According to Cohen *et al.* (2020) The National Health Act (RSA Act 61 of 2003) provides the legal framework for healthcare provision in South Africa. It addresses some aspects of data management, however, it lacks comprehensive provisions specifically focused on data and information governance in public healthcare. This exclusion might lead to inadequate data

protection measures. The absence of explicit guidance on data protection and security standards poses risks to patient privacy and confidentiality.

The lack of clear regulations around collecting, storing and sharing of personal health information raises the potential for unauthorised access and breaches of sensitive health data (Cohen *et al.* 2020). Mars and Scott (2019) adds that the National health Act also has limited emphasis on interoperability, arguing that it does not prioritise interoperability standards for seamless data exchange and integration across the country. This oversight can hamper on efficient collaboration, coordination and the ability to capitalise on health data for research and analysis purposes (Mars and Scott, 2019).

The prospects of NHI requires overhaul of health system in the country in order to operate effectively and provide health equity to all south Africans. As mentioned earlier in chapter 2, the NDoH mentioned that, in order to implement NHI successfully, there is a need for a reliable electronic register that can track patients as they move from one health care provider to another across the country. Introduction of Electronic Health Records Policy of 2011 was one move to achieve one patient identifier. This was followed by the development of other policy documents such as National Digital Health Strategy for SA (2019) and The Health Normative Standards Framework (2022) which put emphasis on interoperability.

South Africa's Electronic Health Records policy was formulated in 2011, with the aim of facilitating the digital transformation of health records in public healthcare facilities (NDoH, 2011a). However, there are few limitations to the policy itself that impede its effectiveness. Firstly, there has been inadequate rollout of the policy in public health facilities across the country which affects accessibility and usage (Suleman *et al.* 2016). In addition, researchers (Katurura and Cilliers, 2018) found that insufficient funding and inadequate technical capacity contributed to the inconsistent adoption of the policy. As a result, this has negatively affected the potential benefits of electronic health records for improved patient care and data analysis.

According to Suleman *et al.* (2016) there has also been insufficient focus on data security and privacy because the policy itself lacks comprehensive guidelines for safeguarding personal

patient health data within the digital space. These concerns regarding data security and protection against breaches require the establishment of clear convincing consent mechanisms for data sharing to build trust between the health sector and communities it serves. Katurura and Cilliers (2018) also identified lack of health ICT infrastructure including internet connectivity and unstable power (electricity) supply in the country to have negatively impacted implementation of policies like this one and others that require digital skills and health ICT infrastructure (Akanbi *et al.* 2012 & Juma *et al.* 2012).

However, the government has also acknowledged inadequate skills in digital and data analytics which can have potential to affect the country's efforts in advancing implementation of e-government (NDoH, 2019). This limitation leads to sluggish implementation and adoption of innovative digital government policies, delaying progress on e-health specifically. Katurura and Cilliers (2018) also found that lack of adequate funding which is exacerbated by costly implementation of policies that support e-government in the country, poor management of donor funding especially in public health sector and political buy-in regress envisioned policy gains in the long run.

Although Protection of Personal Information Act (POPIA) is applicable to all sectors, Kohler *et al.* (2018) argues that it has more implications for personal health information held in the health sector and therefore, recommend specific sector guidance to address unique challenges of the public healthcare sector. This will address intricacies related to special exemptions to access confidential patient information, collection and use of such sensitive patient data.

4.4 Chapter summary

The chapter has discussed some of the overarching legislation relevant to the topic under investigation. The quest for the South African health sector to implement modern technologies requires standards to safeguard the use of personal information. The sector deals with crucial people information and there is a need to regulate how that information is used and accessed. Legislative framework discussions above, directly and indirectly highlight the need for accountability in managing state information, patient or personal.

The legislation and policies surrounding data and information management in South Africa's public healthcare system exhibit notable strengths and weaknesses. As technology continues to evolve, it will be crucial for South Africa to continue to review and update its legislative frameworks to ensure they remain effective and relevant in addressing emerging challenges in data and information management. To address these shortcomings, it is vital to enact dedicated legislation that explicitly addresses data protection and security and these must be sector specific.

Lastly, enhancing interoperability standards, providing comprehensive sector-specific guidance for data management and strengthening compliance mechanisms in legislation and policy documents remains essential across all sectors. Allocation of sufficient resources, funds and prioritising technical capacity building are fundamental for effective adoption, utilisation and maintenance of e-government, especially e-health. By addressing these issues, the country can establish a solid foundation for data and information management in public healthcare, promoting quality patient care, data-driven decision-making and overall responsive, efficient and sustainable health system. The next chapter discusses the unit of analysis.

Chapter 5: Pelonomi Tertiary Hospital

The previous chapter discussed the legislation and policy mandates surrounding the topic under investigation. In this chapter, Pelonomi Tertiary Hospital will be discussed looking at its role as a tertiary hospital, its mandate and how it manages data it produces. The main focus will be to respond to the research question of how data is being collected and managed within the hospital until the aggregation level. The unit of analysis forms an integral part of the Free State Department of Health system. This chapter will provide the provincial profile where after all discussions will be around PTH.

5.1 Free State Province Profile

According to Statistics South Africa (2023), Free State Province is home to about 2.9 million people and it accounts for 4.8 per cent of the country's population and a population density of about 201/km². It is divided into four municipalities and a metro namely, Mangaung Metro, Thabo Mofutsanyana, Lejweleputswa, Fezile Dabi and Xhariep Districts. Most of the population resides in the Mangaung Metro and Thabo Mofutsanyana District. Xhariep District is the most sparsely populated of the five districts and the smallest in population share.

According to South Africa Regional eXplorer v2375 (2023), average population growth in the Free State is estimated to be 0.7 per cent per annum which is about half of the population growth of the country at 1.47 per cent. FS is a landlocked province. Mangaung Metro Municipality (MMM) observed a higher population growth at 1.22 per cent more than the provincial average growth.

Table 3: Population growth by District in FS 2012, 2017 and 2022

	2012	2017	2022	Average Annual growth
Mangaung	801 000	857 000	904 000	1.22 per cent
Xhariep	124 000	123 000	124 000	0.04 per cent
Lejweleputswa	632 000	637 000	649 000	0.27 per cent
Thabo Mofutsanyana	741 000	746 000	764 000	0.32 per cent
Fezile Dabi	500 000	525 000	549 000	0.93 per cent
Free State	2 797 634	2 888 975	2 990 924	0.67 per cent

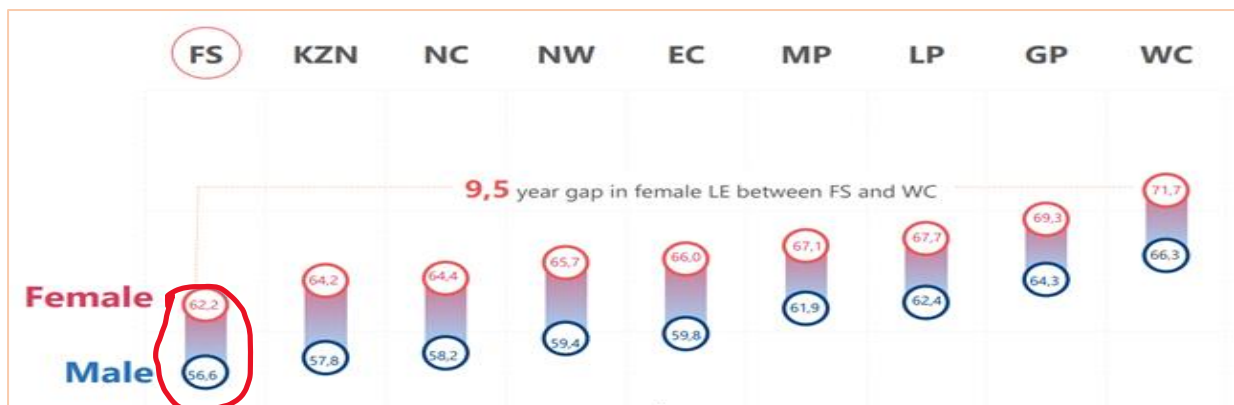
Source: South Africa Regional eXplorer v2375 (2023:20)

The key economic driver in the FS remains the agricultural sector characterised by both large and small commercial and subsistence farming. There is a mining sector but it has recently contributed very little to the provincial gross domestic product due to the closure of mining operations. Generally, there is high unemployment in FS and more people are living below the poverty line.

Statistics South Africa (2021) explained that medical aid insurance coverage has declined nationally from 17.2 per cent in 2019 to 15.2 per cent in 2020. Free State Province remains below the national average at 12.2 per cent coverage in 2021. This means the provincial uninsured population is estimated at around 87.8 per cent. In the absence of the recent statistics, there is a possibility that the figure could be lower than 12.2 per cent. This is due to the current sluggish economy and the negative aftermath of the COVID-19 pandemic. Lower medical aid coverage could also imply a greater dependency on public health services and lead to an over-stressed health system.

FS is also the province with the lowest life expectancy at birth in the country. Life expectancy at birth reflects the overall mortality level of a population (Statistics South Africa, 2022).

Figure 7: Life Expectancy SA and Provinces 2021-2026



Source: Statistics South Africa Mid-year Population Estimates 2022:25

Health and health outcomes are not only affected by healthcare or access to health services. They result from multi-dimensional and complex factors linked to the social determinants of health, which include a range of social, political, economic, environmental, and cultural

factors that impact health outcomes, including human rights and gender equality. These are the major underlying factors contributing to health inequities and the related outcomes.

Health is influenced by the environment in which people live and work as well as societal risk conditions such as polluted environments, inadequate housing, inadequate access to clean drinking water, poor sanitation, unemployment, poverty, racial and gender discrimination, destruction and violence. Addressing these social determinants of health is key to achieving health equity. Social conditions such as unemployment, poverty, cultural beliefs and practices, as well as lifestyles affect health-seeking behaviour and fuel the burden of disease (BOD).

5.1.1 Mangaung Metro Profile

Pelonomi Tertiary Hospital is situated in Mangaung Metropolitan Municipality (MMM). MMM is nestled in the heart of FS Province and is considered the economic hub of the province and it is the judicial capital of SA. It is one of the eight metros in SA. According to the Local Government Handbook (2020), MMM shares boundaries with three districts and one country, on the north is Lejweleputswa District, to the south is Thabo Mofutsanyana District, towards the northeast, is Xhariep District and in the southeast, it shares the border with the country of Lesotho, popularly known as the Mountain Kingdom.

It covers a square area of 9 886 km². There are three urban centres, namely Bloemfontein, Botshabelo and Thaba-Nchu, and it is surrounded by small sparsely scattered rural towns that are mainly characterised by extensive commercial farming. MMM carries most of the population in FS and 63 per cent of the population of MMM resides in Bloemfontein which is the capital city.

5.1.2 Gender and age profile of Mangaung

According to the South Africa Regional eXplorer v2375 (2023), the largest share of the population is within the young working age 25-44 years population, 31.8 per cent of the total population. This is followed by young children 0-14 years with the share of 25.6 per cent and

then the older age of 45-64 years at 18.1 per cent. The old age group of 95 years and older is the smallest share of the population with 7.4 per cent of the population in MMM.

5.2 The Free State Department of Health

The vision of the FS DoH is “Healthy and long life for the Free State community” and the mission is “Provision of accessible, efficient and quality healthcare services to the Free State community” (FS DoH, 2023). The health services are accessible in all four districts including the MMM in the province through district health services as the point of entry into the health system. The FS DoH is currently offering health services through the following service delivery platform:

Table 4: Service Delivery Platform FS DoH

Org Unit Type	Fezile Dabi District Municipality	Lejweleputswa District Municipality	Mangaung Metropolitan Municipality	Thabo Mofutsanyana District Municipality	Xhariep District Municipality	Grand Total
Clinic	35	42	46	71	16	210
Community health centre	5	1	2	1	1	10
District Hospital	4	5	3	9	4	25
EMS stations	9	16	6	23	15	69
Mobile services	14	14	10	15	6	59
National Central Hospital	-	-	1	-	-	1
Provincial Tertiary Hospital	-	-	1	-	-	1
Regional Hospital	1	1	-	2	-	4
Specialised Hospital	-	-	1	-	-	1
Grand Total	68	79	70	121	42	380

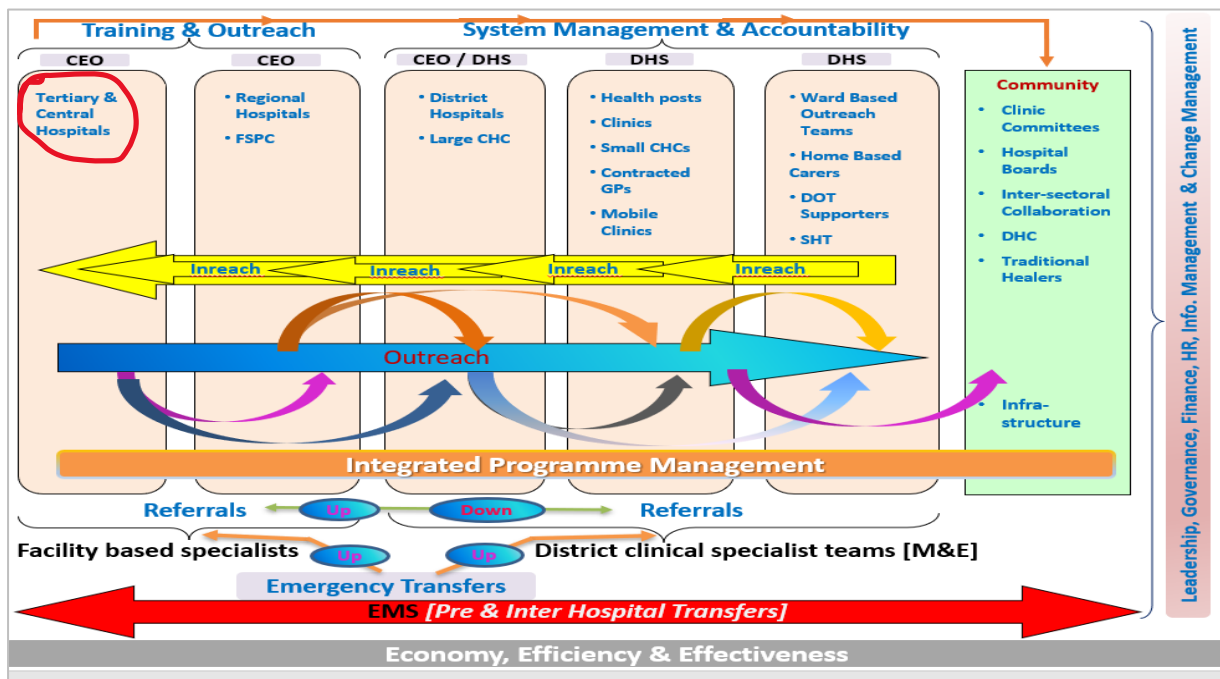
Source: FS DoH 2023:28

To reconfigure the health services to meet the service demands, the draft service transformation platform of FS DoH envisions improved quality of care through universal access and coverage, in line with NHI principles, to reduce the burden of diseases and promote personal health ownership, improve and maintain acceptable health infrastructure, continuous availability of essential equipment at all levels of care, maintain functionality of the referral system, including referrals to and outside the department and building capable human resources for health. Service transformation plan also has prospects to guide the

solidification of the equitable distribution of resources with a deliberate bias towards strengthening health promotion and preventative strategies.

The right to healthcare is enshrined in South Africa’s Constitution. This necessitates equal access to quality health by communities at all levels of care. The model below shows the envisioned plan of the FS DoH in optimising resource utilisation efficiently and effectively for the achievement of functional health services by all citizens to reduce BOD and improve the quality of life. This implies that data quality remains the guiding principle to achieve the desired outcomes and resource planning.

Figure 8: The Health System Governance and Accountability Model



Source: FS DoH 2017:45

The guiding principles of the above HSGA model harness system effectiveness by implementing health-related constitutional mandates to ensure that all citizens in the FS have access to services. It also aims to ensure that available resources mirror the health service packages. Proper implementation of the referral policy will result in seamless access to care for all patients and maintain the cost-effectiveness and sustainability of patient treatment.

The involvement of community governance structures is also key as a linkage between the community and the department for effective communication and improving the quality of services including patient satisfaction rate in health facilities.

The clinical in-reach and out-reach health services are aimed at complementing resources in different levels of care including capacity building for a competent workforce as well as improving service coverage. This will improve both downward and upward referrals operating smoothly with a burdening system and this will also see responsive emergency medical services (EMS) with improved coverage. Integrated strategic health programmes such as maternal and child health, HIV and AIDS and TB. cut across all levels of care but are managed at the provincial level and duplicated at the district level.

5.2.1 FS Departmental ICT and Health Information Management

Of great importance is the ICT and Health Information Management. According to the FS DoH ICT's strategy (2022), a detailed information flow between all parties concerned in the management of healthcare is critical to effectively reduce costs, manage financial risk as well as manage operational costs. The objective of primary healthcare includes enhancing the patient's health and quality of life and reducing the need for hospitalisation with a fiscal outcome of lowering healthcare spending.

Technology supports this by facilitating information flow, centralising all activities and giving relevant parties access to appropriate information from where decisions are electively made, thus ensuring that quality-based patient outcomes become a reality. The DHMIS policy highlights the need to produce comprehensive and integrated district health management information system which provides comprehensive, reliable, timeous and good quality evidence for tracking and improving health service delivery through the use of technology.

The main data collection system is web-based DHIS 2 which is approved nationally and other systems collect data, which creates parallel systems.

There are standardised health facility data collection tools that contain both national indicator datasets and provincial indicator datasets. These feed into the web-based DHIS 2. Data is captured at each health facility on a paper-based tool or from any other source of data

depending on the level of care and is then captured into the web-based DHIS 2. There are data clerks and information officers who are responsible for all management processes. Data clerks are mainly responsible for the collation and capturing of data, this includes validation of data against the data sources to maintain data quality while information officers have the responsibility to oversee the entire data management life cycle including performing M&E functions and an M&E official who performs monitoring and evaluation for the entire hospital for performance information, including issues of quality. PTH uses the same model and also has other parallel reporting systems such as Meditech, HPRS and Ideal Health Facility system to name a few.

The data is generated in PHC facilities and hospitals per ward or cost centre in bigger hospitals. The cost centre managers in hospitals and operational managers both in hospitals and PHC facilities are at the point of generation and are expected to record correctly to ensure that inputs into the web-based DHIS 2 as a system used for data collection can be trusted. DHMIS policy outlines the roles and responsibilities of all role players in data management to ensure accountability at each level (NDoH, 2011).

5.2.2 Pelonomi Tertiary Hospital Services

Pelonomi Tertiary Hospital is situated in the heart of MMM in the city of Bloemfontein and it is located in the heart of the township just a few kilometres from the city centre. Pelonomi Hospital renders tertiary and specialised services. The hospital is a tertiary hospital but is funded as a regional hospital. It also serves as part of the training platform for both undergraduate and postgraduate health programmes and has been accredited for internship training by the HPC SA.

The hospital is commissioned for 758 beds (NdoH, 2011) but only 588 beds are usable. Other beds are affected by the ongoing infrastructure projects while the remaining 133 beds are occupied by Netcare Hospital due to the ongoing Public Private Partnership (PPP) (FS DoH, 2023). PPPs are defined as working arrangements based on mutual commitments and responsibilities between the public sector and any organisation outside the sector (Bovaird, 2004; Goss, 2001; Mitchell, 2003). These partnerships go over and above what is implied

contractually (Bovaird, 2004) and are typically long-term in nature (Mitchell, 2003).

Despite challenges identified in PPPs, according to Grandos *et al.* (2017), Kwak and Chin (2009) and Salamon (1995), partnerships work only when both partners benefit from the relationship, and the expected benefits are made clear in advance (Mitchell, 2003). One of the common reasons for PPPs is financial benefits and these financial mechanisms can be direct or indirect for private organisations, however, in public hospitals innovative and re-constructing ways of doing things could help in cost-containment and improve services in hospitals. Researchers (Gottwald *et al.*, 2016; Karawajczyk *et al.*, 2017; Kwak and Chin (2009); Reijneveld, 2012; Sadeghi *et al.*, 2016) explain that PPPs have been used in many countries (both under-developed and developed) to reform the healthcare sector constructively.

They further demonstrate that other than financial gains, PPPs in the public health sector facilitate innovations and open platforms for research in several areas of medicine and patient care. This includes research related to vaccines and the unearthing of vaccines for the treatment of communicable diseases, such as in the case of the COVID-19 pandemic, development of specific personalised medications and infrastructure growth.

PTH is a referral health facility in MMM and all over the province. This includes referrals from four regional hospitals and district hospitals from districts within the province which do not have level 2 hospitals like Xhariep District. It also serves as a referral hospital for neighbouring provinces like the Eastern Cape and Northern Cape including the Kingdom of Lesotho.

PTH offers specialised clinical services such as obstetrics and gynaecology, paediatrics, neonatology, renal dialysis, general surgery, maxillo-facial, urology, orthopaedics, spinal surgery, intensive care, internal medicine, ear-nose-and-throat, neuro-surgery, burns surgery, isolation trauma and emergency to name a few. There are also clinical support services such as clinical engineering, radiology and radiography, pharmacy, laboratory (phlebotomy). Support services are classified under administration and finance and supply chain management services, HR, ICT and HIM.

The MMM 2023/24 District Health Plan (FS DoH, 2023) outlines the previous performance on some standardised national hospital efficiency indicators. It implies a rather bleak picture, showing a heightened strain on healthcare services. According to FS DOH (2023), the inpatient

bed utilisation rate (IBUR) for some cost centres was above the 75 per cent national benchmark between the 2019 and 2023 financial years and the average length of stay (ALOS) was above six days against the national benchmark of six days for this type of hospital. According to Mangaung Metro District Health Plan (2021), some cost centres such as maternity, orthopaedics sometimes overflow with patients - IBUR around 90 per cent with ALOS of 9.6 days and neonatal high care 110 per cent IBUR and ALOS of 13 days. In 2022/23 alone PTH had a 102,051 headcount at the outpatient department (OPD) and around 20,000 accident and emergency (casualty) and trauma unit headcount – emergency (FS DoH, 2023).

Over the past five financial years, PTH has treated a significant number of patients including the ones that bypass the referral system and walk directly to the hospital without any form of referral – 55 290, which is about 9.4 per cent. This shows that human capacity should be prioritised to ensure that the workload of caring for patients remains manageable to improve the quality of care. According to the WHO (2021), there should be a balance of safety and quality in the nurse-patient ratio and organisations need to evaluate staffing plans. Literature from Ahmat *et al.* (2022) indicates that the professional nurse-patient ratio should be determined by headcount and discipline, especially in areas of speciality such as the intensive care unit (ICU) neonatal unit – a ratio of 1:1 or 1:2 is recommended (Denosa, 2012).

Table 5: Patients treated at Pelonomi Tertiary Hospital

Provincial Tertiary Hospital - Pelonomi						
Data element/indicator	Apr 2018 to Mar 2019	Apr 2019 to Mar 2020	Apr 2020 to Mar 2021	Apr 2021 to Mar 2022	Apr 2022 to Mar 2023	Total
Inpatient separations	29 443	31 007	24 940	26 587	26 263	138 240
OPD headcount - sum	160 616	162 913	73 244	92 439	102 051	591 263
OPD headcount not referred new	24 450	24 678	1 205	2 214	2 743	55 290
Delivery in facility - sum	4 577	5 035	4 584	5 075	5 124	24 395

Source: FS DoH DHIS 2023, np

The hospital is also using web-based DHIS for data management, however, there are other parallel information systems such as Meditech, Ideal Health Facility System and HPRS. Meditech is used mainly for patient admissions and billing, the ideal health facility system is mainly for quality data such as capturing complaints from patients, and HPRS is for the management of hospital headcounts. Due to the size of the hospital and the type of services rendered, it uses a cost centre model and each is responsible for their activities. Cost centre

managers have a responsibility of safeguarding clinical quality and generating data, ensuring that it is of good quality.

As clinicians, they are also responsible for patient care. Proper recording is crucial in this regard. The DHMIS policy has clearly outlined the prescribed roles at each level, the use of standardised data collection tools, analysis of data following the prescribed data quality dimensions by SASQAF (NDoH, 2011).

The Public Finance Management Act of 1999 (as amended) instructs the accounting officer of an institution to establish mechanisms for quarterly reporting to the executive authority to enable effective performance monitoring, evaluation and remedial actions. This means institutionalisation of data dissemination and use at the health facility level is important for performance monitoring of the health system.

5.2.3 Data products at Pelonomi Tertiary Hospital

The hospital produces various reports on performance information from DHIS on a monthly and quarterly basis. Satisfaction survey results based on patients' experience of care are reported once per financial year during September month through a DHIS PEC model. The survey aims to improve the quality of care and experience of patients in health institutions. Quality improvement plans are developed, implemented and monitored upon access to the survey results to improve areas of poor performance.

There is also a Basic Accounting System (BAS) mainly for revenue collection and it is reported every month. Others include the Persal system, which is mainly for staffing and salaries and Meditech for clinical data, also reported monthly. All these systems run parallel across the hospital. As mentioned earlier, HPRS, Logis and Ideal health facilities are also available for reporting patients' complaints and adverse events relating to patients. Reports are compiled monthly on most of the data collected through the use of this system.

The hospital has adopted the DHMIS policy and a specific data flow policy that outlines what needs to happen regarding data flow processes, and standard operating procedures have also

been developed to guide the processes of data management and outline responsibilities at each level. Data is consolidated on the registers by nursing staff and then the data clerks/captors consolidate it into summary forms and capture it on the web-based DHIS. The information officer of the hospital is responsible for ensuring data quality assurance. The operational managers in the cost centres have to ensure that data generated from the registers is complete and represents activities of each section well; they are responsible for ensuring that inputs into the DHIS are correct. It is also the responsibility of the cost centre managers to ensure overall data quality and the management of the hospital is tasked with reviewing and signing off hospital data.

5.3 Chapter summary

Pelonomi Hospital is a tertiary hospital within the Free State Department of Health providing specialised services. It is also offering a training platform for health professionals. Data quality is crucial for evidence-based medicine and for improving the general quality of care for the populations in and around Free State Province, as mentioned earlier. The chapter has also shed light on the number of systems used to collect data in the hospital and only a few basic ones have been mentioned. The number of patients bypassing the referral system also calls for the strengthening of referral policy across Mangaung Metro to maintain the efficiency and sustainability of the health system. Treating patients at this level of care can be costly. The next chapter looks at data gathering and analysis of the findings.

Chapter 6: Data Collection and Analysis

This chapter details the research design and methodology deployed in data collection including how data was analysed for results. The previous data provided information on Pelonomi Tertiary Hospital as the unit of analysis. The data management processes were also highlighted as role players and their responsibilities. As mentioned earlier, the research answers whether the current data management practices at PTH contributed to improved data quality which could be used for evidence-based decision-making. Four research objectives were also developed to respond categorically to the research question.

6.1 Introduction

In case study research, the researcher is a key instrument. The case studies respond mainly to “how” and “why” questions (Rowley, 2002:16). In Chapter 1, information on research design and methodology, the unit of analysis, data collection and analysis, and sampling design, have already been highlighted.

The data collection methodology used to collect data was best suited for this type of study to achieve the intended objectives of the study. A descriptive qualitative case study was deployed. This chapter discusses data collection and analysis.

6.2 Research design and methodology

Research design symbolises both the intended process and product towards the achievement of a valid argument that has factual premises. According to Yang and Miller (2008:76), a good research design delivers a reliable direction to formulate processes for building a constructive argument. Yang and Miller (2008:77) add that research design determines for what purposes and by whom the results of the research will be valuable. A descriptive case study was selected because of the type of study concept decided upon. According to Yin (1994:9), a case study is rendered useful in investigating how and why questions that respond to contemporary events which the researcher has limited to no control of. It can also be viewed as an action plan from questions to conclusions (Rowley, 2002:18).

6.3 The unit of analysis

The detailed information regarding the unit of analysis has already been detailed in the previous chapter. Rowley (2002:24) mentions that a unit of analysis serves as a basis for a case study. The unit of analysis may be a person or an event (such as a decision, a programme, an implementation process or organisational change (Yin, 1994) or an organisation or team or department within the organisation (Rowley, 2002:19) or an element igniting interest in the researcher. In this case, the unit of analysis is Pelonomi Tertiary Hospital. The hospital offers tertiary services and highly specialised medical services in the Free State Province, situated in Mangaung Metro Municipality (MMM).

6.4 Data collection

A typical case study research makes use of a variety of evidence from different sources, such as artefacts, documents, observations (semi-structured or unstructured) and interviews and according to Flyvbjerg (2011: 309), this can go beyond evidence from a range of sources that might be accessible in historical studies. Creswell (2002:166) adds that data collection processes set boundaries for the study and further explains that protocol for recording information must also be established.

Data was collected using semi-structured interview guides and self-administered questionnaires. Creswell (2013) states that data collection through interviews is a common method in case studies. Some information regarding the unit of analysis has been obtained from the FS DoH reports and other non-empirical materials that were useful for the study. The semi-structured interviews were conducted with management and cost centre operational managers whereas self-administered questionnaires were allocated to information personnel of PTH.

The recording was used to collect data for interviews with management and operational managers in cost centres. The recordings from the interviews were transcribed to Word for easier content analysis.

6.5 Data analysis

The data analysis process involves sense-making out of image data and data Creswell (2002:171) and this means moving deeper to try and understand the meaning of data and interpretation to find larger meaning. In qualitative data analysis, analysis is conducted through conceptualisation (Creswell, 2013; Saunders *et al.*, 2000). The data collected has been analysed using thematic coding. Coding is the process of organising text segments to bring about meaning.

Data analysis is a crucial process, it assists in selection of relevant research content. This process is dependent on what the study aims to achieve and the researcher's level of experience on the subject under investigation. In an analysis of data to maintain a level of privacy and confidentiality, pseudonyms were used for all respondents in different groups. Thematic coding identifies themes or patterns in the data collected, concentrating specifically on data of interest and importance. These were linked to the themes of the study to address research objectives and respond to the research question.

6.5.1 Thematic coding

Thematic coding is a method used in qualitative research to identify and analyse patterns or themes within the data. According to Braun and Clarke (2006), thematic coding provides an accessible and flexible theoretical approach when analysing qualitative data. The researcher familiarised herself with the data collected and translated it to Microsoft Word for easier analysis. Application of general codes was done and this was followed by the identification of important concepts and phrases. These codes represented key ideas and content.

The researcher started to organise and sort the initial codes into potential themes. Themes were then reviewed and refined per the identified themes, relevant to the research question and objectives of the study. The themes were then labelled or named to represent the content in a meaningful way. The final stage was to write up an analysis and document the findings following the thematic coding process. The documentation throughout the process

was done to allow for transparency, traceability and credibility of analysis and this allowed for more content discovery.

6.5.2 Sampling design

Purposeful sampling was chosen to serve the purpose of the study. This allowed the researcher to select informants according to their familiarity with the subject, the position they hold in the institution and their experience. Case studies aim to examine one or several smaller cases in depth (Huberman & Miles, 1994:27, Yin, 2003:41) primarily targeting “analytic” rather than “statistical” validity. This will increase the transparency of the findings Yin (2003:32) and provide an organised collection of the evidence base.

As mentioned earlier, participants in the study were four (4) members of the executive management of the hospital, eight (8) different cost centre operational managers/professional nurses and ten (10) members of staff handling data (information personnel) such as data clerks/information officers and/or M&E officers. This shed light on their perspectives on data management and the quality of data produced by the hospital. All in all, there were 22 respondents which was the total sample size and the response rate was 100 per cent. The DHMIS policy further states that it is the responsibility of the hospital management and other managers within the health institution to ensure that the data produced is of good quality (NDoH, 2011).

Executive managers were selected because they are the key drivers in decision-making and there was a need to hear their perspective on the data management processes and quality of data at the hospital. DHMIS policy mandates heads of health institutions to sign off data from their institutions to the next level of care (NDoH, 2011:23). This compels the executive management to take direct responsibility for data produced in their health institutions.

The cost centre operational managers were also an option because they are at the point of data generation. It was also important to hear their views on data management as they also have a role to play in the process, as they are at the point of data generation. They also form part of decision-making within individual-specific programmes. Both cost centre operational

managers and information personnel provide an insider's view on the actual processes of data management and they are also in a good position to give valuable information on the quality of data produced at the point of generation.

Data was collected through semi-structured interviews with four members of executive management including the eight operational managers. Prior arrangements were made with respondents for interviews and data was collected using self-administered questionnaires only from the information personnel (data clerks, information officers and M&E officials).

6.6 Research ethics

Application for ethical clearance was done through the ethics committee of Stellenbosch University (SU) before conducting this research. The documented approval was also granted from both the FS DoH and the facility where the study was conducted (all are added as annexures).

Informed consent was obtained from all participants and all requirements for the study were explained to the participants, including their right to partake in the study. These included providing them with information regarding confidentiality and anonymity including sharing of data collected, whereby they were informed that data will only be shared with the research supervisor and be discarded later. The study abided by the Protection of Personal Information Act (Act 4 of 2013) which requires the protection of personal information.

6.7 Chapter summary

This chapter discussed the research design, methodology and data collection. The next chapter presents actual data analysis and results. As mentioned earlier, the total sample size was 22, consisting of four (4) members of hospital management, eight (8) operational managers and ten (10) data handling personnel (information officers, data clerks and M&E officers). The response rate was 100 per cent. The next two successive chapters discuss the findings of the study and recommendations.

Chapter 7: Data Analysis and Results

This chapter presents an analysis of data collected and case study research findings from the data analysed. As mentioned earlier, the data was collected from three different groups, namely management, and operational managers at cost centres through semi-structured interviews and personnel handling institutional data using self-administered questionnaires. The previous chapter discussed the data collection method used. This was to respond to the study question and address all four objectives of the study. The research question was to find out whether the deployed data management practices at Pelonomi Tertiary Hospital contributed to high data quality for evidence-based decision-making.

7.1 Introduction

The chapter bears an important part of the study as they interpret the views of the respondents. The data was collected at PTH, which was the unit of analysis. The data was analysed using thematic coding, as indicated earlier. The respondents were purposefully selected based on their responsibilities and familiarity with the topic of study. The research question was to find out to what extent the data management practices at Pelonomi Tertiary Hospital (PTH) ensure data quality as outlined in the District Health Management Information Systems Policy (DHMIS) and how can they be improved to inform evidence-based decision-making.

The four objectives of the study were to:

1. Develop a conceptual framework drawn from the academic literature and policy for assessing the impact of data management processes and controls on data quality in a South African tertiary hospital.
2. Assess data management processes at PTH and their influence on data quality concerning the conceptual framework.
3. Identify barriers to good quality data and their impact on evidence-based decision-making in PTH.
4. Make recommendations on strategies that can enhance the effectiveness of data management processes to improve data quality in PTH.

The main purpose of the study was to enhance data management processes or practices at PTH for improved data quality which will then inform evidence-based decision-making. The themes were divided into five categories after thematic analysis, namely data management practices, barriers to data quality, use of data for evidence-based decision-making, perceived level of data quality in the institution and strategies for improving data quality. Each category of results is presented below.

7.2 Theme 1: Data management practices in PTH

Literature confirms that data management processes are crucial for the attainment of high-quality data, not just in health but across organisations worldwide. However, it is more crucial in healthcare as it involves risk mitigation to save human lives and poor data quality may result in loss of lives. DHMIS policy stipulates that data management involves all procedures in data collection including the use of standardised data collection tools. According to the policy, these are fundamental requirements for a functional routine information system towards improving the quality of data (NDoH, 2011).

Data gathered indicated that categorically, respondents were aware of what was expected of them in carrying out data management responsibilities and the process entailed including tools used in the hospital for data collection. They were aware of DHIS as the official system used for capturing and storing aggregated hospital data standardised hospital registers, and midnight statistics. Midnight statistics in hospitals is a parameter used to measure the overall occupancy of inpatients at midnight, in some instances it is called midnight census.

Effortlessly, 100 per cent of the participants were able to outline the processes of data management in the hospital. One of the respondents said, "I check registers and midnight statistics after collection of data in the ward. We are a call centre but I am an operation manager of this section and make sure that nurses have entered all information."

However, despite their awareness of data management processes, the findings reveal that operational managers are adamant that data management roles belong to the information personnel (data clerks, information officers and M&E officials) as it places a burden on the

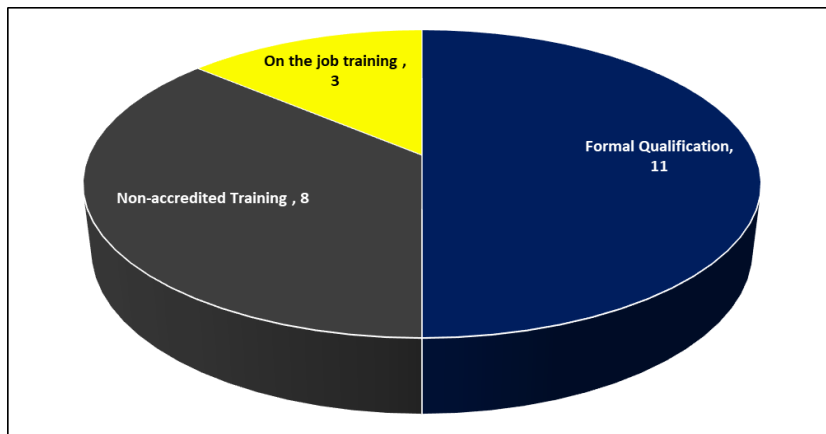
already inadequate nursing staff. Some management personnel shared the same sentiments on this issue. The policy stipulates the role of each manager in data management processes. The nursing personnel could be adamant that their role in data management was laborious due to staff shortages and this promoted a negative attitude towards tasks related to data management and this could affect the quality of data produced and impact negatively on decisions made using that such data.

It was also found that 100 per cent of information personnel were aware of the DHMIS policy, including 50 per cent of management. The other 50 per cent of management were not aware of the data management policy citing that it could be due to focus on their specific fields. This implies that some managers who were not aware of the policy might not take accountability for issues relating to data quality or support data quality efforts in the hospital, such as signing off on data, using data or ensuring that resources for data management were adequate to carry out the related tasks. The policy outlines the role of management and provides resource needs to maintain functional HIS processes for improving data quality.

Data collection tools were mostly still paper-based and respondents feel this contributes to unnecessary data management workload for everyone involved and paper-based data collection tools had some challenges themselves despite being standardised. The challenges with paper-based data collection tools are transcription errors from registers to summary forms; these could be easily misplaced and damaged if not properly filed or kept. All the above reasons could affect the quality of data and decision-making. Transcription errors could lead to garbage-in and garbage-out situations. In some instances, there could also be limited space for physical record keeping if record-keeping systems were not in place and in line with record management policy requirements. For the hospital, these big and busy, paper-based data collection tools are simply not ideal.

Furthermore, other positive findings from the case study include the fact that 50 per cent had formal qualifications, 36.4 per cent had non-accredited training and the remaining 13.6 per cent of respondents indicated that they had on-the-job training in data management. Even though 13.6 per cent might sound low, this could contribute to the undesired quality of data for the hospital.

Figure 9: Respondents Qualification on Data Management



Findings also revealed that data was captured daily by relevant personnel, there were data clerks in cost centres, use of standardised data collection tools, including unwavering support from the information management office at the hospital. Operational managers checked summary forms against the registers and the overall checks were done by the information officer to ensure that all inputted data corresponds with the data sources. The M&E official should also carry out this task, and as part of capacity building, data clerks must be involved in every step of data management processes and quality checks to develop as part of human resource development cited in the DHMIS policy.

One respondent indicated that there were data clerks, however, they were not enough to fulfil all the data management tasks diligently.

“We do not have a solid team that deals with information, as indicated by the management information unit on the organogram, which can be a hindrance as partners dispatch three or four personnel to assist our first information officer in capturing data. This supporting staff is contracted to non-governmental organisations and occasionally the partners run out of funds. You are constantly training new employees on tasks and this affects quality, which impacts output and volume. The FIO is placed in a position where they must perform menial duties such as capturing data, not doing data analysis and preparing reports that are intended for management. It is a shortcoming because the facilities lack an organogram for the information team. Human resource capacity is one of the challenges.”

In summary, the respondents were aware of their data management responsibilities. However, operational managers feel that data management responsibilities should solely be entrenched in data management personnel. The use of paper-based data collection tools was another challenge whereby data was manually transferred from the register to the standardised summary forms and then captured on the DHIS system. This was found to be a setback because literature by Heeks (2013) reveals that human errors in data management can account for more than 80 per cent of data quality. According to the CARTA framework, this could affect completeness due to heavy workloads, accuracy, reliability and timeliness as the whole exercise of transcribing from register to paper can be time-consuming and lead to fatigue.

7.3 Theme 2: Perceived barriers to data quality

The findings of this case study reveal that respondents perceived an array of barriers to data quality ranging from lack of resources to inadequate management support. These are key in improving data management processes to achieve high data quality which can be used for evidence-based decision-making.

7.3.1 Lack of Resources

The findings revealed that there was a “37 per cent vacancy rate” workload on nursing personnel was too high and this affected the quality of data produced. One of the respondents said, “To be honest sometimes we want to have good data but it is a lot of work and it gets very busy with patients and I’m sure you also know that our responsibility is with patients, sometimes there are still some gaps in the registers but when we have time nurses go back and complete.” Another respondent indicated that there was no balance in the nurse-patient ratio, and there were way too many patients for the available nurses. In Chapter 5 under the unit of analysis, the details on the number of patients admitted on an annual basis have been provided to justify how over-stretched the human resources in this hospital were. This calls for management to address staff shortages.

Another finding highlighted the fact that there was no solid information management structure on the hospital organogram. The structure of the hospital was too big to display here, however, it was included as part of the appendices. This was a challenge because issues relating to stability and strengthening of data management within the hospital will never be strengthened. Inadequacy in personnel has also been reported on the number of data clerks within cost centres to perform data management responsibilities. Inadequacy is due to no solid and clear structure of information management on the hospital organogram. The current organogram placed data clerks under the nursing manager which is a challenge because there has to be a clear link between the data management structure to the responsibilities. There are 14 data clerks on the organogram, however, only seven were currently in posts, which meant a 50 per cent vacancy rate for data clerks.

The issue of information management structure on the organogram is very crucial because if it is not urgently attended to it affects efforts that could be implemented for enhancing data quality including developing and implementing data governance to improve quality. The level of accountability and support for data management will never be attained. The main purpose of well well-thought-out organisation structure is to assist an organisation in achieving its goals. It groups members of the organisation and demarcates their functions accordingly, in a way that creates order and accountability. It ensures the smooth efficient functioning of an organisation and improves communication.

Again, on the issue of structure for information management human resources, the DHMIS policy recommends an information manager position who must be responsible for overall data quality and encourage local use of data for the hospital such as this one. This manager must be above the information officer and needs to be at a certain salary level. However, there is no information manager salaried per the policy. This could also affect the quality assurance of data reported and overall oversight of data management activities in the hospital.

Due to a lack of activity when data clerks/captors are on leave, proper human resource planning is crucial to ensure that data capturing is up to date at all times. The findings indicated that there was no form of relief when a data clerk/captor was on leave, the work

piled up and they had to back-capture upon return. For a hospital this big and busy, the back-capturing and workload might affect the quality of data, exacerbated by the unforeseen impact of load shedding. Load shedding also affects the timely availability of data, which means decisions made might be on outdated or incomplete data.

7.3.2 Role clarification

Roles and responsibilities clarification is also key to the production of good quality data. The case study findings reveal that in some ways there are some uncertainties in data management roles which require clarity. One of the respondents said:

“Role clarification is one of the greatest challenges because there are always disparities when it comes to data collection, but you must let the process run and allow section managers to do their jobs. Particularly at the lower level, who should acquire data and which data? Who is required to submit? It is not my responsibility; rather, it is yours...nurses doing clerical duties, admin and data capturers!”

The lack of role clarification has a direct negative impact on data quality as it creates poor accountability and responsibility for data management activities. However, DHMIS policy clarifies the role of data clerks to capture data and the responsible managers in different wards or cost centres need to make sure that data from the registers as source documents is available and reflects all activities within each cost centre. The uncertainties could be due to high staff turnover and both data clerks and health professionals feel the workload was too much for them.

7.3.3 Data curation

The case study found that there is generally a poor culture of data management in the hospital. A respondent said, “... there is no culture of data management, managers don’t know the importance of data”. The findings further reveal inadequate data use and poor record keeping, where a respondent indicated that this did not only affect data quality but was “driving medical litigations skyrocketing”. The challenges of increasing medical litigation harmed the quality of care and resources meant for service delivery are diverted towards

settling legal cases, putting strain on service provision and support services. Medico-legal cases could perhaps be due to poor clinical records keeping because they were still mainly paper-based. The issue of paper-based records and data collection tools was addressed earlier in the chapter.

There was a large degree of consensus, especially from the operational manager and data personnel that hospital management is not using data sufficiently for hospital planning since nursing staff were mostly experiencing high staff turnover but few replacements. The hospital is very busy and requires adequate functional personnel at all times.

However, management respondents reported that 75 per cent of them use data daily for decision-making, whereas operational managers revealed that 62.5 per cent of them use it every quarter and the remaining 37.5 per cent of the operational managers indicated the monthly use of data. Findings also revealed a lack of feedback and poor communication regarding changes in cost centres. This affects data management processes which then have negative implications on data quality. The frequent culture of data use could promote regular feedback and updates within cost centres that affect data management and quality.

Another finding from the case study is that ward registers are sometimes incomplete. One of the respondents commented, "...sometimes there are still some gaps in the registers but when we have time nurses go back and complete". Data goes into the hospital standardised data consolidation forms with gaps until such time that responsible personnel can go back to the source documents to close the data gaps. Staff shortages also made it difficult to complete datasets since they probably built up over time and were harder to correct as time went by. This negatively affected the quality of data produced. According to the Carta framework, data completeness is crucial as it indicates whether all datasets were completed.

7.3.4 Computer hardware and systems

Findings from the respondents indicated challenges with systems being offline during load shedding and there was no data back-up during load shedding. One of the respondents said, "current back-ups cover clinical areas only". Another finding was that the hardware

equipment used was old and there were connectivity challenges, and poor access to the internet at the hospital. However, DHMIS policy states that “All DHIS users shall have internet and intranet access as a right, not a privilege” (NDoH, 2011:33). Internet access should be granted to all users and control measures must be put in place to limit misuse. In some instances, respondents indicated having to share computers due to issues of hardware malfunction and the turnaround time to fix malfunctions sometimes took too long.

In addition to this, data from registers, and hospital systems called Meditech and DHIS do not correspond due to load shedding. Despite load shedding, the findings show that, generally, the data from Meditech and DHIS were constantly not correlating as a result of Meditech being exempted from load shedding and the data sources for each differ. DHIS data is from summary forms, whereas Meditech carries data directly from patients and this is also affected by issues of inconsistencies in capturing data and quality thereafter.

The 2014/15 financial year audit findings for both central and tertiary hospitals by the Auditor-General SA indicated that,

“The FMPI requires auditees to have appropriate systems to collect, collate, verify and store performance information to ensure valid, accurate and complete reporting of actual achievements against planned objectives, indicators and targets. I was unable to obtain the information and explanations I considered necessary to satisfy myself as to the reliability of the reported performance information. This was because the auditee could not provide sufficient appropriate evidence in support of the reported performance information, as patient files could not be submitted in some instances” (FS DoH 2014/15).

It must be noted that due to the size of the public health sector, every health establishment is not audited yearly but they are randomly selected by the Auditor-general South Africa and the determination of predetermined objectives is solely dependent on them. Both the DHMIS policy and FMPI place responsibility on the heads of health establishments to ensure that data quality checks and audits are conducted regularly and data quality improvement plans are developed, implemented and monitored to improve areas of poor performance.

As mentioned in Chapter 4, the Auditor-General of South Africa uses FMPI as a guide for conducting audits in the public sector. These exercises are worthwhile as they improve learning throughout the organisation by benchmarking on good practices from other cost centres that might be doing well to improve data management processes and the quality of data in the hospital.

The overall findings under this theme indicated rather diverse challenges in data quality that require attention from relevant personnel. For instance, role clarification, use of data, and issues of resources. These challenges require a focused internal organisational approach to address.

7.4 Perceived level where data errors occur

Study participants were aware that data errors arose in different stages of data management. Errors occurred between the registers, summary forms and capturing on DHIS. The respondents believed that if proper verification of data took place as it should, many of these errors could be eliminated. Another respondent specified that it happened in the pre-analytic phase due to poor verification processes.

The consensus amongst the data handling group (data clerks, information officers) that answered this question was that it happened at the collection point where registers (their major source of data) had data gaps. When the systems were offline, not much activity took place and some data errors occurred during this period. This implied that the data did not meet the assessment criteria for quality by both SASQAF and Carta frameworks for completeness and accessibility and data gaps affected the quality of data produced and used for decision-making.

7.5 Consequences of poor data quality

All participants were aware of the implications of poor data quality. However, the scale of seriousness differs among the respondents. Data gaps in data elements or raw data lead to inaccurate indicator performance and give rise to incorrect assessments of the reported

performance of the hospital in general. This could create the perception of the hospital as unable to meet the set targets or over-achieving while not. Other findings include poor resource planning, e.g., planning for equipment, personnel, medication and consumables and management would not be able to account for the budget allocated to the hospital.

This would fail to monitor disease trends, poor surveillance and inability to curb the burden of diseases which in turn would compromise the quality of services provided. Some respondents specified that healthcare was dealing with people's lives and data of poor quality can lead to loss of lives – “people will die,” one respondent highlighted. And another provided an example of the COVID-19 pandemic where data was used to curb the spread of the disease.

7.6 Theme 3: Perceived use of data for evidence-based decision-making (EBDM)

Findings from the management of the hospital who took part in the study and operational managers, who had specific questions on the frequency of data use for EBDM indicated that 41.7 per cent used data quarterly, 25 per cent monthly, another 25 per cent daily while the remaining 8.3 per cent reported to have used it once a week. The use of data was mainly for resource planning to improve the quality of care to patients and address the issues of non-negotiables such as the availability of medication for patients and their other needs. They also cited resources in terms of addressing staff shortages. From the previous chapters, the literature revealed the importance of EBDM in healthcare.

The findings of the study revealed that respondents were aware of the use of data in healthcare for EBDM. However different reasons were cited for the use of EBDM. One of the interviewees responded:

“We hold these meetings that we have made statutory, such as adverse events, clinical governance and morbidity and mortality meetings; they are all information-driven meetings. They happen every month across all academic disciplines...

We work with data, and only data drives our actions. I do not believe in opinions, including expert opinions. In actual medicine, we now use evidence-based medicine, the most reliable source of evidence meta-analysis.”

Another one said, "... it is daily because we see patients daily and because maternal and mortality reviews are conducted daily".

However, 58.3 per cent of respondents mostly cited challenges with resource allocation due to limited use of data for EBDM. Others cited different reasons such as disease surveillance, improving quality of care, clinical quality, reviewing correct implementation of referral systems and cost centre performance on certain indicator targets. Possibly, there is a need for capacity building of EBDM for the hospital to gain full benefits from it.

7.7 Theme 4: Perceived level of data quality in the institution

The perceived level of data quality dimension from 12 respondents who rated each dimension on a scale from 0 to 5, with 0 being least and 5 being best showed an acceptable level of DQ. However, a lot still needs to be done to support efforts for producing high-quality data such as implementing measures that strengthen data quality and ensuring compliance with policies that guide data management and quality in the hospital.

According to Restuccia *et al.* (2012), hospitals that reported high use of health information systems showed acceptable information quality in a significant number of measures and strategies.

Results from the study showed that timeliness of data was scored low by most respondents, followed by completeness. All in all, the results showed acceptable levels of DQ despite the challenges attributed earlier, however, improvements are necessary to improve the overall quality. One respondent said, "... it is good and my argument depends on the fact that sufficient data is being collected". Another said, "... data quality is good, the team is very committed".

Another finding from the case study showed on average 7.4 out 10 of hospital performance data could be confidently used to monitor programme performance, keep track of set performance targets, planning purposes, resource allocation, monitor the burden of diseases and trends, monitor policy implementation, evaluate the performance of new policies and

evaluate programme performance. However, this applied to 18 respondents who had to respond to this question.

7.7.1 Strategies for improving data quality

Respondents have offered some solutions to the current data quality challenges. All respondents revealed that data was a standing item on the agenda during the meetings. Developing strategies for data quality requires targeted interventions for data quality solutions.

7.7.1.1 Computer hardware and systems

Availing of adequate resources has been cited as one of the strategies for improving the quality of data, such as the replacement of old computers with newer ones and timely IT support to fix malfunctioning computers. The respondents indicated the need for alternative sources if the system for capturing data was down and requested access to the internet. Some form of reliable backup must be provided to avoid recapturing and loss of data during load shedding so that there is a correlation between the systems (DHIS, HPRS and Meditech) and registers.

Another recommendation for high data quality was for management to provide laptops instead of computers so that respondents who were tasked with data collation and capturing could carry them around the hospital for data capturing instead of a piece of paper from one ward to another which could easily get lost. Laptops were more convenient because they could continue to operate by the battery during load shedding especially during lower stages of load shedding.

7.7.1.2 New technologies and automation

The findings of the study also revealed that respondents were open to the implementation of new technologies for data management. They believed that it could assist in reducing the workload for both data personnel and nursing staff; 22.7 per cent of the respondents

indicated that they lacked knowledge of modern technologies regarding data management but were willing to try it if it could assist in reducing the workload on managing data and caring for patients.

However, findings also revealed that on a scale of 0 to 5, 0 being the least and 5 being the best, most nursing personnel rated their computer literacy level as 2, which suggested inadequacy and will require training on computer literacy should the hospital implement new technologies. One of the respondents said, "... the change is too slow, but the sooner we transition away from paper, the sooner our quality will be safeguarded...We simply need to disinhibit people from fear of technology and computers".

While there was a consensus amongst respondents on the implementation of modern technology, one could also sense the level of anxiety amongst nursing personnel requesting adequate training on computers. Other than the use of modern technology, and automation of systems for online access, respondents advocated for the reduction of paper-based registers and data collection tools. "It can help to reduce paperwork and personnel can be able to focus more on patients." Due to *the* heavy workload, respondents felt that the implementation of technology across the hospital would somehow minimise their workload.

Another concern found was load shedding, which was also still going to affect the systems. Management would have to find an alternative power supply or exclude all hospital systems from load shedding not only clinical services. The interviewees also cited the need to safeguard personal DHIS login credentials for security purposes as anybody who had access to them could perform changes on the organisational units in the system which caused confusion and affected data quality. This suggests that data security policies on user rights need to be strengthened.

The findings of this case study also revealed that respondents advocated for system integration across the hospital because they had other data collection systems apart from the DHIS in the hospital which sometimes produced different outputs from the DHIS. Systems such as HPRS and Meditech run parallel to DHIS and the inputs often differ. In addition to the adoption of newer technology for managing data, respondents felt it would improve access,

accuracy and timeliness of data. One respondent indicated that new technology will make things easier, "... click of a button information will be available," and another advocated for cloud computing due to backup challenges during load shedding.

7.7.1.3 Performing data quality checks

Performance of data quality checks was done by 100 per cent of respondents and over 70 per cent reported doing it monthly. While the findings earlier indicated some uncertainties in the roles and responsibilities of data management, 100 per cent of respondents agreed to partake in data quality checks. Findings also revealed that all respondents were aware that they had a role to play in improving the quality of data at the hospital. However, in some instances, they were aware of such tasks but insisted it was the responsibility of other people not themselves despite having taken part in data quality checks and audits. This also could be due to the daunting tasks of patient care and having to perform administrative data management duties, especially for nursing personnel.

7.7.1.4 Data governance

The findings reveal that respondents believed that there were inadequate human resources, as indicated earlier, a "37 per cent" vacancy rate in the hospital. This puts much pressure on the available human resources. Recruitment of more personnel, both data clerks and nursing staff would allow health professionals to pay more attention to patient care and keep up the registers and data personnel would maintain up-to-date data inputting on the DHIS.

Data management should be part of the key performance areas (KPA) of all managers in the hospital and it is the responsibility of hospital management to ensure that this happens. The DHMIS policy stipulates that data management should form part of management KPA, and how management cascades this function to the lower level of management would be up to them so that data quality remains every manager's responsibility.

Respondents also indicated that management needed to make resource and contingency plans for when personnel go on leave to alleviate the heavy workload on return. Another

suggestion for improving the quality of data was for managers to maintain data ownership and use for EBDM. The findings also suggested that managers must review data more and rectify their mistakes such as data incompleteness on registers and perform analysis of data based on the services provided in each cost centre. One response cited, "... data not used at the point of generation, its quality is pointless". Emphasis should be placed on both quality of data and usage.

The respondents indicated that paper-based data registers should be used as backup for patient registrations at admissions in the absence of alternative automated tools and in cases of load shedding or power supply loss. However, this would still require back-capturing when electricity power was restored.

The findings revealed that respondents required regular meetings to address data-related issues and unit managers to maintain constant communication with information staff regarding changes that could affect data accuracy – 85.7 per cent of personnel who had to respond on the availability of data policy, highlighted the need to adhere to the policy requirements to improve data quality in the hospital.

Another finding was the need for strengthened management and leadership support to ensure that data management processes were carried out effectively so that data quality could be of an acceptable standard and be regarded as valuable by all users – 90 per cent of the respondents believed that there was a link between data management and quality because the proper articulation of data management tasks could lead to improved quality of the hospital data.

The section above discussed all the findings from the research. There were rather mixed reactions from respondents at different levels in terms of addressing data quality issues for EBDM. However, not much consensus was reached in data management processes despite issues of heavy workload. The section below discusses the findings of the study.

7.8 Discussion and analysis

The literature indicates that good data management practices are essential for improving the quality of data used for evidence-based decision-making (Senthilkumar *et al.*, 2018:62, Boone & Heywood, 2015:17). However, findings from the study revealed that data management duties sometimes were not a priority due to competing workload, especially on nursing personnel. The data at the point of collection was on paper-based tools, “standardised service registers and midnight statistics”. However, literature shows that traditional data management techniques are not coping due to the exponential growth of health data and the amount of activity going on in hospitals (Ibrahim *et al.*, 2012:300-304; Senthilkumar *et al.*, 2018:62). According to Kerr *et al.* (2008:260), management of data in healthcare has become increasingly complex due to the emergence of technology. The findings of the case study also revealed that respondents were aware of the voluminous amount of data produced in their hospital daily and were open to the adoption of technology for the reduction of workload.

7.8.1 Data management

Modern technology is transforming the landscape of data management in healthcare. The respondents (over 80 per cent) were aware of new data management technologies and willing to adopt them. The exponential growth of data requires efforts for continuous investment in BDA to ensure integrated care of patients in hospitals and strengthen HIS for the efficiency of services (Carvalho *et al.*, 2018). These latest technologies are promising to process data from different sources, with the use of convergence databases and cloud storage to securely store data and make use of BDA to ensure use of data (Wang *et al.*, 2016) and tools in BDA can be used to perform all kinds of data analysis for decision-making (Aceto *et al.*, 2020). The use of modern technologies allows for the use of data analysis in different formats (structured or unstructured) to meet the needs of users. It can create different forms of dashboards for easier use and programme performance monitoring.

7.8.2 EBDM

Evidence-based decision-making in public health policy-making is gaining momentum globally (Nutbeam & Boxall, 2008; Rychetnik *et al.*, 2012). To perform EBDM, data has to be of high quality. The findings of this research show that EBDM was used for different reasons which included resource allocation and taking care of patients' needs. However, one respondent indicated that "In actual medicine, we now use evidence-based medicine, the most reliable source of evidence meta-analysis".

In developing countries like South Africa (SA) lack of adequate resources in the healthcare sector is proving EBDM crucial for rational resource allocation, and cost optimisation to prevent waste (Majdzadeh *et al.*, 2012; Shafaghat *et al.*, 2022:3). According to Rousseau (2012:12), EBDM requires capacity for application and many practitioners have insufficient capacity to apply it in healthcare. There is a gap between theory and practice in EBDM and Zhang *et al.* (2020) describe it as "easier said than done", calling for empowering managers other than in the medical field on EBDM in the healthcare environment to save human lives. In addition, new technologies boost healthcare EBDM, from the management of resources to improving performance in hospitals (Benzidia *et al.*, 2021; Kumar *et al.*, 2021; Maglaveras *et al.*, 2016).

7.9 Barriers to quality

Data quality is critical in healthcare as it contributes to EBDM, however, low data quality is one of the persistent challenges in healthcare. Many critical factors contribute to poor data quality. In this research, shortage and burdened staff have been attributed to issues of data timeliness and incompleteness. This leads to low confidence in the use of data generated within the hospital. This also harms the quality of data produced and it can affect decisions used based on such data. Patients can die due to decisions based on data of poor quality.

According to the findings of this research, staff shortages demoralised the workers who performed HIS functions and professional health workers were reluctant to perform data management activities, citing their role as patient care rather than the latter. There were no

plans devised for when personnel were on leave, upon coming back, the work was still waiting for them on their return, for instance, back-capturing of data from when the staff member was on leave to the day they came back to work. One respondent indicated that “to manage timeliness and completeness of data...unit managers to have contingency plans to prepare for unforeseen absenteeism and/or planned vacations”.

Some health workers have low levels of computer literacy and amongst some respondents, this was a challenge if the hospital were to adopt new technology or rigorous strengthening of current use of data management systems in the hospital. They require immediate management support to address data quality challenges. According to Valizadeh *et al.* (2022), despite the employment of HIS in every unit of the nominated hospital for their study, the interviewees, mostly nursing and para-clinical personnel, lacked appropriate knowledge about how to use HIS.

The study found that ICT infrastructure which included connectivity and fragmented information systems was a challenge in advancing effective data management and quality at PTH. Data collection tools were still mostly paper-based at the points of collection and this affected the integrity and quality of data collected and recorded. According to Heeks (2013:74-84), more than 80 per cent of data errors occur during the following stages in data handling: capturing, input, processing, storage and output phases, and this can either be human or technical.

According to the findings of this study, a lack of management support was also cited as an enabler of poor data quality. One of the respondents mentioned that “managers still do not know the importance of data.” If managers do not know the importance of data, they will offer little or no support to activities towards data management and its quality and this is more of an organisational behavioural issue than technical. Management support and buy-in are crucial in improving the quality of data.

7.10 Suggestions for improving data quality

The literature argues that understanding data quality dimensions is a prerequisite leading to appropriate data quality undertakings (Batini *et al.*, 2015; Huang *et al.*, 2012). The findings of this research indicate acceptable levels of data quality dimensions despite the demonstrated challenges. This was attributed to the confidence of management in the use of data produced in the hospital for evidence-based decision-making.

7.10.1 Institutional data governance

Developing a specific targeted facility data governance strategy that drives the processes of data management is key to improving data quality. Data governance is comprehensive and outlines all key activities in terms of data handling, role clarification, resource needs, strategic intent, and policies including strategies to strengthen HIS for the adoption of modern technologies (Ogundaini & Achieng, 2022; Olson, 2003; Wang, 2001).

Modern technologies will ease the burden of resources and reduce many data management and quality issues by integrating data and encouraging interoperability across healthcare. BDA in large academic hospitals significantly improved data quality (Ahmadian *et al.*, 2018) and revolutionised the entire e-health ecosystem by seamlessly integrating all hospital data and analysing at speed.

Many respondents showed eagerness to adopt modern technologies to reduce heavy workload despite others indicating their lack of knowledge about it and expressing some sort of anxiety and requesting training in advance should the organisation embark on new technologies. Integration of hospital information and processes remains crucial for knowledge generation and sharing to improve the quality of care (Lancharoen *et al.*, 2020).

7.10.2 Integrated performance information structures and systems

The FMPI National Treasury (2007:13-14) outlines the responsibilities of the head of the institution in terms of ensuring the integration of performance information within existing

processes. The framework further requires the head of the institution to define technical standards for data collection to ensure that roles and responsibilities are clear. This goes for the documentation of institution-specific data flow, from collection to storage, including providing appropriate systems for this and availing suitable hardware and resources to perform HIS duties. The framework also compels the head of the institution to put processes in place for the appropriate use of information for budgeting, planning and management.

The contents of FMPI are embedded in the DHMIS policy which also outlines the roles and responsibilities of each level of care regarding data management (NDoH, 2011:22-32). This addresses the uncertainties in role clarification from the findings above. Both DHMIS policy and FMPI compels all concerned managers and other line function personnel to have data management as KPA. However, this remains the responsibility of the management of the hospital to ensure that data management is KPA to certain relevant managers within the institution.

7.11 Conclusion

Data management practices at the Pelonomi Tertiary Hospital contribute to improving the quality of data used for evidence-based decision-making and the burden it plays on nursing personnel. The hospital has adopted the use of DHIS policy in the hospital, however, there is a need to develop hospital-specific data governance to address some inconsistencies in data management that can affect the quality of data in the long run. This includes addressing the dire need for staff shortages, data handling personnel and nursing personnel if they are still expected to do information duties and nurse patients at the same time.

The study also found that while staff members were able to use data for evidence-based decision-making, capacity building is necessary across board to explore extensive use of evidence-based decision-making, not just for resource allocation as indicated by many respondents. The findings of the study revealed that the use of paper-based data collection tools in hospitals of this calibre affects the quality of data and burdens staff. Investment and adoption of new technologies will positively change the landscape, not only in data management, but it will improve operational efficiencies throughout the hospital.

In chapter 5, the indication is that there are other multiple data collection systems, such as Persal and Meditech in this hospital, to name a few. The concept of the framework in chapter 2 aims to integrate all hospital data in a seamless but effective way so that all data can be in one place. It also demonstrates a visual change, interrelationship and logic between the levels of data handling. This will also address some systematic data quality challenges as mentioned in chapter 3. One of the strategies to improve data quality is through the development, implementation and monitoring of data governance. However, the hospital might not be able to do so because it has not fully complied with the human resource needs of data management staffing as stipulated in the policy (DHMIS).

Quality assurance, oversight, privacy and security in data management are very crucial and require careful consideration by authorities. Management support is necessary to address some of the internal organisational challenges that affect data management practices in the hospital in order to improve quality of data and encourage data curation for evidence-based decision-making.

The subsequent chapter provides recommendations on the findings of the study and conclusion thereafter.

Chapter 8: Recommendations and Conclusion

The chapter provides discussions on recommendations on the findings of the study and conclusion. The study aimed to enhance data management practices at Pelonomi Tertiary Hospital to improve data quality for evidence-based decision-making. The study aimed to answer whether the current data management practices at this hospital contribute to data quality for evidence-based decision-making. Both the research question and aim of the study led to the development of four study objectives. The previous chapter discussed the findings and this chapter will provide the recommendations.

8.1 Introduction

From the literature reviewed, it is important to note the concurrence of different scholars on the importance of proper data management practices that can transform the quality of data produced in the health sector for evidence-based decision-making. Evidence-based decision-making is crucial in medicine and the sector as a whole.

The research question for the study was: To what extent do the data management practices at Pelonomi Tertiary Hospital (PTH) ensure data quality as outlined in the District Health Management Information Systems Policy (DHMIS) and how can they be improved to inform evidence-based decision-making?

To respond to the research question, four objectives were developed and the recommendations were made in line with the objectives of the study. The general purpose of the study was to enhance the effectiveness of data management processes at PTH for improved data quality to inform evidence-based decision-making.

Objective 1: Develop a conceptual framework drawn from the academic literature and policy for assessing the impact of data management processes and controls on data quality in a South African tertiary hospital.

While there is limited literature specific to a similar type of hospital, data regarding healthcare data management processes and controls on data quality is sufficient. Pelonomi Tertiary

Hospital has adopted the use of DHMIS policy and DHIS for the data management process. Staff perform routine data management processes as stipulated in the DHMIS policy. However, the use of paper-based data collection tools despite standardisation harms data quality. The researcher developed a data management concept that could be used in line with modern technology that uses BDA to improve both management and quality of data.

Objective 2: Assess data management processes at PTH and their influence on data quality concerning the conceptual framework.

Following the SASQAF and Carta, the quality of data at the hospital met acceptable quality dimension standards. However, issues of data completeness, timeliness and additional resources need to be further addressed to fully complement the data quality assessment criteria. Modern technologies have the potential to improve data quality to harmonise data flow and seamlessly augment system integration. The DHMIS policy outlines the need for each personnel at each level of care to perform stipulated data management tasks to improve the quality of data.

Objective 3: Identify barriers to good quality data and their impact on evidence-based decision-making in PTH.

Barriers to quality data were mostly attributed to a shortage of personnel and other resources. This has a direct impact on data quality. The low data quality affects evidence-based decision-making and this can lead to loss of lives. Poor quality data is a high risk in the health sector and requires immediate mitigation strategies. Some identified barriers require internal rigorous management solutions to harmonise system flow challenges. More are org-centric than technical and can be addressed internally with management and leadership support.

Objective 4: Make recommendations on strategies that can enhance the effectiveness of data management processes to improve data quality in PTH.

While there is progress in the entire country in the development and implementation of e-health, the adoption and use of the newest technologies seem sluggish. However, BDA has the potential to integrate HIS and manage heaps of health data generated daily while addressing staff shortages and reducing/eradicating the level of fragmentation. The benefits of BDA are not only in managing data but in a wide range within the health system.

8.2 Recommendations

The adoption of modern technologies promises to change the landscape in the healthcare arena for managing data. Over decades, big data analytics have shown the potential to significantly bring innovation to data management techniques. Traditional data management tools are not coping with health data demands, especially the voluminous amount of data generated daily in this hospital. The research findings show that at the point of generation data management tasks were regarded as laborious, derailing nurses from their core business which is patient care.

1. It is recommended that Pelonomi Tertiary Hospital should automate some activities in data management to improve data quality, especially on the challenges of completeness and timeliness which scored low, as well as patient care.
2. The FS DoH should support the hospital with resources for the automation of some services to reduce fragmented systems and the use of manual paper-based data collection tools. According to the DHMIS policy, both national and provincial departments are responsible for gradually working towards more advanced technology if there is adequate ICT infrastructure capacity.

Generally, findings indicate that data quality standards at the hospital meet acceptable quality criteria despite most of the data management processes being regarded as daunting. All interviewees were aware of the different consequences of low data quality.

3. Consideration to slowly invest and adopt the use of modern technology to harness the current system challenges of fragmentation will improve the performance of HIS functions

that are related to data management processes. It also can integrate data (structured or unstructured) across different sources seamlessly to allow interoperability and reduce issues of fragmentation.

4. The hospital should also consider timeframes for filling funded vacant posts to avoid high staff turnover and the FS DoH should support such efforts. This will not only lift the “burden” on health professionals but it would improve efficiencies within the hospital.

It can also improve data curation, provide secure storage for personal information and data and promote access anywhere through leveraging cloud computing as an enabler for the new data dissemination paradigm. Most new data management tools have proven reliable and perform with speed and agility effortlessly. All interviewees are aware of the different consequences of low data quality.

5. The FS DoH should support the hospital in strengthening leadership and coordination of health information – this will address issues such as role clarification which emanates from staff shortages. Adoption of modern technology can also solve many resource challenges and alleviate the burden of data management demands at the point of generation. This will give more time to nursing staff to care for patients and will also likely reduce the use of paper-based data collection tools.

6. The availability of adequate resources is a prerequisite to achieving high-quality data and improving data management practices. The DHMIS policy compels the head of the health establishment to ensure the availability of resources such as tools for data management, software and hardware including means of communication. The hospital management is recommended to provide up-to-date and adequate resources for data management, for example, replacing old computers, and opting for laptops across for all data management personnel so that they can still perform their duties even when there is load shedding. They can always carry their laptops around different wards if required to work there other than their normal workplaces.

Respondents have some form of qualification in data management but training for staff members who never had training on HIS should be arranged to boost their confidence in

performing HIS duties so that high data quality can be maintained. The FS DoH should also support capacity-building initiatives to ensure that all personnel required to perform HIS functions are well-capacitated to produce quality data. The policy requires the development of a human resource plan for both new and old members of data management staff. This training should not only focus on data management but should perhaps include basic computer skills as some interviewees implied low levels of computer literacy. This could lead to resistance to change should new technology be fully introduced within the hospital.

The DHMIS policy makes recommendations for human resources requirements. The policy requires a health information manager, information officer and data capturers or data clerks. Pelonomi Hospital is recommended to comply with the policy and fulfil all staff requirements. The information manager's responsibilities include "overall data quality assurance and encouraging local use of information". The location of information management on the organogram of the PTH needs urgent attention from the hospital management. The current organogram does not clearly show where the information management is located. The management needs to address this issue as a matter of urgency.

7. Another recommendation is that the hospital should strengthen internal controls to ensure full compliance with DHMIS policy. For instance, security compliance on access to data management systems, including adherence to the policy on data security and ethics and encrypting the systems or data to keep it safe and protected. Strengthening internal controls will also ensure compliance with the data flow policy so that everyone is aware of their roles and responsibilities to strive for improved data quality. This is not limited to performing regular data quality audits and FS DoH should support these initiatives, not wait for scheduled audit dates by the Auditor-General South Africa.
8. The policy stipulates that data management should form part of management's KPAs and this should be addressed to improve accountability and responsibility for data quality within the hospital. This remains the responsibility of the management of how this is

cascaded to the middle management and supervisors of different programmes within the hospital.

8.3 Conclusion

In conclusion, the study findings revealed that data management processes are regarded as tedious and laborious. Staff members at PTH were aware of their duties in fulfilling data management tasks but the workload was hindering their performance. Despite this, the data quality produced by PTH appears to meet acceptable quality standards however, there is a need for improvement in some data management activities. The study also found that evidence-based decision-making had very limited application to the improvement of quality of patient care in PTH and for disease surveillance but was mostly utilised for resource planning and allocation.

Capacity building on EBDM and use of data was required to maintain high data quality. The use of data must start at the point of generation till the top tier of the hospital to plant a culture of usage and ownership. There was a shortage of resources in the hospital, more especially nursing staff and data management personnel, and this also should be addressed – the indication was that there was a 37 per cent vacancy rate, which was too much for a hospital of this magnitude.

There was no proper location of information management structure on the hospital organogram and this needs attention from the relevant managers to strengthen data management practices. The additional data personnel can assist clinical staff in the cost centres and different wards to perform data management duties and undertake data quality checks and audits regularly in the absence of modern technology. This will improve the quality of data and provide confidence in the data used not just by authorities but by all data consumers.

Gradually, the hospital can transition from paper-based data collection tools with the support of FS DoH and adopt modern technologies. This would be effective for day-to-day efficiencies and address some limitations highlighted on data management processes that affect the

quality of data produced such as back-up and data discrepancies reported from different data systems.

Finally, the purpose of the study was to find out whether the data management processes at PTH contribute to data quality for improved data quality for evidence-based decision-making. To a certain extent, the data management process contributes to high data quality for EBDM. However, room for improvement is recommended to ensure the smooth running of data management operations within the hospital for improved data quality. Leadership and management support to data management practices and adoption of culture for data and information products utilisation is encouraged. Capacity for EBDM is also encouraged so that data can be used extensively within the hospital.

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List of Addenda

Addendum 1: Research Ethical Clearance



CONFIRMATION OF RESEARCH ETHICS APPROVAL

REC: Social, Behavioural and Education Research (SBER) - Initial Application Form

2 October 2023

Project number: 28682

Project Title: Enhancing the effectiveness of data management to improve data quality for evidence-based decision making: A case study of Pelonomi Tertiary Hospital

Dear Ms MA Malahleha

Identified supervisor(s) and/or co-investigator(s):

Prof T Ajam

Your REC: Social, Behavioural and Education Research (SBER) - Initial Application Form submitted on 01/08/2023 23:23 was reviewed and approved by the Social, Behavioural and Education Research Ethics Committee (REC: SBE).

This approval is only valid until the end of the protocol approval period:

Protocol approval date (Humanities)	Protocol expiration date (Humanities)
2 October 2023	1 October 2026

GENERAL COMMENTS PERTAINING TO THIS PROJECT:

INVESTIGATOR RESPONSIBILITIES

1. Please take note of the General Investigator Responsibilities attached to this letter.
2. Always use your project ID number (28682) in all correspondence with the REC: SBE concerning your project.
3. Please note that the REC has the prerogative to ask further questions, seek additional information, and monitor the conduct of your research and the consent process, where required.

List of documents approved by the REC: SBE:

Document Type	File Name	Date	Version
Proof of permission	M_Malahleha_20594461 REQUEST FOR STUDY	14/07/2023	1
Informed Consent Form	SU Consent Form 31_JUL_2023	31/07/2023	2
Data collection tool	DATACO-3	31/07/2023	2
Data collection tool	DATACO-1	31/07/2023	2
Data collection tool	DATACO-2	31/07/2023	2
Research Protocol/Proposal	RESEAR-3	31/07/2023	2
Default	RESPON-1	31/07/2023	1

If you have any questions or need further help, please contact the REC administrative officer, Mr Aden Williams at aden@sun.ac.za

Sincerely,

Mrs Clarissa Robertson (cgraham@sun.ac.za)

Secretariat: Social, Behavioral and Education Research Ethics Committee (REC: SBE)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.

Addendum 2: District Health Management Information Systems Policy



District2520Manage
ment2520System%252

Addendum 3: Pelonomi Tertiary Hospital Organogram



Pelenomi Hospital
Organogram 29 Nov

Accessed: 29th November 2023