A UNIFIED ARCHITECTURE FRAMEWORK FOR HEALTHCARE MOBILE SYSTEMS TO IMPROVE BIG DATA USEFULNESS IN A GOVERNMENT ENVIRONMENT

By

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DECLARATION

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

ABSTRACT

Governments of many countries, including Namibia, build public hospitals to provide healthcare services to its community members. In the process, various types (such as text, image, and video) of data are generated from patients and the facilities. Over the years, the data grow to a point where some of the health facilities struggle to manage it. This includes the use of different techniques and tools, such as mobile systems to store and access data. What makes the situation even more challenging is the lack of flexibility and integration among information systems, such as mobile systems and healthcare big data. The challenges cause difficulties in attempts to access the big data for the purposes of healthcare services delivery. Thus, the study aimed to propose a solution that can be used by the healthcare facility in Namibia, to ease access to patients' big data. Based on the research aim, the following research questions were developed: (1) What are the factors that influence the use of mobile systems in accessing healthcare big data for service delivery in the Namibian environment? and (2) What are the factors that can be used to guide and enable integration between health mobile systems and healthcare big data for improved healthcare service delivery?

To achieve the study's aim, a qualitative research strategy was followed. A case study design was employed by using two cases, namely the Ministry of Health (MoH), and Healthbridge Public Hospital (HPH) in Namibia. Data were collected through semi-structured interviews and documentation. The semi-structured interview was considered the main data collection technique. The hermeneutic method was applied in the analysis of the qualitative data, which was guided by the duality of structure from the perspective of Structuration Theory (ST). There were findings from the analysis of data from both organisations used in the study: MoH - communicative tools, network of people, policies compliance, technology Monopolistic, governance, data management system, and lack of interactive systems – and HPH - mobile systems ease of use, systems user training, online consultation, medical history traceability, access to external facilities, and practitioner's collaboration.

The Technology Acceptance Model (TAM) was employed as a lens to help make more sense of the findings. This was primarily to gain a deeper understanding of the factors that influence how healthcare big data is accessed, used and managed in the Namibian environment, and how the factors impact the interaction and integration between health mobile systems and healthcare big data towards improving service delivery.Based on the empirical evidence, the findings from the two cases:(1) Ministry of Health which include communicative tools, network of people, policies compliance, technology monopolistic, governance, data management system, and lack of interactive systems, and (2) Healthbridge Public Hospital (HPH), which

include mobile systems ease of use, system user training, online consultation, medical history traceability, access to external facilities, practitioner's collaboration, systems decentralisation, and technology infrastructure flexibility were found to be important in the use of health mobile systems. In the end, a Unified Architecture Framework (UAF) was developed. The UAF is therefore proposed as a solution to improve the use of mobile systems in gathering, storing, accessing, and managing patients' big data in Namibian health facilities. The UAF provides governance and standards that guide the selection, development, and implementation of Information Systems/Information Technologies solutions for healthcare purposes. This is primarily to improve efficiency and effectiveness of healthcare service delivery in the country. The contributions of this study come from theoretical, practical, and methodological perspectives. The study is intended to benefit academics, IT specialists, and healthcare practitioners as follows:

To the academics: the study adds to the existing literature. In literature, much has been researched and written on big data. However, research on big data in the area of healthcare, especially in developing countries, have been lagging. The study also brings forth a new perspective from the application of two different theories, Structuration Theory and Technology Acceptance Model. The complimentary use of theories is always a challenge especially their order of use.

IT specialists and Healthcare practitioners: this study will contribute to enterprise architecting as there are only a few studies related to architecture in the healthcare domain. The findings will also enable policy developers and decision makers to understand how mobile systems can be integrated and used as a tool for data management in healthcare. Moreover, management will benefit from the study's findings in terms of the factors that contribute to, or impact, system adoption and resistance. Based on that, management will be in a better position to assess both technical and non-technical factors before implementing information systems and supporting technologies as solutions.

Keywords*:* Architecture, Big data, Healthcare, Health mobile systems, Information Systems, Structuration Theory, Technology Acceptance Model

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DEDICATION

This study is dedicated to my parents, Loini Shaanika and Shaanika Naftali. It's because of your support and love I was able to push this far. You laid the foundation by investing and sending us (me and my siblings) to the city for better education. May the almighty God gracefully bless you.

TABLE OF CONTENTS

DECLARATION ii
ABSTRACT iii
ACKNOWLEDGEMENTS v
DEDICATION vi
LIST OF FIGURES xii
LIST OF TABLES xii
GLOSSARY xiii
CHAPTER 1 1
INTRODUCTION TO THE STUDY 1
1.1 Introduction 1
1.2 Background 1
1.3 Problem statement 2
1.4 Research problem 4
1.5 Research questions 4
1.6 Research aim and objectives 5
1.7 Significance of the study 6
1.8 Delineation of the research 6
1.9 Literature review 7
1.9.1 Information Systems/Information Technologies 7
1.9.2 Health mobile systems 8
1.9.3 Healthcare 9
1.9.4 Big data 10
1.9.5 Architecture 12
1.9.6 Underpinning theories 13
1.9.6.1 Structuration Theory 13
1.9.6.2 Technology Acceptance Model 15
1.10 Research design and methodology 16
1.10.1 Research philosophy 16
1.10.2 Research approach 18
1.10.3 Research strategy 18
1.10.3.1 Quantitative research method 19
1.10.3.2 Qualitative research method 19
1.10.4 Research design 20
1.10.4.1 Case study design 20
1.10.5 Data collection 21

1.10.5.1 Interview technique 21
1.10.5.2 Documentation technique 22
1.10.6 Data analysis 23
1.10.7 Units of analysis 24
1.11 Ethical considerations 24
1.12 Structure of the thesis 25
1.13 Summary 25
CHAPTER 2 27
LITERATURE REVIEW 27
2.1 Introduction 27
2.2 Information Systems/ Information Technologies 27
2.3 Healthcare 30
2.4 Healthcare mobile systems 33
2.5 Big data 35
2.6 Architecture for integrated healthcare systems 38
2.7 Underpinning Theories 41
2.7.1 Structuration Theory 42
2.7.1.1 Duality of structure 44
2.7.2 Structuration Theory and IS/IT studies 45
2.7.3 Technology Acceptance Model 46
2.7.4 Technology Acceptance Model and Information systems studies 49
2.7.5 Structuration Theory and Technology Acceptance Model 49
2.8 Summary 50
CHAPTER 3 51
RESEARCH DESIGN AND METHODOLOGY 51
3.1 Introduction 51
3.2 Research philosophy 51
3.3 Research approach 53
3.3.1 Inductive approach 53
3.3.2 Deductive approach 53
3.4 Research strategy 54
3.4.1 Qualitative research method 54
3.4.2 Quantitative research method 55
3.4.3 Mixed research method 55
3.5 Research design 56
3.6 Data collection 58
3.7 Data analysis 63

3.8 Units of analysis 64
3.9 Delineation of the research 65
3.10 Summary 65
CHAPTER 4 67
OVERVIEW OF CASE STUDIES 67
4.1 Introduction 67
4.2 Fieldwork 67
4.3 Case studies 68
4.3.1 Ministry of Health 68
4.3.1.1 MoH: IS/IT Division Structure 70
4.3.2 Healthbridge Public Hospital 72
4.3.2.1 Healthbridge Public Hospital: IT support 73
4.4 Summary 73
CHAPTER 5 74
DATA ANALYSIS 74
5.1 Introduction 74
5.2 Data Analysis: Overview 74
5.3 Case 1: Ministry of Health 76
5.3.1 Signification/Interpretative scheme/Communication 79
5.3.2 Domination/Facility/Power 84
5.3.3 Legitimation/Norm/Sanction 88
5.4 Case 2: Healthbridge Public Hospital 94
5.4.1 Signification/Interpretative scheme/Communication 95
5.4.2 Domination/Facility/Power 100
5.4.3 Legitimation/Norm/Sanction 105
5.5 Summary 109
CHAPTER 6 110
FINDINGS AND INTERPRETATION 110
6.1 Introduction 110
6.2 Ministry of Health: Findings 110
6.2.1 Communicative tools 111
6.2.2 Networks of people 112
6.2.3 Governance 113
6.2.4 Lack of an Interactive system 113
6.2.5 Technology monopolistic 114
6.2.6 Data Management System 115
6.2.7 Policies compliance 115

6.3 Healthbridge Public Hospital: Findings 116
6.3.1 System users training 117
6.3.2 System decentralisation 117
6.3.3 Online consultation 118
6.3.4 Technology infrastructure flexibility 119
6.3.5 Practitioners' collaboration 119
6.3.6 Access to external facilities 120
6.3.7 Medical history traceability 121
6.3.8 Mobile System's ease of use 121
6.4 Interpretation and discussion of the findings 122
6.4.1 Technology Acceptance Model: Overview 123
6.4.2 Information and Communication Technology solutions 125
6.4.3 Standardisation 126
6.4.4 Systems interaction 126
6.4.5 Collaborative networks 127
6.4.6 Information and Communication Technology management 128
6.4.7 Database management 128
6.4.8 In summary 129
6.5 A Unified Architecture Framework for Healthcare Mobile Systems 129
6.5.1 Governance 130
6.5.2 Database engineering 131
6.5.3 Security and privacy 132
6.5.4 Technology connectivity 133
6.5.5 Human collaboration 133
6.6 Summary 134
CHAPTER 7 135
CONCLUSION AND RECOMMENDATIONS 135
7.1 Introduction 135
7.2 Summary of the study 135
7.3 Revisiting the aim and objectives of the research 137
7.3.1 The aim of the study 137
7.3.2 Research objectives 138
7.4 Contributions of the research 142
7.5 Assessment of the study 144
7.6 Recommendations 146
7.6.1 External facilities accessibility 146
7.6.2 Using interactive systems 147

7.7 Benefits of the study 148
7.7.1 Body of knowledge 148
7.7.2 Healthcare and ICT domains 148
7.8 Limitation of the research 148
7.9 Further research 149
7.10 Conclusion 149
REFERENCES 150
APPENDICES 168

LIST OF FIGURES

Figure 1.1: The three Vs of big data (Russom, 2011)..... 11
Figure 1.2: Duality of structure (Giddens, 1984) 15
Figure 1.3: Technology Acceptance Model (Lee et al., 2012)..... 16
Figure 2.1: Components of IS/IT (Iyamu & Adelakun, 2008:3)..... 27
Figure 2.2: The three Vs of big data (Russom, 2011)..... 36
Figure 2.3: Architecture domains (Aziz et al., 2005) 40
Figure 2.4: Duality of structure (Giddens, 1984:29) 45
Figure 2.5: Technology Acceptance Model (Davis, 1989) 47
Figure 3.1: Unit of Analysis 66
Figure 4.1: Association of cases..... 69
Figure 4.2: MoH division of IT structure 71
Figure 4.3: Healthbridge Public Hospital: IT structure 74
Figure 5.1: Duality of structure (Giddens, 1984) 76
Figure 6.1: Access and Interaction with Healthcare Big Data..... 112
Figure 6.2: Mobile systems for healthcare big data..... 117
Figure 6.3: Mapping of result 124
Figure 6.4: Technology Acceptance Model (Davis, 1989) 124
Figure 6.5: Mobile systems integration for accessing big data 126
Figure 6.6: Unified Architecture Framework for healthcare big data 131

LIST OF TABLES

Table 3.1: Ministry of Health participants..... 61
Table 3.2: Windhoek community participants..... 61
Table 3.3: Healthbridge Public Hospital participants 62
Table 3.4: Documents Obtained..... 63
Table 5.1: Dimensions of the Duality of MoH structure..... 79
Table 5.2: Duality of HPH Structure 96

GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
Mobile systems	Referring to laptops, mobile phones and tablets
Architecture	A design of components and their interrelationships
HIS	Health Information Systems
IT	Information Technology
IS/IT	Information Systems/Information Technologies
ST	Structuration Theory
TAM	Technology Acceptance Model
UAF	Unified Architecture Framework
MoH	Ministry of Health
HPH	Healthbridge Public Hospital

CHAPTER 1
INTRODUCTION TO THE STUDY

1.1 Introduction

This Chapter introduces the entire study from chapter 1 to 7. As the first chapter of the study, it presents the research background, problem, aim, objectives, and questions. Also introduced in this chapter are the literature review and research methodology. The literature review is presented in more details in chapter 2. The research design and methodology are comprehensively explained in chapter 3. The remainder of this Chapter covers the delineation of the study, significance of the study, ethical considerations that were followed in the course of the study and the structure of the thesis. Finally, the conclusion of the Chapter is drawn.

1.2 Background

The Namibian healthcare industry is considered to operate complex systems, which is influenced by its cultural and geographic spread and diversity. According to Iyamu and Hamunyela (2014: 262), "the Namibian healthcare levels of operandi cover both rural and urban areas following the fourteen political and administrative regional demarcations of the country". The levels of operandi consist of both public and private facilities, which has unconsolidated data and unintegrated systems. Additionally, many of the systems are lacking flexibility and scalability, which affects the storage and accessibility of data.

The Ministry of Health (MoH) and Healthbridge Public Hospital (HPH) are the main healthcare service providers in the country. Hamunyela and Iyamu (2016:47) report that "the Ministry of Health and Social Services (MoHSS) is the leading organisation in Namibia when it comes to healthcare provision". The Healthbridge Public Hospital (HPH), which is based in Windhoek, is a referral hospital. Patients from across the country, who require healthcare services and could not be attended to at regional hospitals, are often referred to central hospital in Windhoek. Thus, the patients' data grow rapidly, but services get worse in terms of response time and diagnoses.

This could also be attributed to the fact that the public healthcare organisations' data are unorganised and scattered all over the environments, hence challenges and delay in patients' diagnoses and treatments. It is reported by Iyamu and Hamunyela (2014:54) that "healthcare records in Namibia public hospitals are not centralised and visualised, making accessibility into patient's record difficult or impossible". The situation has become even more complex considering the increase of various types of data, such as images, videos, texts, and voices,

being collected. Thus, the hospitals are dealing with voluminous data sets that they are unable to manage in order to offer quality healthcare services

Moreover, the government as a stakeholder in healthcare services delivery, through the MoHSS, attempts to address this problem by implementing a Healthcare Integrated System. Shaanika (2016:262) reports that "a Health Information System (HIS) called Integrated Healthcare Information Management System (IHCIMS) was implemented at the central hospital as part of the MoSS initiatives to eradicate manual processes and improve healthcare service delivery". However, the system did not work or did not fulfil its objectives, which was attributed to both technical and non-technical factors, such as flexibility and scalability. Karon (2016:176) reports that "IHCIMS was not fully being utilised by all actors due to integration challeges". Thus, public hospitals' data management challenges persist.

1.3 Problem statement

Globally, healthcare is one of essential human needs. Healthcare is also one of the many indicators that is used to determine a country's economic growth. According to Taz et al. (2016), a proper healthcare system and its management is imperative to ensure a healthy body, healthy community, and a healthy nation. Thus, governments of countries, including Namibia, build hospitals, clinics, and other primary healthcare facilities, which are dedicated to providing and improving healthcare services. Abor (2013) asserts that the primary aim of hospitals and healthcare centres are to take care of the public health. Through these services, healthcare data grow increasingly large. 'Big data' is the term used to describe the rapid growth of data, which come from various sources in an organisation. Ohlhorst (2012) defines 'big data' as a situation in which data sets have grown to such enormous sizes that conventional Information Systems/Information Technologies (IS/IT) can no longer process them effectively.

Through its use, big data are intended to improve healthcare service delivery to the patients. However, this is not the case, as it seems to contribute more challenges than benefits. This could be attributed to the fact that growth in healthcare data results in consumption of more storage space, increases in sources and velocity, and it is therefore difficult to manage (Ohlhorst, 2012). According to Patil and Seshadri (2014), the healthcare industry is witnessing an increase in sheer volume of data in terms of complexity, diversity, and timeliness. Liu and Park (2014) explain that a single patient's stay generates thousands of data elements which includes diagnoses, procedures, medications, medical supplies, digital image, lab results, and billing.

Furthermore, big data consist of high volume of structured, semi-structured, and unstructured data. All types of data structures need to be processed and managed in order for healthcare organisations to offer efficient services. Managing such data can be challenging as the existing IS/IT systems are not capable of handling large amount of the data being generated. Zhang et al. (2013) argue that processing big data by traditional methods is too complicated and time-consuming. Big data, therefore, require architecture to improve its use within context.

Due to healthcare increasing essentiality to the public, innovation and approaches, such as IS, have been integrated to improve its services. According to Lulembo and Silumbe (2016:3), "IS strive to efficiently collect, format, and communicate information to a wide variety of people". Karon (2016:170) mentions that "there are many factors, of technical and non-technical nature that impact the utilisation of health IS, especially in the public healthcare sector, particularly in many developing countries". Subsequently, governments invest technically and non-technically in their healthcare systems, with the overall aim of providing better and improved healthcare services. According to Horner and Coleman (2016:134) "where health information systems have been implemented in developing countries, there are often challenges of data quality and lack of information management skills". A study conducted by Lulembo and Silumbe (2016) reports that in Zambia, even the largest hospitals are still operating on paper-based systems.

Nowadays, IT has become so portable that services can be delivered and accessed as people move from one geographical location to another. This is enabled by the advancements in mobile technologies that resulted in the development of mobile systems, which has the capabilities and availability of wireless networks (Berri, 2014). This increases availability and stability of healthcare mobile systems, through architecture enablement. Labrique et al. (2013) argue that with differing architectures, a number of health mobile systems projects have not been successfully implemented in the healthcare settings and adopted by users. This, in turn, has contributed to more complexity and disparity in the accessibility, consolidation, and management of big data in many environments.

Due to complexity, the use of mobile systems to access and manage healthcare big data is challenged, which affects big data usefulness for service delivery. Thus, unified architecture, which can enable the integration of both mobile system and healthcare big data, is required. According to Ahsan et al. (2009), the architecture is the description of the set of components, their interaction, and their relationships in a given domain. The unified architecture provides universal flexibility and scalability for integration and management.

1.4 Research problem

As in many other environments, there are different types of data sets within healthcare environments, which include video, images, texts, and audio. These sets of data increase in size and velocity making it big data. As big data increase in size, variety, and velocity, it becomes more complex and challenging to use or manage, which affects its accessibility and usefulness. This type of situation with big data is common within the healthcare environments, particularly in many African countries, such as Namibia. The complexity and challenges can be classified into five main categories: (i) inaccuracy of data sets flow. (ii) deficiency in information sharing between actors: practitioners-to-patients, practitioner-to-practitioner, (iii) flow of incomplete data sets, (iv) the use of various incompatible systems, to access healthcare data, and (v) low response time. These challenges are due to lack of flexibility, scalability, and poor integration between the healthcare big data and the information systems, such as mobile systems that are used to access them. These challenges become bigger problems as they manifest in decision-making and diagnoses, which affect human lives.

Thus, big data are considered to be highly critical and important in the delivering of healthcare services. It is therefore defined by factors, such as accessibility, usefulness, and management. Kearny et al. (2016) asserts that due to the increase in volume and diversity of available data, organisations are challenged with storing, managing, and processing data into useful information. Fernández-Alemán et al. (2013) found that the increasing volumes of health data from various sources are stored fragmentedly across different locations and systems. In Namibia, the situation is even worse as the big data are often unstructured and scattered within public hospital environments. Karon et al. (2015) reports that healthcare systems in Namibia is characterised as slow and incompetent by its users as the acquisitions of data have gone from difficult to impossible as hospitals struggle with none centralised systems. Thus, the healthcare organisations seek different ways through which they can access, use, and manage the various forms of data.

Therefore, this study aims to propose a solution that can be used by the healthcare facility in Namibia, to ease access to patients' big data. Otherwise, the problem and challenges as articulated above will persist.

1.5 Research questions

From the research problem as articulated above, the main and sub-research questions were formulated as follow:

Main research question

How can a big data perspective inform the development of a unified architecture, integrating mobile systems and healthcare data, to improve service delivery within the Namibian environment?

Sub- research questions:

i. What are the factors that influence the use of mobile systems in accessing healthcare big data for service delivery in the Namibian environment?

ii. What are the factors that can be used to guide and enable integration between health mobile systems and healthcare big data for improved healthcare service delivery?

1.6 Research aim and objectives

In alignment with the main and sub-questions as presented above, the aim and objectives are formulated below. The aim is the bigger picture of what the researcher intended to achieve.

Aim

To develop a unified architecture, which can be used to enable scalability and integration of healthcare mobile systems with healthcare big data.

The unified architecture framework is intended to guide the development of healthcare mobile systems and ease of scalability, accessibility, usability and manageability of healthcare big data. The mobile system is used as the medium through which stakeholders can interact with the healthcare big data

Sub-objectives

To examine and understand:

i. The factors that influence how healthcare big data are accessed, using mobile systems in the Namibian environment.

   Even to the practitioners and general stakeholders, it is difficult to understand how and why healthcare big data are accessed, used, and managed in the way that they currently do. This objective helped the researcher gain deeper understanding in order to be able provide a solution that can improve service delivery.

ii. The factors that could impact the interaction and integration between health mobile systems and healthcare big data in service delivery.

The interaction between the mobile systems and healthcare big data consists of both technical and non-technical factors, which is always a challenge, and will continue to do so if it is not addressed. This objective helped the researcher to understand factors that impact and enable ease of scalability and flexibility between health mobile systems and healthcare big data, for improved services within the Namibian environment.

1.7 Significance of the study

This study is of significance to the academics and practioners. This is due to the relevancy of the study to the two groups.

From an academic perspective, much has been researched and written on big data. However, research on big data in the area of healthcare, especially in developing countries, has been lagging. This study contributes to academics by filling this gap by adding to existing literatures through the study's findings. The study also brings forth the application of two different theories, Structuration Theory (ST) and Technology Acceptance Model (TAM). At the time of this study, the application of ST and TAM in the same study was not found. Thus, the combination of ST and TAM brings uniqueness to this study. The complimentary use of theories is always a challenge especially to upcoming researchers. In this study, the complimetary use of these two theories aims to help scholars in understanding where one theories ends and where the other begins to fill the gaps that the first theory created.

From the practioner's view, this study, through its findings, enlightens both medical practitioners and IT managers on the criticicality of developing and implementing an architecture for data management. Importantly, this study contributes to enterprise architecting as there are only few studies related to architecture in the healthcare domain. The findings can also enable policy developers and decision makers to understand how mobile information systems can be used as a tool for data management in healthcare. Moreover, management can benefit from the findings of analysis in terms of the factors that contribute or impact systems adoption and resistance. Based on that, management may be in a better position to assess both technical and non-technical factors before implementing information systems and supporting technologies.

1.8 Delineation of the research

This study focused on healthcare data management within the Namibian governement hosptials. As a result, a referal public hospital, HPH and MoH were selected as cases. MoH is resposbile for supprting and managing public hospitals in terms of the procedures and all

resources required for healthcare services delivery. The study focused on the developement of a unified architecture for health mobile systems and big data interaction.

1.9 Literature review

Based on the scope of the study, which includes the problem statement and research aim, areas of focus were identified. This includes Information Systems/Information Technologies (IS/IT), mobile systems, healthcare, big data, and architecture. As such, the relevant literature was consulted in these areas. Also covered in this section are the two theories, structuration theory (ST) and technology acceptance model (TAM), which underpinned the study. This literature review provide a brief context to the study in order to understand the research problem. A detailed literature review is presented in chapter 2.

1.9.1 Information Systems/Information Technologies

Information Systems/Information Technologies (IS/IT) include the software and hardware used by organisations to automate business processes. Lulembo and Silumbe (2016:3) state that “IS constitutes a number of components, and hardware, software and network are the most common components”. Zaydi and Nasserddine (2016) assert that IS/IT is the cornerstone for value delivery and their unavailability have undeniable human impacts. Therefore, it has become difficult, if not impossible, for many organisations to operate successfully without IS/IT. According to Jairak et al. (2015), IS/IT have become a vital and integral part of many individuals and industries. Thus, organisations are frequently incorporating various IS/IT in all aspects of their business activities (Amin et al., 2016:501). Kitsios and Kamariotou (2016) report that with the use of IS/IT, organisations customise services and adapt to customer needs.

However, deploying IS/IT do not always bring benefits, due to the associated challenges. The challenges are attributed to the complexity of technical and non-technical factors that make up IS/IT. Firmansyah and Bandung (2016) explain that most often the unpredictable changes in IS infrastructures can cause disruptions to services in organisations. The challenges and complexities could also be attributed to the components of IS, which are often unpredictable. According to Shalannanda and Hakimi (2016), IS consist of people’s efforts, processes, and information technology which are different in characteristics, but which interact to support an organisation’s needs. Zaydi and Nasserddine (2016) explain that the environment and technology are constantly changing and IS/IT are increasingly exposed to uncontrollable risks, which are other factors of complexities. Thus, the effective use of IS/IT requires IT governance (Ping-Ju Wu et al., 2015).

Nonetheless, with various challenges encountered, organisations continue to rely on IS/IT for effective services delivery. For example, the utilisation of mobile systems has become a common tool in processing and sharing of data across organisations' units and their customers. Filho and Aquino (2016) share that many IS/IT are changing to mobile computing context and provide ways to make their data available through mobile applications. Mobile systems used in the healthcare sector are referred to as health mobile systems.

1.9.2 Health mobile systems

Mobile systems are increasingly the focus of many individuals and organisations including healthcare. In this study, mobile systems refer to portable systems, such as cellular phones, tablets, and laptops, with the capability of connecting to various network types. Ayed et al. (2016) explain that due to the application of mobile systems in dynamic environments, they enable users to carry out a variety of activities in differing situations. For instance, health mobile systems enable physicians to monitor patients' blood levels and prescribe the necessary medicines even if they are not at the hospital.

Lin et al. (2015) assert that the computing landscape is undergoing a massive transition from stationary desktops to mobile systems. It is argued that the mobility feature of mobile systems is changing the way people use different technologies all over the world (Tawalbeh et al., 2016). People are no longer confined to their physical environments when carrying out activities but rather tasks are carried out simultaneously in comfort anywhere in the world. Jeong et al. (2016) explain that in the post personal computer (PC) era, a flood of mobile systems has emerged, using devices such as smartphones and tablets. Moore (2009) discusses mobile systems with two different devices: (i) laptop and mobile computers; and (ii) the wearable computing devices, such as mobile phones, smart phones, and personal digital assistant (PDA) which can be used in a wider range of environments, as users move from one geographical place to another.

Dahal et al. (2016) note that the application of mobile systems sharing of information in the form of audio, video, and images through mobile devices has been overwhelming. Tawalbeh et al. (2016) explain that this higher penetration is due to the many tasks mobile systems perform in our lives, such as location determination, time management, image processing, booking hotels, selling and buying online, and staying connected with others. Kumar (2013) describes mobile systems as useful and user friendly primarily because of their information retrieval ability from many information repositories, such as web, database, and cloud, from anywhere through wireless channels. As a means to provide healthcare to individuals, wireless

systems are routinely used to collect, store, retrieve, display, and transmit data (Justice et al., 2009).

Clemons et al. (2013) argue that initially, mobile systems offered limited features, such as audio and text communication. Nowadays, mobile systems have evolved into complex structures capable of running sophisticated integrations. It is believed that due to the mobile systems' power and ubiquity, there have been changes in the way users use or interact with them (Sharma et al., 2013). Due to their benefits, mobile systems are being widely used in various industries. Healthcare is one of the many industries that can benefit from the utilisation of mobile systems.

1.9.3 Healthcare

The healthcare industry is concerned with people's health and wellbeing. As an industry, healthcare strives to prevent illness, cure diseases, and ensure effective and efficient healthcare service delivery to its patients. Nemutanzhela and Iyamu (2016:102) elaborate that "healthcare focuses on diagnoses, such as treatment, and prevention of disease, illness, injury and other physical and other mental impairments". However, these healthcare processes are complex and challenging due to the many technical and non-technical factors that are involved. Addressing challenges such as data management in the healthcare industry is an everyday task. As stated by Lulembo and Silumbe (2016), management of patient data and information is one of the many issues affecting service delivery.

Healthcare is a data intensive industry, as such patient's visits to hospitals often leads to the generation of various types of data to ensure effective service delivery. It is reported that "healthcare industries store a massive amount of sensitive personal data, such as patient names, dates of birth, and personal medical records" (Mohammed et al., 2015:191). Furthermore, healthcare service delivery is a very fragile and sensitive matter as it involves people's lives. Therefore, due to healthcare's sensitive nature. it is critical to ensure appropriate data management and prevent erroneous processes that could hamper the data integrity. Shaanika (2016) acknowledges that due to the sensitivity of patients' data, healthcare services providers require more adequate, reliable, and accurate information.

Healthcare, like many other sectors, has grown rapidly with the introduction of Information Systems (IS) (Tawalbeh et al., 2016). Information systems used to support healthcare services are often called Health Information Systems (HIS). HIS and supporting technologies, such as electronic medical record (EMR), are being deployed in healthcare with the purpose of improving healthcare services delivery, data management, and costs reduction. According to

Tawalbeh et al. (2016) the major drivers for IS/IT-based healthcare are the demands for increased access to quality of healthcare, system inefficiencies, variations in quality of care, and high prevalence cost of medical errors. According to Ni et al. (2015:173), “HIS supports healthcare services more efficiently through both preventive and medical cares, rehabilitation, and health education”.

Providing healthcare services via mobile systems would be advantageous in many aspects such as accessing health medical records any time and keeping record of healthcare data (Boontarig et al., 2014). These will enable patients and healthcare providers to have access to health information in real time, thereby enabling making improved decisions.

1.9.4 Big data

Big data are about volume and velocity. Even though big data have been around for a long time, there seem to be different definitions for it. According to Zhang et al. (2016), big data refer to large-scale data sets that cannot be captured, managed, or processed by common software tools. Wang et al. (2015) state that big data were first defined in terms of the volume, velocity, and variety (the three Vs) of its data. Rahman and Slepian (2016) also affirm volume, variety, and velocity as the essence of big data. Din et al. (2015) explain that big data assets are difficult to aggregate, store, process, and analyse using existing traditional technologies. Big data systems are, therefore, known for managing high volume data, high velocity, and/or high variety information assets (Jiang et al., 2016).

Figure 1.1 below illustrates the three Vs of big data. The three Vs are considered by many as the main components of big data and they are likely to appear in one’s definition of what is big data.

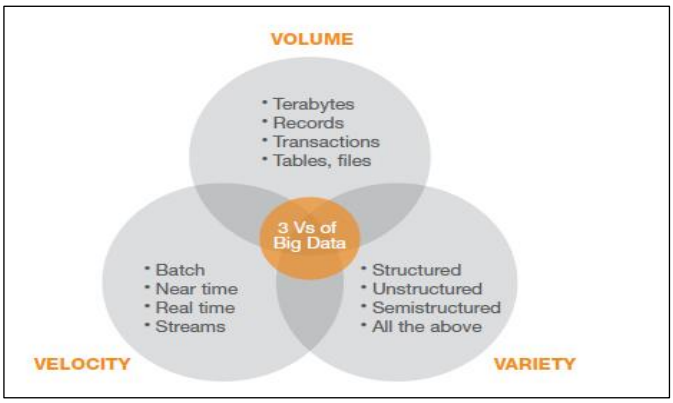

Figure 1.1: The three Vs of big data (Russom, 2011)

Volume is viewed as a key characteristic of big data and most organisations define big data in terabytes or petabytes (Russom, 2011; Roski et al., 2014). According to Manovich (2011), big data sizes range from a few dozen terabytes to many petabytes of data in a single data set. Wu et al. (2014) argue that one of the fundamental characteristics of big data is the huge volume of data represented by heterogeneous and diverse dimensionalities. The heterogeneity of data is due to the many different mediums through which data is collected.

As one of the characteristics of big data, variety represents the various sources of big data. According to Russom (2011), one of the things that makes big data really big is that it is coming from a greater variety of sources than ever before. In healthcare, these sources include medical imaging, audio and video files, emails, and all data collected from healthcare supporting systems. Shu (2014) affirms that the sources of big data are everywhere and databases, documents, emails, phone records, meters, sensors, images, audio and video files, and financial transactions are examples of sources.

Velocity is the frequency of data generation or the frequency of data delivery (Russom, 2011). The speed at which data is collected, stored, processed, and managed illustrates organisations' ability to respond and act on business processes urgently. It is pointed out that for many applications, the speed of data creation is even more important than volume, and real-time or nearly real-time information makes it possible for an organisation to be much more agile than its competitors (Ahmad et al., 2002). In addition to the three Vs, known as the general features for describing big data, some organisations describe big data as the five Vs. According to Runciman (2014) and Chen et al.(2016), big data are also characterised by veracity and value, adding to volume, velocity and variety.

Big data veracity refers to the legitimacy of the data being collected and stored. The question is whether healthcare is collecting the right information and whether the organisations can depend on it to make informed decisions. Kearny et al. (2016) affirm that data used in organisations to make decisions is not always trustworthy or relevant to the problem at hand. Big data veracity is influenced by the collection and management techniques used. The value of big data is determined by its usefulness. This first requires big data processing. It is believed that a piece of data finds its value in its use and that organisations are aware that they are far from using all the data at their disposition (Iafrate, 2015).

While big data can yield extremely useful information and insights, it also presents new challenges with respect to data storage, data management costs, whether the data will be secure, and how long it must be maintained (Michael & Miller 2013). Wu et al. (2014) discuss that while the volume of big data increases, so do the complexity and the relationships underneath the data. Consequently, traditional data models are incapable of handling complex data in the context of big data (Wu et al., 2014). Hence, the storage of this voluminous data requires huge storage devices (Ragothaman et al., 2016).

As a result, healthcare organisations need to invest in computing infrastructures capable of handling these data sets. Iafrate (2015) argues that processing these data sets (its volume and its format) is another problem. According to Nepal et al. (2015), managing large, heterogeneous, and rapidly increasing volumes of data, and extracting value out of such data have long been challenging. Tawalbeh et al.(2016) state that some big data could be processed offline, but other applications need real-time processing for this data. According to Roski et al. (2014), for healthcare organisations to rely on big data, enabling IT infrastructure has to be available. With this in mind, the adoption and innovation of medical technologies and IS hold great promise to reduce costly healthcare treatment and resolve unnecessary errors.

1.9.5 Architecture

Architecture is the logical plan and design of an object. It illustrates the interrelationships of the various components that constructs the object. According to Bernard (2012), an architecture represents a structured framework for the analysis, planning, and development of all resources in an entity. Tupper (2011:13) describes that “architecture is an abstracted framework or outline that provides guidelines for the construction from the beginning to the end”. An architecture enables organisations to design their current business processes and envision future business processes. Thus, it is important to view architectures as living subjects that are dynamic in their growth according to the changes in the environment (Tupper,

2011). Architecture is, therefore, an ongoing process that must be regarded as a vehicle through which organisations should accommodate changes and evolve.

Within Information Systems/Information Technologies, there are different domains of architecture. This includes data, application, and technology architectures (Bakar & Selamat, 2016). As an architecture domain, data architecture describes organisational data needs, different data types, and their flow across business units. According to Kearny et al. (2016), data architecture structure the organisation's physical and logical data management resources and data assets. Data is shared, communicated, and managed across an organisation's units through applications. Therefore, the application architecture model specifies how organisations' applications are designed and developed and how they interact with each other. Applications are supported by technological infrastructures. Kearny et al. (2016) discuss that the technology architecture provides the description of the hardware and software capabilities required to support the deployment of different services. The domains of architecture are dependent on one another to ensure organisations' effective operations.

Due to the criticality of data, it is important for organisations to develop and implement data architectures to guide the collection, storage, retrieval, and management of big data. It is believed that the way data is collected, processed, and stored has resulted in the area of study called data architecture (Inmon & Linstedt, 2014). As an architectural domain, data architecture provides a holistic understanding of the organisational data in terms of collection, processing, and storage, and their flow across the business units. Wang et al. (2005) assert that to recognise the potential benefits of big data, it is fundamental to understand its architecture and component functionalities. According to Inmon and Linstedt (2014), there are many efforts that are necessary in understanding data architecture, which are i) the physical manifestation of data, ii) the logical linkage of data, iii) the internal format of data, and iv) the file structure of data. These factors aided the researcher in examining the structure and management of healthcare big data in Namibia.

1.9.6 Underpinning theories

Two theories, Structuration Theory (ST) and Technology Acceptance Model (TAM), were selected to underpin the study. These two theories guided the study from two different perspectives, namely: data analysis and the interpretation of findings.

1.9.6.1 Structuration Theory

Structuration theory focuses on the evolution of social structure through on-going interactions of people with one another and the social institutions which they are part of (Whitman &

Woszczynski, 2004). The theory focuses on the social factors which include agents and structure (Iyamu, 2013). According to Friedman and Starr (1997), agency and structure are the defining components for understanding human interaction within a society and of the explanation of social phenomena. The theory focuses on Agency. According to Giddens (2013:9),"agency refers not to the intentions people have in doing things but to their capability of doing those things in the first place". To be an agent means to be capable of exerting some degree of control over the social relations in which one is involved, which in turn implies the ability to transform those social relations to some degree (Sewell, 1992).

Giddens (1984) argue that power itself is not a resource, but resources are media through which power is exercised. According to him, resources can be classified into two types, authoritative and allocative. Sewell (1992) assert that authoritative resources are the human resources and allocative resources nonhuman resources. As such, non-human resources are objects, animate or inanimate, naturally occurring or manufactured, that can be used to enhance or maintain power while human resources are physical strength, dexterity, knowledge, and emotional commitments that can be used to enhance or maintain power (Sewell, 1992).

Structure refers to rules and resources (Giddens, 2013). Sewell (1992) posits that structures are virtual and are only put into practice in the production and reproduction of social life. It explains further that structures do not exist concretely in time and space except as memory traces, the organic basis of knowledgeability, and as they are instantiated in action (Sewell, 1992). Structures both enable and constrain social actions (Fuchs, 2003). Giddens (2013) define action to be a continuous process, a flow, in which the involuntary monitoring, which the individual maintains, is fundamental to the control of the body that actors ordinarily sustain throughout their day-to-day lives. Rose and Scheepers (2001) defines structuration as the process whereby the duality of structure evolves and is reproduced over time and space.

i. Duality of structure

Agency and structure are interrelated, and all social systems are comprised of agents and structures (Friedman & Starr, 1997). According to Whitman and Woszczynski (2004) social structures exists in the actions of human agents as they use existing structures and create new ones in the course of everyday life. Figure 1.2 below depicts the dimensions of duality of structure, describing the interaction between structure and human agents.

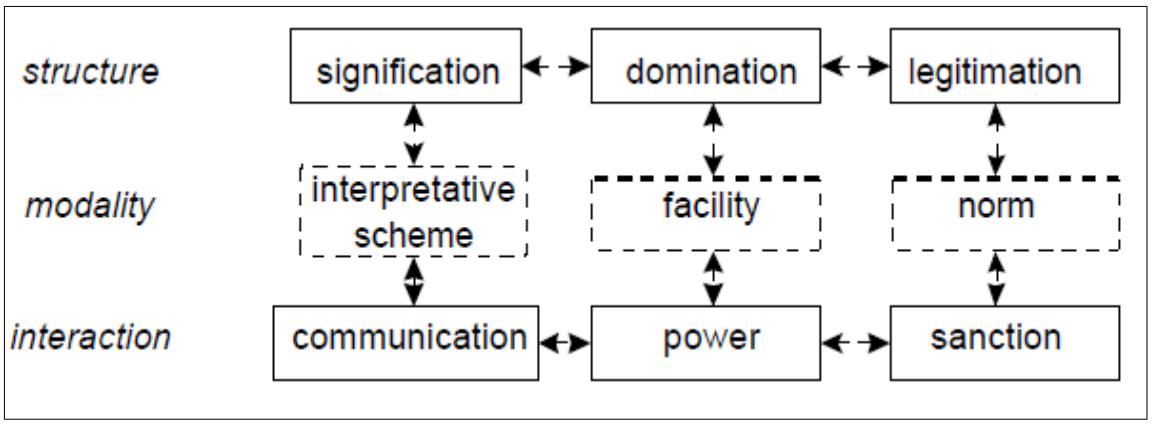

Figure 1.2: Duality of structure (Giddens, 1984)

Social structure and human interaction are broken down into three dimensions and the recursive character of these dimensions is illustrated by the linking modalities (Rose, 1998). Giddens (1984) highlights three characteristic forms of interaction in which agency is performed: communication, the exercise of power, and sanction. These three forms of interaction are analytically associated with three corresponding structural dimensions of social systems: signification, domination, and legitimation.

When human actors communicate, they draw on interpretive schemes to help make sense of interactions; at the same time those interactions reproduce and modify those interpretative schemes which are embedded in the social structure as meaning or signification. Similarly, the facility to allocate resources is enacted in the wielding of power and products and reproduces social structures of domination, and moral codes help determine what can be sanctioned in human interaction, which iteratively produce structures of legitimation (Rose & Scheepers, 2001).

1.9.6.2 Technology Acceptance Model

Organisations invest in IS/IT, and expect economic return and enhanced productivity (Tang & Chen, 2011). However, technology is not always accepted by its users. The technology acceptance model (TAM) is one of the models used to study factors that lead to acceptance or rejection of IS in organisations. The model was first proposed by Davis (1989:320), who argued that "valid measurement scales for predicting user acceptance of computers are in short supply". According to TAM, technology acceptance is dependent on two variables: perceived usefulness and perceived ease of use. Davis (1989:320) defines perceived usefulness as

The degree to which a person believes that using a particular system would enhance his or her job performance and perceived ease of use to be the degree to which a person believes that using a particular system would be free of effort.

Adding unto this definition, Gu and Liu (2011) state that the perceived usefulness indicates how one person considers the depth of improving his work accomplishment using a concrete system and the perceived ease of use indicates how easy one person considers using a concrete system. Based on how the users perceive a system to be useful and easy to use, they develop attitudes and behaviours towards actual systems use. The perceived usefulness and ease of use of the system is influenced by external factors. Therefore, the purpose of TAM is to provide a basis for discovering the impact of external variables on internal beliefs, attitudes, and intentions (Davis, 1989). The figure below depicts TAM.

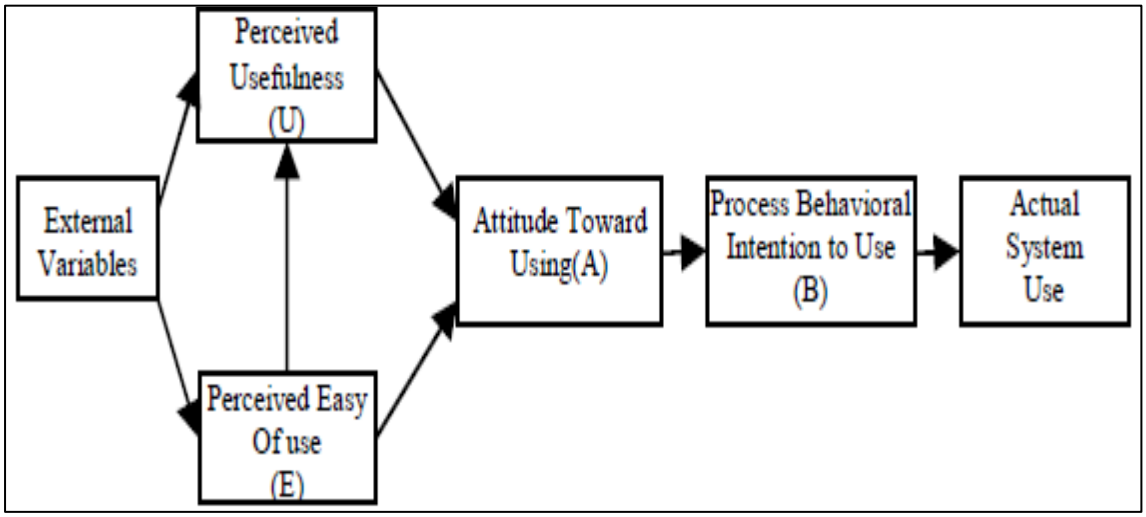

Figure 1.3: Techology Acceptance Model (Lee et al., 2012)

1.10 Research design and methodology

Research is not carried out in vacuum. A researcher needs to follow designs and apply methods to resolving problem and achieving its objectives. According to Taylor et al. (2015:3), “methodology is the way in which we approach problems and seek answers”. Thus, research design and methodology are vehicles through which research objectives can be achieved, and, they should be appropriately selected. This section discusses the research philosophy, strategy, design, data collection techniques, and data analysis that are applied in the study.

1.10.1 Research philosophy

Research philosophy defines the school of thought under which selected research designs and methods belong to. The research philosophy selected influence how the researcher will approach the study in order to achieve defined objectives. Moon and Blackman (2014) explain

that philosophy provides both the natural and social sciences with the general principles of theoretical thinking, whether ontological or epistemological.

Ontology is concerned with the existence of objects. According to Gray (2013:19), “ontology is the study of beings, which includes the nature of existence and what constitutes reality”, which this study seeks to establish in developing unified architecture. Therefore, ontology tries to answer questions of what exists and the reality of its existence. Meanwhile epistemology is concerned with the study of knowledge. According to Gray (2013:19), epistemology provides “a philosophical background for deciding what kinds of knowledge are legitimate and adequate”. Bryman and Bell (2015) state that epistemology concerns the question of what is or should be regarded as acceptable knowledge in a discipline. Knowledge legitimacy is represented differently across the various epistemological paradigms which include positivism and interpretivism.

Positivism holds that methods of the natural sciences are appropriate for social enquiry because human behaviour is governed by law-like regulates, and that it is possible to carry out independent, objective, and value-free social research (Ritchie et al., 2013:24). According to Moon and Blackman (2014), positivism is objectivist as it is based on the conviction that only knowledge gained through the scientific method through the unbiased use of the senses is accurate and true. Therefore, positivism epistemology is about objective rather than subjective statements and only the objective statements are seen to be proper way of research (Greener & Martelli, 2015).

On the other hand, interpretivists argue that natural reality and the laws of science and social reality are different and, therefore, require different kinds of methods (Gray, 2013:23). Interpretivists view the world as socially constructed, meaning that knowledge is available only through social actors (Eriksson & Kovalainen, 2015). Ritchie et al. (2013:22) assert that “interpretivism emphasise the importance of understanding people’s perspectives in the context of the conditions and circumstances of their lives”. Therefore, interpretivism is an epistemological view associated with subjectivism.

This study followed an interpretivism philosophy to study mobile systems’ interaction with big data in Namibian public hospitals. The selection of interpretivism paradigm is guided by the study objectives which are to examine and understand (i) factors that influence how healthcare data is accessed, used and managed in the Namibian environment, (ii) the factors that could impact the interaction between mobile systems and healthcare big data in service delivery.

In order to achieve the study objectives, it requires the researcher to engage with healthcare environments and interact with the actors. This is necessary to understand the subjective meanings, which patients and practitioners, including the IS/IT personnel, associate with the various activities in the use of healthcare big data to provide and receive services.

1.10.2 Research approach

A research approach may involve deductive or inductive reasoning (Saku & Ketokivi, 2013; Bryman & Bell, 2015). According to Bhattacherjee (2012), deductive research is theory testing research, while inductive research is called theory building research.

In deductive research, the researcher tests concepts and patterns known from theory using new empirical data (Bhattacherjee, 2012). Creswell (2013) adds that with the objective, deductive research tests rather than develops a theory; therefore, the researcher advances a theory, collects data to test it, and reflects on its confirmation or disconfirmation by the results. Thus, deductive process uses evidence in support of a conclusion whereby a hypothesis is first developed, and evidence is then collected to confirm or reject it (Ritchie et al., 2013:6).

Inductive research is often associated with qualitative research. “An inductive approach starts by looking at the focus of research and through investigation by various research methods, aims to generate theory from the research” (Greener & Martelli, 2015:19). Ritchie (2013) argues that induction reasoning is a bottom-up process through which patterns are derived from observations of the world.

This study employed inductive reasoning. This is primarily because there was no testing of any concepts; instead the focus was on developing a theory in the form of a unified architecture framework.

1.10.3 Research strategy

Research strategy represents the umbrella under which the selected research designs, methods, and techniques are covered. Qualitative method or quantitative method or mixed method are used in research, often as strategy. Moreover, Bryman and Bell (2015:38) explain that “each strategy is different in terms of the role of theory,epistomological issues, and ontological concerns” .

1.10.3.1 Quantitative research method

Researchers employ the quantitative method primarily for measurement purposes in their studies (Bryman & Bell, 2011). According to Denzin and Lincoln (2011:8), "quantitative research emphasises the measurement and analysis of causal relationships between variables, not process". As a result, quantitative research tends to be confirmatory and deductive (Atieno, 2009; Bryman, 2012). Quantitative studies often begin with a hypothesis and variables that need to be tested and the results obtained are used for generalisation. In IS, the methods have been used more for confirmatory studies, such as theory testing, as explained by Venkatesh et al. (2013).

Quantitative methods are usually considered to be underpinned by a positivist thinking (Conboy et al., 2012). Researchers from the positivist background argue that reality should be studied objectively by the researchers who should put a distance between themselves and what is being studied (Yilmaz, 2013). Positivists assume that behaviours can be observed and objectively measured and analysed (Chris & Jones, 2010).

1.10.3.2 Qualitative research method

Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena (Taylor et al., 2015) . Qualitative researchers do not view reality as fixed, but instead try to understand individuals in order to bring a unique perspective to the way they see and comprehend the world around them (Nollaig, 2011). Taylor et al. (2015) explain that when researchers reduce people's words and acts to statistical equations, they will lose sight of the human side of social life. Therefore, qualitative research aims to capture meanings or qualities that are not quantifiable, such as feelings, thoughts, and experiences (Chris & Jones, 2010). In an attempt to achieve these aims, qualitative studies are carried out in the natural environment of subject(s). Researchers, such as Atieno (2009) and Bryman and Bell (2011), pointed out that the best way to understand the behaviours and meanings of a phenominon is to become part of its natural environment. Methods that belong to qualitative research strategy are, therefore, designed to help us understand people, social, and cultural contexts within which they live (Myers & Avison, 2007).

Conboy et al. (2012) describe qualitative approaches as being associated with an interpretivist stance. According to Chris and Jones (2010), interpretive approaches allow the researcher to explore and uncover explanations, rather than deduce them from measurements. To qualitative researchers, each individual experiences the world from their own point of view; therefore, each of us experience a different reality. Qualitative researchers are keen to provide

considerable descriptive details in that they typically emphasise the importance of the contextual understanding of social behaviour (Bryman & Bell, 2011; Nollaig, 2011).

Based on this study's objectives, qualitative methods were employed. Qualitative methods enabled the researcher to gather different views, opinions, and seek clarity from the individuals that access, use, and manage health mobile systems and health big data .

1.10.4 Research design

Research strategies are associated with different kinds of research design (Bryman & Bell, 2011). Yin (2003) defines a research design as the list of procedures that connects the empirical data to a study research questions and ultimately to its conclusions.The study employed case study as research design. The research design was selected based on the study objectives.

1.10.4.1 Case study design

A case study is a detailed exploration of a specific case, which could be a community, organisation, or person (Bryman & Bell, 2015). Case study is versatile in that it can be used with any philosophical perspective whether it is positivist or interpretivist (Dube & Pare, 2003). Swanson and Holton (2005) describe case study to be very appropriate when the researcher is interested in processes or seeks an in-depth understanding of a phenomenon because of its uniqueness. A case can be an individual or it can be a group, such as a family or a class, or an office, but one can also study multiple cases (Woodside, 2010).

A study by Benbasat et al. (2007), summarises three reasons why case study is applicable in IS studies: (1) the case study approach enable the researcher to generate theories from practise by studing IS in a natural setting, (2) It enable the researcher to answer the "how" and "why" questions needed to understand the nature and complexity of the processes, and (3) with the rapid change in IS field, a case approach is the appropriate way to research an area in which few previous studies have been carried out.

Two organisations participated in the study, namely, the Ministry of Health (MoH) which also included Windhoek community members and the Healthbridge Public Hospital (HPH) as cases. The primary rationale for selecting these cases include: (i) they are the main provider of healthcare services in the country, (ii) accessibility was granted, and (iii) proximity was added advantage. Based on the sizes and services, the cases were selected to enable a deeper understating of the actors' activities, interactions, and their behaviours which occur

within the healthcare environment. The Windhoek community was considered as part of the MoH case that represented public individuals that utilises mobiles systems to access, retrieve, and manage their healthcare data.

1.10.5 Data collection

Data collection is critical to research. The goal of data collection is to obtain a rich set of data surrounding the specific research issue, as well as capturing the contextual complexity (Benbasat et al., 2007). There are different types of data collection techniques, such as questionnaires, documentation, and interviews. In this study, semi-structured interviews and documentation are employed as data collection techniques for both cases. The choice of data collection techniques is influenced by the study aim and objectives.

1.10.5.1 Interview technique

Interviewing is regarded as the formalised method of interpersonal communication used for research (Nollaig, 2011). Armstrong (2009) postulated that interviews are important qualitative methods as as they enable factual data and insights into attitudes and feelings. Interviews are categorised according to structure and formality which can either be unstructured, structured, or semi-structured (Beaudry & Miller, 2016; Nollaig, 2011).

i Unstructured interview

The researcher conducting unstructured interviews does not prepare guiding questions before hand; rather, participants can share their views without being guided. Nollaig (2011) noted that with an unstructured interview, the participant directs the interview in its entirety. According to Armstrong (2009), this kind of interview provides greater insight into the interviewee's perspective as researchers avoid fitting participants into predetermined responses, but they can be inconsequential and lead to poor data that are difficult to analyse.

ii Structured interview

Structured inteview is one in which each participant is asked a series of questions according to a prepared and fixed interviewing schedule (Brace, 2013). Freebody (2006) adds that structured interviews restrict the domains of relevance of the research to a predertermined set of questions. This type of interview does not allow the researcher to collect data other than what is indicated in the interview guidelines. As concured by Freebody (2006), any materials outside of that domain of relevance are not sought, and are not taken into the compilation or analyses of the data.

iii Semi-structured interview

The dialogue in semi-structured inteview between the researcher and the interviewees is guided by a set of interview questions (Runeson & Höst, 2009). However, the order of interview questions is not always followed. Runeson and Höst (2009) concur that in a semi-structured interview, questions are planned, but they are not necessarily asked in the same order as they are listed. This approach enables the interviewer to phrase questions and vary their order to suit the special characteristics of each interviewee (Armstrong, 2009). Beaudry and Miller (2016) explain that in a good semi-structured interview, the interviewee does the most talking and the interviewer's job is to listen actively and only intervene when there is a need to paraphrase or ask the interviewee for more clarity. However, the interviewee can also ask the interviewer for more clarity on matters being discussed.

Semi-structured interviews support and enable flexibility during the interview dialogue. Both the interviewer and the participants can seek clarity from each other on the matters they do not understand or need further clarity.

The semi-structured interview was used as the main data collection technique in this study. Participants from Ministry of Health, Windhoek community members, and Healthbridge Public Hospital were interviewed about healthcare service delivery and the use of mobile systems in accessing and managing healthcare big data.

1.10.5.2 Documentation technique

Most often, researchers fail to include documents in their data; yet, documents can provide valuable data (Nollaig, 2011). Prior (2002) argues that without documents, there are no traces of social history. Documents do not simply reflect, but also construct social reality and versions of events (Blaxter, 2010). Documents regarding healthcare policies and procedures, data collection, and management in the Namibian public health sector were gathered during the interview process.

This study also employed documentation techniques to gather more insights regarding mobile healthcare systems and data collection, storage, accessibilty, and management in the Namibian public health sector. Using documantation as a data collection technique provided more explanation and clarification on some of the aspects that could not be elaborated in more details during semi-structured interview.

1.10.6 Data analysis

The data collected need to be analysed to associate meaning to them. As discussed above, data was collected using semi-structured interviews and documentation. Analysis of the data was carried out using a hermeneutic approach within the interpretive paradigm. Interpretivism focuses on reality as a human contrast which can only be understood subjectively (Kroeze, 2012). Bahari (2010) posits that with the interpretive approach, the findings are influenced by the researcher's perspectives and values.

The documents were also interpretively analysed as what the researcher read from the documents is a product of their view point. According to Blaxter (2010), documentation analysis proceeds by abstracting from each document those elements which are considered to be important or relevant and by grouping together these findings.

Duality of structure from Structuration Theory (ST) was used to guide analysis of the data. The theory was employed as a lens to enable the researcher to see beyond the normal settings as it could have been impossible to achieve the study's objectives without its application.

ST was used as a lens through which to examine the interaction that occur between systems, humans and procedures, from four different perspectives:

i. How structure (rules and resources) influences interactions and activities of the agents in the accessibility and use of big data to provide healthcare services in an environment. The agents include technical (such as medical apparatus, IS/IT artefacts and data) and non-technical (such as human and procedures);
ii. The roles of both technical and non-technical agents in the accessibility, usage, and management of healthcare data. This is to examine the enabling and constraining factors in the interaction with healthcare big data;
iii. How structure and agents influence the use of health mobile systems to access, and utilization of healthcare big data; and
iv. The interaction that happens between the agency and structure and how socially they manifest, to reproductively impact health mobile systems and healthcare big data.

The Technology Acceptance Model (TAM) was employed in the interpretation of the results. TAM as a lens was used to examine and understand the usability and acceptance of health mobile systems from three different folds:

i. The perceived usefulness and ease of use of health mobile systems in healthcare among different actors. System usefulness is different across systems users. TAM

helped to examine and understand how different actors view or perceive mobile systems and healthcare big data usefulness in providing services;

ii. How and why patients and practitioners make use of health mobile systems to access healthcare big data for services; and

iii. How mobile systems can be accepted and used in healthcare big data management. For technology systems to be accepted and used, they need to be useful by enabling users to perform their activities as they intend, with ease.

1.10.7 Units of analysis

Units of analysis represent the categories from which data was collected and analysed. In this study, the units of analysis were drawn from the two cases, Ministry of Health (MoH) including Windhoek community members and Healthbridge Public Hospital (HPH). At the MoH, participants included IT specialists, such as database administrators, systems analysts, and computer technicians, healthcare programs directors, and policy makers. Medical personnel (doctors, nurses, pharmacists) and administrative employees (data entry clerks and payments officers) participated in the study at HPH. Members of the Windhoek community, who have at one point or the other received healthcare services from the public hospitals, were also involved in the study.

1.11 Ethical considerations

The research processes involve different people from different backgrounds and institutions. Ethics in research promote collaborative work, trust, accountability, mutual respect, and fairness (Gajjar, 2013). Especially when the study is carried out in a healthcare environment, ethics need to be highly emphsised. Primarily because of the sensitivity of the healthcare-related data being collected.

The resecher abided by the Cape Penisula University of Technology's reseach ethics and rules. Before embarking on data collection, the reseacher sought permission from the cases studied. In doing this, a letter from the university indicating the researcher's details and the purpose of the study was presented to the Directorate of Health Information Systems and Research (HISR) management in order to grant access and permission to conduct interviews.

Interview conversations were recorded. The researcher sought interviewees' permission to be recorded before commencement of the conversation. Neither the identity of interviewees nor their organisations were revealed. Instead, labels were used to identify each interviewee. Data collected was shared only between the reseracher and supervisor and is not be used for any other purposes other than this research objectives.

1.12 Structure of the thesis

The thesis is structured into seven chapters as follow:

Chapter 1: Introduction - the chapter introduces the thesis to the readers by proving a brief overview of the research problem, aim, objectives, and questions, and the structure of the thesis.

Chapter 2: Literature review - this chapter presents the study's literature review. Included in the review are the two theories that underpined the study.

Chapter 3: Research methodology - the chapter discusses the steps, the researcher undertook to achieve the reseach objectives. Research strategy, design, data collection, and analysis are presented in this chapter.

Chapter 4: Cases overview - the study employed two cases. This chapter presents the cases including their organanisational structure.

Chapter 5: Data analysis - this chapter presents the analysis of the collected data. The duality of structure from the Structuration Theory (ST) was applied in the analysis.

Chapter 6: Findings and Interpretation - this chapter presents the findings from the cases and their interpretations. The interpretation was guided by Technology Acceptance Model (TAM).

Chapter 7: Conclusion and recommedations - in this chapter, the research process comes to an end. Thesis contribution, recommendations, and conclusion are presented.

1.13 Summary

This chapter described the study problem and background of the problem. Based on this, the study's aims, objectives and questions were presented. As was indicated in the chapter, the problem statement, study questions, aims, and objectives are interlinked components which influenced the choice of methodology and methods used in the study.

The study employed a qualitative strategy. The selection of a qualitative strategy was influenced by the study's objectives, which required the researcher to study subjects in their

natural environments. A qualitative strategy enabled the researchers to study the phenomenon from an interpretivist angle.

In this study, ST and TAM are introduced as the two socio-technical theories that underpinned the study. The two theories will be disccused in detail in the literature review section (see Chapter 2). The study's key words, namely big data, healthcare, mobile systems, IS, and architecture, are also discussed in the same section.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

Based on the scope of the study, which included the problem statement and research aim, a review of the literature was conducted. The areas of focus included Information Systems/Information Technologies (IS/IT), healthcare mobile systems, healthcare, big data, and architecture framework. Also covered in this chapter are literature reviews about Structuration Theory (ST) and Technology Acceptance Model (TAM), how the theories underpin the study. The primary motives for selecting the two theories and how they have been applied in other information systems studies are presented in the chapter as well.

2.2 Information Systems/ Information Technologies

Information Systems/Information Technologies (IS/IT) consist of systems and technologies that are used by people through processes. According to Shalannanda and Hakimi (2016), IS consist of people's efforts, processes, and information technology which are different in characteristics but interact to support organisation needs. Therefore, through interaction between the involved components (people and process), IS/IT activities, such as selection, development, and implementation, are enabled or constrained (Cresswell & Sheikh, 2013). By recognising the criticality of the interactions between these components, it can be viewed that IS/IT do not operate in a vacuum, but with people and through processes. The figure below depicts the interrelationship between the components.

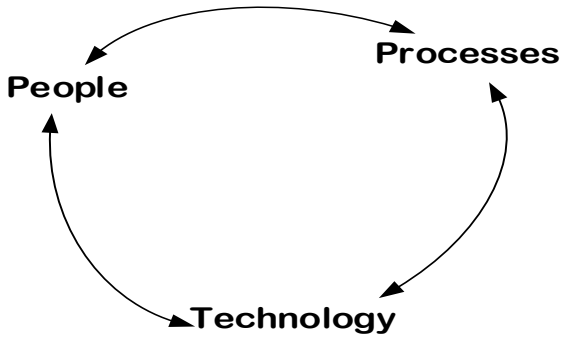

Figure 2.1: Components of IS/IT (Iyamu & Adelakun, 2008:3)

The application of IS/IT is within industries such as manufacturing, retailing, and healthcare. Albeladi et al. (2014) stated that most organisations today are heavily dependent on IS/IT and are impacted by its reliability, responsiveness, and efficiency. For example, in healthcare, the reliability, responsiveness, and efficiency of IS/IT are considered critical in order to prevent situations, such as wrong diagnoses and loss of life (Ancker et al., 2012). Jairak et al. (2015)

argued that IS has become a vital and integral part of many individuals and industries. Hence, “organisations are frequently incorporating various IS in all aspects of their business activities including the use of data” (Amin et al., 2016:501). IS/IT incorporated in healthcare processes to facilitate improved healthcare services are often referred to as health information system (HIS) or hospital information systems (Sensuse et al., 2017).

Organisations use IS/IT artefacts to carry out various activities, such as processing data, collecting and storing information, accumulating knowledge, and expediting communication (Chan, 2000:224). Zaydi and Nasserddine (2016) asserted that IS/IT are the cornerstone for value of service delivery, and therefore their unavailability has an undeniable impact on humans. For example, the lack of IS/IT in public hospitals has made the sharing of patients’ medical histories across medical practitioners, bureaucratic and challenging, which causes delays in patients’ treatment and medication management. Hence the problematisation of IS/IT such as mobile systems to improve big data usfulness in healthcare government organisations.

However, the implementation of IS/IT artefacts, such as mobile systems, can be challenging considering the continuous changes that are required by both users and service providers (Hsieh & Wang, 2018). As healthcare big data keep growing in size, at various speeds, and in different types from daily operations, the supporting technologies are constantly redesigned in response so as to fulfil patients need (Chatterjee et al., 2017). Thus, Shropshire et al. (2016) shared that developing, implementing, and maintaining IS/IT are complex processes influenced by technical and non-technical factors, such as people, technology, processes, and organisational structures.

The implementation of IS/IT artefacts is influenced by people’s activities, processes, and the tools they use (Stockdale & Day, 2009). In healthcare, due to the various medical practitioners such as dentist, pharmacist and cardiologist, various IS/IT and different tools are implemented to enable and support of the processes (Chatterjee et al., 2017). Through organisational structures, employees gain powers by which they share resourses that influence the selection, development, and implimentation of IS/IT. According to Rubino et al. (2017:24), “organisation structure defines the lines of resposiblity and how the existing authority is managed”. Organisation structure illustrates the actors who are associated with the organisational units and any skills or competencies that are required to perform a particular role (Jensen et al., 2011).

Through architecture guidelines, people follow processes to select, design, develop, and implement IS/IT (Gajbhiye & Shrivastva, 2014). Branchet and Sanseau (2017) explained that the architecture, policies, standards, and principles are formulated to help address challenges of both technical and non-technical factors during and post implementation of IS/IT artefacts. Some of these challenges includes integration and organisational structure (Shropshire et al., 2016). Processes used are influenced by the organisational policies and regulations. According to Johnson (2014), policies and procedures communicate to employees what the business wants to achieve and how the activities should be carried out. Therefore, policies and regualtions enforce standards and formalities across IT processes as well as business units. Kyriazoglou (2010) adds that IS/IT policies are needed to establish a good operating environment for IS/IT infrastructures and systems, and ensure successful operational of the IS/IT for the orgnanisation. However, the architecture cannot be generic due to the uniqueness of some systems and environments, such as healthcare.

Healthcare is an industry highly concerned with the sensitivity of patients' big data (Sheeran & Steele, 2017). Consequently, the lack of processes within this environment maycreate chaotic behaviours that could interrupt the successful operation of the orgnaisation (Benyoucef et al., 2011). Like any other socio-technical area, healthcare systems also encounter uncertainty and risks. When it comes to HIS, risks such as cyber-attacks or systems crashes compromise big data usefulness. Thus, there is a need for an architecture to guide the development and implementation of processes and their supporting technologies.

Benkhayat et al. (2015) pointed out that to remain competetive, organisations should ideally align their IS/IT and organisational strategy. However, Ullah and Lai (2013) explain that achieving IS/IT alignment between organisational activities and IS/IT can be challenging because of the constant changes in the business and IS/IT environments. Shropshire et al. (2016) noted that IS/IT should be flexible enough to adapt to the organisation's changing environments. According to Lu and Lu (2009), being flexible means that organisations can respond to the uncertainty of markets, the faultiness of markets, and the fluctuation of its requirements. However, implementing IT/IS in healthcare can be challenging owing to the underlying complexity of healthcare processes and the number of actors involved in such processes (Benyoucef et al., 2011).

Therefore, it is not good practice to have only IS/IT implimented; instead, it is imperative to have systems that work in perfect harmony with the organisational strategy (Benkhayat et al., 2015). For this to happen, Hayles (2007) advised that businesses should drive IS/IT unit activities and IS/IT should not impliment systems and other activities without the clear

understanding of the current environment it supports and the goals, missions, and objectives of the business. This will promote shared understanding across organisational units and ensure that business knows about IS/IT projects undertaken to support them.

The IS/IT artefacts do not always deliver benefits, as organisations also encounter challenges with the implementation, use, support, and management of these (Shaanika & Iyamu, 2015). The challenges are attributed to the complexity of technical and non-technical factors that influence the implementation, use, and management of the IS/IT artefacts. According to Cresswell and Sheikh (2013), the implementations of IS/IT is difficult and there are a range of inter-related technical, social, and organisational factors to be considered. Saetang and Haider (2016) noted that the management of IS/IT infrastructures and its effectiveness have not been easy in many organisations for several years. Firmansyah and Bandung (2016) explained that most often the unpredictable changes in IS/IT infrastructures can cause disruptions to services offered to customers by an organisation. Moreover, the challenges and complexities could be attributed to the components of IS/IT, which are often unpredictable. Zaydi and Nasserddine (2016) explained that organisations' environment and technologies are constantly changing and IS/IT are increasingly exposed to uncontrollable risks. Thus, the effective use of IS/IT requires an approach, such as the architectural governance (Ping-Ju Wu et al., 2015). The architecture enables and supports the structuring of IS/IT artefacts, including interrelationship of the associated components based on organisational needs, making the computing environment more manageable.

Even though there are many challenges that are encountered, organisations continue to rely on IS/IT for services delivery, as they strive to eradicate or reduce information bottlenecking to improve efficiency and effectiveness (Yeh, Lee & Pai, 2012). For example, the utilisation of mobile systems has become a common tool in processing and sharing data across organisations' units and their customers. Filho and Aquino (2015) argued that, increasingly, many organisations are deploying mobile systems in their environments, making their data available through mobile applications.

2.3 Healthcare

Healthcare is a distinct industry that focuses on care and well-being through its services to prevent or cure illnesses (Glowik & Slawomir, 2015). The health services are provided through and within facilities that often consist of different units, such as general practice, physicians, and radiology (Gargiuloet al., 2017); hence, there is a need for organisational structure. As an industry, healthcare strives to prevent illness, cure diseases, and ensure effective and efficient healthcare service delivery to its patients. Nemutanzhela and Iyamu (2016:102) elaborate that

“healthcare focuses on diagnosis, such as treatment, and prevention of disease, illness, injury and other physical and other mental impairments”. However, these healthcare processes are not always straightforward, sometimes they are complex and challenging, because there are many technical and non-technical factors that are involved in each service or operation. According to Hone (2008), the services of the healthcare constitute relationships among patients, healthcare professionals (such as pharmacists, physicians, nurses, and doctors), and the facilities.

Healthcare organisational structures differ from one country to another. The organisational structures influence management of their activities (Sarkis & Mwanri, 2013), including the use and usefulness of artefacts, such as big data, in their quest to providing services across the facilities (Iyamu & Mgudlwa, 2017). The structures help with organisation of distinct objectives, deliverables, and areas of specialisation. Through organisational structures, it seems easier to track and trace activities and coordinate processes (Anumba et al., 2002).

Additionally, there are dual heathcare systems in many countries, which consist of private and public healthcare (Katuu, 2016; Iyamu et al., 2014). In such cases, public healthcare is completely funded and manged by the State, while private is funded by an individual or group of invidivudals. For example, in Korea, the healthcare system is operated both publicly and privately , though the majority of the medical institutions are privately owned (Han & Lee, 2003). In South Africa, “the public sector is comprised of government health institutions that serves predominantly the indigent population, while the private sector comprising profit organistions and individuals serves the insured population or those who can afford care on an out-of pocket basis” (Pillay, 2009:39).

Healthcare is a big data intensive industry, as such patients’ visits to health facilities (hospitals and clinics) lead to the generation of various types of data sets, which are used to improve service delivery. It has been reported that “healthcare industries store huge stock of sensitive personal data, such as patient names, dates of birth, and personal medical records” (Mohammed et al., 2015:191). Furthermore, healthcare service delivery is very fragile, private and sensitive matter as it involves people’s lives (Matthew, 2013). Therefore, due to the sensitive nature of healthcare, it is critical to ensure appropriate data management and prevent erroneous processes that could compromise the integrity of the data. Shaanika (2016) acknowledges that due to the sensitivity of patients’ data, healthcare services, and products, providers require adequate and reliable tools and approaches, such as a unified architecture, to ensure the integration of infrastructures and big data usefulness.

Healthcare, like many other sectors, has grown rapidly with the introduction of IS/IT (Tawalbeh et al., 2016). IS/IT used to support healthcare services are called Health/Hospital Information Systems (HIS). Aggelidis and Chatzoglou (2008:101) define HIS "as a computer-based system designed to facilitate the management of the administrative and medical information within a hospital". HIS and the supporting technologies, such as electronic medical record (EMR), are being implemented in healthcare systems across the world (Tawalbeh et al., 2016). The EMR are computerised medical records of patients, replacing the manual processes of managing paper-based patient healthcare records. Kohli and Tan (2016) described that electronic records consolidate diagnosis and treatment activities of a patient. According to Gastaldi et al. (2012), the EMR are primarily implemented with the purpose of improving healthcare services delivery, data management, and costs reduction. EMR are beneficial over the paper-based records as they are created and maintained electronically and can easily be backed up for further use. According to Ni et al. (2015:173), "HIS supports healthcare services more efficiently through both preventive and medical cares, rehabilitation and health education".

In the absence of IS/IT in healthcare, organisations, such as hospitals, were faced with many challenges, such as incorrect recording of diagnoses, unavailability of patient information, delays in accessing the information, and limited space for recording (Adesina et al., 2011). The challenges could be attributed to the manifestations of the technical and non-technical factors within healthcare. Challenges, such as big data management, resulted from the rapid generation of various data types beyond what hospitals and clinical settings could process and manage. Kohli and Tan (2016) explained that due to the increases in data volumes, rapid speed and complexity of various data types' integration efforts have been challenging. Lulembo and Silumbe (2016) highlighted that management of big data is one of the many issues affecting healthcare service delivery.

Healthcare, especially among African countries, continues to be challeged with fragmented IS/IT and poor quality of data (Sæbø et al., 2010). According to Sabooniha et al. (2012), the major issue in healthcare is the large number of heterogeneous IS/IT that have been designed and developed by different vendors to support specific processes. Due to the IS/IT heterogeneity, integration of systems become difficulty due to the different platforms each system is built on. Lack of systems' integration does impact the sharing and usefulness of big data in providing healthcare services to those in need. Sabooniha et al. (2012) asserted that the lack of sharing of data sets results in isolation, as each system stores and manages its own data sets, which contributes to duplications of efforts and resources within the

organisation. Therefore, there is a need for architecture that can provide integration for improved services (Katal et al., 2013).

Due to the privacy and sensitive nature of healthcare, providing healthcare services via mobile systems would be advantageous in many aspects, such as accessing patients' data any time and keeping record of healthcare data (Boontarig et al., 2014). This will enable patients and healthcare providers to have ease of access to health information, and at real time, thereby contributing to improved decisions and services.

2.4 Healthcare mobile systems

Mobile systems are increasingly the focus of many individuals and organisations. Ayed et al. (2016) explained that due to the application of mobile systems in dynamic environments, they enable users to carry out a variety of activities, such as healthcare data management. Lin et al. (2015) asserted that the computing landscape is undergoing a massive transition from stationary desktops to mobile systems. Furthermore, Filho and Aquino (2015) acknowledged that mobile systems nowadays have processing power that only existed in computers systems with large memory and processing capacity. Thus, it is argued that the mobility feature of mobile devices is changing the way people use different technologies all over the world (Tawalbeh et al. 2016). For example, nowadays people use mobile systems to access the internet and carry out activities such as sending and receiving emails, taking images, video and text messages, browsing web pages, searching for information of interest, and obtaining semantic web services anywhere and anytime (Yu et al., 2012).

Mobile systems that are used in healthcare are referred to as healthcare mobile systems (Wu et al.,2013). Healthcare mobile systems include tablets, laptops, cellular phones, and any other portable wireless IS/IT. Moore (2009) discussed two types of mobile systems: (i) laptops and mobile computers, and (ii) wearable computing devices, such as mobile phones, smart phones, and personal digital assistant (PDA) which can be used in a wider range of environments, as users move from one geographical place to another.

With healthcare mobile systems, people are no longer confined to their physical environments when carrying out healthcare-related activities, rather tasks are carried out simultaneously in comfort anywhere in the world (Lockamy & Smith, 2009). For example, a physician using a laptop with radio-frequency identification (RFI) incorporated can monitor a patient's blood pressure from his home. In general, mobile systems are defined by three properties: (i) communication, (ii) caching, and (iii) computing (Liu et al., 2016). According to Liuet al., (2016), mobile systems' communication property is about their ability to provide information over a

given bandwidth and power, caching refers to mobile systems' ability to store information, and computing is concerned with logic and algebraic operations (Liuet al., 2016).

Mobile systems are primarily intended to be readily available and useful to the community of users being supported (Dix et al., 2000). The availability and usefulness of healthcare mobile enhance and support real time information sharing across healthcare stakeholders. Dahal et al. (2016) noted that, due to healthcare mobile systems, sharing big data in its various form such as audio, video and images have improved service delivery. Moreover, due to the many processes and activities that mobile systems perform, there is a higher penetration of new healthcare mobile systems (Tawalbeh et al., 2016). Kumar (2013) states that healthcare mobile systems would continue to be useful because of their information retrieval functionality from many information repositories, such as the web, databases, and the cloud, from anywhere through wireless applications. Breaking the distance and time barriers, healthcare mobile systems are used to routinely collect, store, retrieve, display, and transmit data through web-based infrastructures (Justice et al., 2009).

Through the years, healthcare mobile systems have changed and evolved. Clemons et al. (2013) explain that initially mobile systems offered limited features, such as voice and text communication. Nowadays, healthcare mobile systems have evolved into complex structures able to run sophisticated applications and offering performance equivalent to some of the desktop computers. It is believed that due to the healthcare mobile system's power and ubiquity, there have been changes in the way users interact with IS/IT systems and applications (Sharma et al., 2013). For example, due to processing power of some mobile systems, one can have more than one application running. Thus, there is a need to understand how people use healthcare mobile systems and the relationship with such technologies in order to inform developmental activities of these systems (Dix et al., 2000). As a result, a unified architecture is required as a guide to understand the interaction between people and healthcare mobile systems.

Healthcare mobile systems also have drawbacks, as explained by Yu et al.(2012). Some of the healthcare mobile systems challenges include limited computational capacity, small storage, small screen, and small keyboard for text input. Love (2005) adds that mobile systems are challenged by short battery life, inconsistent network coverage, and finding ways of providing information to users on a small screen without losing content. Consequently, some of these drawbacks, such as small screen, has limited their application in healthcare industries in many countries, particularly in Africa and Asia. From the Asian perspective, Wu et al. (2013) indicated that due to some healthcare mobile systems' limited computational capacity and

limited battery life, heavy multimedia and signal processing are unable to run on them. Thus, Yu et al. (2012) recommended that the IS/IT hardware and software for these mobile systems should be re-engineered to address these constraints.

Significantly, healthcare mobile systems challenges could be viewed as an opportunity for growth and development of new insights to make services delivery effective and efficient. As a result, even with the various challenges healthcare mobile systems encounters, due to its significance and benefits in improved services, it continues to be widely used across the healthcare industry (Savory & Fortune, 2014). Consequently, governments of many countries are investing in healthcare mobile IS/IT to deliver cost-effective healthcare services (Fitch & Adams, 2006).

Healthcare mobile systems are being applauded for their ability to reach remote and isoloted areas to support communication in real time as this was difficult before (Adesina et al., 2011). This is beneficial considering that majority of the populations are geographically dispersed especially in African countries such as Namibia where this study is being conducted. Sahaana et al. (2014) support the notion that healthcare mobile systems are advancing the developments in healthcare through technological artefacts such as medical surveillance, which is used to the understaffed environments at any moment. Thus, both patients and healthcare providers benefit from the introduction of healthcare mobile systems as it leads to improved services (Sahaana et al., 2014). Medical practitioners will have readily-available information for prescription and diagnosing illness, and patients will be able to track and share their medical histories with various healthcare practitioners.

2.5 Big data

Big data refer to data sets with characteristics such as volume, variety, and velocity. Data sets with such characteristics have been around for a long time; yet, the term ‘big data’ has only recently been used (Cervone, 2016; Sukumar et al., 2015). According to Zhang et al. (2016), big data refers to large-scale data sets that cannot be captured, managed, or processed by’ traditional software tools and thus requires new sophisticated IS/IT infrastructures for management. Wang et al. (2015) state that ‘big data’ was first defined in terms of the volume, velocity, and variety of its data. Rahman and Slepian (2016) also affirm that volume, variety, and velocity as the essence of big data. However, Din et al. (2015) explained that big data assets are difficult to aggregate, store, process, and analyse using existing traditional technologies. Big data systems are, therefore, known for managing high volume data, high velocity, and or high variety information assets (Jiang et al., 2016). Figure 2. 2 below illustrates the characteristics, volume, variety, and velocity (the three Vs) of big data.

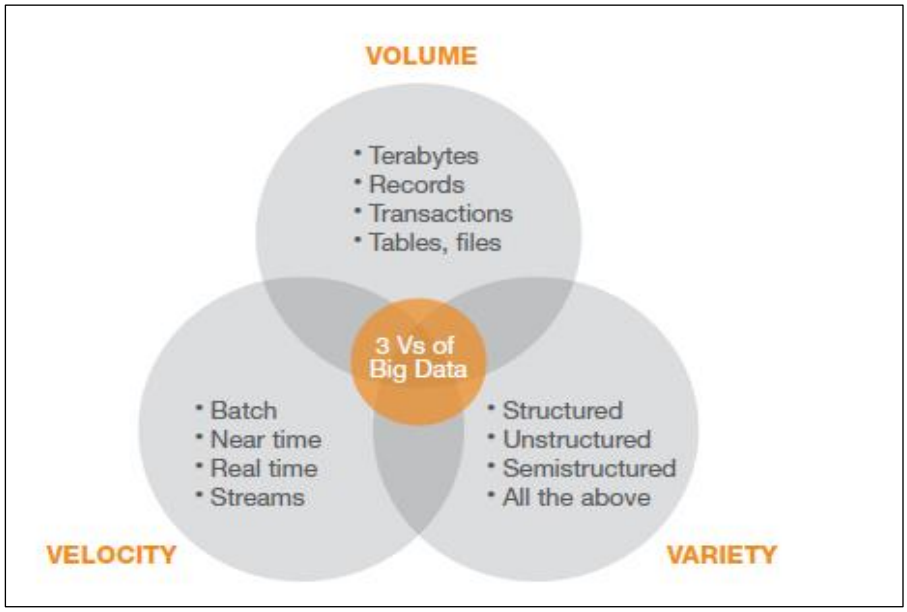

Figure 2.2: The three Vs of big data (Russom, 2011)

Volume is viewed as a key characteristic of big data; most organisations define big data in terabytes or petabytes (Russom, 2011; Roski et al., 2014). According to Manovich (2011), big data sizes range from terabytes to many petabytes of data in a single data set. Wu et al.(2014) argue that one of the fundamental characteristics of big data is the huge volume of data represented by heterogeneous and diverse dimensionalities. The heterogeneity of data is due to the many different mediums through which data are collected and stored (Iyamu & Mgudlwa, 2017). In their different sizes, patients' medical histories, x-rays, videos, texts, summary of physicians, and images contributes to the big data volume.

As one of the characteristics of big data, variety represents the various sources of big data. According to Russom (2011), one of the things that makes big data really big is that it comes from a greater variety of sources than ever before. In healthcare, the sources of data sets include medical imaging, audio and video files, emails, and other healthcare supporting systems. Shu (2014) affirms that the sources of big data are everywhere and databases, documents, emails, phone records, meters, sensors, images, audio and video files, and financial transactions are examples of sources.

Velocity is the frequency of data generation or the frequency of data delivery (Rummon, 2011). The speed at which data is collected, stored and processed, and managed illustrates organisations' ability to respond and act upon business processes urgency. The rate or speed at which big data is available to parties involved in the treatment to make decisions affects the effectiveness of service delivery (Gargiulo et al., 2017). It is pointed out that for many

applications, the speed of data creation is even more important than volume and real-time or nearly real-time information makes it possible for an organisation to be much more agile than its competitors (Ahmad et al., 2002).

Big data veracity refers to the legitimacy of the big data being collected and stored. The question is whether healthcare is collecting the right big data and whether the organisations can depend on it to make informed decisions. Kearny et al. (2016) affirm that data used in organisations to make decisions are not always trustworthy or relevant to the problem at hand. Big data veracity is influenced by the collection and management techniques used. When the collection technique is manually oriented, the process is vulnerable to many risks which could influence the trustworthiness the general data generated (Gargiulo et al., 2017). Thus, the need for an architecture to enforce legitimacy of big data collection, accessibility, and usefulness through the means of health mobile systems

Organisations rely on data to make decisions. With the implementation and utilisation of IS/IT, collaborating and sharing data across business units and their business partners have been positive. However, to have access to big data, it requires sophisticated methods to provide reliability, correctness of managed data, and performance (Kvet & Vajsova, 2016). Mariyah (2014) stated that big data give values only if the organisations make sense of data. Benjelloun et al. (2015) pointed out that the insights organisations gain from big data can help decision-makers to enhance their strategies and optimise their plans.

In healthcare, majority of data sets that are collected is via manual approach (Ramesh, 2015). Sukumar et al. (2015) stated that the integration and management of data are primarily done through manual approach in the healthcare world. The manual processes of data entry have encountered bureaucratic challenges resulting in many wrong entries causing errors across healthcare.

While big data can yield extremely useful information and insights, it also presents challenges with respect to data storage, data management, privacy, security, and maintenance (Michael & Miller, 2013). Wu and Chen (2014) explained that as the volume of big data increases, so does the complexity and the relationships underneath the data. Consequently, traditional data models are incapable of handling complex data in the context of big data (Wu & Chen, 2014). Hence, the storage of this voluminous data requires huge storage devices (Ragothaman et al., 2016). However, the huge storage does not remove the complexities, nor does it guarantee ease of access; thus, architecture is required to guide integration of the artefacts including data sets, for improved service delivery (Ramesh, 2015; Katal et al., 2013) .

However, big data are not about collecting or generating massive amounts of data, but about making sense of it (Mousannif et al., 2016). Thus, organisations are rather concerned with how to make sense of the big data they have acquired. Iyamu and Mgudlwa (2017) examined how healthcare big data can be transformed through analysis in order to improve its usefulness. Howard et al. (2016) noted that the use of big data technologies in healthcare is still at an early stage compared with other industries. This means that efforts at improving the environments will continue, with specific focus on the highlighted notable areas that concern people and technology components (Ludwick & Doucette, 2009). This requires intergration of both non-techncial and technical factors to capture the value and usefulness of big data.

As a result, healthcare organisations need to invest in computing infrastructures and approaches, such as architecture and healthcare mobile systems, which can handle these data sets and the challenges that are associated to them. According to Nepal et al. (2015), managing large, heterogeneous, and rapidly-increasing volumes of data, and extracting value out of such data, have long been a challenge. Tawalbeh et al. (2016) stated that some big data could be processed offline, but some applications need real-time processing for this data. According to Roski et al. (2014), for healthcare organisations to rely on big data, enabling IS/IT infrastructure has to be available. With this in mind, the adoption and innovation of IS/IT, such as healthcare mobile systems, enable opportunities to reduce costly healthcare treatment and resolve unnecessary errors.

Clearly, there is a need for architecture to guide interaction among health mobile systems and all other actors, both technical and non-technical, in the management of healthcare big data. This study, therefore, aims to develop a unified architecture framework to support flexible and scalable mobile systems for managing healthcare big data.

2.6 Architecture for integrated healthcare systems

An architecture is the logical plan and design of an object, which guides and illustrates the interconnection and interrelationships of the various components that construct and are related to the object. The process of architecting involves analysing a problem and, deconstructing that problem into its constituent buildings blocks (Jensen et al., 2011:14). According to Bernard (2012), an architecture represents a structured framework for the analysis, planning, and development of all resources in an entity. A healthcare architecture is about the design and representation of all components (technical and non-technical) in the health environment and how they interact.

Thus, healthcare architecture enables the design of their current and future activities and processes. As big data continues to grow from daily operations, there is a need for an architecture to plan and manage future and continuous growth of data sets (Ramesh, 2015). Thus, it is important to view architectures as living products that are dynamic in their growth according to the changes in the environment (Tupper, 2011). An architecture is, therefore, an ongoing process that must be regarded as a vehicle through which organisations should accommodate changes and evolve. Lankhorst (2017) elaborates that architectures changes due to the environmental changes and as new technological opportunities arises. Ideally, architecture should be viewed as a change agent supporting organisations' agility (Shaanika & Iyamu, 2015). As healthcare organisations identify new ways of managing, accessing and efficiently using big data, architecture become even more important as it becomes the process through which organisational changes are reflected and communicated .

Thus, an architecture is a process. As a process, architectural development entails the interaction of various components of an organisation(Jahani et al., 2010). These components include organisational objectives, rules, business processes, data, people, and technology. Lankhorst (2017) describes that the achitecture process involves various steps, such as design and implementation phases to become an operational system.

Within IS/IT, there are different domains of architecture. These include business, data, application, and technology architectures (Bakar & Selamat, 2016). Structuring IS/IT architecture into domains establishes boundaries, which enables organisations to enforce controlling and integrating mechanisms for a flexible system. In figure 2. 3, Aziz et al. (2005) describe different domains of architecture.

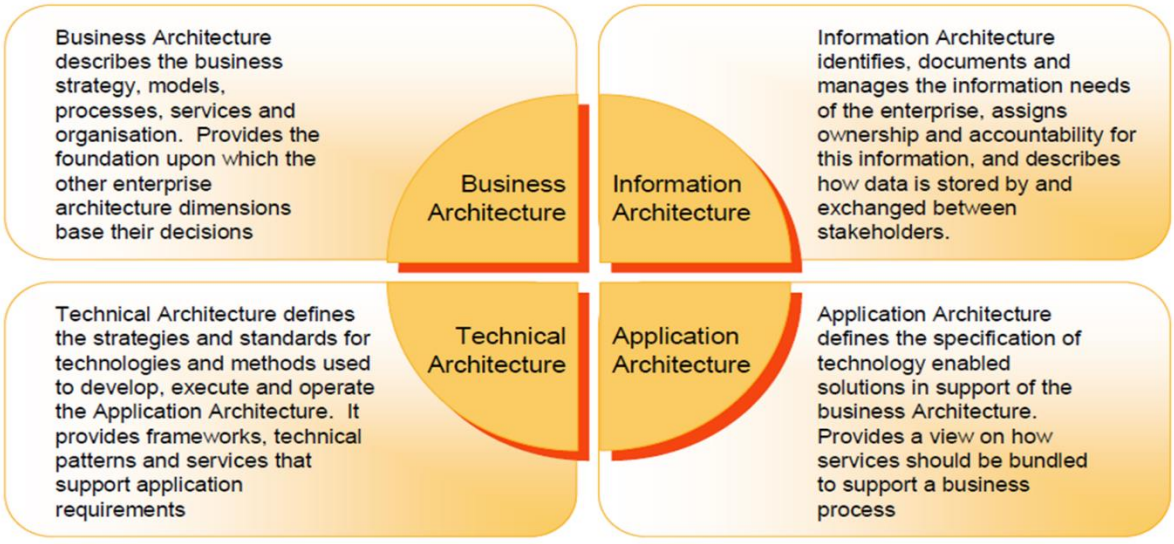

Figure 2.2: Architecture domains (Aziz et al., 2005)

An architecture is the foundation for any IS/IT, as by nature, one cannot build IS/IT without an understanding of the parts that it is made of (Jensen et al.,2011). Thus, the utilisation of healthcare mobile systems with big data requires architecture in order to improve the effectiveness and efficiency of their usefulness in providing services to the needing.

To offer products and services, healthcare service providers require data sets (Raghupathi & Raghupathi, 2014). The types of big data used in healthcare to offer services includes texts, videos, images, and x-rays in both structured and unstructured form (Yu et al., 2012). As an architecture domain, data architecture describes organisational data needs, different data types, and their flow across business units. According to Kearny et al. (2016), data architecture structures the organisation's physical and logical data management resources and data assets.

Data is shared and managed across organisational units and business partners through applications. Therefore, the application architecture models designs, and develops organisational applications, as well as how they are interconnected with each other. Yu et al. (2015) noted that, along with data architecture, application architecture provides the organisation with the information needed to execute business processes. Application architecture provides a blueprint for individual applications to be deployed, their interactions, and their relationships to the core business processes of the organisation (Open Group, 2011).

Applications are supported by technological infrastructures. Technological infrastructures include software and hardware. Kearny et al. (2016) discuss that the technology architecture provides the description of the hardware and software capabilities required to support the deployment of different services. To access big data, healthcare mobile systems need to be integrated with IS/IT technological infrastructures, such as databases and servers (Raghupathi & Raghupathi, 2014).

The domains of architecture are dependent on one another. Yu et al. (2015) state that the outputs of each domain is needed as an input for development of other domains. Thus, interdependency of the domains has certain implications, as such modification to one domain would require other domains to be changed.

Due to the importance of big data, it is necessary for organisations to develop and implement architectures to guide the collection, storage, retrieval, and management of big data by healthcare mobile systems. As Sousa (2011) explained, it will be difficult to manage huge

amounts of data that exists in the organisation without an architecture and supporting infrastructure. Wang et al. (2015) asserted that to recognise the potential benefits of big data, it is fundamental to understand its architecture and component functionalities. According to Inmon and Linstedt (2014), there are many efforts that are necessary in understanding architecture for data management, which are:

i) the physical manifestation of data,
ii) the logical linkage of data,
iii) the internal format of data, and
iv) the file structure of data.

These factors guided the researcher in studying how data structures are designed and managed.

2.7 Underpinning Theories

This study is underpinned by two theories, namely Structuration Theory (ST) and the Technology Acceptance Model (TAM). The order of use for the theories in this study is based on the study objectives; these are to examine and understand

(i) factors that influence how healthcare big data is accessed, used, and managed in the Namibian environment, and
(ii) factors that can impact the interaction and integration between health mobile systems and healthcare big data in service delivery.

In the context of this study, duality of structure from the Structuration Theory (ST) perspective has been applied to guide the data analysis from both cases. ST was applied in the analysis firstly, to aid in identifying and understanding the different types of agents, and the relationship between the agents that existed in the healthcare environment, and secondly to aid in identifying and understanding the types of rules and resources that existed, and how and why those rules and available resources were applied in the course of providing healthcare services to the patients.

The findings emerged from the analysis. TAM was employed in the interpretations of these findings. TAM was employed from social perspectives primarily to gain a deeper understanding of individuals' and groups' perceptions about the usefulness and ease of use, of the factors that influence mobile systems for healthcare services. Perceptions of the individuals and groups manifest into behaviours that affect mobile system actual use in accessing healthcare big data.

2.7.1 Structuration Theory

Structuration theory (ST) is a social theory that was developed by a British sociologist, Anthony Giddens (Giddens, 1979, 1984). Schmitz et al. (2016:665) define structuration "as the process through which agents select, adapt, apply, manipulate and alter available structures". The main tenets of the ST are agent (or agency) and structure (Iyamu, 2013). McGarry (2016) explains that structure and agency reconstitute each other over a period of time and space. Therefore, it is impossible for structure to exists without the agent, and similarly for agents exist within structure (van Rooyen, 2013). Agents are both technical (such as computers) and non-technical (such as human) entities (Olikowski, 1992). In structuration, structure is not organisational hierarchies but rules and resources (Iyamu, 2010).

Agents are knowledgeable entities that have the capacity to create and remember their actions (Giddens, 1984). Thus, agents perform social activities, such as the use and management of healthcare data and systems, based on their skills and knowledge. Akgün et al. (2007:278) noted that to be "knowledgeable means that the individuals are aware of and understand the circumstances of their actions and the rules they are following". However, it is argued that agents are not always entirely in control of their actions, and the outcomes (Segre, 2014). Jones and Karsten (2008) explained that unacknowledged conditions and unintended consequences can result from intentional actions.

In ST, structures are the rules and resources that human agents make use of as they interact with other agents (Hossain et al., 2011). Rules are laws and regulations that guide agents in their interactions and activities. According to Rescher (2010), rules coordinate agents in the course of their actions. Rules are either implicit or explicit.

Resources are the material and non-material objects that are used to carry out actions. Resources are categorised as either allocative or authoritative (Giddens, 1984:333). Allocative resources are material objects such as personnel capacity, and tools, while authoritative resources enable control over means of space and time and the coordination of people (Moldaschl, 2002). Akgün et al. (2007:279) stated that "allocative resources involve material features, produced goods, while authoritative resources (control over persons) refer to transformative capability generating command over persons or agents by highlighting emotions".

Agents acts using structures. Thus, structures affect the actions of agents (Akram, 2013). Vyas et al. (2017) explained that structures not only enable human actions, but they also

constrain them at the same time. Thus, structures are not present in time and space, but are only recognisable during the production and reproduction process (van Rooyen, 2013).

Together, agents and structure create social systems (Giddens, 1984), such as the healthcare environment. This means that social systems are neither produced nor reproduced by agents alone, but through the use of structures (Jones & Karsten, 2008). Hence, ST is often used to examine and understand the relationship and interaction between structures and human agents, to produce and reproduce social systems (Hoffman & Cowan, 2010). Social systems are found within many forms, such as national society, industry, organisations, or a specific project team, such as strategy project team (Whittington, 2010). According to Englund and Gerdin (2014:163), social systems are characterised as "(i) comprising of actual activities of human actors, (ii) taking place in a specific time-space settings, and (iii) always associated to specific subjects".

As agents interact, they create social structures, which, at the same time, influence the actions and interactions of humans (Burridge et al., 2010). This can be attributed to the fact that human actions are not static but have a transformative capacity that enable them to produce and reproduce structures (Vyas et al., 2017). Agency is, therefore, an "individual['s] capacity to take intentional actions" (Burridge et al., 2010: 26). According to Cleaver (2007), agency is the capability or power to act knowingly or unknowingly, which is a distinct character of human beings. Hence, agents are said to have acted with agency if they have consciously carried out an activity. Consciousness is the ability of the agents to relate their actions with events that have occurred (Giddens, 1984). There are three types of consciousness: discursive consciousness, practical consciousness, and unconsciousness (McPhee & Canary, 2014).

Discursive consciousness occurs when an agent can verbally express his/her actions (Giddens, 1984). McPhee and Canary (2014) asserted that discursive consciousness is formulated in words and accessible through deliberative thought. Meanwhile, practical consciousness "involves recall to which the agent has access in the *durée* of action without being able to express what he or she thereby knows" (Giddens,1984:49). According to McPhee and Canary (2014), practical consciousness is non-discursive knowledge that can be used purposefully. On the other hand, unconscious is a "lack of awareness however it affects actors' ontological security and existential anxiety" (McPhee & Canary, 2014:77).

The interaction between structures and social systems is recursively interrelated, known as the duality of structure (Englund & Gerdin, 2014). In the course of interactions, the agents make use of available structures and, in the process, reproduce such structures over a period

of time (Hoffman & Cowan, 2010). According to Giddens (1984:29), “humans’ interactions are linked with social structures in the concept of duality of structure”.

2.7.1.1 Duality of structure

Structures are made up of “rules and resources and they are the interactions that are involved in the production and reproduction of social systems” (Giddens, 2003:455). Thus, a “structure enters simultaneously into the constitution of the agent and social practices” (Coad & Herbert, 2009:176). These occur as agents apply structures in carrying out their social activities, and within the same social system, the structures change the agents as they are being created and recreated. Agents interact using structure, and agents exist within the structure, a process that is produced and reproduced, which is known as the duality of structure (Yokoyama, 2014). Thus, Coad and Herbert (2009) explained that structures are not independent of agents.

The duality of structure, as shown in Figure 2.4, consists of three dimensions: structure, modality, and interaction (Giddens, 1984). Each of the dimensions consists of corresponding entities as follows: structure - signification, domination, and legitimation; modality – interpretive scheme, facility, and norm; and interaction - communication, power, and sanction (Giddens, 1984).

The dimensions of structure and those of interactions are interconnected by the modality, which include interpretive scheme, facility and norm. Larsson (2012) stated that, modality is where agency and structure meet, the duality of structuration is made visible, and agency and structure reproduce. The modalities are medium through which systems of interaction are reproduced (Coad & Herbert, 2009).

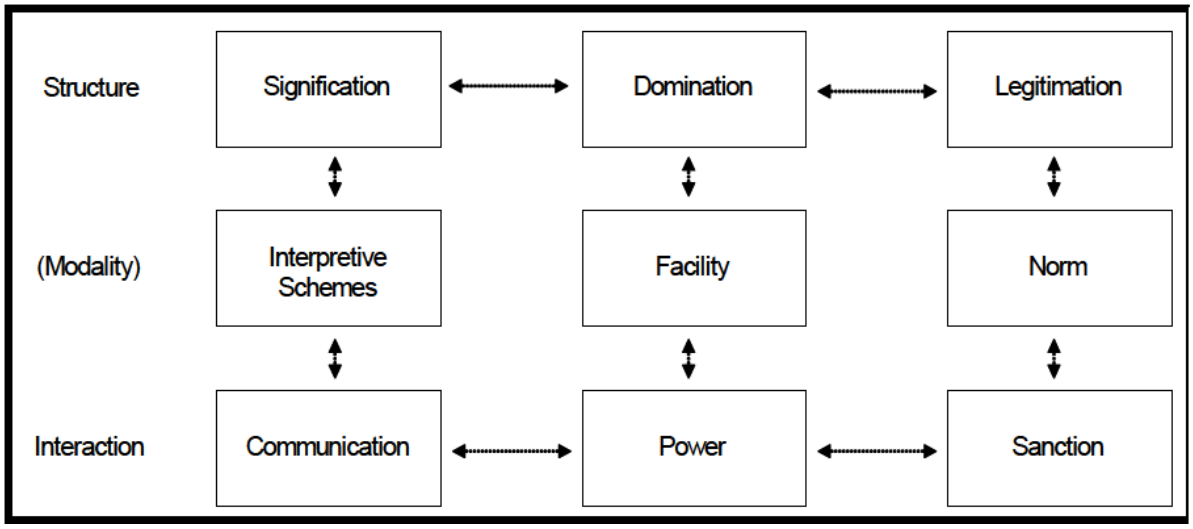

Figure 2.3: Duality of structure (Giddens, 1984:29)

To interact with the others, agents communicate, exercise power, and apply sanctions (Coad & Herbert, 2009). When human agents communicate, they depend on interpretive schemes to make sense of the interactions. Interpretative schemes are the "modes of typification incorporated within agents' stocks of knowledge, applied reflexively in the sustaining of communication" (Giddens, 1984:29). According to Chang (2014), interpretive schemes are the shared stock of knowledge that humans use to analyse actions so that they can gain meanings of the interactions. As agents use their stock of knowledge to study their actions as well as other agents' actions, they produce what is of significant to them. Hardaker and Singh (2011) pointed out that signification is concerned with the meanings produced and reproduced through communication. Thus, signification comprises of rules, procedures, and techniques to produce meanings to which agents refer via interpretative schemes when they communicate (Akgün et al., 2007:279).

As agents interact and communicate, they employ their power. The extent to which agents' actions can influence structures is used as a measure of power (Burridge et al., 2010). In ST, power is defined as the ability of the agent to make a difference in the process of production and reproduction of actions (McPhee & Canary, 2014). Yokoyama (2014) stated that agents exercise power over others through domination. Hence, the structure of domination relates to the use of power through the modality of facility (Hardaker & Singh, 2011). The facilities being used are the allocative and authoritative resources. Thus, the structure of domination (rules and resources) provide facilities through which power is exercised (Englund & Gerdin, 2014).

As agents interact, they sanction their actions. These actions are sanctioned according to agents' approved norms, such as cultures and behaviours that are deemed moral. Norms are the rules governing what agents view as legitimate actions (Chang, 2014). Thus, as agents apply these norms, they produce and reproduce legitimation structures. According to Akgün et al. (2007), legitimation structures regulate agents' interactions based on the accepted norms; therefore, sanctioning their interactions.

2.7.2 Structuration Theory and IS/IT studies

Structuration theory (ST) has its originality in social sciences. Jones and Karsten (2008:129) posit that "ST is a general theory of social organisation rather than a theory specific to IS/IT". Over the years, ST has been applied as a lens in many IS/IT studies, to guide data analysis, particularly from qualitative methods' perspectives (Rose & Scheepers, 2001; Jones & Karsten, 2008; Larsson 2012). According to Sekweleo et al.(2017), the theory had been employed in 107,000 peer reviewed social sciences articles by 2016, and its application has extended to the field of Information Systems/Information Technology (IS/IT).

Hossain et al. (2011) asserted that ST has been applied in IS studies since its inception. For example, Orlikowski (1992) developed the duality of technology based on ST's duality of structure, a model used to understand information technology's influence in an organisation. A study by Jones and Karsten (2008) reported that ST has been applied in 331 IS/IT articles published between 1983 and 2004. ST was also used as an approach in understanding affordances in human computer interaction by Vyas et al. (2017).

In the area of healthcare, ST has been used to inform empirical investigation regarding IT programmes for resolving data fragments in United Kingdom's (UK) national health service (Greenhalgh & Stones, 2010). The study, which employed ethnographic research, reported that human agents constitute complex socio-cultural frames, and healthcare IT programmes need to be studied in terms of the interplay between these factors.

ST has also been employed in Enterprise Architecture (EA) studies, such as by Mezzanotte and Dehlinger (2012), to address human behaviours as a significant input to formulating and implementing EA. The study revealed that existing EA frameworks do not address users' behavioural patterns and the impacts of organisational changes as a result of EA. Therefore, they used ST as lens to align EA and IT with a socio-communicative framework that considers people's behaviour (Mezzanotte & Dehlinger, 2012:67).

2.7.3 Technology Acceptance Model

Organisations employ (IS/IT) artefacts to support and enable their activities, towards enhanced productivity (Tang & Chen, 2011). However, the IS/IT artefacts are not always accepted and used by users. This have caused challenges for many organisations from competitiveness and Return on Investment (RoI) viewpoints.

Thus, the Technology Acceptance Model (TAM) has been used in many IS/IT studies to examine the factors that lead to acceptance or rejection of IS/IT artefacts in organisations. According to Iyamu (2015),TAM is a behavioural model that is based on theory of action by Ajzen and Fishbein (1980).The model was first proposed by Davis (1989:319), who argued that "valid measurement scales for predicting user acceptance of computers are in short supply". TAM uses perceived usefulness, ease of use, attitude, behavioural intention, and actual system usage as determinants in predicting the acceptance of a new technology (Davis, 1989). These determinants are illustrated in figure 2.5 and discussed below.

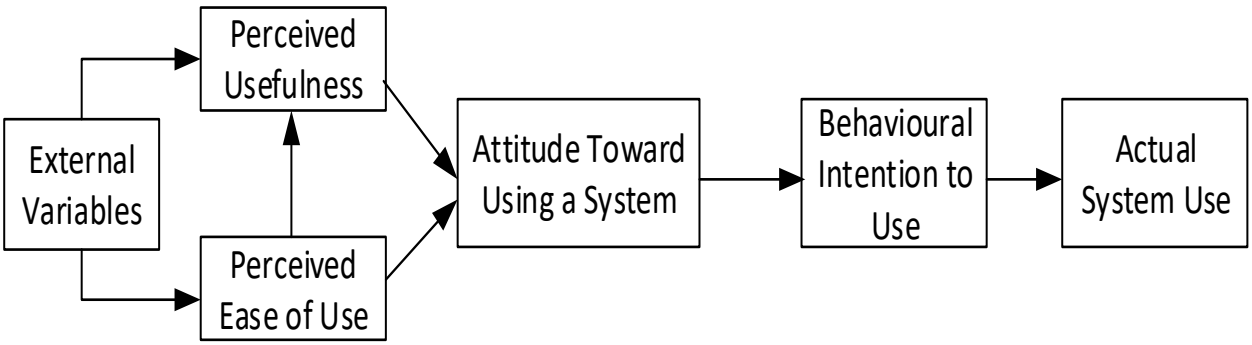

Figure 2.4: Technology Acceptance Model (Davis, 1989)

The purpose of TAM is to provide a basis for discovering the impact of external variables on internal beliefs, attitudes, and intentions (Davis, 1989). It is argued that perceived usefulness and ease of use are mainly affected by external factors based on the characteristics of technology (Park & del Pobil, 2013). Alsajjan and Dennis (2010) mentioned that external factors, such as information richness, web quality, and experience, have an impact on perceived usefulness and perceived ease of use.

TAM assumes that a person's acceptance of technology is determined by his/her voluntary intention to use that technology (Yousafzai et al., 2010). However, a person's intention is determined by his/her attitude toward the use of that technology and his or her perception concerning its usefulness (Yousafzai et al., 2010). Cheung and Vogel (2013) define attitude as the degree to which a user is interested in using the system. This is the overall evaluation of the liking when a person uses a particular IS/IT (Park & del Pobil, 2013). According to Kim (2016:1537), attitude "refers to a prospective users' favourable or unfavourable feelings toward using a specific technology or system". Aboelmaged and Gebba (2013:37) posit that "attitude toward using a particular system is a major determinant of the intention to use that system". Attitudes are formed from the beliefs a person holds about the technology. The beliefs are influenced by how the technology was communicated and presented to them.

Davis (1989:320) defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance his or her job performance". Gu and Liu (2011) stated that perceived usefulness indicates how one person considers the depth of improving his work accomplishment using a concrete system. Aboelmaged and Gebba (2013) have examined that this proposition is justified from the perspective that people's intentions to use the technology will be greater despite their attitude toward the technology alone, if they expect a technology to increase their performance of the job. Thus, people are likely to accept and use

technology that helps them complete their jobs effectively with the resources at hand, within the allocated time and without extra costs incurred.

The other variable known to greatly impact technology user acceptance is perceived ease of use. Davis (1989:320) explains perceived ease of use as “the degree to which a person believes that using a particular system would be free of effort”. The term “ease” is explained as freedom from difficulty or great effort (Davis, 1989:320). According to Gu and Liu (2011), perceived ease of use indicates how easy one person considers using a concrete system. It is argued that ease of use may directly or indirectly influence the perceived usefulness of the technology (Davis, 1989), as such people tend to accept and continue using technologies that are not complicated to understand (Aboelmaged & Gebba, 2013). Alloghani et al. (2015) affirmed that complexity of the technologies will influence the ease of use. IS/IT that are easy to use enable users to complete their tasks effectively compared to technology systems that are difficult to use. Hence, if the technology is useful but its interface and instructions are difficult and frustrating to follow, users will grow resistant towards that technology.

Both perceived usefulness and ease of use are influenced by external factors. These external factors are the many variables that are unique to individuals and organisations. Schade and Baum (2007) examined that acceptance is based on an individual’s personal attitudes, expectations, experiences and subjective evaluation of the system, and the effects of using it. According to Venkatesh and Davis (1996:453), “external variables are influenced by system characteristics, training, user involvement in design, and the nature of the implementation process”. Horberry et al. (2014:5) argued that technology acceptance is influenced by the social, legal, cultural, political, and organisational context in which the technology is implemented, and by the amount and type of exposure the user has regarding the technology.

The type of attitude a person have manifest into behavioural to use the system which eventually leads to actual system use (Davis, 1989). Thus, the behaviours people develop towards technologies are determined by their attitude they hold regarding the technology. Therefore, TAM postulates that, based on whether the users perceive system to be useful and easy to use, they develop attitudes and behaviours towards the actual systems in use. Cheung and Vogel (2013) asserted that in TAM, perceived ease of use and perceived usefulness are known to have a direct effect on the person’s attitude toward the use of technology.

However, the model is criticised for not focusing on the external factors that could influence perceived ease of use (PEOU) and perceived usefulness (PU) (Park, 2010). Others also

believe that PEOU and PU should not be considered as the only beliefs impacted by external factors to determine attitude and intentions (Alsajjan & Dennis, 2010).

2.7.4 Technology Acceptance Model and Information systems studies

The implementation and support of Information Systems are costly and yet many IS encounter low usage across organisations (Legris et al., 2003). According to Venkatesh et al. (2008), the underutilization of IS limits organisations' efforts to gain benefits from such systems. Thus, the adoption and use of IS/IT remains a concern to information systems research and practise (Venkatesh & Davis, 2000).

Iyamu (2015:127) asserted that "TAM is often employed from a social context to understand individuals and groups perceptions in the adoption and use of technologies from different perspectives". The use of TAM in IS/IT studies provides organisations with valuable insights on why and how IS/IT are accepted or rejected by users in organisations. These enable organisations' management to make better and more informed decisions when selecting, developing, and implementing IS/IT. Ideally, the advantage of TAM lies in its design to be used in the acceptance of technology and as a result it has become the accepted model for research in IS/IT adoption models (Iyamu, 2015).

Thus, TAM has been applied in many IS studies in the area of healthcare (Karahoca et al,, 2017; Ahadzadeh et al., 2018), big data (Wang et al., 2017), mobile systems (Martens et al., 2017; Lindsay et al., 2011), and enterprise architecture (Hazen et al., 2014; Per et al., 2012). IS/IT plays a significant role in healthcare such as managing patients' records and monitoring chronic diseases. To improve the potential of IS/IT in healthcare, we need to understand the interrelationship between healthcare professionals and technologies. Karahoca et al. (2017) recommend that for the industrial development of new technologies, it is important to investigate and examine its acceptance by its users. Therefore, the application of TAM in IS/IT healthcare studies is an opportunity to study and understand factors influencing healthcare practitioners' and patients' behaviours and attitudes towards IS/IT.

2.7.5 Structuration Theory and Technology Acceptance Model

The use of one theory to underpin IS/IT studies may not always be sufficient, where the scope and objectives are broad as in doctoral studies. Hence, the complementary use of theories in IS/IT studies have been on the increase (Iyamu, 2013). For example, Iyamu and Roode (2012) used ST and Actor Network Theory (ANT) to study socio-technical factors impacting the development and implementation of IT strategy in a financial organisation. In this study duality

of structure from ST and moments of translations from ANT were used as lenses in the data analysis respectively.

At the time of this study, the application of ST and TAM in the same study was not found. Thus, the combination of ST and TAM brings uniqueness to this study. ST and TAM are completely two different theories, each with a unique focus. ST is a purely sociological theory, focusing on the production and reproductions of structures as technical and non-technical agents consciously and unconsciously interact, while TAM is a behavioural model focused on technology acceptance or rejection in organisations. TAM argues that the major determinants of technology acceptance in organisations is perceived usefulness and perceived ease of use (Wallace & Sheetz, 2014). Perceived usefulness and perceived ease of use are viewed as determinants of a user's attitudes, which eventually determines actual system usage (Alsajjan & Dennis, 2010).

In this study, ST is applied first in order to understand how people interact and access healthcare big data. The application of ST enables the interrogation of how and why the rules and resources in place enable and constrain big data accessibility, usefulness, and management through mobile systems.

By firstly interrogating the interaction of technical and non-technical actors, it enables understanding of the manifestation of structures and how they impact the accessibility and usefulness of big data. Based on these findings, the study examines how the individuals perceive the usefulness and ease of use of mobile systems in accessing and managing their healthcare. Therefore, TAM was used to guide the interpretation of the findings in order to understand how the factors influence the acceptance of mobile technologies in healthcare.

2.8 Summary

This chapter presented a review of the relevant literature. The literature review was based on the keywords that were identified according to the study's focus and objectives, namely healthcare, Information Systems/Information Technology, big data, health mobile systems and architecture.

In addition to the keywords, this chapter also included the socio-technical theories that underpinned this study. The two theories are Structuration Theory (ST) and Technology Acceptance Model (TAM). From ST, the lens of duality of structure is used in this study to analyse the data, while TAM is used as a lens through which to interpret the findings. The perspective that each theory brings to this study was also discussed in this chapter.

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This Chapter presents and discusses the research design and methodology that were applied in this study. Research is not carried out in vacuum. A researcher needs to follow designs and apply methods to resolve the problem and achieve the defined objectives. According to Taylor et al. (2015:3), methodology is the way in "which people approach problems and seek answers". Thus, research design and methodology are vehicles through which research objectives can be achieved. Therefore, they should be appropriately selected. The research design and methodology were based on the aim of the study, which was to develop a unified architecture framework, which will enable scalability and integration of healthcare mobile systems with healthcare big data.

The remainder of this Chapter is structured into nine sections. The first section discusses the research philosophy under which the design and methods used belong to. The second section covers the research approach that was used in this study. The third section discusses the research strategy. In the fourth section the research design applied is presented. The fifth section gives an overview of the data collection process. In the sixth section, data analysis is presented. Unit of analysis and delineation of the study are presented in sections seven and eight, respectively. Finally, the Chapter conclusion is drawn.

3.2 Research philosophy

Research philosophy defines the school of thoughts to which the selected research designs and methods belong. The research philosophy selected influenced how the researcher approached the study in order to achieve defined objectives. Moon and Blackman (2014) explain that research philosophy provides both the natural and social sciences with the general principles of theoretical thinking, whether ontological or epistemological. Holden and Lynch (2004) state that ontology and epistemology are consequential to each other; as such, a researcher's view of ontology affects their epistemological persuasion which further influences their view of human nature.

Ontology is concerned with the existence of objects. According to Gray (2013:19), "ontology is the study of beings, which includes the nature of existence and what constitutes reality",

which this study sought to establish in developing a unified architecture. Therefore, ontology tries to answer questions of what exists and the reality of its existence.

Meanwhile, epistemology is concerned with the study of knowledge. Gray (2013:19) explains that, epistemology provides "a philosophical background for deciding what kinds of knowledge are legitimate and adequate". Bryman and Bell (2015) state that epistemology concerns the question of what is or should be regarded as acceptable knowledge in a discipline. Knowledge legitimacy is represented differently across the various epistemology paradigms which includes positivism and interpretivism.

This study followed an interpretivism paradigm to study healthcare mobile systems interaction with big data in the Namibian public hospitals. The selection of interpretivism philosophy was guided by the study objectives.

Interpretivists argue that natural reality and the laws of science and social reality are different and, therefore, require different kinds of methods (Gray, 2013:23). Interpretivists view the world as socially constructed, meaning that knowledge is available only through social actors (Eriksson & Kovalainen, 2015). Ritchie et al. (2013:22) assert that "interpretivism emphasise the importance of understanding people's perspectives in the context of the conditions and circumstances of their lives". Interpretivists aim to describe and explore in-depth phenomena from a qualitative perspective (Crossan, 2003). Therefore, interpretivism is an epistemological view associated with subjectivism

Unlike interpretivism, positivism is based on the premise that the reality of objects exists independent of human behaviour and is thus not a creation of human mind (Crossan, 2003). Positivism holds that "methods of the natural sciences are appropriate for social enquiry because human behaviour is governed by law-like regulates, and that it is possible to carry out independent, objective and value free social research" (Ritchie et al., 2013:24). Moon and Blackman (2014) argue that positivism is objectivist as it is based on the conviction that only knowledge gained through the scientific method, through unprejudiced use of the senses, is accurate and true. Based on positivism, the external world is shaped and regular, and there is an objective reality/ truth that has patterns, which cannot be predicted or explained through theories or laws (Winit-Watjana, 2016). Thus, positivists believe that their interest, values, and beliefs have no influence on what they are studying as studies are carried out independently of what is being observed (Holden & Lynch, 2004).Therefore, positivism epistemology is about objective rather than subjective statements and only the objective statements are seen to be the proper way of research (Greener & Martelli, 2015).

In achieving the study objectives, there was a need for the researcher to interact with the actors in the healthcare environment. Engaging with the actors in the healthcare environment enabled the study of the problem in its entirety. This is necessary to understand the subjective meanings, which patients and practitioners including the IS/IT personnel associates to the various activities in the use of healthcare big data to providing and receiving services.

3.3 Research approach

A research approach may involve deductive or inductive reasoning (Saku & Ketokivi, 2013; Bryman & Bell, 2015). Although there is also a third form of reasoning – abductive – this section will focus solely on inductive and deductive reasoning. According to Bhattacherjee (2012) deductive research is theory testing research, while inductive research is called theory building research. The approaches influence the choice of research design and data collection techniques.

3.3.1 Inductive approach

This study employed inductive reasoning primarily because there was no testing of concepts but rather the development of a theory in the form of a unified architecture framework. Inductive research is often associated with qualitative research. Holloway and Galvin (2016) explain that inductive research works from the specific case and then generalising the results. According to Ketokivi and Mantere (2010), researchers using an inductive approach, generalises the insights they have collected. Thus, "an inductive approach starts by looking at the focus of research and through various research methods, aims to generate theory from the research" (Greener & Martelli, 2015:19).

3.3.2 Deductive approach

Unlike inductive research, deductive research is mostly used in theory testing research (Bryman & Bell, 2015). In deductive research, the researcher tests concepts and patterns known from theory using new empirical data, rather than developing new theories (Bhattacherjee, 2012; Creswell, 2013). Therefore, the researcher advances a theory by collecting data to test it and reflects on its confirmation or disconfirmation by the results (Creswell, 2013). Ketokivi and Mantere (2010:318) explain that deductive research "proceed[s] from a set of general premises to a more specific conclusion, with the strict condition that the conclusion must follow analytically from the premises". A deductive approach uses evidence in support of a conclusion whereby a hypothesis is first developed, and evidence is then collected to confirm or reject it (Ritchie et al., 2013:6).

3.4 Research strategy

The research strategy represents the umbrella under which the selected research designs, methods, and techniques fall. Qualitative, quantitative, or mixed method are used in research, often as strategy. Moreover, Bryman and Bell (2015:38) explain that “each strategy is differrent in terms of the role of theory,epistomological issues, and ontological concerns”.

3.4.1 Qualitative research method

Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena (Taylor et al., 2015) . Holloway and Galvin (2016:3) define qualitative reseach as “a form of social inquiry that focuses on the way people make sense of their experiences and the world in which they live”. Qualitative researchers do not view reality as fixed, but instead try to understand individuals in order to bring a unique perspective to the way they see and comprehend the world around them (Nollaig, 2011). Taylor et al. (2015) explain that when researchers reduce people’s words and acts to statistical equations, they will lose sight of the human side of social life.

Therefore, qualitative research aims to capture meanings or qualities that are not quantifiable, such as feelings, thoughts, and experiences (Chris & Jones, 2010). In an attempt to achieve these aims, qualitative studies are carried out in the natural environment of subject(s). Researchers, such as Atieno (2009), Bryman and Bell (2011), have pointed out that the best way to understand the bevaviours and meanings of a phenomenon is to become part of its natural environment. Methods that belong to qualitative research strategy are, therefore, designed to help us understand people, and the social and cultural contexts within which they live (Myers & Avison, 2007).

Conboy et al. (2012) describe qualitative approaches as being associated with an interpretivist stance. Qualitative research focuses on the interpretive approaches to social reality and in the description of the lived experience of human beings (Holloway & Galvin, 2016). According to Chris and Jones (2010), interpretive approaches allow the researcher to explore and uncover explanations, rather than deduce them from measurements. To qualitative researchers, each individual experiences the world from his/her own point of view; therefore, each of us experience a different reality. Qualitative researchers are keen to provide considerable descriptive details in that they typically emphasise the importance of the contextual understanding of social behaviour (Bryman & Bell, 2011; Nollaig, 2011).

3.4.2 Quantitative research method

Researchers employ the quantitative method primarily for measurement purposes in their studies (Bryman & Bell, 2011). Quantitative is about the counts and measurements of things. According to Denzin and Lincoln (2011:8), “quatitative research emphsises the measurement and analysis of causal relationships between variables, not process”. As a result, quantitative research tends to be confirmatory and deductive (Atieno, 2009; Bryman, 2012). Quantitative studies often begin with a hypothesis and variables that need to be tested and the results obtained are used for generalisation. In information systems (IS), this research methods has been used more for confirmatory studies, such as theory testing, as explained by Venkatesh et al. (2013).

Quantitative methods are usually considered to be underpinned by positivist thinking (Conboy et al, 2012). Researchers from the positivist background argue that reality should be studied objectively by the researchers who should put a distance between themselves and what is being studied (Yilmaz, 2013). Positivists assume that behaviours can be observed and objectively measured and analysed (Chris & Jones, 2010).

3.4.3 Mixed research method

Mixed method is an approach that combines quantitative and qualitative research methods in the same research inquiry (Venkatesh et al., 2013). Brannen (2002) points out that most often a study’s objectives and questions cannot be addressed by a single research strategy. As a result, it becomes necessary to use both strategies. According to Bryman and Bell (2011), quantitative and qualitative research represent different research strategies and each has its differences in terms of the role of theory, as well as epistemological and ontological concerns. According to Venkatesh et al. (2013), the methods can either be used concurrently, independently of each other or sequentially, where findings from one approach inform the other.

The use of mixed method approach has been criticised by some scholars. Some argue that due to the differing philosophies underlying each of these strategies, it means that they cannot be combined (Nollaig, 2011). Atieno (2009) explains that quantitative researchers operate under different epistemological assumptions from quantitative researchers. For example, qualitative reseachers believe one cannot study a phenomenon out of its natural context, wheras quantitative researchers believe one can only study a phenomenon outside of its natural context. Due to such criticisms, the strategies often compete with each other. Considering the above, Blaxter (2010) upholds that while researcher will emphasise either qualitative or quantitative methods, it is difficult to imagine research that is wholly quantitative

or wholly qualitative in its approach. Mixed methods are used where numbers, objectivity, and generalisability are needed, but where researchers also want to support the data with rich descriptions of experience from the perspective of the individual (Nollaig, 2011).

In some studies, such as Bryman and Bell (2011) and Armstrong (2009), it is highlighted that the choices of research strategy have to be aligned with the research questions. Myers and Avison (2007) stated that given the tremendous scope of the IS/IT field, both qualitative and quantitative research are welcome. To provide rich insights into various phenomena and develop novel theoretical perspectives, Venkatesh et al. (2013) are in support of IS/IT researchers using mixed methods research where applicable. Blaxter (2010) emphasises that combining qualitative and quantitative strategies enables researchers can take advantage of the strengths that each has to offer in combination. Combining both qualitative and quantitative methods can address both exploratory and confirmatory questions within the same research inquiry explain (Venkatesh et al., 2013). When more than one strategy is selected, according to Brannen (2002), a study may employ a variety of methods and techniques of data collection and types of analysis to address different research questions.

Nevertheless, based on this study's objectives, a qualitative research method was deemed appropriate. The qualitative method enabled the researcher to interogate and seek clarity about the accessibility, use, and management of healthcare mobile systems and big data. Additionally, the nature of qualitative method allows the phenomenon to be studied in its natural environment.

3.5 Research design

Research strategies are associated with different kinds of research designs (Bryman & Bell, 2011). Yin (2003) defines a research design as the list of procedures that connects the empirical data to a study's research questions and ultimately to its conclusions.

Based on this study's objectives, qualitative methods were selected through which understanding of cases was sought. Within that context, a case study research approach was selected as theresearch design.

3.5.1 Case study design

Case study referes to the detailed exploration of a specific case, which could be a community, organisation, or person (Bryman & Bell, 2015). Explaining further, Woodside (2010) states that a case can be an individual or a group, such as a family, a class, or an office, but one can also study multiple cases. According to Dube and Pare (2003), a case study is versatile because

it can be used with any philosophical perspective whether it is positivist or interpretivist. Tran (2016) reports that a qualitative case study examines a phenomenon within its real-life contexts. Additionally, Swanson and Holton (2005) describe case study to be very appropriate when the researcher is interested in process or seeks an in-depth understanding of a phenomenon because of its uniqueness.

A study by Benbasat et al. (2007) summarises three reasons why case study is applicable in IS/IT studies:

(1) the case study approach enables the researcher to generate theories from practise by studying IS/IT in a natural setting,
(2) it enable the researcher to answer the "how" and "why" questions needed to understand the nature and complexity of the processes, and
(3) due to the rapid changes in the IS/IT field, a case approach is the appropriate way to research an area in which few previous studies have been carried out.

This study employed two cases, namely the Ministry of Health and Healthbridge Public Hospital. The cases were selected to enable a deeper understanding of the activities, interactions, and behaviours which occur within the Namibian healthcare environment. Additionally, the cases were selected because of their different roles and responsibilities in the healthcare services in the Namibia government. These will now be discussed individually.

- The Ministry of Health was selected as a case in this study as it is the sole provider of healthcare services in the country. The Ministry is responsible for the regulation and policies development as well as the management of healthcare related activities. Members of the community form part of this case. This was because community members do sometimes access or retrieve healthcare data from public hospitals in Namibia.

- Healthbridge Public Hospital was selected as case because it is one of the main referral hospitals in the country offering healthcare services to individuals from all regions in the country. Additionally, the hospital was selected due to its accessibility as the hospital is situated in the city centre.

3.6 Data collection

Based on the objectives of the current study, as stated in section 1.6, questions were formulated to illicit information from participants. Due to the nature of the study, as well as the organisations used in the study, three sets of questions were formulated to achieve the objectives.

Data were collected by means of semi-structured interviews and documentation. Semi-structured interview was used as the primary data collection technique as they enable flexibility and clarity from both parties. Because of the physical presence of the researcher, the participants were able to ask for clarity on the questions they did not understand during the interview process. Such clarity ensured that the participants gave relevant information.

Owing to the criticality of data collection, it was essential to document the entire process, into two phases, before and during the interview.

i. Before the interview

Before the actual interview began, two things were crucial, namely, requesting permission and formulating interview guidelines.

a) Requesting permission

Permission was sought from the Directorate of Health Information Systems and Research to have access to and use the Ministry of Health (MoH) and Healthbridge Public Hospital (HPH) as cases in this research. Before permission was granted, the Directorate of Health Information Systems and Research requested the following documents from the researcher:

1) research proposal,
2) permission letter to conduct research from the university,
3) documents illustrating how data confidentiality was going to be enforced, and
4) the researcher's curriculum vitae.

These documents were submitted in hard copies. Upon receipt of these documents, permission was granted.

b) Formulating interview guidelines

Before the interview process, the interviewer designed interview guidelines, which were questions used in the collection of data from participants. The purpose of these guidelines was to ensure consistency and uniformity during the interview process. The set of questions were extracted from the main and sub-questions, which are also presented in section 1.5:

Main question

How can a unified architecture framework, which can be used as guide and enable the integration between mobile system and healthcare big data for improved healthcare delivery, be developed?

Sub-questions

i. What are the factors that influence the use of mobile systems in accessing healthcare big data for service delivery in the Namibian environment?

ii. What are the factors that can be used to guide and enable integration between health mobile systems and healthcare big data for improved healthcare service delivery?

The set of guidelines enabled the researcher to collect enough data as the questions were simplified to enable understanding for the participants. From the main research question, nine data collection questions were formulated. From the first research sub-question, eight data collection questions were derived, and eight data collection questions were derived from the second research sub-question. For each data collection question formulated subsequent-follow up questions were designed. Follow-up questions enabled the interviewer to probe further and interrogate the areas being discussed

ii. Interview process

Before the interview process, the participants were briefed about the aim of the study, as well as about how data privacy will be kept. Participants were ensured that data from this study will not be used for any purposes other than this research. To ensure anonymity, neither participants' personal information, nor the organisation they work for, were revealed. Instead pseudonyms were used. Briefing about data privacy allowed participants to be at ease and comfortable with taking part in interview process.

The participants from the Ministry of Health involved IT specialists and various healthcare program officers and directors. From Healthbridge Public Hospital, the participants involved senior registered nurses, pharmacists, and administrative employees such as data clerks. All participants interviewed from the Ministry of Health and Healthbridge Public Hospital had been in their positions for more than two years at the time of the interview. This was to ensure that the participants are knowledgeable and capable of discussing areas pertaining to their positions.

The participants from the MoH and HPH were interviewed concurrently as such the interviewer followed up on some of the matters that were discussed by the previously interviewed participant from either case. This enabled the interviewer to seek clarity and confirmation on areas discussed previously.

Interviews took place at an agreed time. At times when participants were not available, interviews were rescheduled. For the Windhoek community members, interviews were conducted at different venues, such as at individuals' work offices, homes, or public libraries. For the MoH and HPH participants, all interviews were conducted at the participant's work places.

All interviews were recorded with a voice recorder, as the interviewer was unable to note down everything that was being discussed. Before recording, the interviewer sought permission to record the conversation and explained the ethical policies and how data will be kept confidential in this study. Participants were assured that neither their identity nor their organisations' names would be revealed; instead, interview labels were used.

In cases where the interviewee was interrupted during the interview process, the voice recorder was paused and replayed after disruptions. This allowed the interviewer to record only conversation related to the study.

After each interview, the recorded data was transcribed by the researcher. The voice recorder and Microsoft Word document were used in the transcription process. The researcher transcribed the data by playing the voice recordings back and forth to grasp and write down what had been recorded. All the interviews were conducted in English. The decision to stop data collection was taken when no new information was being gathered during the interview process and thus the saturation stage was reached. As shown in Tables 3.1, 3.2, and 3.3, three sets of interviews were conducted. In total, 28 participants were interviewed.

Table 3.1: Ministry of Health participants

Ministry of Health	
Participants	No. of participants
Monitoring and Evaluator Officer (TB- Programs)	1
National Programs Co-ordinator (Primary healthcare)	1
Systems Analyst (Division of HIS)	1
Database Support (Division of HIS)	1
Technicians	2
Chief Systems Administrator (IT)	1
Systems Administrator (E-Health system)	1
Total Interviews	8

Table 3.2: Windhoek community participants

Windhoek community members	
Participants	No. of participants
Individuals from the Windhoek community	11
Total Interviews	11

Table 3.3: Healthbridge Public Hospital participants

Healthbridge Public Hospital	
Participants	No. of participants
Billing Clerk	1
Data Entry Clerk	1
Senior Registered Nurse	5
Pharmacist	1
Radiologist	1
Total Interviews	9

iii. Documentation process

Data was also collected through the documentation technique. This study employed documentation technique to gather additional insights regarding mobile healthcare systems and data collection, storage, accessibilty, and management in the Namibian public healthcare sector. Nollaig (2011) mentions that most often researchers fail to include documents in their data collection; yet, documents can provide valuable data. Prior (2002) argues that without documents, there are no traces of social history. Documents do not simply reflect, but also construct social reality and versions of events (Blaxter, 2010).

The documents obtained for this study provided further explanation and clarification on some of the documented aspects that could not be elaborated on during the semi-structured interview. Documents were requested from the participants during the interview process. In total, three documents were received. All documents received were in hard copy format. The table below indicates the different types of documents received. Documents were labelled Doc01, Doc02 andDoc03 for ease of reference during data analysis.

Table 3.4: Documents Obtained

Documents gathered
Doc01 NDP 4 Healthcare Policies Report of 2018
Doc02 Health Information Systems Report
Doc03 Monthly/Quarterly Vital Event and Activity Report Form

iv. Cleaning of the data

After data collection process, the transcribed data was cleaned by correcting grammar errors, and inserting appropriate punctuation marks, to make it readable and useable for the data analysis process. After data cleansing, all transcribed data for each case were put together in one document. Participants in the cases were labelled accordingly: from Ministry of Health, as MoH01 to 08, from the Windhoek community as TC01 to 11, and PH01 to 09 for participants from Healthbridge Public Hospital. Line numbers were inserted in all document margins, because data was referenced according to the corresponding line numbers in the study.

v. Challenges

During data collection process, some challenges were encountered. Two of the challenges that stood out are discussed as follow:

a. Not probing enough

During the first interview, one of the challenges was insufficient probing by the researcher on the matters arising from the interview conversation. When the researcher does not probe enough, gaps are created leading to poor data collection. Thus, probing allows the researcher to interrogate matters as they unfold during the conversation. Probing further is important for quality data collection.

To manage probing challenges, the interview was rescheduled. During the second interview, the researcher focused on the areas that were not probed fully. The areas were interrogated by asking more “why” questions. These enabled the participants to explain in more details why things happen the way they do.

b. Participants' willingness to be recorded

Before the interview processes, participants were briefed about the ethical and privacy policies. However, some of the participants were not willing to be recorded but still wanted to partake in the study. The researcher agreed to this and during the interview process notes were taken. Taking extensive notes was challenging as it was difficult to write and at the same time listen attentively to what was being said. After the interview, the researcher immediately summarised what had been discussed.

3.7 Data analysis

Data analysis is the process whereby data is explored thoroughly to look for patterns and relationships in order to discover new phenomena (Silverman, 2018). Beaudry and Miller (2016) assert that qualitative data analysis is a rigorous and complex process that requires preparation. During data analysis, the researcher aimed to make sense out of the data collected.

In this study, data was analysed using the hermeneutic technique from the interpretive approach. Hermeneutic was selected as it allows for a phenomenon's to be studied subjectively. Hermeneutic focuses on reality as a human contrast, which can only be understood subjectively (Kroeze, 2012). Furthermore, Bahari (2010) notes that the findings are influenced by the researcher's perspectives and values. Consequently, an interpretivist approach was used to understand how healthcare big data can be accessed, used, and managed with mobile systems within governmental healthcare environments.

Additionally, the documents were interpretively analysed, as such what the researcher read from the documents was influenced by the reader's viewpoint. According to Blaxter (2010), documentation analysis proceeds by abstracting from each document elements, which are considered important or relevant, and by grouping these findings together.

Analysis of the data was guided by the duality of structure from the Structuration Theory (ST). In this study, the ST duality of structure was used to examine the interaction of systems, human and procedures, from four different perspectives:

v. How structure (rules and resources) influences interaction and activities of the agents in the accessibility and use of big data to provide healthcare services in an environment. The agents were technical (such as medical apparatus, IS/IT artefacts, and data) and non-technical (such as human and procedures);

vi. What the roles are of both technical and non-technical agents in the accessibility, usage, and management of healthcare data. This was to examine the enabling and constraining factors in the interaction with healthcare big data;
vii. How structure and agents influence the use of healthcare mobile systems to access, and utilise healthcare big data; and
viii. What the interaction is between the agency and structure and how they manifest socially to reproductively impact healthcare mobile systems and healthcare big data.

Thereafter, the interpretation of findings from the analysis was guided by the technology acceptance model (TAM). TAM was used to examine and understand the usability and acceptance of healthcare mobile systems from three different folds:

iv. The perceived usefulness and ease of use of healthcare mobile systems in healthcare among different actors. System Usefulness is different across system users. TAM helped to examine and understand how the different actors viewed or perceived mobile systems and healthcare big data usefulness in providing services;
v. How and why patients and practitioners made use of healthcare mobile systems to access healthcare big data for services; and
vi. How mobile systems can be accepted and used in healthcare big data management. For technology systems to be accepted and used, they need to be useful by enabling users to perform their activities as they intend, and with ease.

In summary, socio-technical theories were used on two different levels; firstly, data analysis and, secondly, interpreting the findings. At the first level (i.e. data analysis), ST was employed, and at the second level (i.e. interpretation of the findings), TAM was used. The complementary use of the two theories was to bridge the gap between interaction and acceptance towards the development of a unified architecture, for the scalability, flexibility, and integration of healthcare mobile systems and healthcare big data.

3.8 Units of analysis

Units of analysis represent the categories from which data were collected and analysed. In this study, the units of analysis categories were derived from the two cases: Ministry of Health (MoH) and Healthbridge Public Hospital (HPH).

At the MoH, data were collected from technical employees, such as IT specialists who implement and maintain IS/IT in the Ministry, and non-technical employees, such as healthcare policy makers, and healthcare programme directors and officers. In addition, as

part of MoH, data were collected from the Windhoek community which represents individuals that seek healthcare services from public hospitals.

At Healthbridge Public Hospital (HPH), data were collected from various medical practitioners which included senior registered nurses, radiologists, and pharmacists at the HPH. In addition, data were collected from administrative employees which included billing officers and data entry clerks. The unit of analysis used in this study is illustrated in figure 3.1 below.

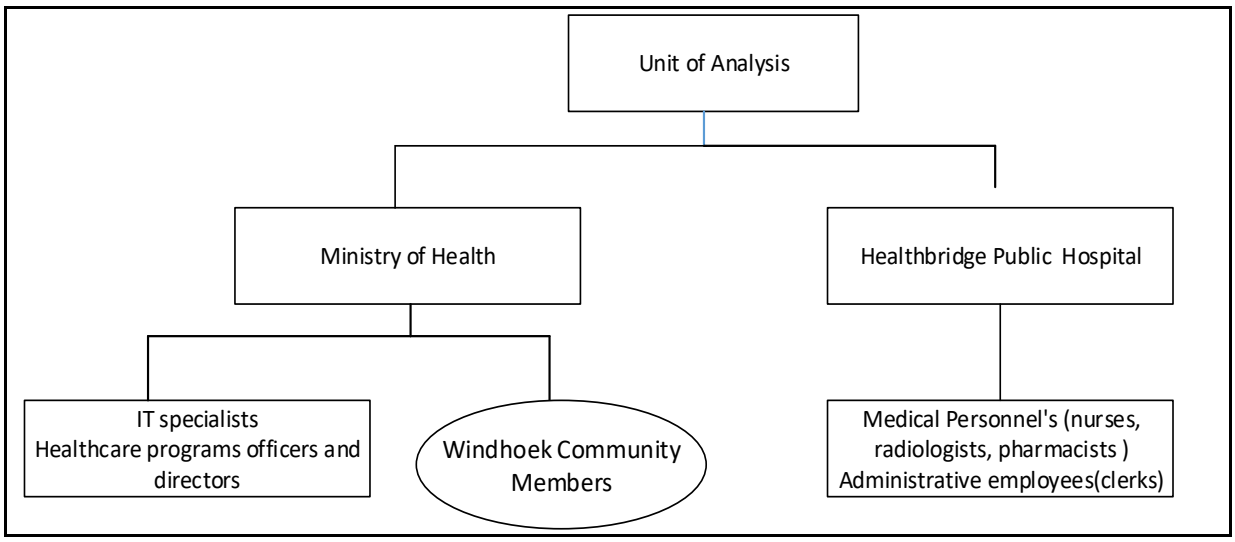

Figure 3.1: Unit of Analysis

3.9 Delineation of the research

This study focused on healthcare data management within the Namibian public hospitals. As a result, the MoH, which is resposible for policy development and implementation as well as managing the government healthcare services, was selected as a case. A public refferal hospital was also selected. The study focused on the developement of a unified architecture framework for healthcare mobile systems and big data interaction.

3.10 Summary

This Chapter presented the research design and methodology employed in this study. The design and methodology were selected based on the study objectives and aim. Therefore, based on the study's objectives and aims, a qualitative strategy was selected. In order to support and bring clarity for the qualitative strategy selected, the research philosophy, research approach, research design used, and data collection methods were also discussed in this Chapter. Data was collected by means of semi-structured interviews and documentation technique.

In addition, this Chapter discussed data analysis and unit of analysis. Two theories, ST and TAM, were used as lenses to underpin this study. The two theories are explained in more detail in Chapter 2.

CHAPTER 4
OVERVIEW OF CASE STUDIES

4.1 Introduction

This Chapter gives an overview of the cases studied. Based on the research objectives, as stated in Section 1.6 of Chapter 1, two cases were studied. These cases were the Ministry of Health (MoH) and Healthbridge Public Hospital (HPH). Members of the Windhoek Community were also studied as part of the MoH case. The two cases were viewed differently and not treated as one. As such, the data collected from each case were analysed separately.

The remainder of this Chapter is structured into four sections. Section one gives a brief overview of the fieldwork carried out. Section two provides detailed information about the two cases used in this study. In section three, the cases' organisational structures are discussed. Finally, the Chapter conclusion is presented.

4.2 Fieldwork

Data were collected by means of semi-structured interviews from the two cases. The semi-structured interview was selected and used in this study because it allows for instant probing by both interviewer and interviewee. This enables clarification from both parties. The documentation technique was also used to collect data from the MoH and HPH. The documentation technique enabled the collection of recorded data which the interviewees could not fully explain due to time limits.

Data collection questions, which acted as guidelines, were set up. The questions helped to maintain consistency and uniformity across the interview process. For the MoH and HPH cases, the interviews were carried out at the interviewees' workplaces, and for the Windhoek Community participants, interviews were conducted at different places, such as interviewees' workplaces, homes, and the public library.

Before the interview process, the interviewees were briefed about the study and topics to be discussed in the interview. For the interviewees, the briefing created awareness of what will be discussed. Before interviews, permission was sought to record the interview process. Recorded interviews were transcribed onto a Microsoft Word document. The analysis of the data was conducted using the hermeneutic method, which was guided by the duality of structure from Structuration Theory (ST).

4.3 Case studies

This research was based on two cases. The researcher consulted and sought permission to conduct research from both cases with a formal letter from the Cape Peninsula University of Technology. The formal letter served as a reference letter, introducing the researcher, topic, and objectives of the study. Additionally, a consent letter was presented to the cases. The consent letter was used to seek permission to record the interviews. Data collected from the cases were only used for the purpose of this study purpose.

Each case has its own objectives and goals as they carry out different activities. Thus, the cases were mainly selected because of their roles and responsibilities in the healthcare services delivery within the government of Namibia. The diagram below illustrates the association between the cases during the time of the study. The case documentation is guided by the diagram. Cases are discussed individually below.

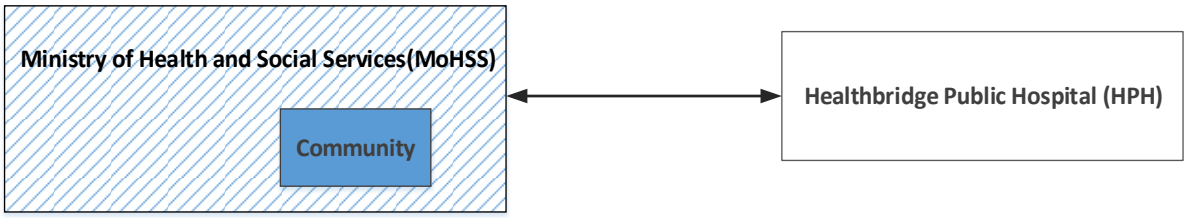

Figure 4.1: Association of cases

4.3.1 Ministry of Health

The Ministry of Health (MoH) is responsible for the development and implementation of policies, the regulation of healthcare services in the country, as well as the provision of public healthcare. The mandate of the MoH is to oversee, provide, and regulate public, private, and non-governmental organisations in the provision of quality health and social services, ensuring equity, accessibility, affordability, and sustainability. This mandate is derived from the Namibian Constitution, Article 95, where the state is required to maintain the welfare of the people by putting in place legislations that seek to provide healthcare of the people and to ensure social welfare for the people.

To achieve its mandate, the Ministry is divided into three levels:

i. Central level

The central level represents the national MoH head office in Windhoek. The head office is responsible for policy formulation, strategic planning, legislation and regulation, monitoring,

and overall coordination. Found at the head office are the ministerial offices, offices of the Permanent Secretary, and deputy permanent secretary.

The Permanent Secretary (PS) of the Ministry is the overall supervisor of the Ministry assisted by the Deputy Permanent Secretary. At the time of this study, the Ministry of Health and Social Services was divided into three departments:

1) regional health and social welfare services,
2) policy development and resource management, and
3) health and social welfare policy.

ii. Regional level

The department of regional health and social welfare services is divided into thirteen regional directorates. Regional directorates are headed by directors who are chairpersons of the regional management teams as the highest body at the level.

iii. District level

Each regional directorate is divided into health districts and the health district is headed by principal medical officers who are the head of the district's coordinating committees as the highest body at the level.

The three levels work together to plan and manage the resources required to ensure healthcare services are delivered efficiently and effectively across the country.

In addition, as part of the MoH, Windhoek community was also studied. Windhoek community represents the individuals that seek healthcare services from Ministry of Health through the Healthbridge Public Hospital (HPH). The various healthcare services sought by community members from HPH includes, but is not limited to, x-rays, clinical operations, medical check-ups, rehabilitation, and medicine. Community members seek these services primarily to cure, mitigate, treat, or prevent sicknesses. Thus, these services are of critical importance in order to maintain community members' wellbeing.

Patients that seek healthcare services at HPH have been referred from other healthcare facilities such as local clinics and regional state hospitals country wide. As a result, patients are first treated at their nearest health facilities before they are referred to HPH.

4.3.1.1 MoH: IS/IT Division Structure

The division of IT operates under the directorate of Human Resource Management and General Services within the department of Policy Development and Resources Management. The IT division is responsible for the procurement, development, implementation, maintenance, and management of the Information and Communication Technologies (ICT) resources required for the management of all healthcare related activities and processes in the ministry.

Figure 4.2 illustrates the Ministry's division of IT structure. The structure is perceived to be big and this could be attributed to the reasons that the Ministry operates healthcare centres, clinics, and hospitals across the country and such facilities are all ICT supported. Additionally, the Ministry gets support from Office of the Prime Minister (OPM), which manages the procurement process of ICT resources, the development and implementation of ICT policies and standards for all the Namibian government Ministries.

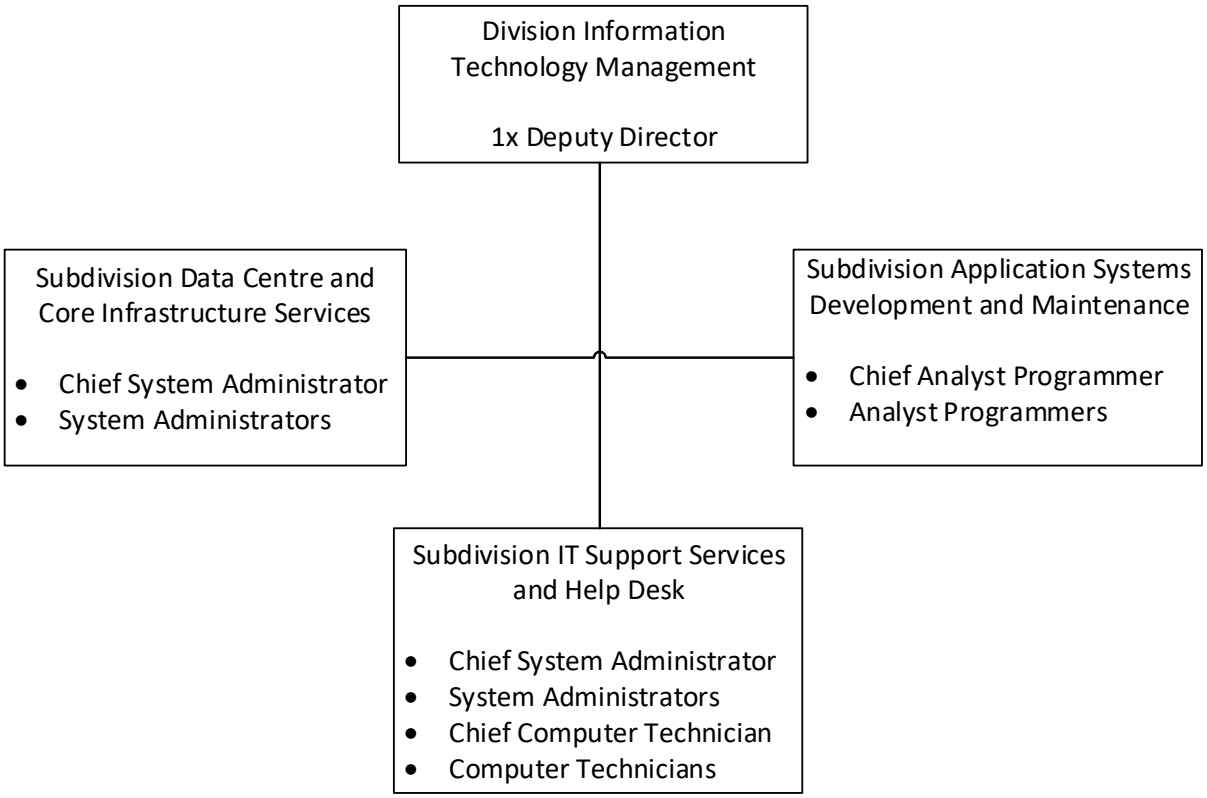

Figure 4.2: MoH division of IT structure

The division of IT is divided into three subdivisions, namely: (i) data centre and core infrastructure services (ii) applications systems development and maintenance (iii) IT support services and help desk. The three subdivisions are not independent of each other but work collaboratively to deliver ICT services efficiently. Subdivision's roles and responsibilities are discussed as follow:

i. Deputy director

In the Ministry of Health (MoH), the deputy director is responsible for the management of the IT division. The deputy director's responsibilities include the management of the division's financial budget and ensuring that the department is equipped with the right resources. These resources include competent IT workforce, ICT systems, and applications required to support healthcare-related activities and processes. Therefore, the deputy director ensures that all relevant information is communicated to the department's employees and relevant stakeholders. All IT employees under the division of IT reports to the deputy director.

ii. Subdivision: Data centre and core infrastructure services

The data centre and core infrastructure services subdivision is responsible for the deployment and management of all hardware and software in the Ministry. This subdivision manages and maintains servers, network infrastructures, databases, and other ICT systems that process and manage the ministry's data.

Employed under this division are the chief system administrator and system administrators. Their daily activities include network connectivity, system backups, managing file servers, as well as monitoring firewalls to ensure ICT infrastructures safety. Additionally, the chief system administrator and system administrators are responsible for training new employees and getting them equated with the hardware and software operations of the ministry.

iii. Subdivision: Application systems development and maintenance

The subdivision for applications development and maintenance is responsible for the design, development, and implementation and debugging of the application systems in the Ministry. The Ministry operates various applications, such as Integrated Health Record Management system, Integrated Financial Management system, and Human Resources Management system.

Working under this subdivision are the analyst programmers and system administrators. They are responsible for users' and systems' requirements collection and analysis. In addition, they study application systems requirements and assess their compatibility and interoperability with

existing applications. The analyst programmer and system administrators ensure that the applications can be supported by the Ministry's current network bandwidth.

iv. Subdivision: IT support services and help desk

The IT support services and help desk subdivision is responsible for providing ICT technical support to all employees in the ministry. Employees, such as system administrators, chief IT technicians, and IT technician, are found under this subdivision.

Their responsibilities include computers and printers troubleshooting, installation of computer applications, and fixing and installing internet cables and access points. They report and keep count of faulty computer systems and functional systems used by the employees. The chief technician and technician also assist employees who have difficulties with using computers and printers.

4.3.2 Healthbridge Public Hospital

Healthbridge Public Hospital (HPH) was established in 1982 and became fully operational as a health facility in 1984. In 1990, after the Namibia attained independence, the hospital remained a government facility and was identified as the National Referral Centre for specialised healthcare services. It is Namibia's largest referral hospital and one of two state hospitals in Windhoek, the capital city of Namibia. The hospital's mission is "to provide an integrated, affordable, accessible, quality, patient centred healthcare service that is responsive to the needs of the population".

To achieve its above-stated mission, HPH offers various healthcare services such as cardiac services, sterilizing services, eye clinic, intensive care unit, mental healthcare centre, maternity department, nuclear medicine, occupational therapy, pharmaceutical services, quality assurance, radiation oncology, social services, speech therapy, spinalis and spinal services, operational theatre, urology, radiology services, etc. In most cases, these healthcare services are not available or are limitedly available at regional clinics and hospitals.

Patients visiting the hospital are referred by medical practitioners, clinics, and regional hospitals within the referral system. The referral process is only applicable to patients who need emergency specialists' medical care which cannot be rendered at the regional hospitals, clinics, or medical practitioners.

4.3.2.1 Healthbridge Public Hospital: IT support

The hospital gets ICT support from the MoHS's IT division. Because of the criticality of healthcare services provided, the hospital has a dedicated IT workforce residing on its premises. Figure 4.3 below illustrates the hospital's IT department structure. The structure is perceived to be small as most of the IT workforce operates from the MoH head office and from other regional clinics and hospitals around the country.

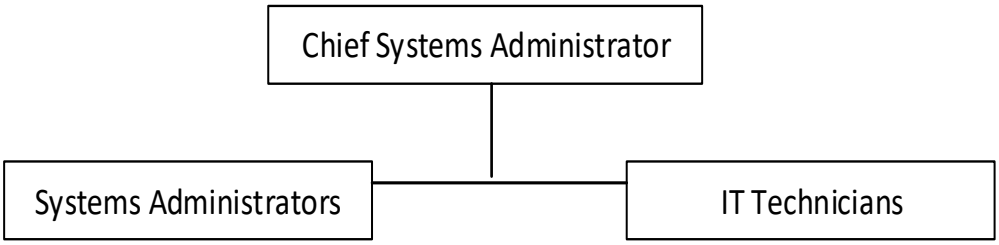

Figure 4.2: Healthbridge Public Hospital: IT structure

The IT department at the HPH is headed by the chief systems administrator who is responsible for the overall management of ICT artefacts at the hospital. The system administrators also communicate the hospital's ICT needs to the IT deputy director in the Ministry. Reporting to the chief systems administrator are the systems administrator and IT technicians. Systems administrator and IT technicians are responsible for setting up and troubleshooting computers, printers, networks, and all the ICT-related artefacts at the hospital.

4.4 Summary

This Chapter documented the cases that were studied, namely the Ministry of Health and Healthbridge Public Hospital. The documentation included the cases' background and their IT division structures. The IT division structure influenced the employees' roles and responsibilities. Therefore, as one move down the division structures, employees are associated with less power.

CHAPTER 5
DATA ANALYSIS

5.1 Introduction

This chapter presents data analysis. As discussed in chapter 1 and chapter 3, the study aim is to develop architecture framework, which can be used to guide and enable the integration of mobile systems with healthcare big data. Based on the objectives of the study as stated in chapters 1 and 3, the hermeneutic method was applied in the analysis of the qualitative data. The method was guided by the duality of structure from the perspective of Structuration Theory (ST).

The remainder of this chapter is divided into four main sections. The first section presents an overview of the data analysis process. The second and third sections presents case 1 and case 2 data analysis respectively. In the last section, the chapter conclusion is drawn.

5.2 Data Analysis: Overview

As discussed in chapter 3, data were collected from the two cases: (1) Namibian Ministry of Health (MoH); and (2) Healthbridge Public Hospital (HPH). Data was also gathered from members of the Windhoek community, which formed part of the second case. Details about the cases are presented in chapter 4.

From case1, data was gathered from eight (8) participants, while from case 2, nine participants were interviewed; and from the Windhoek community eleven participants were interviewed. The participants were labelled in accordance to the cases. The community members that were interviewed were also labelled. The MoH participants were labelled MoH01 to 08. The HPH participants were labelled PH01 to 09, and the members of the community that participated in the study were labelled TC01 to 11. The labels were important, firstly, for helping help with the citation of the participants in the study, secondly, for helping the researcher to protect the identity of the participants, which is within both the university's (CPUT) and healthcare ethics' code of conduct.

In conducting the analysis, the hermeneutic method of the interpretivist paradigm was applied. The Hermeneutic focuses on how humans construct meanings socially (Robinson & Kerr, 2015). The method was applied to following:

(1) the meanings which individuals give or associate to events and artefacts;
(2) how those meanings manifest in the course of providing health services; and

(3) how the meanings were used to interact with the rules and regulation within the environment.

This was guided by the duality of structure.

As explained in Chapter 3, the duality of structure from the perspective of Structuration Theory (ST) was used as lens to guide the data analysis in this study. As presented and discussed in more detail in Chapter 2, the duality of structure focus on interaction and relationship between agents in the reproduction of actions (Vyas et al.,, 2017). Thus, the duality of structure, as shown in Figure 5.1, was primarily employed for two main reasons:

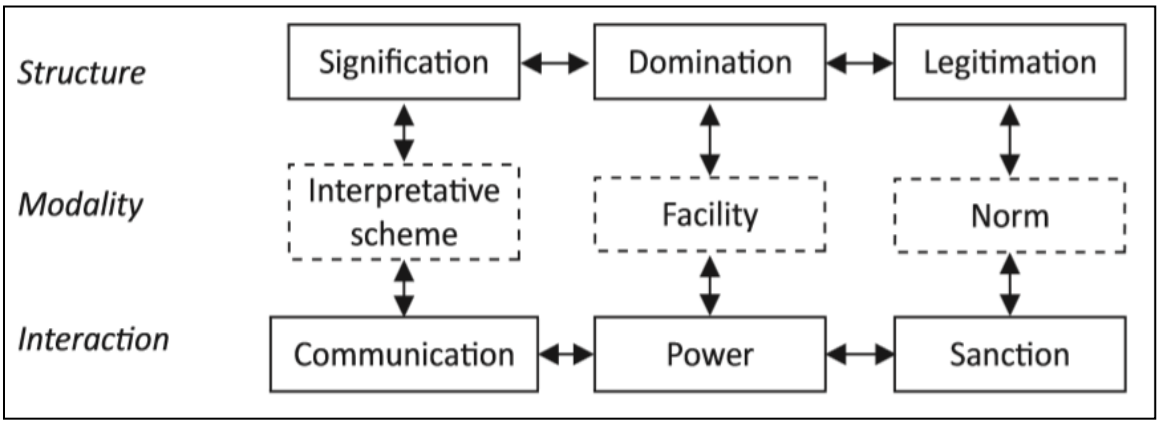

Figure 5.1: Duality of structure (Giddens, 1984)

1) It was necessary to identify and understand the different types of agents, and the relationship between the agents that existed in the healthcare environments. This helps to establish the roles of the agents as they interact to reproduce healthcare services through their use of patients' big data. This was to examine and understand the factors that influences the types of healthcare services that are provided to the community.

2) It was critical to identify and understand the types of rules and resources that existed, as well as how and why those rules and available resources were applied in the manner that they did in the course of providing healthcare services to the patients. ST focuses on reproduction of structure (rules and resources).

The analysis of two cases was carried out separately, first case 1, and then case 2The findings were also discussed separately before they were combined. This helped with generalisation, which is supported by the inductive approach that was employed in this research. Case generalisation allows for events or occurrences to be applied to similar specific phenomena anywhere in time and space (Nørreklit et al., 2016).

5.3 Case 1: Ministry of Health

As explained in Chapters 3 and 4, the Ministry of Health (MoH) provides rules and regulations and guides the operations of healthcare facilities in the country. In addition, the MoH is responsible for the provision and management of healthcare infrastructures and resources. Thus, the MoH was considered as an agency.

i. Agent

In ST, agent (agency) refers to any entity that can make a difference in a social system. This includes both technical and non-technical agents of which the human agents are knowledgeable about their environments (Rose & Scheepers, 2001). At the MoH, the technical agents included personal computers and desktop computers, printers, technology networks, telephones, and Information Systems applications such as district information systems. The non-technical agents were humans, such as system analysts, systems administrators, healthcare program officers and technicians, guides and regulations, and processes. AT the MoH, technical and non-technical agents were dependent on each other in the provision of healthcare services. As result, it was impossible for a technical agent to exist without a non-technical agent and vice versa.

ii. Structure

In ST, structures are rules and resources that are used by agents in the production and reproduction of social activities (Roberts, 2014). At the MoH, rules and resources were used in the operations of the healthcare. The rules included the regulations and policies such as data access and management policies. Referring to one of the rules, a participant stated:

> "*We have standard operating procedures (SOP) that guide what and how data should be collected" (MoH01, pg.2:62-63).*

The rules were of much importance to both the providers and the recipients of the services. Thus, the rules were often employed to guide employees' interactions and actions in their activities. Moreover, rules played pivotal roles in enforcing standardisation, which would otherwise have been difficult to do so at MoH. Without the enforcement of the standards, there would have been high rates of poor services, which can be detrimental to the patients.

The resources included mobile devices, such as phones and laptops; desktop computers; database systems; information systems applications such as integrated financial management systems; data warehouse and databases; finances, such as budgets; documents; cabinets;

and people. The people consisted of different practitioners and specialists which included IT personnel such as technicians, system analysts, system administrators, analyst programmers; medical personnel's such as nurses, doctors, pharmacists, and radiologists; human resources personnel; financial management personnel, such as accountants; and administrative employees, such as clerks and vehicles drivers.

The rules and resources were the means through which healthcare objectives were achieved. However, the rules and resources not only enabled the operations of the healthcare, but also constrained them. A responded shared that:

> "*We want to use many people as possible to record data on systems. It's just that of course there are financial implications and data clerks don't have the necessary knowledge to question the data that is being reported*" *(MoH02, pg. 6: 218-221)*.

The reproductive action from the interaction and relationship between agent and structure is enacted by the duality of structure. Stones (2017) describes duality of structure as a process whereby agents use structures to produce actions, whose effects in turn changes the structures.

The duality of structure by Giddens (1984) consists of three sets of dimensions. These are structure (signification, domination and legitimation) and interaction (communication, power, sanction), that are enabled or constrained via modality (interpretive scheme, facility and norm). Based on the enactment of the modality, the duality of structure was applied in vertical form: signification/interpretive scheme/communication, domination/facility/power and legitimation/norm/sanction.

The data analysis, which used the duality of structure as a lens, is summarised in Table 5.1, and the full analysis is presented thereafter. Thus, the table should be read with the discussion that follows, to gain better understanding.

Table 5.1: Dimensions of the Duality of MoH structure

	Signification	Domination	Legitimation
Structure	The major healthcare stakeholders, which include citizens (community members), healthcare practitioners, and the government (MoH) strongly believe that healthcare is essential and critically important. However, some stakeholders view the importance from different perspectives. For example, to the government healthcare is important for maintaining citizens' wellbeing. Furthermore, some people think that the use of mobile devices can enhance the ways in which healthcare services are provided and received. The views of the stakeholders were informed by their ability to interpret the information that are related to healthcare services in the country.	Even though the healthcare is a highly sensitive environment, some of the policy statements were not seriously considered important, making some health practitioners to employ their personal values and beliefs as opposed to that of MoH. Thus, some of the practitioners relied on their stock of knowledge to carry out activities, which sometimes made them dominant forces within the environment. The stock of knowledge was gained, either through training and development or through years of working experience. Owing to such stock of knowledge, some practitioners were consciously or unconsciously legally allowed to carry out certain activities.	On behalf of the government, the MoH is solely mandated to formulate and promulgate healthcare policies. Thus, the MoH oversees and strictly controls every activities and processes within the healthcare, due to the highly sensitive nature of the environment. Over the years, this has been the status quo.
	Interpretive scheme	**Facility**	**Norm**
Modality	Many of the stakeholders' opinions about the importance and essentiality of healthcare services were based on their subjective views, which were influenced by individuals and groups' subjective interpretation of the information that they had access to. The subjective views were guided by individuals' stock of knowledge which was based on how the healthcare services were communicated to the stakeholders.	The MoH formulated policies, to govern the healthcare sector in the country. These policies were therefore used as power to enforce control and management of healthcare activities and processes. However, some or parts of the policies were interpreted differently by various personnel and groups, such as health practitioners and members of the community, to favour their activities, which were sometimes considered norm.	The MoH employs various resources, such as policies and principles towards improving the services of healthcare in the country. Thus, all employees including members of the community and health facilities in the country abides by the policies of the MoH. This is primarily to achieve healthcare objectives of the government.
	Communication	**Power**	**Sanction**
Interaction	The importance and essentiality of healthcare services were communicated to the stakeholders. The communication was carried out by different people according to their roles in the organisation. The information about the healthcare services were communicated through different mediums such as printed booklets, mobile devices, radio, televisions, emails and word of mouth. The medium of communication was influenced by many factors such as the type of information and targeted audience.	At MoH, some employees were considered to be more powerful than others, which was linked to their privilege access to information. Similarly, some members of the community were seen as more powerful than others, which was attributed to their access to infrastructures such as mobile phone and internet through which they had access to more healthcare information than others. Also, the responsibilities that were bestowed on some employees were used as source of power, which they employed to control and managed activities of the MoH. These were hardly questioned by other employees.	One of the norms is that most policies including activities and processes of the MoH could only be approved by the Minister of Health. This gave the Minister absolute power, which enabled, and sometimes constrained, certain actions and procedures.

5.3.1 Signification/Interpretative scheme/Communication

Duality of structure: Signification

Signification refers to what is considered important by agents as they interact within a social system, such as the healthcare. At MoH, three things were essentially important, namely rules and regulations, resources, and the services that that health organisations provide to the community.

Through these three means and factors as mentioned above, the government provided healthcare services that were required to maintain the citizens' well-being. The provision of healthcare services is one of the vital components for the achievement of the country's vision for 2030, as such, health community members are crucial to optimising productivity in organisations.

The rules and regulations were based on the policies, which were used to guide, manage and control employees' actions as they interact with other employees, community members, and mobile systems for MoH's purposes.

In the workplace, employees interacted with other employees according to the MoH's code of conducts. The code of conducts defined acceptable behaviours and principles that guided and controlled employees in the workplace. However, not all employees complied with the principles. The non-compliance with principles often led to disciplinary precautionary measures for employees. Employee's interaction with community members was also guided by the rules and regulations. Due to the sensitive nature of healthcare services, it was critical that employees followed the rules and regulations to ensure and promote health well-being community members.

Additionally, the interaction between employees and mobile systems at the MoH was guided by rules and regulation. The rules and regulations that guided employees as they interacted with mobile devices were extracted from the ICT policies. Rules, such as unique user names and passwords complexity, were enforced to ensure data security. One of the participants expressed his view on how data security was maintained in the environment:

> "*Each user is assigned identifier consisting of username and password, which uniquely identify each individual as they access the systems" (MoH08, pg.32:1375 -1376).*

The significance of the rules and regulations was based on individuals' and groups' interpretations. Thus, employees responded differently towards the same policies. A healthcare officer explained that:

> "*Procedurally, every patient is expected to undergo counselling before they are tested for HIV. So, you can't have more people tested and less people counselled. But some nurses don't understand these types of verifications and thus we have more people tested than those that are counselled at facilities" (MoH03, pg.16:268-286).*

The discrepancies or lack of adherence to policies can be attributed to the gap in the system, which is none existence of automated system for verification and monitoring of such activity.

Resources were also considered important at MoH. This was primarily because resources were the means through which employees and community members interacted and communicated. Resources were all the technical and non-technical things that were used to provide healthcare services to community members. Technical resources included Information Systems such as e-health systems, personal computers, printers, mobile devices, mobile systems, ambulances, finances, medical records, books and files, cabinets, medications, and buildings. The non-technical resources included employees, patients, processes, rules, and duration of time.

Both technical and non-technical resources were of critical importance and required for MoH to provide healthcare services. In some areas, it was almost impossible to provide healthcare services to the citizens in the absence of either technical or non-technical resources. One of the participants narrated how lack of resources made healthcare services provision a challenge within communities:

> *"We often do not have enough of human resource on the ground. As a result, when there are issues, we are not able to attend to them. Also, we are not able to travel due to financial constraints. So, the HR and Finance components impact our activities and performance" (MoH06, pg.25:1043 - 1046).*

Healthcare services are essential and critically important for the development and growth of the country. Thus, the government, through the MoH, provided healthcare services to the community members. The criticality and urgency of healthcare services was communicated to

employees and community members through different resources, such as presentations, booklets, radio advertisements, and messages on mobile systems. The resources that employees used in their communication included mobile systems. This communication tool enabled and supported quick and easy accessibility to healthcare services. According to one of the participants:

> "*Especially in the districts where by people don't have access to desktop computers, having mobile phones, make it easier to reach them*" (MoH06, pg.26: 1095-1097).

Duality of structure: Interpretative scheme

The rules and policies formulated and implemented by the MoH were interpreted and understood subjectively by the employees and the community members. The interpretation was influenced by the individual's stock of knowledge, which people use to gain an understanding and meaning of the information communicated. In MoH, employees' stock of knowledge was acquired through various ways such as formal education, training and workshops, and work experiences.

Formal education refers to the learning process that take place at schools, colleges, and universities. Through the formal education, many employees at MoH obtained different types of qualifications, which included certificates and degrees. The certificates and degrees were associated with status and levels of seniority. The levels defined the standards of skills and competence needed for each qualification. Thus, employees who had qualifications with higher levels were considered to be experts in their areas.

At the MoH, employees also acquired knowledge through training and workshops. Due to the dynamic and sensitive nature of healthcare's activities and process, MoH invested in its employees' knowledge and skills development through training and workshops. As compared to formal education, training and workshops were often conducted for a short period of time. Based on the depth of the content covered, training and workshops were usually not longer than 6 months. Training and workshops were conducted to supplement employees' skills. A participant explained that:

> *"Community healthcare workers are people with basic training on healthcare systems. They are not healthcare professionals as such, or qualified health professional because they are trained for a period of six*

months only. So, the training curriculum is not intensive to the extent that we even train them on data entry" (MoH05: pg.20, 860-863).

Employees at the MoH also acquired stock of knowledge through past work experience. Some of the employees have been in their positions for many years. As a result, they get accustomed to, and familiarised with, carrying out activities and processes in healthcare. Thus, based on many years of service, some of the employees gained more experience, and they were assigned corresponding job titles, such as Senior Nurse, Chief System Administrator, Chief Clerk, and Superintendent.

Each job title comes with responsibilities and levels of authority in the activities of the organisation including channel of communication. Thus, based on job titles, some employees have autonomy to communicate and manage healthcare activities and processes. A participant described some of the employees' authority as follow:

" If you are a Chief Clerk, you are expected to administer all the other clerks on the system, and supervise their activities" (MoH08, pg.35:1473-1474).

Duality of structure: Communication

Healthcare services policies and information related to health activities were communicated to employees and community members. Communication was important as it created awareness among the different agents.

At the MoH, communication was carried out according to the organisational structure. The organisational structure represents employees' positions and their level of seniority. Through the organisational structure, appropriate channels of communication, as well as the flow of information, were maintained. Therefore, the organisational structure indicated to employees with whom they must communicate for the organisations to operate effectively. One of the employees explained her understanding of reporting structure in the organisation as follow:

"We have five levels, through which formal communications are carried out. We start at the facility level, which is what we call our service point; from there, data is sent to the district level. This is done manually. The regional level receives the data from the district level for analysis" (MoH02, pg.05:203-205).

Based on the mandate that was bestowed on the levels of the organisational structure, each position was associated with a certain degree of power to a certain degree. Some employees used their power to influence how communication and information was shared across the organisation. As such, some employees at the lower and middle management positions were restricted and could only share and communicate information based on the Minister's directives.

At the MoH, communication to employees was carried out through various ways such as electronic mail (emails), departmental meetings, and memorandums. The use of emails was the most used effective means of communication in the organisation. This was because emails allowed instant sharing of information among the employees within the organisation. Information to employees was also communicated through departmental meetings. Departmental meetings enable employees to meet on face-to-face basis, to discuss organisational matters. Departmental meetings were mostly conducted on a weekly basis at the time of this study.

In addition to emails and departmental meetings, information was also communicated through memorandums. Memorandums were used as formal written reports to communicate important matters to all employees. To ensure information authenticity and credibility, all memorandums were written using the MoH official letterhead with the permanent secretary office stamp and signature. One of the participants stated as follow:

> *"Before we implement anything, it has to be approved by head and then by permanent secretary" (MoH07, pg.31: 1300-1301).*

To the community members, communication was also carried out through various mediums such as mobile systems, booklets, and radio advertisements and messages. The use of different mediums was to ensure that healthcare information reached a wide range of individuals, both literate and illiterates, at various locations. This was important as community members were geographically dispersed and were only reachable through the different mediums of communication. One of the participants discussed how information was shared with the community members:

> *"The Ministry publish data that they deem fit for public consumption through things like annually reports, newspaper articles and adverts" (MoH01, pg.4:131-132).*

However, the different mediums that were used to communicate both enabled and constrained the sharing of healthcare information. This could be attributed to the fact that not all employees and community members were able to use or had access to the type of medium used. Therefore, based on the mediums that were used, healthcare services information was not readily available to some of the employees and community members for respective action. A participant described how data was shared at some of the facilities:

> "*For remotely based clinics to send data to a district on a monthly basis was challenging. This was because the data was sent via a boat or public transportation. This means were used because they didn't have car at the facility that could be used to transport the data to the district. This method of transport was a high risk, some forms containing data got lost in the process, and others were late or got damaged" (MoH02, pg.6: 243-246).*

5.3.2 Domination/Facility/Power

Duality of structure: Domination

MoH was the sole agency responsible for the development and implementation of healthcare services policies and standards in the country. This responsibility was in alignment with the government's goal to provide excellent and affordable healthcare services for all citizens in achievement of the country vision 2030 (Doc01:41). Based on this mandate, the MoH was also responsible for regulating and enforcing legal healthcare activities and process in the country. Thus, the MoH played a supervisory role in the services that related to healthcare in the country. The mandate and supervisory roles make the Ministry very popular in the healthcare sector.

In the positions to which employees were assigned, some of them gained stock of knowledge. The stock of knowledge was applied, within the mandate of the MoH influenced how available resources were importantly used in the provision of healthcare services. Because of the individual's stock of knowledge, not all employees were able to use the available resources to provide healthcare services. Some of the employees were not able to use technological resources, such as desktop computers, emails, and printers, to communicate and share healthcare-related information due to their computer user skills challenges. This impacted how the MoH conducted its activities.

Only knowledgeable employees were authorise to provide healthcare services within the rules and regulation. This was due to the sensitivity and criticality of healthcare services. Some of

the employees, used their roles and knowledge to dominate others, in the provision of healthcare services. A participant described one of the roles as follows:

> "*For data entry we do not just use anybody. We use nurses that are certified as clinicians by profession, which is their primary job, and took an oath to do*" *(MoH01, pg.2:77-79).*

The MoH was accountable for the acquisition and management of the available healthcare resources, which gave the Ministry supervisory roles over health facilities in the country. In achieving healthcare goals each financial year, the government allocated a budget to MoH. As a focal entity in the health sector, the MoH also received support of technical and non-technical resources from various donors. A participant discussed the support they received:

> *" We have an online system that is not maintained by the Ministry but by the donors as they are the custodians of the system. So, when the system goes off, we have to call people from the donor agencies for assistance" (MoH04, pg.17:718-720).*

Duality of structure: Facility

The MoH was bestowed the mandate owing to how the government, as well the citizens, understood the sector. For example, the healthcare sector is a highly sensitive environment; as a result, the MoH was mandated to employ facilities to manage and control them. Thus, the MoH formulated and enforced policies about the privacy and security of patients' information. This was due to the implications that lack of privacy might have a negative impact on individuals' lives and well-being. In addition, the policies and regulations are used to manage and control behaviours, such as negligence and non-compliance, with rules, professionalism codes, and ethics, which thereby reduce costly actions that could have leads to patients' death or fatal damages. Thus, roles and responsibilities were assigned to employees. A participant explained that:

> "*To make sure we don't record data which is not representative of what is being done in the community, it is the duty of the healthcare facility manager to go through the data together with the community healthcare workers and make sure data is relevant, cleaned and making sense*" *(MoH05, pg.21:884-888).*

In addition to the non-technical facilities, such as policies, rules, and regulations, technical resources were employed in executing the mandate of the MoH. Some of the technical resources included desktop computers, laptops, printers, books, ambulances, telephones, and information systems such as e-health, x-rays machines, and medical passports. Resources, such as mobile devices, enabled ease of communication between the employees of the MoH, employees of the MoH and the general health sector, and employees of the MoH and the community members.

Technical and non-technical resources were used by employees to enable the healthcare services they provided. At the same time, these resources constrained healthcare operations at MoH. Consequently, some of the activities could not be carried out due to the policies and regulations that needed to be complied with. A participant shared how policies constrained their work:

> "*If we have to order something and implement it, it first has to go through procurement channels where it has to be approved by head of department and then by permanent secretary. Those channels are the ones delaying our work*" *(MoH07, pg.31:1299 -1301).*

These resources, consciously or unconsciously, influenced the types of data that were gathered and used to provide and re-provide health related services to the general public.

Duality of structure: Power

The mandate bestowed on the MoH is a source of power in two different but connected ways, firstly, it can formulate and enforce policies and regulations for the healthcare sector in the country, and secondly, it has the absolute right to revoke a healthcare practitioner's licence, if he or she is deemed unfit to practice. This sort of mandate or power was intended to protect the citizens, as well as to promote quality healthcare services to the citizens.

The rules and regulations were also used to guide how employees were assigned roles and responsibilities in their provision of services. Roles and responsibilities represented the division of labour, through which some employees could be held accountable for their actions. Through the various roles, some employees also saw themselves more relevant than others, which was linked to their levels of knowledge about healthcare services.

Some employees and community members used their knowledge about resources as a source of power to dominate in their environments. This was considered to be a norm as some

individuals used their power to manipulate activities and process in their favours. A participant explained that:

> "*At many times it is very hard to get hold of IT technical team due to their availability and sometimes when they come to the site, they don't solve the problem at that time, it might even take weeks. Like with the firewall it's more than a year now they are trying to get it right. So, you have to keep pushing every time*" *(MoH06, pg.26: 1088 -1091).*

Based on the different levels of knowledge among the employees, some of them sometimes withheld information, which may affect accuracy and appropriateness of data, as well the processes or activities that were carried out. As such, when knowledgeable employees are not at work or available, the process come to a standstill. One of the participants shared that:

> *"The firewall was implemented by Telecom and they are conversant with it. But at many times it is very hard to get hold of Telecom technical team due to their availability and sometimes when they come to the site, they don't solve the problem at that time, it might even take weeks" (MoH06, pg.26:1086-1088).*

When someone with the necessary knowledge is committed, activities seem to be operating effectively. As such, committed employees are most often present and available at work for assisting other employees and patients with the necessary information that they need to execute in conducting healthcare processes and activities.

Additionally, some of the employees used their official positions as a source of power to control activities, such as not making the funds that were required to execute healthcare related projects available. Employees in lower management were dependent on top management for support and availing of financial resources to implement activities and projects in the organisations. However, due to the lack of funds, some of the projects could not be implemented. In some of the business units, lack of funds contributed to staff shortages. An employee narrated his experience as follows:

> "*We don't have enough of human resource on the ground and when there are issues, we are not able to attend to them because we are not able to travel due to financial constraints*" *(MoH06, pg.25:1041-1043).*

There were various sources of power depending on the activities or services that was being carried out. These sources of power were also not one-way, from top management to the lower levels of employees. Employees at the lower levels also had power that they gained from their roles and responsibilities as bestowed by the policies. Compliance to the policies enacted these sources of power.

5.3.3 Legitimation/Norm/Sanction

Duality of structure: Legitimation

The government mandated the MoH to ensure that the Namibian people and all who reside in the country have access to quality healthcare services. The mandate made the processes and activities of the MoH legitimate. Thus, the MoH formulated healthcare policies and regulations on behalf of the government. In the addition, the MoH promulgated the policies and regulations within which the healthcare organisations, including hospitals and clinics, provide services to the needing. The policies and regulations were employed as rules which guide the use and management of health-related resources in the provision of services.

The policies and regulations were primarily used in four main aspects, to guide the:

(1) establishment and operation of healthcare facilities in the country,
(2) activities of healthcare facilities,
(3) relationship between the MoH and healthcare facilities, and
(4) conduct of healthcare professionals in providing services to the patients.

Thus, these policies were considered important for the provision of legit healthcare services.

However, the implementation thereof was a challenge. This could be attributed to lack of ease of accessibility. The policies could be more effective if they were implemented through interactive systems. A participant described the type of interactive system they lack as follows:

> *"We need patient's electronic record management system in Namibia. So that when patients go to facilities for healthcare services, they are able to be tracked at different facilities. This enable healthcare professionals to control patient's movement and have their medical history" (MoH02, pg.10:414-417).*

This means that the processes and activities of healthcare were measured and assessed within the ambit of the policies and regulations as promulgated by the MoH. Examples of the policies and regulations that guided the four main aspects mentioned above are:

(1) all healthcare facilities, such as clinics, hospitals, healthcare practitioners, and pharmacies, should be registered with the Namibian healthcare council;

(2) healthcare facilities should only practice activities they are registered for and these should be carried out by the registered professionals as per their qualifications;

(3) MoH regulates the registration of healthcare facilities and the education, training, and qualifications of the persons practising such professions and resolve grievances and disputes that may arise; and

(4) healthcare professionals must protect the identity of the patient and administer safe medicines and drugs and must correctly use and apply the equipment available for the purpose of such treatment.

Healthcare services were legitimated through the organisational norms, which were the acceptable behaviours and morals by the employees of MoH. The legitimacy also covers the community members and healthcare service providers that interact with the MoH. Acceptable behaviours and morals, as defined by the code of conduct, were reflected through the organisational structure. The organisation structure represented, firstly, employees' positions, and, secondly, the exchange of information through which communication takes place in providing and receiving healthcare services. The communication channel was not automated, which makes it easily manipulated by those who have access to the information. One of the participants described how communication was carried out:

> *"Nurses at the health centres, hospitals and clinics collect data manually using tally sheets, registers and summary forms. Than such data is submitted at the district level" (MoH02, pg.05:193-196).*

The representation of employees' positions in the organisational structure was of importance as they enabled the placements of knowledgeable employees at MoH. Based on their positions, some employees dominated in the allocation and execution of activities and process in providing healthcare services to the general populace. One of the participants described that:

> "*For the administrative employees stationed in the wards, working in the weekend is considered as overtime and thus if management cannot avail money for overtime, these employees will not work during weekends*" *(MoH08, pg.35, 1459-1461).*

Duality of structure: Norms

The guidance that the policies and regulations provide was regarded as the norm by the stakeholders within the healthcare sector in the country. Thus, the stakeholders, which includes employees of MoH, health professionals, and community members (particularly patients), employed rules to provide and access healthcare services. For example, when providing healthcare services, for healthcare professionals to trace one's medical histories, patients must have their medical passports.

Employees at the MoH carried out activities and processes according to the organisation's norms and values. The organisation's norms were created over a period of time by an individual or group of people within various departments. These norms and values were the shared cultures and behaviours that rendered employees' and community members' activities and processes legitimate. Therefore, the norms and values were very important as they were used to communicate acceptable and unacceptable behaviours to the employees and community members. A participant explained some of the unacceptable behaviours as follows:

> *"Sharing of computer systems account settings such as a user's username and password with colleagues is not allowed because such practise is viewed as a violation of security measures put in place to protect patient's data and privacy" (MoH08, pg.32:1369-1370)*

Even though some actions and behaviours, such as treating patients without advising and counselling them about their health conditions, were regarded as the norm, they were not part of the MoH's policies or regulations. However, some of the employees or stakeholders continued to practice those activities as norm mainly because there were no systems to validate and monitor such activities. This could be attributed to unconsciousness in the actions of those who practiced such activities who were not part of the health sector rules or regulations. This was considered a high risk, owing to the sensitive nature of the healthcare environment.

Additionally, some of the rules or activities that were practiced as norm in providing health related services were not documented, and as such they were not easily accessible. Some of the non-documented norms were, therefore, considered not mandatory by some stakeholders. Thus, some employees did not comply with those undocumented rules or activities in their actions. According to one of the participants:

> *"I train the new employees based on what I know from using the system, because this e-health system has no system documentation. We don't have any documentation because the contract between the ministry and the system providers was terminated and the system providers left with their documents" (MoH08, pg.36, 1526-1533).*

Documented norms at MoH were viewed as rules and policies by the employees. These rules and policies guided the interaction between employees and the use of mobile systems, to communicate with community members and other stakeholders. A participant shared their opinion about the policy of security as follows:

> *"We create profile for each user that make use of the system. The user gets an account, which include username and password" (MoH08, pg.32:1372-1373).*

The rules and policies were established with the aim of achieving the organisation's goals and objectives. Individually, employees' actions affected the use of resources such as mobile systems. These actions were consciously or unconsciously carried out. At the MoH, not all employees used mobile systems to communicate and provide healthcare services. Some employees preferred using manual systems to carry out their activities. The use of manual systems was considered ineffective by employees who relied on mobile systems to collect and manage patient's data. As such, it had a negative impact on the accuracy and usefulness of the big data collected and managed. The view of one of the participants was that:

> "*There are several challenges with collecting data manually. From reporting viewpoint, this has impact on data quality such as accuracy of the data, timeliness, and the completeness' of the data*" *(MoH02, pg.6:233-234).*

At the MoH, rules and policies were also used to control and manage the use of mobile systems for activities like interaction. The rules and policies guided the selection, development, implementation, and utilisation of mobile systems for healthcare services, such as the Pregnancy-tracker system. Due to the sensitive nature of the healthcare environment, it was important to have rules and policies in order to ensure that the right type of mobile systems are implemented and used correctly to support healthcare activities and processes. A participant briefly explained:

"We have a policy that whatever system is being implemented in the government Ministry, it must be hosted with the Office of the Prime Minster" (MoH02, pg.08:335-337).

This type of monopolistic approach retards flexibility and innovation. This makes activities, such as storage, security, and management of big data, overgrow the technological solution that is supposed to enable and support it. A participant alluded that:

"We don't have a backup policy in the Ministry. So, we had data recovery challenges when we lost our data as the system was not backing up and then it went down for a couple of 3 to 4 months. So, we only managed to recover data up to year of 2016. The other years' data was corrupt and thus not usable" (MoH08, pg.36, 1518-1521).

Employees and stakeholders were dependant on mobile systems for the provision of effective healthcare services. Mobile systems enabled and supported fast communications between healthcare professionals, patients, and other stakeholders. Additionally, the systems enabled healthcare professionals to collect and store patients' data for diagnoses of diseases and ease of accessibility to records. According to one of the participants:

"It is a directive from the Minister that all the medical procedures that the patients undergo must be documented on the e-health system. Thus, all patients have profiles that are linked with their unique IDs that we call medical registration (MR) number" (MoH08, pg.31:1323-1325).

Employees at MoH created a culture of resistance towards some of the computer systems through their actions as they provided healthcare services to community members. The culture created has an impact on employees' beliefs, behaviours, and attitudes. Thus, employees from one business unit acted the same. A participant described the situation as follows:

"*Most of the doctors gave up on using the e-health system. They don't use the system even though there are functionalities for doctors' activities. So, the reason that they will give is that, 'after seeing my patients I don't have time to come sit and punch in the information on the computer*" *(MoH08, pg.35:1485-1488).*

The doctors get away with this type of action because there were no monitoring systems, which validated their activities and processes. In addition, this type of loophole made patients' data vulnerable or compromised.

Duality of structure: Sanction

At MoH, the rules, policies and regulations were approved at various levels. These were the levels as defined by the organisational structure. A participant alluded to the process as:

> *"It is just how the government structure is set up. If we procure something, it goes through many channels before approval. It has to be approved by head and then by permanent secretaries" (MoH07, pg.31:1926-1302).*

The approvals were sometimes the consequence of consciousness or unconsciousness actions. The unconscious nature of action, such as management signatories, makes mitigation and response plan unavailable. This can be detrimental in an extremely sensitive environment such as the healthcare.

On the other hand, the conscious behaviour was mostly exercised by practitioners that had less experience in the profession. These groups of professionals were too scared of making mistakes, which might be costly due to the sensitivity of the health environment. A participant stated that:

> "*We do have security measures in place but it's more of self-discipline as employees are very aware how serious is to disseminate data that does not make sense or not approved for publication*" (MoH01, pg.02:85-86).

Additionally, some of the more experienced professionals relied on their stock of knowledge, making them sometimes unaware of their actions, which had an impact on the services that are provided to patients.

Moreover, community members approved healthcare services provided. As such, before providing treatments, healthcare practitioners communicated and advised patients about the benefits and risks of such treatments. In critical circumstances, such as where the patients were unable to decide, healthcare practitioners used their stock of knowledge as a source of power to approve the medical treatments. This was because healthcare practitioners were entrusted with community member's safety and, thus, the responsibility to always act in their

best interest. One of the community members expressed her view of seeking healthcare services directly from hospitals:

> *"The hospital is the most authentic place for healthcare treatment because their medications are likely to be genuine and reliable in the sense that they are not medications from the street or unreliable sources" (TC04, pg.11:431-432).*

The Minister was considered to have absolute power when it came to approving healthcare activities and processes. However, some of the processes and activities were approved by managements within their different business units. Due to the sensitive nature of healthcare processes, only knowledgeable employees were entrusted with approving healthcare processes and activities. However, there was no automated system for the action, whether only the knowledgeable employees carried out the approval.

In summary the analysis of the data was guided by the duality of structure from structuration theory. Overview of MoH data analysis is provided in section 5.3, table 5.2.

5.4 Case 2: Healthbridge Public Hospital

As explained in Chapters 3 and 4, the Healthbridge Public Hospital (HPH) provides healthcare services to the public directly. The main focus of the public hospital is, therefore, to maintain patients' healthcare in the country. Duality of structure was used to guide data analysis. The table 5.2 below gives an overview of the HPH structure.

Table 5.3: Duality of HPH Structure

	Signification	Domination	Legitimation
Structure	First and foremost, the health conditions of every patient were of significance to the hospital management, health practitioners, patients and their relations. Thus, each patient's big data were of significance and critical to the practitioners. As a result, the systems and technologies that are used to collect, store, and use and manage the big data were as well very important.	More often than not patients' health conditions dominated the operations of the professionals. Another domineering factor was the processes that were exceptionally employed in attempts to provide service to the patients. In addition, some health conditions require the service of a specialist, making such professionals to be popular.	Due to the sensitive nature of the environment, legitimacy of healthcare services as well as patients' privacy were critical. Thus, management of patients' health conditions including access to big data were guided by policies and ethics code of conduct.
	Interpretative scheme	**Facility**	**Norm**
Modality	An understanding of most healthcare professionals was guided by subjective views, which were influenced by the individuals' stock of knowledge, from personal or health viewpoint. The employees' stock of knowledge was also influenced by how systems were used to communicate to them. Thus, the collection, storage, use and management of big data were carried out differently across the hospital.	The hospital was equipped with resources: technical (personal computers, medical apparatus) and non-technical (human, policies, processes) to enable efficient and effective operations of healthcare activities. Healthcare practitioners therefore used available resources including the services of their colleagues: in the best way that they know; and for personal interest, in providing services to the patients.	All the employees at Healthbridge Public Hospital including patients abide with the policies to keep patient data confidential and refrain from allowing access to patients' data to unauthorised personnel or community members. This was primarily to protect patient's identity and keep matters related to their health conditions confidential.
	Communication	**Power**	**Sanction**
Interaction	Information gathered from patient's big data was communicated to other health professionals including the patient concerned. Different means, such as letters (hardcopies), email, and mobile phone (text and voice) were used in the communication. Thus, the communication was: professional-to-professional; professional-to-patient.	At the hospital some of the employees were considered to be more powerful than others. This was attributed to factors such as access to information and skillset. Some employees were skilled and had the abilities to use and operate systems to collect, store, retrieve and manage big data about patients, which many other health practitioners could not do.	To ensure patient data security and privacy access to data storages such as file cabinets and system databases were not accessible to all employees. Measures such as guards at rooms' entrances, cabinet locks and systems user passwords were used to restrict access.

5.4.1 Signification/Interpretative scheme/Communication

Duality of structure: Signification

At the Healthbridge Public Hospital (HPH), three things were considered to be primary of significance: (1) patients' data, (2) patients' healthcare, and (3) mobile systems. The three

things were significance to both the healthcare professionals and patients including the relations of the patients. In structuration, signification is the production of meaning which people associated to things or events (Giddens, 1984).

Patient data was important because it was the primary input that enabled healthcare professionals, such as nurses, doctors, and pharmacists, to keep record of, as well as track and trace, patients' health conditions towards their healthcare. As in other healthcare facilities, the healthcare professionals at Healthbridge Public Hospital (HPH) were able to examine and diagnose a patient's illness, by taking into cognisance the patient's past record as stored in the set of data or big data. According to one of the participants:

> "*In the case of referral, the patient presents his/her referral letter. Thereafter, observation is carried on the patient, and prescribed medications are checked*" *(PH07, pg21:858-861).*

Patient data were collected from different sources (such as wards, diagnoses, and X-Rays), and were used and managed in various ways by different employees at the public hospital. These employees included administrative clerks, IT personnel (such as systems administrators), nurses, doctors, and pharmacists. At the HPH, employees used both manual and computerised systems to collect patient data. Manual system was the primary way of data collection. Data was collected manually through register forms, tally sheets, and patients' healthcare passport that is a small booklet in which the doctor's documents the patients' health conditions and medications they need. One of the participants narrated how they collected data:

> *"When patients come to our department, their details are first entered in the book at the reception and then they are given number cards. These number cards are then brought at the back office so that such information can be entered in the computer system" (PH01, pg1:32-35).*

In addition to manual systems, computerised systems were also used reproductively to collect data about both in and out patients. Some of the computerised systems that were used at the hospital at the time of this study included healthcare information systems, known as e-health, x-ray machines, mobile systems and desktop computers. A radiologist explained that:

"For the general x-rays, we have machines, and computer systems that are used to capture patients' details for processing of their images. This includes the printer that are used to produce the images" (PH01, pg1:8-10).

Based on the criticality of data to trace health conditions, these artefacts were considered important to those, such as health professional, who understood the value. Such understanding comes from interactions with the artefacts over a period of time.

The artefacts become more significant because each set of data often requires its system or technology for storage, retrieval, use, and management. Many patients have big data, in the form of video, images, and text, which comes from various sources, such as X-Ray, diagnoses, and verbal interaction between a patient and health practitioner. The use of these artefacts to reproduce their actions towards providing services for patients' health conditions enhance the practitioners' experiences and know-how. In turn, the experiences and know-how that were gained over a period of time helped many of the practitioners at the HPH in their interactions and communications with peers and patients in the course of duty. For example, one of the participants, a newly-recruited employee, explained that:

"To make use of the new equipment, such as the blood machines, I rely on my colleagues that have been working here for a long time to assist me with operating the machine" (PH06, pg24:967-968).

Duality of structure: Interpretation

The importance of patients' data and patient healthcare depended on the employees' and patients' subjective views. This is because not all the healthcare professionals that were employed at the public hospital viewed patients' data (or big data) and their care to be important. Instead, what was important to some of the healthcare professionals was the security of their job for economic purposes. The views and interests were based on individuals' interpretation of the environment, the nature of work, and the health conditions that the practitioners were often and consistently confronted with at the Healthbridge public hospital. One the participants expressed her views about the hospital management as follows:

"The management must stop enriching themselves and at least just try to see the importance of the work or the importance of the system introduced then they should try to send the right person for the trainings" (PH04, pg17:683-685).

Employees' and patients' views were influenced by individual and group's subjective interpretation of the types of information they had access to. The subjective interpretation was guided by the individuals' stock of knowledge. Healthcare professionals gained their stock of knowledge through past working experience, formal education, and on-the-job training.

Some of the healthcare professionals have worked for many years at the HPH. As a result, these groups of healthcare professionals had a better understanding of the various types of patients' data, where data sets come from, and how the data are structured. Based on this understanding, these groups of healthcare professionals were considered to be more competent in some of the healthcare processes and activities that were carried out in the course of providing services. Thus, some of the employees, especially the newly-appointed healthcare professionals, and patients relied on their knowledge for healthcare advices.

At HPH employees also acquired stock of knowledge from education, which included formal training (education) and on-the-job training. The training contributed to how they understood the various types of health big data of patients. A participant shared her views on a past training as follow:

> *"I don't think we were trained enough because when it comes to compiling data, the computer system does it. But we don't really know how to use the system properly" (PH01, pg3:97-99).*

At the HPH, employees hold various qualifications, such as certificates, diplomas, and degrees, which they obtained from institutions of higher learning, which include universities and colleges. According to one of the participants:

> *"Most of the nurses employed here are trained through the University of Namibia (UNAM) and they are good at working with computers" (PH03, pg11:465-466).*

Some of the employees also gained their stock of knowledge through on-the-job training. Even though this type of training was often over short periods of time, such as 6 months, it was more practical oriented and focused. Thus, patients' health conditions and big data were often used as cases scenarios and materials for the training. A healthcare practitioner explained that:

”For every new computer system that we get, there have to be a training. Sometimes, when you find a system there when you start working, then you get an in-service training from your colleagues” (PH01, pg3:113-116).

Individuals’ stock of knowledge influenced how employees interacted with mobile systems that were used to provide services. Despite its popularity, some of healthcare professionals were challenged with the application of mobile systems. According to one of the participants:

“Not everyone is computer literate. Especially the healthcare workers that have been working here for a long period time and they were not using computers during their years” (PH01, pg3:107-108).

This negatively impacted processes’ consistency at the public hospital as some of the employees opted to use manual systems due to the lack of knowledge in using mobile systems.

Duality of structure: Communication

The importance of patient data and patient care was regularly communicated to the healthcare professionals and patients. The communication was carried out to create awareness and educate the healthcare professionals and patients about the sensitive nature of healthcare services. Communications were carried out in three ways: (1) patients to patients, (2) healthcare professionals to healthcare professionals, and (3) healthcare professionals to patients.

At HPH, information was communicated through the organisational structure. The organisational structure defines employees’ positions, including roles and responsibilities. Thus, the flow of information in the organisation was dictated by its hierarchy. At HPH, the flow of information was bidirectional, as communication was either carried out from top management to lower management employees or vice versa. Thus, communication was carried out by employees according to their roles and positions at the hospital, which influenced and shaped how the information was interpreted and understood. An employee narrated their roles as follows:

“We as nurses follow doctors’ orders. So, the doctor examine[s] the patients and prescribe medication and we give the patient such medication. Also, if the doctor says he/she needs patient blood sample, we take the blood sample” (PH06, pg21:840-842).

Information was communicated through different mediums, such as emails, telephones, mobile phones, and memorandums. The choice of communication medium was influenced by many factors, such as the targeted audience and the urgency of the information communicated. Describing the form of communication that they use, a participant stated as follows:

> *"Patients verbally explain their challenges or health conditions. After listening, we always request or advise them to put it in writing, because that is how our head of department want it, for documentation purposes" (PH07, pg25:996-998).*

5.4.2 Domination/Facility/Power

Duality of structure: Domination

As in every healthcare facility, patients' healthcare was a priority and primary objective at HPH. In the course of fulfilling its objective, tools (medical apparatus, processes, and medication) were required. Patients' health conditions could not be attended to without the tools, and in the same vein, the tools were insignificant without patients. This makes both patients' health and the tools domineering in the course of providing and receiving healthcare.

Additionally, the tools cannot operate themselves, which makes the practitioners popular within the hospital. One of the healthcare practitioners explained the interdependence between some of the tools as follows:

> "*As a radiologist, there is no way I could do my job without a computer as my work revolves around computers" (PH01, pg3:103-105).*

Some health conditions required specific services of the specialists. In such circumstances, the medical specialists were popular within the hospital. Such popularity was attributed to the knowledge and expertise of the practitioners, which the hospital relied on, to provide healthcare services. A healthcare professional reported on the medical procedures stating that:

> *"Patients are first seen by any medical doctor, and after that they are then sent to a specialist who will then decide whether to admit them and by when" (PH06, pg.20:825-826).*

Therefore, in the absence of such specialists, some patients' health conditions could not receive the necessary treatment at HPH and they were referred to other hospitals inside or outside the country. In such circumstances, computer systems were needed to search for a specialist or hospital for referral. This was often a challenge in that some of the computer systems at HPH were not centralised or linked to systems in other health facilities in the country. Additionally, there was no medical database where information about hospitals outside the country could be accessed. An employee narrated that:

> *"Doctor's contact details are recorded down in a file. So, if you are looking for a certain doctor you just have to search in the book." (PH06, pg.22:882-884).*

At HPH, various types of processes, such as admissions and operations, were developed and implemented. Healthcare professionals and patients followed such processes as they interacted with one another and provided healthcare services. Due to the sensitive nature of the patient's health conditions, not following the predefined processes could lead to life-threatening situations. The processes were implemented to enable consistencies and coordination of the healthcare activities carried out. According to one of the participants:

> *"This is a hospital and any other person cannot just come and say I need this information as there are procedures to be followed" (PH05, pg.19:767-768).*

Duality of structure: Facility

At HPH, technical and non-technical resources were used in providing healthcare services to the patients. Technical resources included medical apparatus, such as x-ray machines which aid in the diagnosing and monitoring of patients' conditions, computer systems, such as personal computers, mobile telephones, and cellular phones, and printers.

The non-technical resources that were used at HPH included processes, policies, and humans. Processes were the set of actions that healthcare professionals carried out as they provided healthcare services. At HPH there was two types of processes: namely, automated

and manual. An employee at the hospital shared her views on the hospital processes as follows:

> *"On one side people are using the manual system and some people are using the automated system. For example, we the administrators, we are more onto the systems while the nurses and doctors are more on manual" (PH04, pg.16:647-650).*

The automated processes were the set of actions that were carried out through the means of computer systems, such as the use of mobile systems for data collection, storage, and retrieval. According to one of the participants:

> *"The integrated Health Information System is the system we use to do the billing, registration and services booking" (PH05, pg.17:705-706).*

In addition to automated processes, the hospital also used manual processes to provide healthcare services. These were the processes that were paper-based and mainly relied on manpower for execution. For example, record-keeping was a manual process, as such patient files were stored in file cabinets. An employee described the manual filling process as follow:

> *"Because we are using a manual filling system where we put all patients' files in the boxes, it is very difficult to trace the contacts on the file its self where the contact details are written" (PH04, pg.14:549-551).*

The non-technical resources, such as policies, were the primary factors that governed and guided interactions that happened between professionals, professionals and patients, and professionals and mobile systems. At HPH, policies, such as patient data protection, were implemented and complied with to ensure patients' confidentiality. Policies were needed in order to maintain order considering the sensitive nature of healthcare services. However, these policies were not easily accessible to the employees and other stakeholders. This could be linked to various factors, such as how policies documents were stored for retrieval by the employees.

At the HPH, human resources included patients and their relations, healthcare professionals, such as nurses, doctors, and pharmacists, and administrative employees, such as clerks and ambulances drivers. The relationship between these personnel was critical in the provision of care to the patients. In some instances, employees used other resources, such as policies

and mobile systems, to provide healthcare services according to their subjective understanding. Employees' subjective understanding was informed by their stock of knowledge. According to one of the participants:

> *"After patients see the doctors, they come to the pharmacy with the prescription and then us the pharmacists we read the prescriptions, interpret it and give medicines based on that" (PH02, pg4:140-142).*

Some of the employees used their stock of knowledge as a source of power to influence how they communicate with others when providing healthcare services. The subjective understanding and interpretation of policies, as well as the use of power, affects relationships between the practitioners, which sometimes influence how they communicate and provide services. A participant explained that:

> *"When patients are prescribed medicines that are not in stock, we call doctors to inform them about the substitutes medicines we have and then they can recommend from that" (PH02, pg4:163-165).*

Duality of structure: Power

Some of the employees at the HPH were considered to be more powerful than others, which could be attributed to various factors such as employee's positions, access to information, and skillset.

As depicted in the hospital's organisational structures, some positions were associated with more power than others. For example, employees in management and supervisory positions, such as senior nurses or the hospital superintendent, were associated with more power than those in junior positions when it came to giving directives and resolving organisational conflicts, including patients' challenges. An employee narrated his experience as follows:

> *"Management did not communicate to us data clerks that the diagnoses will no longer be recorded in books but rather in forms. These was only communicated to the nurses" (PH04, pg.15:591-592).*

In addition to employee positions, some of the employees were considered to be powerful as they had access to organisational information which included patient information. At HPH, information was stored in computers systems and physical files cabinets. However, not all employees could access the stored data, due to authorisation policies:

“Most of us don’t have access to the information in the computers as we don’t know the password. So only those that know the password uses the computers” (PH06, pg.23:931-932).

Inaccessibility to information affected communication among employees. As a result, some of the healthcare activities were not carried out or were rather not performed on time as employees relied on their colleagues with access to avail the required information. This could be attributed to the fact that levels of access to information and other facilities were not properly defined. As a result, interpretation was subjective and manipulated by the privileged personnel. One of the participants described how communication occur in their department:

“*Miscommunication is also happening in our office. You book the transport and people are not handing each other the report and the one who is on duty will not know that there is a nurse to be picked up at 5 a.m.in the morning ”(PH07, pg26:1067-1069).*

Individuals’ skillsets also played a role in the power relationship between employees. As a result, those considered to be highly or more skilled employees had the ability to use and operate computer systems in order to collect and retrieve stored patient data, which they were sometimes reluctant to share with colleagues. One of the participants, who is knowledgeable about using computers, described that:

“To move files between computers or for printing we use flash drives, but sometimes sharing of flash drives with colleagues leads to the spreading of computer viruses” (PH03, pg.12:467-475).

At HPH, healthcare professionals, who were challenged with using computer systems, often sought technical assistance from the IT personnel. IT personnel, such as systems administrator and IT technicians, were considered to be more knowledgeable about the operation and management of the computerised systems implemented at the hospital. An employee shared that:

”We have IT technician or systems engineers dedicated to the system. When we need their help, we communicate via WhatsApp or we call them, and they assist us through the team viewer” (PH09, pg32:1273-1275).

5.4.3 Legitimation/Norm/Sanction

Duality of structure: Legitimation

As in other parts of the world, only legitimate facilities are allowed to provide healthcare services in Namibia. This means that as a facility, the HPH was a legitimate healthcare service provider to the general populace at the time of this study. This also meant that the processes, events, and activities of the hospital must be legitimately executed by adhering to the policies of the government (MoHSS), as well as the professional bodies that the practitioners belong to. Some of the policy statements are that patients' personal information must be kept confidential, and that patients' health conditions must be treated with quality and dignity. One of the policy statements stated in the patients' charter document is as follow:

> "*We treat people with dignity, respect and compassion. We respect diversity of culture, beliefs and values in line with clinical decision making*" (Doc03, pg08).

These and other policies statements and standards make the healthcare environment very sensitive. Due to the sensitive nature of patients' health conditions, providing legitimate healthcare services at the HPH was vital. To ensure service legitimacy, professionals that provided healthcare services were trained and made to, at all time, remain sensitive to patients' health conditions. To ensure and enforce compliance, some of the policies forms part of the employment contract, which the employees have signed.

Healthcare professionals used various tools, such as mobile systems, to legitimately communicate in providing healthcare services to the patients. An employee described how she used mobile systems to communicate as follow:

> *"When it comes to verification of wards reports I make use of the office line or sometimes my mobile phone to call the staffs in the wards" (PH09, pg.30:1222-1224).*

Even though many of the employees make use of mobile systems, such as the cellular phone, in a legitimate manner, the approach is contentious because of the challenges and complications it brings to comprise sensitive information. One of the challenges is whether those communications are recorded and/or documented, which, generally they were not, at the HPH. This makes it difficult to reference information (communication) about a patient's health, which influences care.

At HPH, mobile systems were used to collect, retrieve, and manage data about patient's health conditions. However, the legitimate use of mobile systems in the provision of healthcare does not necessarily guarantee security and privacy of patients' personal information. One of the participants expressed her views on mobile systems security as follow:

> *"Some files can be deleted from the computer and you don't have evidence that it is you who really gave that information. Because anything can happen with the computer" (PH08, pg.29:1175-1177).*

Leak of a patient's health condition compromises sensitivity, and therefore raises question about the legitimacy of the services.

Duality of structure: Norm

The retrieval, use, and management of patients' data were done towards one main goal: confidentiality. According to one of the employees:

> *"I cannot reveal a patient sickness to another person as there must be confidentiality. That's why we can't give any information to anybody" (PH03, pg19:763-764).*

Maintaining confidentiality was primarily to comply with the policies that govern the health sector in the country, and the HPH in particular. In the course, compromises (reproductive actions) were consciously or unconsciously made and experienced by some health practitioners at HPH.

Physical file cabinets and personal computers were used to store patients' information. The retrieval was carried out through hardcopies and electronic means. A participant explained that:

> *"Some of the information are in the computers but for now we are not typing we are writing in the books" (PH07, pg26:1051-1052).*

In the use of information about patients' health conditions, some practitioners used mobile systems (through devices such as cellular phones) to share information and communicate with their peers and the patients. Both patients and the hospital managers accepted this practice. One of the participants shared that:

> *"Most of the patients are coming from the regions and most of the time the doctor can only contact their relatives through the telephones after the operation" (PH03, pg.10:377-378).*

One of the main reasons for the acceptance of this practice was efficiency. This was without, or little, consideration on the possible negative implications, such as the implications for the security of patient's health personal information, and the inappropriate documentation of conversations that happen between health practitioners or health practitioners and patients, by using a cellular phone.

Employees tend to fully adhere to policies, which ensure confidentiality of information about a patient's health condition. This was the norm at HPH. As a result, there was tight restriction on patient information, which means that not all health practitioners could access information about patients' health conditions. The challenge was, therefore, that information about patients' health was either incomplete or unavailable in some cases. A healthcare officer explained that:

> *"You find that the submitted records are not complete in the sense that there are fields that need to be filled in such as the age of the patient or the date of admission" (PH09, pg30:1211-1213).*

This had an impact on the quality of service that was provided to patients in the community.

Duality of structure: Sanction

At HPH, various security measures were implemented to protect patients' data against intruders or un-authorised access. The measures were generally accepted, not because they were the best options, but because they were convenient and comfortable for most of the employees. The measures could also mean that the managers of the facility did not know better, which implies unconsciousness in their actions. Some of the measures that were implemented include (1) locking physical cabinets containing files, (2) implementing system user's password, and (3) the presence of security guards at the entrance of the rooms where the cabinets were stored:

(1) *Locking files cabinets*: most of the patients' files and medical records were stored manually in cabinets. These cabinets were secured with padlocks and keys that were only accessible by authorised personnel. However, most of the employees were not in support of the cabinet

storage approach due to the document retrieval and security challenges it presented. In some cases, retrieval of the saved documents was a difficult effort as the documents were not always saved in any particular order. Therefore, some of the patients' files were declared lost and some healthcare processes needed to be redone, causing a delay in patient's treatments. A participant shared some of the challenges encountered with cabinets filling:

> *"It is very difficult to trace the contacts from the file where the contact details are written because the filing system, we are using here we are just putting everything in the boxes." (PH04, pg14:549-551).*

(2) *System user's password*: in addition to cabinet storage, patients' data and other medical files were also stored on computer systems which included personal computers and systems databases. To access these types of data storages, authorised users were assigned usernames and passwords. A participant described how she managed her computer password as follows:

> *"I am the only one dealing with my password as you know when working with patients not everyone is allowed to view their information" (PH05, pg19:759-761).*

However, some of the employees at HPH did not take data privacy policies seriously as they shared their computer login credentials with colleagues, or they left their computers unattended without logging out of their accounts. Such behaviours were posing confidentiality threats to the patient data and their health conditions.

(3) *Guarding room's entrance*: the movement of employees in the hospital's wards and data storage rooms were monitored to prevent intruders or unauthorised entries. To enter various hospital rooms, employees were required to identify themselves through the show of staff cards. This was enforced by guards who monitored employees' and patients' movement at room entrance. In some case, biometric systems were used to read authorised employees' finger prints. Through this measure, HPH was effective at limiting access to some of the patient information and, as a result, there were minimal opportunities for data leakage. However, when personnel with access were not present at work, the required information could not be availed on time and thus their absenteeism from work caused healthcare processes delays.

5.5 Summary

This chapter presented an analysis of the data collected. Data were collected from the two cases: Ministry of Health and Healthbridge Public Hospital. The analysis was guided by the duality of structure from Structuration Theory. The application of duality of structure enabled the researchers to examine and gain a deeper understanding of the factors that influence the use of mobile systems in healthcare. Without the theory lens, it could have been difficult to identify and understand such factors.

CHAPTER 6
FINDINGS AND INTERPRETATION

6.1 Introduction

In the previous Chapter, the analysis of the data was presented. This Chapter presents the findings from both cases, Ministry of Health (MoH) and Healthbridge Public Hospital (HPH), and their interpretations. The technology acceptance model (TAM) was employed in the interpretations of the findings. This was primarily to gain a deeper understanding of the factors that influence how healthcare big data is accessed, used, and managed in the Namibian environment, and how the factors impact the interaction and integration between healthcare mobile systems and healthcare big data in service delivery.

This Chapter is structured into six sections. The Chapter introduction is carried out in the first section. The second and third section discusses findings from case 1 and case 2, respectively. The fourth section presents mapping of the findings as well as their interpretation. The proposed architectural framework is presented in section five and in the last section, the Chapter conclusion is provided.

6.2 Ministry of Health: Findings

From the analysis of the data, as presented in Chapter 5, seven factors were found to have significant influence on how healthcare big data is accessed, used, and managed for service delivery. This includes the impact which the factors can have on the implementation, management, and use of mobile systems for healthcare services delivery. The factors are:

1. Communicative tools,
2. Network of people,
3. Policies compliance,
4. Technology monopolistic,
5. Governance,
6. Data management system, and
7. Lack of interactive systems.

As illustrated in Figure 6.1 below, the factors are interconnected and depend on each other for the successful operation of healthcare mobile systems in accessing big data.

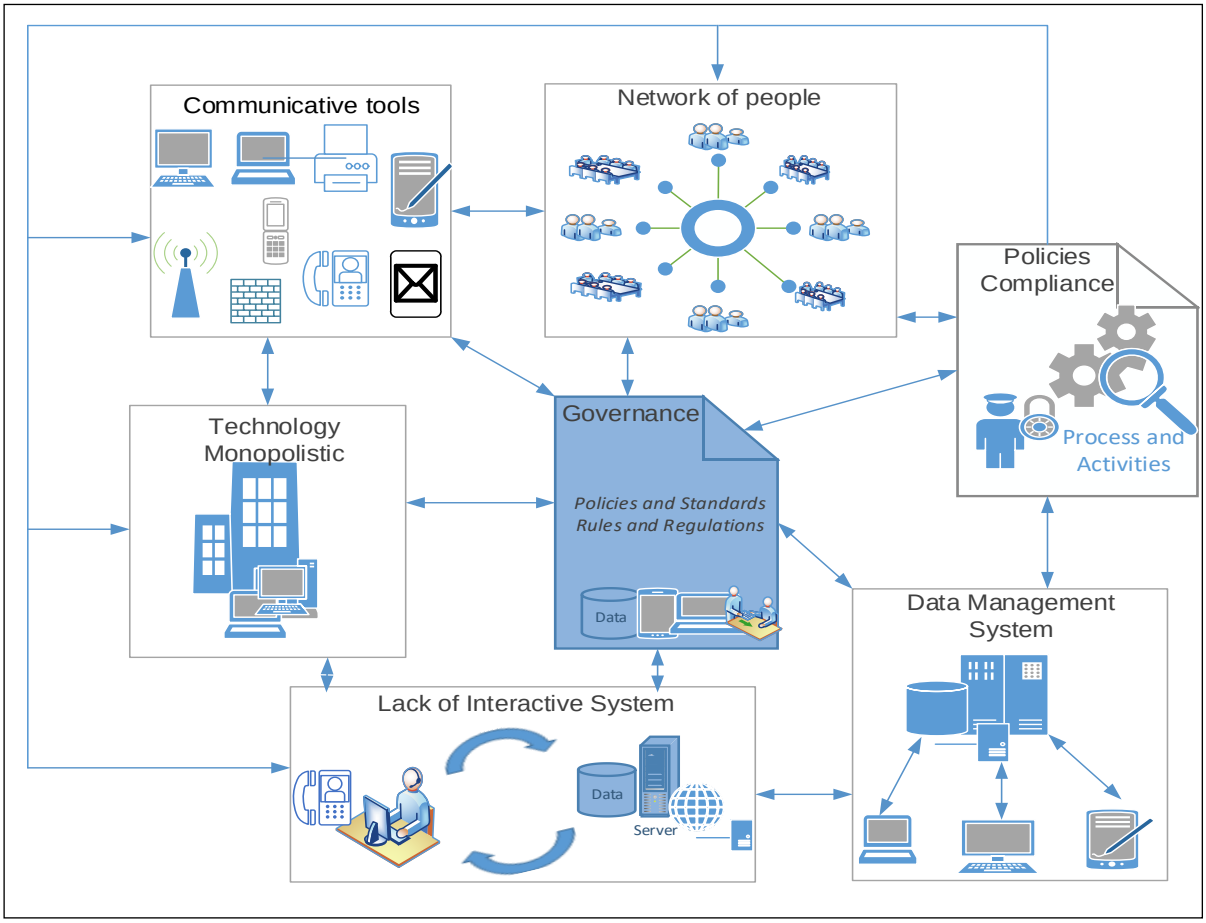

Figure 6.1: Access and Interaction with Healthcare Big Data

The seven main factors, as shown in Figure 6.1, are discussed below. The discussion should be read with the figure in order to gain a better understanding of the factors and how they are interconnected and influence mobile systems in accessing healthcare big data.

6.2.1 Communicative tools

Communicative tools refer to the communication mediums (such as technologies and processes) through which different types of healthcare information is stored, processed, retrieved, and shared with various respective and authorised stakeholders and users. In the context, there are two main types of communication tools: (1) manual, such as posters, memorandums, medical passports, and prescription notes, and (2) electronic, such as emails, landline telephones, desktop computers, laptops and cellular phones. Using different types of communication tools allows for accessibility and sharing of healthcare information with a wide range of audience. However, the use of these tools require architecture to enable a more appropriate coordinated, integrated, and consolidated approach.

Employees use communicative tools according to their understanding which is influenced by their knowledge. As a result, communicative tools are used differently by employees to communicate and share healthcare information. The architecture is primarily to maintain and manage the security and privacy of information, as the communicative tools are used to provide a platform for user's interaction when providing and receiving healthcare services.

The use of mobile systems enables ease of accessibility for healthcare big data. The application of mobile systems for accessing healthcare big data is impacted by the communicative tools used. As such, through communicative tools, mobile systems are connected seamlessly and securely with other systems, which requires architectural design. This provides the ability to share information instantly, eradicating delays when providing healthcare services. Additionally, mobile systems allow for information of different types and sizes to be shared conveniently without distance and time barriers. This is achieved through the capability of mobile systems to connect seamlessly and securely with other systems.

6.2.2 Networks of people

Networks of people refer the group of individuals with common interest in providing or receiving healthcare services. Callon (1986) defines network as a group of actors with allied interest. According to Iyamu (2015), networks enable people to form interactive groups through their right of association. Some of the networks include patients with the same medical condition (such as HIV, or tuberculosis), medical personnel (doctors, pharmacists, and nurses) of the same specialisation, and policy-makers (such as the government). Some of the networks are heterogeneous in that some of the people belong to more than one network.

These networks access patients' big data for different purposes, but may employ the same system, such as the mobile systems. This could be attributed to the uniqueness of each network of people. Thus, access to patients' big data should be categorised into levels, to ensure and enforce policies for security and privacy purposes. However, not all employees from the same network use, or can make use of, mobile systems to access big data in providing healthcare services. As such, as empirically revealed from this study, some employees at the Ministry of Health (MoH) developed negative attitudes towards the application of mobile systems preferred to use manual systems when accessing and sharing healthcare information. These significantly impacted the application of mobile systems within the organisation.

The use of mobile systems by some people, while others do not, in various networks causes disparities in the accessing patients' information including flow and exchange of health

information for healthcare service delivery by MoH. Thus, the networks need to be integrated into one system for a seamless flow of information to avoid duplications and enhance security and privacy of health-related information.

6.2.3 Governance

Governance focuses on the management of resources in the organisation, to promote successful operation of business processes and activities. The organisation, MoH, enforces governance through policies and standards. On the one hand, policies are the rules and regulations that guide employees' interaction as they access patients' big data and health information to provide healthcare services. On the other hand, patients and health facilities are expected to adhere to the MoH policies in interacting with the healthcare system in the country. Therefore, in the absence of policies, it is impossible to appropriately use mobile systems to access patients' health big data without possibly acting against security and privacy guidelines.

Through policies, processes and activities can be better controlled in providing more effective and efficient healthcare services to the community. Policies enforce security measures, which enable secure access to big data. This is important to protect the confidentiality and integrity of patients and their big data.

However, policies not only enable but they also constrain the application of mobile systems, to access health big data. Measures, such as systems controls through user roles and profiles, limit employees' timely access of big data. The approval of processes and activities by management goes through various level of authorities that often delays information flow and decision making within the organisation.

6.2.4 Lack of an Interactive system

An interactive system is a computerised system that allows user-to-user and user-to-system interaction through which health information is shared or exchanged instantly. There are various ways users can interact with an interactive system. The interaction can be through text, voice, and graphics.

As revealed from the analysis (see section 5.3), there was no interactive system at MoH at the time of this study. The lack of an interactive system impacted how health big data was retrieved and shared in the delivery of service to the community. As a result, access to healthcare big data is done by means of physical visits and presence at the healthcare

facilities. This type of process of accessing big data tends to be time consuming, which can be detrimental to health in times of emergencies. Moreover, the process presents security concerns in that data could be lost or damaged in the process. This could be worst if the data is not be recovered.

Accessing big data through an interactive system allows for ease of communication and real-time information sharing, for rapid decision making. With interactive systems, user interaction with the system is documented through action logs or voice recordings, allowing for processes and activities traceability. Processes documentation and traceability is highly important for security and evidence-based purposes.

The interactive system cannot stand alone if it is to provide and enable efficiency and effectiveness for healthcare service delivery. The system must be integrated with communicative tools and configured separately for the various networks of people in the environment. In addition, the use of the system should be governed by policies, procedures, and standard, to ensure that the objectives of the MoH are adhered to.

6.2.5 Technology monopolistic

Technology monopolistic occurs when a specific unit of the MoH controls the selection, development and implementation of the Information Systems/Information Technologies (IS/IT) solutions in an exclusive manner.

Being technologically monopolistic impacts the organisation's innovative capabilities to implement technologies that support big data according to its business needs. As a result, the healthcare organisation relies on external suppliers for IS/IT technical support. Technical support activities include configuring computers systems and diagnosing software and hardware faults.

The dependence on external sources for technical support impacted data accessibility, as such unavailability of suppliers to provide technical support caused process and activities delays. In addition, dependence on external suppliers contributed to a lack of uniformity in the development and implementation of technologies causing challenges such systems compatibility. Therefore, there is a need for an architecture that guides and ensure uniformity and standardisation of systems development and implementation across the organisation computing environment.

6.2.6 Data Management System

The MoH's Data Management System (DMS) is used to collect, store, manage, and retrieve health-related big data in the country. The healthcare big data is collected from various sources, from the community, activities of medical personnel (such as doctors, nurses, and pharmacists) and government strategic plans and vision. The data are of different types and sizes, which means that the DMS must be flexible and have the capacity for voluminous, and ever-increasing data.

The way in which healthcare big data are collected, stored, and managed influences its usefulness in service delivery. This could be attributed to the sensitivity of the environment, which therefore entails security, privacy, and quick response time. Accuracy is also critical, to ensure effective and reliable healthcare services to the communities. From this point of view, it is essential that the DMS integrate with other systems, such as the interactive system and communicative tools, to foster a more effective and efficient health service delivery in Namibia. Architecture is required for the design, enablement, and support of the systems' integration.

The architecture ensures a backup-up plan. This is crucial in case the system fails unpredictably. Data management systems failure can result in the unavailability or loss of data. This is highly and critically guided against within the healthcare environment, primarily because of its consequence, which can lead to severity, such as mortality. The DMS should also enable the centralisation of health-related data, to avoid duplication and cohesion. This will require an integration of mobile system, to enable wider access to services and data. The integration of these (DMS, communicative tools, and interactive system) will be near impossible without architectural design. This is important for the organisation to have timely and complete data required to provide effective healthcare services.

6.2.7 Policies compliance

Employees comply with processes and activities when providing healthcare services. These processes and activities are governed by policies. The policies are formulated and enforced through organisational structures. Ullah (2016) defines organisation structure as the framework that allows organisations to apply policies for controlling its activities horizontally and vertically.

Policies are used to guide employees' decisions making and creating standards of acceptable actions across the MoH. Policies compliance is, therefore, crucially required to protect patients' big data from security threats and being accessed by unauthorised users. Unauthorised access to big data compromises healthcare services confidentiality and privacy.

At the time of this study, measures were implemented to enforce policies compliance at the organisation. Measures, such as user password complexity and length, are used to manage mobile systems security. However, not all employees in the organisation comply with the implemented policies. To some of the employees, policies are regarded as too complex to follow or not critical. Employees with such attitudes consciously fail to adhere to the implemented policies.

6.3 Healthbridge Public Hospital: Findings

From the analysis of the data, as presented in Chapter 5, eight factors were found to have a significant influence on how healthcare big data is accesses, used and managed for service delivery. This includes the impact which the factors can have on the implementation, management and use of mobile systems in accessing healthcare big data. These factors are:

1) mobile systems ease of use,
2) system user training,
3) online consultation,
4) medical history traceability,
5) access to external facilities,
6) practitioner's collaboration,
7) systems decentralisation, and
8) technology infrastructure flexibility

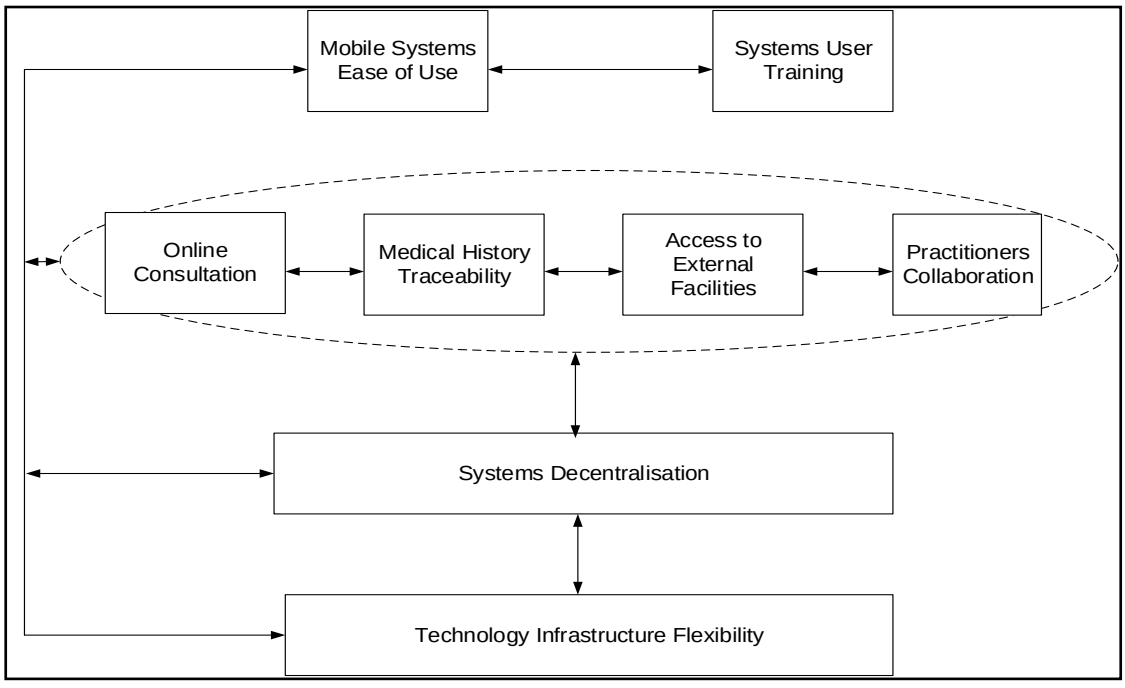

Figure 6.2: Mobile systems for healthcare big data

The factors, as illustrated in Figure 6.2, are interconnected and depend on each other for the successful operation of healthcare mobile systems in accessing big data. Thus, to gain a better understanding of the factors and their interdependence, the discussions should be read with the figure. The factors are discussed as follows:

6.3.1 System users training

Different types of Information Systems/Information Technologies (IS/IT) solutions were implemented at Healthbridge Public Hospital (HPH) as revealed empirically from this study. The IS/IT solutions were primarily implemented to enhance processes and activities of the hospital, for benefits of both patients and medical practitioners. This was ultimately aimed at improving healthcare service delivery, from perspectives such as quality and efficiency. However, not all the practitioners were able or could make use of some of the IS/IT solutions, such as medical doctors.

To promote systems' ease of use, employees received training on the systems implemented. Training users is important as it allows employees to get acquainted with the systems and improve their user skills. Through training sessions, employees are introduced to the systems features and functionalities.

Training and ease of use of systems or technology make users more effective and efficient in delivering their professional responsibilities. When employees are technically challenged in using the systems, productivity is affected, and they would prefer using paper-based approaches. Additionally, training enable users to employ security measures, to keep patients' data secure and prevent unauthorised access.

6.3.2 System decentralisation

System decentralisation occurs as each healthcare facility has systems for managing its big data. These systems are not interlinked with databases that are hosted or stored in other healthcare facilities within the country. This means that the systems are stand-alone and, therefore, do not enable seamless collaboration and sharing of big data among the healthcare practitioners with ease.

As revealed from the analysis, some of the implemented IS/IT solutions, such as e-health at HPH were not linked across healthcare facilities within the country. As a result, this hindered effective and efficient communication and information sharing between the healthcare practitioners in their quest to providing services to the patients. Due to the lack of system

decentralisation, accessing patients' big data from referral healthcare facilities' systems by the HPH healthcare practitioners was difficult and prohibitive. Thus, many patients travel back and forth between hospitals with their healthcare documents. Traveling with healthcare documents pose security concerns as patients could lose their documents, which could end up in the wrong hands and become impossible to trace

System decentralisation allows for managing and accessing of data in other healthcare facilities. Therefore, an architecture is critical to guide the development and implementation of mobile systems decentralisation across the public hospitals. With systems decentralisation, big data are synchronised across various systems to enable processes coordination and access to the same updated information for healthcare practitioners. Thus, systems decentralisation eradicates data redundancy and duplications across the interlinked systems

6.3.3 Online consultation

This is an approach which enables patients, irrespective of location and time, to consult with various medical practitioners through an automated system. One of the primary benefits is that the online consultation approach reduces patients' physical presence at health facilities. Online consultation provides patients with the opportunity to actively ask questions and express concerns related to their illness (Lu, Shaw & Gustafson, 2011). However, the approach can be enabling (comforting) and at the same time constraining (discomforting) to both service providers and recipients of healthcare.

Physical presence for consultation, as well as scheduling appointments, is not always or often easy, particularly for elderly people and those who travel long distances to seek care. In recent years, some patients have compounded their health conditions in the course of travelling long distance to seek care. Online consultations allow patients to access healthcare services anytime and anywhere.

Online consultation can be achieved through communicative tools, such as emails and remote video conferencing between the healthcare practitioners and patients. The use of online consultations can serve as the first point of contact between healthcare facilities and patients. Patients can book and confirm their appointments, as well as access their medical reports through online consultations. Thus, online consultations save on the cost and the inconvenience caused because of travelling.

The use of online consultations requires dedicated technology infrastructures, such as the mobile system. The use of such dedicated system requires policies and standards to enforce

securities and healthcare services authenticity. There is also a need to regulate and monitor the online interaction between healthcare practitioners and patients to ensure the communication is taking place between the correct parties, which can be enabled by an architecture.

6.3.4 Technology infrastructure flexibility

Technology infrastructure flexibility entails adaptability with other IS/IT solutions. This is critical in that many technology infrastructures are not compatible or easily adaptive in an environment. Flexibility of IS/IT solutions allows for the cohesiveness of processes and activities, which enables HPH to be better and more responsive in providing care and services to patients.

In the implementation of IS/IT solutions, such as healthcare systems and databases, there are often questions about compatibility at various levels, as revealed from this study. Compatibility challenges influence contents (big data), including local languages and culture (Drury, 2005), which can be addressed by employing mobile systems.

Mobile systems should enable healthcare practitioners and patients to interact and share information in their local languages. This is important to enable patients to use mobile systems with ease when seeking healthcare services online. This helps to increase privacy, and security of patients' big data, in that an interpreter would not be needed. When patients make use of mobile systems that support their local languages, it enhances their ability to describe their health conditions more clearly (Odigie et al., 2012).

6.3.5 Practitioners' collaboration

Healthcare services are often not provided by a single practitioner in silos, as empirically revealed from this study. Thus, it requires collaboration among health practitioners. The collaboration entails a group of practitioners (doctors, pharmacists, nurses, laboratory technologists, and so on) to complementarily provide patients with care, as each access patient's big data from different perspectives. This group of practitioners collaborates, by sharing information and working together to provide quality healthcare services. When the practitioners from various health disciplines collaborate, then they obtain a more comprehensive view of a patient's condition towards providing quality care.

Additionally, many patients often require referral for their health conditions. Referral of patients by default demands that the medical practitioners who are involved need to interact. Thus,

collaboration occurs between practitioners, such as doctors, pharmacists, and nurses, within the same or between different health facilities, which are situated in the same or different towns or cities across the country. The healthcare practitioners can collaborate through various mobility of systems, such as email, telephone, or video call.

Collaborations between healthcare practitioners require an interactive online system to facilitate effective communication. Through an online system, healthcare practitioners can access patients' big data, discuss their health conditions, and share individuals' medical results, in real-time across centralised or decentralised healthcare systems. When healthcare practitioners collaborate online, they can detect and react to miscommunications about the healthcare services faster than when collaborating only through face-to face or sharing of hardcopy documents.

6.3.6 Access to external facilities

As revealed from the analysis, some of the healthcare conditions require attention of medical specialists who reside outside of the country. This was attributed to the shortage of medical specialists within HPH.

However, access to medical specialists who reside outside of the country was a challenge due to the lack of a healthcare practitioners' databases. The lack of such a database limits healthcare practitioners' ability to access and share detailed information about patients' healthcare conditions.

Access to other specialists in other facilities is essential for obtaining a second opinion in many chronic cases. This type of approach can be facilitated through a collaborated database of health practitioners. Moreover, through access to such database, referrals can easily be made. The approach can promote faster responses to patients' healthcare conditions. However, the development and access to such a database is likely to be more complex than other databases for two main reasons: (1) the data is between countries, and (2) privacy and security concerns. This, therefore, will require an architecture design that incorporates these challenges. In addition, the medical database needs to be governed to promote the completeness and accuracy of the recorded information. This is important to avoid documentation of fraudulent healthcare professionals that if contacted for services could put patients' lives at risks.

6.3.7 Medical history traceability

Medical history is a summary of records about a patient's past healthcare conditions, which include consultations, prescriptions, diagnoses, treatments, and medications. Ufitinema et al. (2016) posit that a medical record is regarded as a legal document that presents the patient's illness, findings on examination, and details of treatment. The medical history can be stored in different forms, such as text, video, and images, and in any sizes depending on the capacity of the storage. This is often referred to as big data. According to Iyamu and Mgudlwa (2018), big data in healthcare hold challenges that are mostly related to its characteristics, volume, variety, velocity, and veracity.

As empirically revealed in this study, most of the healthcare practitioners fully rely on medical history in providing service to the patients. In addition, the medical history enables healthcare practitioners to monitor, assess, and manage patients' healthcare on a continual basis. The medical records can be stored manually (paper-based) or electronically (computerised), or both. At HPH, the records were mostly stored manually.

Having access to patients' medical history creates awareness of their health conditions and other medications that might have an impact on the healthcare services that needs to be provided. As revealed from the analysis, due to the paper-based and cabinet filing systems, it was difficult to trace patients' medical history. As a result, medical processes and activities were often re-conducted. Re-conducting of medical procedures were costly, delayed healthcare treatments, and endangered patients' lives whose health conditions needed urgent medical attentions.

To enable ease of medical history traceability, there is a need for online medical records systems that are linked across healthcare facilities. Using online medical records, the storage and retrieval of medical history will be safer, convenient as it is achieved through the use of unique identifiers. An identifier, such as medical record numbers, promotes secure access to big data as each number uniquely identifies a patient. These will promote the usefulness of mobile systems in accessing and tracing a patient's medical history.

6.3.8 Mobile System's ease of use

Mobile systems are not always easy to use, as claimed by some users. Many people who are not technologically inclined or trained often find mobile systems not easy to use. In the context of this study, ease of use can be subjective, in that the use of a mobile system does not necessarily mean it is easy. Scholtz et al. (2017) define ease of use as the effortless use of a

systems in completing a task. Ease of use has an impact on the user's attitudes and willingness to use mobile systems (Elkaseh et al., 2016).

At the time of this study, not all the healthcare employees at HPH knew how to make use of mobile systems with ease to access patients' big data. The use of mobile systems to access patients' big data entails two angles: (1) operability of the mobile system, and (2) connectivity to the big data storage. These two angles of use make mobile systems even more complex. As a result, some of the employees were technically challenged in using mobile systems. This could be attributed to complex functionalities of the systems. Moreover, there were no guide or documentation on how to use the systems, which increases the technical challenges. In addition, training was not offered to those who find the systems not to be ease of use.

Some employees, such as the IT personnel (IT technicians and systems administrators), were well-versed with the mobile systems' functionalities. As a result, many of the employees in the organisation depended on the IT personnel, who were knowledgeable on how to use the systems, in providing healthcare services to the patients. However, some of the IT personnel were not always available to assist and support the employees who needed assistance in using the systems to access patients' data. This caused delays in providing service, which had an impact on the quality of care.

Some of the IT personnel were soon aware that many of the employees rely on their expertise, to make use of the systems. Thus, they explored, and did not make the know-how easier for the employees who relied on them. Instead, some of the IT personnel employed their skill as a source of power and dominance, to influence their authority and flow of information in the hospital.

6.4 Interpretation and discussion of the findings

The interpretation was carried out to gain a deeper understanding of the findings, from the data analysis. The findings from the two cases, Ministry of Health (MoH) and Healthbridge Public Hospital (HPH) were combined in the form of cross mapping, as shown in Figure 6.3 below, for interpretation purposes. The findings that appear to be similar or closely related were combined. From the mapping, the following factors were assessed to represent findings from both cases: ICT solutions, standardisation, systems interaction, collaborative networks, ICT management, and database management. The factors were interpreted, by using the technology acceptance model (TAM) as a lens.

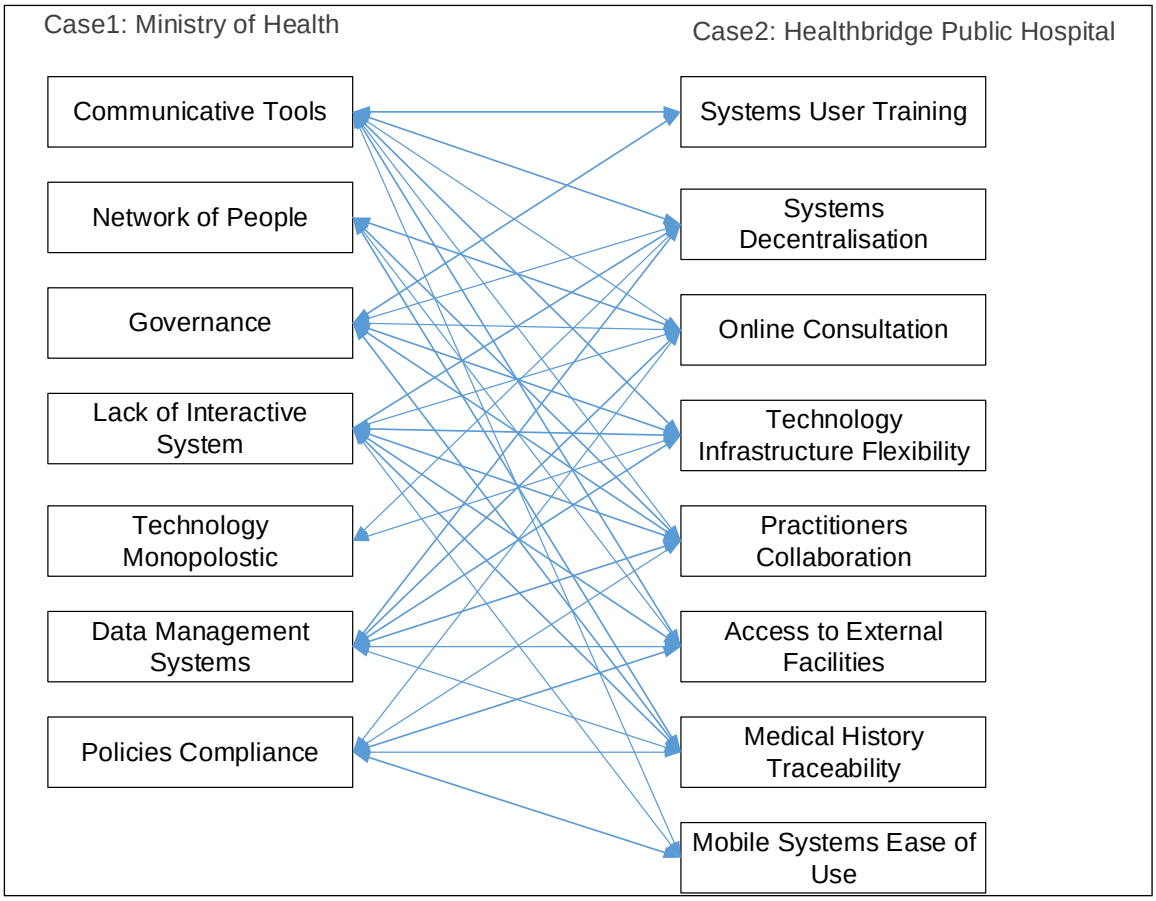

Figure 6.3: Mapping of result

6.4.1 Technology Acceptance Model: Overview

This study applied the Technology Acceptance Model (TAM) as a lens to guide the interpretation of the findings from the two cases, MoH and HPH. TAM was considered most suitable to help understand this study's findings as it focuses on the factors that impact users' behaviours and attitudes towards the acceptance or rejection of technology artefacts (Iyamu, 2015), such as mobile systems. The model consists of four determinants (Davis, 1989), as shown in Figure 6.4 below.

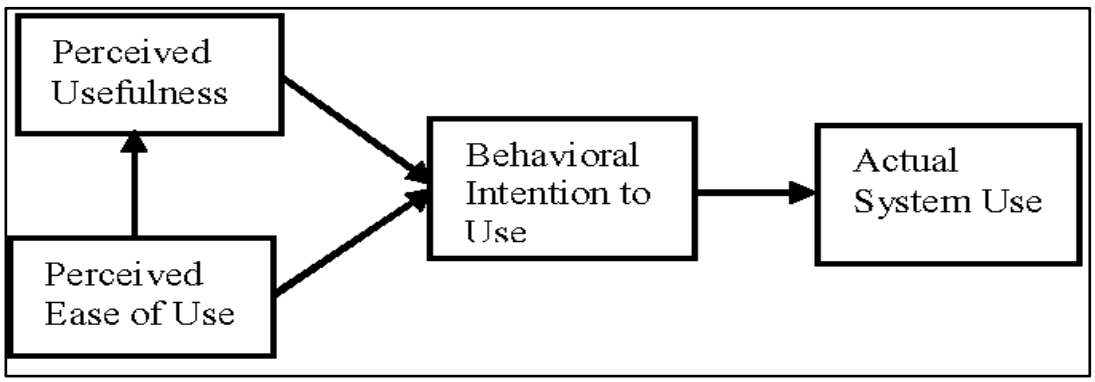

Figure 6.4: Technology Acceptance Model (Davis, 1989)

Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are the two fundamental determinants of technology acceptance (Davis, 1989). PU is explained as the user's subjective belief that using a specific technology will increase one's performance and productivity (Anni, 2018). PEOU is defined as the belief that using a certain technology will be free of difficulties (Wu & Chen, 2017). PU is influenced by PEOU because users consider easy-to-use technologies to be useful (Fathema et al., 2015).

Both PU and PEOU influence the other two determinants, namely behavioural intention to use and actual systems use (Davis, 1989; Iyamu, 2015). Behavioural intention indicates a person's readiness to perform the given behaviour (Ajzen, 2006), which makes it the main predictor of the actual behaviour. According to behavioural intention, intentions to use is an important factor that will determine which users will utilise the system (Tarhini et al., 2015).

As illustrated in Figure 6.3, the findings from the two cases, Ministry of Health (MoH) and Healthbridge Public Hospital (HPH), were combined through cross mapping. From the mapping, findings from both cases were assessed and grouped into six similar or closely-related factors. These factors are:

(1) Information and Technology Solutions,
(2) Standardisation,
(3) Information and Communication Technology Management,
(4) Systems interactions,
(5) Collaborative networks, and
(6) Database management.

Figure 6.5 below illustrates the relationship, interconnectivity and dependence among the factors. The factors are discussed below.

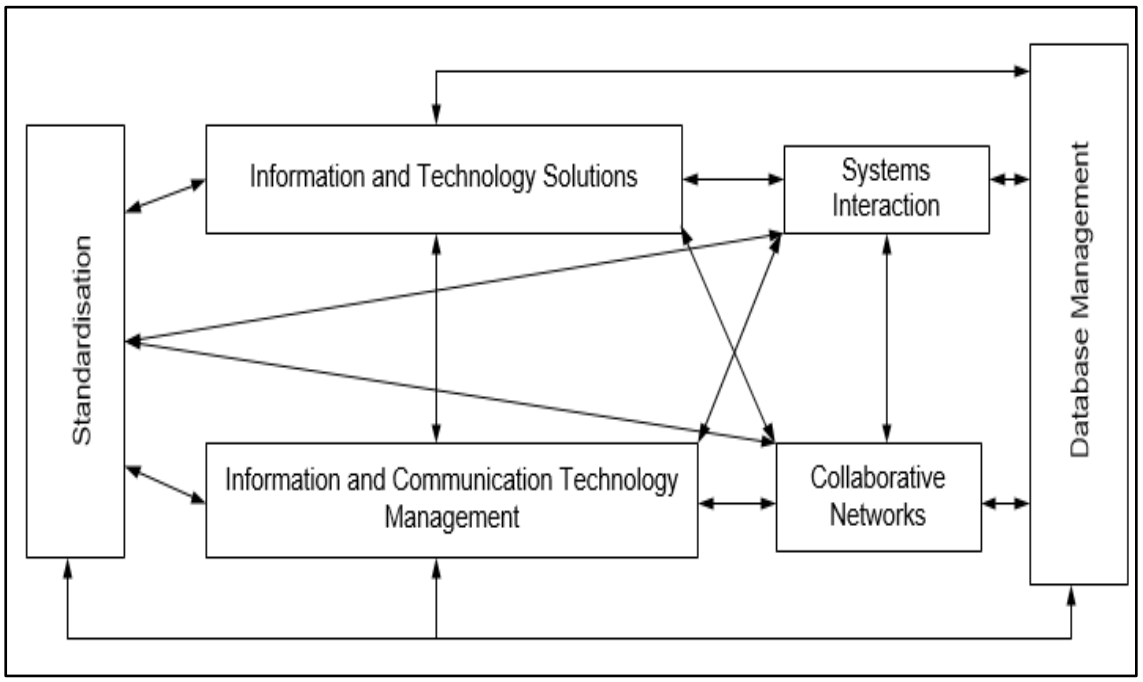

Figure 6.5: Mobile systems integration for accessing big data

6.4.2 Information and Communication Technology solutions

Information and communication technology (ICT) artefacts include hardware, software, and network; together they form solutions which are used to store, process, and manage information about an organisation (Herzfeldt et al., 2017). In healthcare, ICT solutions, such as electronic patient records, enable the storing and transferring of patients' information electronically, which allow immediate access to information (Halford et al., 2010). Replacing paper-based processes with ICT solutions, such as healthcare mobile applications, reduce potential errors in sharing information, leading to a higher level of data accuracy and integrity (Basole et al., 2012).

To improve the quality of healthcare in the Namibian environment, the selection of ICT solutions must be appropriate and specific to the needs of the facilities. The appropriateness is engineered by architecture, which provides guidelines and standards for the selection, deployment, and management of the technologies. This helps to address the technology monopolistic situation that currently exists in the Namibian healthcare environment, as revealed in this research. In addition, the architecture enables scalability and flexibility of the technologies, which enables its centralisation or decentralisation, while achieving the aim and objectives. Moreover, architecture enables and supports the integration of decentralised or standalone systems, which facilitates better service delivery through improved human collaboration.

The technologies and their attributes, which include appropriateness, scalability, and flexibility, are documented. Based on the documentation, users' and stakeholders' attitude towards the technologies are influenced by how they perceived usefulness or ease of use of the solutions, such as mobile systems for healthcare. The increasing popularity of mobile systems makes a strong case for its usefulness in the healthcare environment. Users with positive behaviours towards the use of mobile systems consider them to be useful in delivering improved healthcare services. However, to deliver improved healthcare services, mobile systems require integrated ICT solutions that will enable their ease of use.

6.4.3 Standardisation

With standardization, the production or service process becomes routine with well-defined activities (Ungan, 2006). Standardisation does not operate in vacuum. Thus, standardisation of healthcare processes and the technologies (such as communicative tools) that are used to support the services must be enforced through policies. Additionally, without standardisation, it is difficult to integrate the many systems of the healthcare environments, MoH and HPH. Another critical point is that standardisation helps control the security and privacy of patients' information within the systems. The policies guide both technology and stakeholder's interactions. However, the policies are often understood and interpreted differently, based on the user's skill, experience, and knowledge. Thus, some employees' perception of communicative tools' ease of use and usefulness were different at both MoH and HPH.

Standardisation facilitates uniformity and compatibility, therefore, enabling connectivity, in the use of mobile systems. Thus, standardisation of processes and activities promotes consistencies and uniformity across the facilities, MoH and HPH. This is important in promoting the usefulness of mobile systems as a communicative tool, among the users and stakeholder at the health facilities. However, it depends on how standards are enforced, which influence both users' and stakeholders' behaviour towards communicative tools within the environment. Some of the employees perceive the use of mobile systems as not productive. As a result, some of the employees' negative attitudes towards mobile systems resulted in the actual use of both paper-based and automated communicative tools at the health facilities, MoH and HPH.

6.4.4 Systems interaction

Through systems interactions, a patient's physical presence is not always required at the point of care. As such patients, can request for some of the healthcare services through online interactive systems. The use of interactive systems offers potential benefits to the country's

healthcare system, through cost savings and improved service delivery. The use of online systems for interaction between patients and healthcare providers reduces the inconvenience of travelling back and forth hospitals. Also, patients get an immediate response, which eradicates delays in their medical needs.

Interaction through systems allow for better and improved collaboration on health matters, between patient-to-patient, patient-to-health professionals, and health professionals-to health professionals. The thought of this possibility influences the stakeholders on the usefulness and ease of use of the systems for healthcare services. However, the usefulness can be reconsidered based on other factors, such as eligibility, security, and privacy, which influences their intention to use, and the actual use of the systems when interacting for healthcare purposes.

Online consultation is a service that can be embedded in mobile systems, such as emails (instant messaging) and video conferencing; thereby improving healthcare service delivery. This does not guarantee identity and security. Healthcare services are considered to be highly confidential, the interactive systems need to take security and privacy seriously to promote its usefulness. When mobile systems are not secure, many stakeholders will not perceive them as useful. Users are likely to grow resistant towards such systems as they are more vulnerable to hackers and viruses attacks which may endanger them. Mobile systems that are secure enable authorised users to access patients' data using security measures such as authentication, username, and passwords.

6.4.5 Collaborative networks

Healthcare services are offered by health and medical practitioners to individuals or group of patients, which consciously or unconsciously forms a network. Furthermore, the practitioners of the same or different specialist fields, in the same or between facilities, collaborate by drawing on each other's experience, and sharing information and resources. A network is a group of actors with an allied interest (Borgatti & Halgin, 2011). Each area, such as specialisation, facility, or group of patients, is categorised as network. This type of collaboration contributes to improving the quality of healthcare service delivery.

For effective collaborative networks, practitioners need access to external facilities, facilitated through engineering of databases. External facilities include both local and international medical resources where patients can be referred for further medical treatment. Access to external facilities can be achieved through integrated systems which will enable seamless

interaction. When mobile systems are integrated, the perception is that practitioners are able to collaborate with ease, sharing real-time data via secured networks.

Based on the interest, other persons (patients of practitioners) gather their intention to enrol in a group or groups. Collaborative networks require mobile systems connectivity. Connected mobile systems enable the efficient flow of information, prompting fast decision making across the network of people, which influences stakeholders to perceive the system useful.

6.4.6 Information and Communication Technology management

The implemented ICT solutions at healthcare facilities necessitate management, which requires both ICT specialists and other stakeholders (users and managers). This is primarily to ensure continuity of healthcare services. Management of ICT solutions entails governance and users' capability, which includes skill and knowledge, gathered from training. The management, therefore, creates stability of the solutions, which is critical in a healthcare environment. The stability somehow guarantees increased technology connectivity.

Based on the stability of ICT solutions and technology connectivity for healthcare services, stakeholders form their perceptions on their usefulness and/or ease of use. Furthermore, intentions are created on the actual usability of the solutions. In justification of perception, some stakeholders believe that ICT management enables the organisation to select, develop and implement technology infrastructures that are flexible. As revealed in this study, the healthcare environment lacks flexible infrastructures. Having flexible technology infrastructure enables systems compatibility and modification in order to support constantly-changing business processes. This promotes ease of mobiles systems' connectivity and integration with other systems within various business units.

ICT management in an organisation is influenced by the employees' skills and knowledge. Employees are able to manage systems they are knowledgeable about. As such employees are likely to manage systems which they perceive useful and easy to use based on their knowledge. To improve and enhance employees' ICT skills and knowledge, employees often receive training on the implemented systems. Through systems training, users gain an understanding of the system's features and their usefulness in completing activities.

6.4.7 Database management

Healthcare facilities rely heavily on patients' data for decision making in circumstances such as diagnosis, prescription of medications, and general treatments of patients. Additional, data

from medical history influences the use of medical apparatus. Hence, accuracy, security, and reliability of data are critical. Thus, engineering a database through architecture will increase the quality of management and improve service delivery at the healthcare facility.

In the Namibian Public Healthcare (NPH) environment, data is managed through the use of manual and electronic systems. Both systems are used in parallel to meet an organisation's needs. These have caused various challenges, such as data inconstancies and duplication of efforts endangering patients' lives. Such challenges helped form stakeholders' perceptions that the hospital's usefulness is limited. Thus, the intentions of many patients are not to use the hospital in certain services, such as surgeries that are of severe nature.

At the time of this study, healthcare practitioners at both MoH and HPH are often challenged with medical history traceability. Medical history traceability can be optimised by having integrated database systems across healthcare centres. Integrated databases enable systematic data entry, storage, and retrieval. Through integrated database management, security measures, such data backups, can be implemented. This will create a perception of better management towards improved service delivery, which increases actual enrolment (participation) of patients, at the HPH facility.

6.4.8 In summary

In this study, TAM provided a fresh perspective in the interpretation of the findings from the data analysis. TAM was employed from social perspectives primarily to gain a deeper understanding of individuals' and groups' perceptions about the usefulness and ease of use, and the factors that influence mobile systems for healthcare services. Perceptions of the individuals and groups manifest into behaviours that affect mobile systems' actual use in accessing healthcare big data. Through the lens of TAM, it was possible to examine and gain a better understanding of such behaviours and how they manifest to impact mobiles systems ease of use and usefulness in accessing healthcare big data.

6.5 A Unified Architecture Framework for Healthcare Mobile Systems

Based on the data analysis, findings were reached, which were interpreted and discussed as presented in section 6.4. From the interpretations and discussion, a solution which can be used to address the challenges that confront healthcare services in Namibia, such as secured access to healthcare big data, systems integration, and governance. The solution is proposed through a Unified Architecture Framework (UAF) as shown in Figure 6.6. The framework aims to guide the Ministry of Health and its stakeholders in the design, development, and

implementation of flexible and scalable mobile systems necessary for systems connectivity and process integrations.

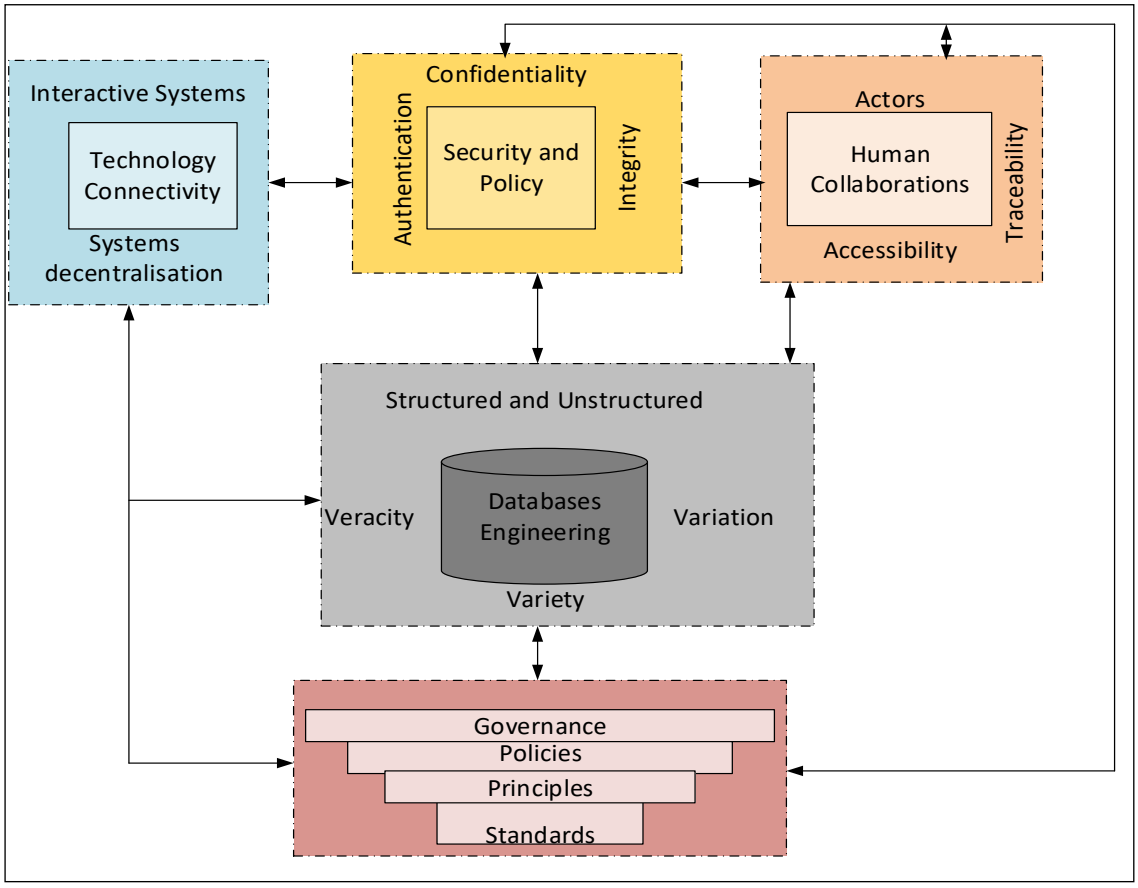

Figure 6.5: Unified Architecture Framework for healthcare big data

Through the UAF, mobile systems for Namibian healthcare services can be developed and implemented. The framework is uniquely important in that it provides a guide for critical aspects of health activities, such as security of patients' information, integration of mobile systems for healthcare services, flexible accessing of healthcare big data, and scalable connectivity between systems. As depicted on the Framework, the main factors of the architecture are governance, databases engineering, security and privacy, technology connectivity, and human collaborations. The factors are discussed next

6.5.1 Governance

Governance is the process of controlling and managing resources and artefacts in the context of computing. From healthcare perspective, governance is about the division of control and patterns of interaction among the different stakeholders that are proving and seeking healthcare services (Dickinson & Pierre, 2016). Governance, therefore, covers both technology (e.g. software, database, and server) and nontechnical (e.g. processes and

procedure) activities. Governance includes the set of policies, standards, and principles. Through these components of governance, systems and database designs are carried out and IS/IT artefacts are selected.

To improve efficiency and effectiveness, policies, standards, and principles are used to ensure appropriate deployment, use, and management of resources (such as patients' information, systems, and big data) for healthcare services. Furthermore, the rules guide patients', healthcare practitioners', and other stakeholders' interactions as they access and use healthcare big data for various services. Thus, the governance is a crucial aspect of architecture for flexibility, scalability, and uniformity purposes.

However, enforcing policies and standards can be challenging. Due to the complexity of healthcare processes and activities, varying levels of governance need to be employed to address various healthcare needs (Delaney, 2015). Strategically, an architecture is needed to coordinate the different actors and guide the development and implementation of policies, standards, and principles to ensure alignment of the different business units and stakeholders needs.

The use and integration of mobile systems to access healthcare big data necessitates policies, standards, and principles. Mobile systems, if not governed, can be vulnerable to mismanagement which has the potential of endangering patients' safety and privacy. Thus, the selection, development, and implementation of IS/IT artefacts need to be guided by an architecture to enable technology flexibility and scalability. IS/IT flexibility and scalability are critical for systems and processes integration. Systems are considered to be flexible if they can be re-engineered to accommodate business processes changes (Danesh & Yu, 2015). Potentially, architecture is used as a change agent, governing the transition from the current stage to the healthcare system's desired stage.

6.5.2 Database engineering

Database technologies support data management by storing and maintaining healthcare data. Thus, data quality is influenced by the data management approaches employed by the organisation. Heath et al. (2017) describe database technologies and data governance structures as some of the factors influencing data quality. When data integrity and availability are compromised, it has detrimental effects on the organisation's decision making (La Torre et al., 2018).

Engineering databases through an architecture guide the design and development of database technologies that enables and supports an organisation's current and future big data needs. The engineered database technologies need to manage a variety of healthcare big data types, such as images, videos, and text. Healthcare data are generated from various sources; thus, they are of different structures and formats (Sarkar & Sana, 2018). Therefore, healthcare data are both structured and unstructured.

In addition, architecture guides the design and development of data management approaches such as back-ups and data recovery that are needed to minimise data loss. Moreover, data security mechanisms are engineered into the database systems to promote data privacy through enabling secure access to healthcare data.

6.5.3 Security and privacy

Due to the sensitive nature of healthcare services, there is a need to have security and privacy measures in place. Jahan, Chowdhury and Islam (2018) posit that security and privacy in healthcare are mainly concerned about user authentication, data integrity, data confidentiality, and patient privacy protection. Healthcare services are sensitive and must be managed securely to ensure the privacy of individuals (Weber-Jahnke & Price, 2007). Security and privacy of healthcare services are attained through enforcement of governance and architecture, primarily because they guide technologies and user interactions. Marcella and Stucki (2014) recommend business and IT units to have policies and procedures for protecting organisation information.

However, the development and implementation of policies and standards is a challenging activity. The complexity of the healthcare environment makes it even more challenging to develop comprehensive policies. Thus, the need for an architecture to guide management and stakeholders in the development of policies and standards that are aligned with the healthcare environment. An architecture can be used to define the types of communication that occur between various stakeholders, and to describe properties' overview of the complex systems they represent (Närman et al., 2011).

Security and privacy mechanisms must be integrated into healthcare mobile systems. Otherwise, mobile systems are perceived as communicative tools endangering patients' lives. This impacts the attitude of collaborators and external facilities that are relying on technology connectivity to share information.

6.5.4 Technology connectivity

In this study, technology connectivity refers to the interface and interaction between computer systems. According to Angelopulo (2014), technologyconnectivity is the linkage between computer systems and the individuals who use them. Through technology connectivity, communication and information sharing are enabled, supported, and, at the same time, controlled and managed. When technologies, such as mobile systems, are connected, employees can have access to big data for healthcare services. Lu and Keech (2015) posit that due to the lack of systems' connectivity, information about patients from one system is not automatically available via other systems. These contribute to the ineffective flow of information within and across health facilities, which hinders timely decision making.

Technology connectivity needs to be guided and achieved through an architecture, to ensure scalability and governance. An architecture drives the organisation's technical direction by defining its technology selection criteria (Jin, Kung & Peng, 2010). This promotes technology standards for the selection and development of the technologies needed to support the healthcare process. Additionally, through architecture, systems' flexibility and compatibility are assessed accordingly. Flexible IS/IT are able to accommodate new changes within acceptable time and costs (Zhao et al., 2016). Due to the dynamic nature of healthcare process, IS/IT flexibility is vital for effective systems' integrations and operations. Danesh and Yu (2015) posit that, due to changes in process and organisations' competitive positioning, developing flexible and adaptable IS/IT is a challenge.

Challenges, such as lack of systems flexibility and incompatibility, hinder technology connectivity leading to the use of technology as stand-alone systems (Guarrera et al., 2013). The use of stand-alone systems leads to human collaboration inefficiency, as such, shared data is not readily available to the collaborators.

6.5.5 Human collaboration

Human collaboration happens between patient-to-patient, patient-to-health professionals, and health professionals-to health professionals. Collaboration facilitates the sharing of information and knowledge required to provide integrated care. When collaborating, people share information, resources, and other capabilities that are needed to achieve an outcome that cannot be achieved individually (Crispeels et al., 2018). Collaboration among healthcare practitioners is essential for promoting best practices and continuity of healthcare services (Assem & Pabbi, 2016).

Human collaboration cannot take place without governance to enforce order and encourage acceptable behaviours for the collaborators. Hence, architecture plays a critical role in fostering successful collaboration by establishing rules and structures that govern the collaborators.

Collaboration is attained through various tools such as emails, video conferencing, and mobile applications. The use of mobile systems for collaboration promotes fast access to information, creating an effective flow of information across the collaborators. Song et al. (2010) assert that mobile systems enable effective responses to medical situations through updated information provisioning services. Effective human collaboration depends on technology connectivity to enable instant sharing of information. Thus, by having an architecture, information vital for human collaboration is made available by designing and implementing interconnected systems.

6.6 Summary

This Chapter presented the findings from the analysis of the two cases studied and the interpretations of the findings. The findings are significance factors that influence the use of mobile systems for accessing healthcare big data in the Namibia healthcare environment. The factors' interconnectivity and interdependence are discussed. The Technology Acceptance Model (TAM) was employed to gain a deeper understanding of how the factors affect processes and activities to access healthcare big data for service delivery purposes. Without the use of TAM, and such interpretation, it was going to be difficult or impossible to interrogate how the factors manifest themselves to influence the use of mobile systems to access and manage big data for service delivery to the community. Therefore, based on the analysis, findings and interpretation, an architecture framework was developed. The framework components were discussed in this Chapter.

CHAPTER 7
CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

This Chapter presents the conclusion and recommendations of the study. Both the conclusion and recommendations are influenced by the findings from the data analysis and the interpretations of the findings.

The aim of the research has been to develop a Unified Architecture Framework that can guide the development and implementation of integrated mobile systems that enable and support ease of accessibility, usability, and manageability of healthcare big data. In achieving this aim, the study employed an interpretive stance, a case study design approach, and semi-structured interview and documentation in gathering qualitative data. Structuration Theory was applied as lens to guide the analysis of the data. The findings from the analysis was interpreted through the Technology Acceptance Model.

This Chapter is divided into ten sections. In the first, current section, the Chapter is introduced. The second section presents a summary of the study as documented from the first to the last Chapters. The third section discusses an evaluation of the aim, objectives, and questions. The three contributions of the study are discussed in section four. Sections five and six presents the evaluation of the study and its recommendations, respectively. The benefits of the study are outlined in two folds in section seven. In section eight, limitations of the research are noted. Section nine outlines the areas of further research and lastly in section ten the conclusion is drawn.

7.2 Summary of the study

The study is divided into seven Chapters. Each Chapter covered a unique area that contributed to the achievement of the study objectives. The Chapters are summarised as follow:

In Chapter 1, the entire study was introduced. The Chapter provided an overview of what the thesis entailed. In this Chapter, the research problem was presented. The research problem leads to the formulation of the study aim, objectives, and questions. The study aimed to develop an architecture that could guide the development of healthcare mobile systems and ease of scalability, accessibility, usability, and manageability of healthcare big data in the Namibian healthcare environment. In this study, mobile systems are the medium through which various healthcare stakeholders can interact in accessing healthcare big data. Thus,

one of the study's objectives was to examine and understand the factors that influence how healthcare big data is accessed using mobile systems in the Namibian environment.

A brief review of the literature is also provided in the Chapter. The review was based on the five keywords of the study: (1) Information Systems/Information Technologies, (2) healthcare mobile systems, (3) healthcare, (4) healthcare big data, and (5) architecture. In addition to the five keywords, two socio-technical theories, Structuration Theory (ST) and Technology Acceptance Model (TAM) which are used to underpin this study, was also provided. The review of the literature helped the researcher to relate what has been studied about mobile systems, their application as a communication tool, and their impact on healthcare big data accessibility. The remainder of the Chapter covered the research design and methodology which includes the research philosophy, research approach, research strategy, data collection techniques, data analysis, unit of analysis, significance of the study, and finally the conclusion is drawn.

A more detailed review of the literature related to the research is presented in Chapter 2. The Chapter was structured into two sections. The first section covered the review of literature according to the five keywords. The review of literature enabled the researcher to gain knowledge in the area of study. Moreover, the literature review enabled the researcher to support the research problem with what has been done by other researchers. This presented an opportunity to identify gaps in the existing literature and assess the relevance of the study in filling such gaps. The second section covered the two socio-technical theories that were used to underpin this study. The review focused on how the theories have been applied as lenses in other studies. The application of the theories in other studies enabled the researcher to gain a deeper understanding of the theories and assess the weakness and strength of each theory.

The methodology that is applied in the research is discussed in Chapter 3. As explained in the Chapter, the research methodology encompasses the research philosophy, research approach, research strategy, research design, and data collection techniques. As discussed in the Chapter, the selection of the philosophy, approaches, methods, and data collection techniques was influenced by the study objectives. The discussions in the Chapter clarified why and how the different techniques, methods, and approaches were employed in the study. The study employed a case study design whereby two cases were studied. Semi-structured interviews and documentation were used as data collection techniques for both cases. The data collection process was documented in the Chapter.

Chapter 4 provided an overview of the cases that are used in the research. This included the organisational structure of the cases.

The analysis of the data, which was conducted by using the hermeneutic method, and guided by the duality of structure from Structuration Theory (ST) is presented in Chapter 5. The results are detailed in Chapter 6. The results showed how certain factors influences the use of technology to gather, store, and access patients' big data in Namibian healthcare facilities. The results show the importance of interaction between human-to-human, human-to-technology, and technology-to-technology in accessing and use of patients' big data in health facilities. The Technology Acceptance Model (TAM) was employed in the interpretation of the results, on which the development of the Unified Architecture Framework was based. This included the reveal about the essential roles of relationship between human and non-human (technology and processes) aspects in the use of ICT solution to enable and support healthcare activities to improve service delivery.

7.3 Revisiting the aim and objectives of the research

The study is evaluated through its aim and objectives. The aim of the study was to propose a solution that can be used by the healthcare facilities in Namibia, to ease access to patients' big data. Based on this aim, two objectives were formulated as stated below, as well as in Chapters 1, 3 and 5.

7.3.1 The aim of the study

The study proposes a solution through a Unified Architecture Framework (UAF) (as presented in Figure 6.6, in Chapter 6). The UAF is a proposed solution to enable scalability and integration of mobile systems that can be used to ease access to and management of healthcare big data in the country.

Access to patients' big data has been difficult due to for many reasons, such as: (1) the stagnant nature of the ICT infrastructures that are used to enable and support the use of patients' big data, and (2) the sensitivity of the environment. It is difficult to integrate the existing ICT infrastructures with emerging technologies (mobile systems). This is a result of incompatibility and lack of flexibility. Moreover, based on the highly sensitive environment of healthcare, security is of utmost importance. However, the current ICT infrastructures fall short in providing highly-secured environments for accessing patients' big data. As a result, many of the activities at the healthcare facilities are manually executed.

These factors, stagnant ICT infrastructure and sensitivity, made it difficult for both healthcare practitioners and the specialists that provide support through ICT infrastructures. The implications are that some of the healthcare activities are slow and that many are manually executed. These implications have an impact on the services that are provided to the patients, which sometimes leads to severity. For example, slow response to accessing patient' data can lead to a fatality that could have been prevented.

The UAF as a solution will guide the development of healthcare mobile systems that can be easily integrated with current environment. Additionally, the UAF will provide ease of use and usefulness in accessing and managing patients' big data through scalability and flexibility of systems and technologies. In addition, the UAF provides a guide in formulating policies and governance for the management of ICT infrastructures for healthcare purposes. The UAF, therefore, enables improvement in stakeholders' interaction through mobile systems, which, ultimately, increase efficiency and effectiveness within the healthcare section in Namibia.

Based on the aim, which is more of a high level, two objectives were formulated. The objectives were mainly to aid and operationalise the aim of the study. This and corresponding sub-questions were formulated respectively. The objectives and sub-questions are presented in Chapter 1 and 3.

7.3.2 Research objectives

As stated in previous Chapters, the two objectives of the study were to examine and understand: (1) the factors that influence how healthcare big data is accessed using mobile systems in the Namibian environment; and (2) the factors that can impact the interaction and integration between health mobile systems and healthcare big data in service delivery.

i. Factors that influence accessing healthcare big data using mobile systems

The study reveals factors that influence accessing big data by using mobile systems. The focus on accessing patients' big data is from both healthcare practitioners' and policy-makers' (i.e., the Ministry of Health) perspectives for the purposes of service delivery. The factors are illustrated in Figures 6.1 and 6.2, in Chapter 6. As depicted in the Figures, there are both technical (ICT artefacts) and non-technical (such as process, procedure, and people) factors.

The factors influence how stakeholders (such as government, health practitioners, and ICT specialists) collect, store, access, and manage patients' big data within health facilities in Namibia. Some of the factors include policy, collaboration, skill-set, and ICT infrastructure. The type of information that is gathered from patients and the approach used in the process

are guided by policy, as promulgated by the Ministry of Health. In many instances, healthcare practitioners rely on or draw from each other's knowledge and expertise in resolving or providing service health conditions. This is because, irrespective of the location or facility where the practitioners are situated, they exchange ideas and share information. However, the infrastructure to carry out such practices of collaboration was limited or non-existent in some areas.

To ensure that legitimate healthcare services are provided to the community members, the Ministry of Health was responsible for the development and implementation of policies and standards. The policies and standards governed the operations and management of healthcare facilities. However, not all employees in the organisation complied with the implemented policies. To some of the employees, policies were regarded as too complex to follow or not critical. Thus, non-compliance of policies created disparities in the use of mobile systems for healthcare big data management.

Communication tools are critically needed for big data accessibility and management. Two types of communication tools were used in the Namibian healthcare environment. These were the manual tools, such as printouts and booklets, and electronic tools, such as emails, telephones, desktop computers, and laptops. As revealed in the study, not all employees use electronic communication tools for healthcare services delivery. The non-use of electronic communication tools by some of the employees caused data management challenges; for example, it was difficult to trace and retrieve patient data that were manually managed.

The use of communication tools was influenced by individual skills and knowledge. Some employees revealed that they were technically challenged in using some of the implemented information systems. However, training programs were offered to improve employees' skills and knowledge for the implemented systems.

Collected data were stored in file cabinets and systems databases. To prevent unauthorised data access, security measures, such as locking cabinets and computer usernames and passwords, were enforced. However, not all employees understood the importance of patients' privacy and data confidentiality; as such, some of the employees shared their passwords with colleagues. Such behaviours were considered to be inappropriate and risky to the patients, as data could be sabotaged.

At the time of the study, data back-ups and recovery processes were not in place. This negatively impacted the recovery and retrieval of healthcare big data after systems failure.

This could be attributed by technology monopoly. Due to technology monopoly within the environment, the IT unit was dependent on external suppliers for their IS/T infrastructures support. Many of the IT technical employees revealed that the dependence on external suppliers often lead to healthcare services delays, as suppliers were not always available for support. Additionally, the dependency on external sources negatively affected the IT division capability to develop and implement mobile systems innovatively according to the organisation's healthcare needs.

At the time of this study, there were no interactive systems. Not having interactive systems impacted how health big data was retrieved and shared for the delivery of service to the community. As a result, access to healthcare big data was done by means of physical visits and presence at the healthcare facilities. This was a costly process due to the long distances patients have to travel.

Through online systems, patients are able to access healthcare services anytime from anywhere. However, online systems require integrated systems. As revealed by this study, systems within healthcare facilities across the country were not integrated. As a result, access to external facilities in order to track patients' medical histories were difficult. In some cases, where medical histories could not be traced, medical procedures were re-conducted.

Additionally, un-integrated systems impacted collaboration among healthcare practitioners. Effective collaborations require practitioners to have access to healthcare facilities inside and outside the country. Thus, the need for systems connectivity. Through collaborations, practitioners share medical expertise and information required to provide improved healthcare services. As revealed in this study, the list of legitimate healthcare facilities and their contact details were not available, making searching for and gaining access to healthcare services challenging for the patients.

ii. The factors that impact the interaction and integration in using mobile systems to access healthcare big data

Interaction and integration are both critical in healthcare service delivery. The factors that impact interaction and integration in the process of using mobile systems to access healthcare big data for service delivery are illustrated in Figure 6.5, in Chapter 6. As empirically revealed by the study, the stakeholders from both service providers' and recipients' perspectives rely on interaction for healthcare service delivery. Similarly, the integration of systems and

processes is essential to healthcare service delivery in the country. This includes the enablement and support of access to centralised or decentralised patients' database.

The integration between healthcare mobile systems and healthcare big data enable a seamless flow of information across the healthcare facilities units and thus improving ease of information accessibility. The integration between mobile systems and healthcare big data requires ICT solutions. The ICT solutions include the hardware, software, and network infrastructures and processes used to enable communication among the various healthcare stakeholders.

Some employees, especially from the IT specialists, have revealed that the organisation's ICT artefacts were outdated and could not be easily integrated. Having outdated ICT solutions hindered the IT unit in rendering comprehensive IT services to support the various healthcare services. As a result, most of the IT solutions were not in use and employees resorted to paper-based approaches to manage healthcare data.

The aim of the IT unit is to support healthcare process through the use of implemented systems. However, to improve the usefulness of mobile systems, the selection of ICT must be appropriate and specific to the needs of the facilities. Thus, the need for mobile systems flexibility and scalability to enable systems integration.

Some of the employees believed that the development and implementation of flexible mobile systems require ICT solutions management. The management of ICT solution was influenced by the employees' skills and knowledge. Users are comfortable managing resources they are knowledgeable about as they will perceive them to be useful. Employees' knowledge and skills were achieved through systems training.

Management of ICT depends on the governance structures in place. Governance enables the controlling and management of ICT resources according to the stakeholders' healthcare big data needs. It is difficult to integrate mobile systems without governance which is achieved through standards. Standards are important as they guide and promote processes uniformity as employees develop, implement, and use mobile systems for big data accessibility. Through standards, security policies are integrated into the development and integration of mobile systems. Employees revealed that mobile systems are only valuable as a communication tool if they can protect patient privacy. Some of the employees developed negative attitudes towards mobile systems as a communication tool due to the data security challenges it presents.

Interaction through mobile systems allows for better and improved collaboration on health matters, between patient-to-patient, patient-to-health professionals, and health professionals-to health professionals. Effective collaborations require databases interconnectivity. The integration of mobile systems with databases enables ease of patient's medical history traceability and access. It was revealed that not all patients' data were stored and managed through the organisational databases. Some of the data were stored and accessed through paper-based systems. Paper-based systems were viewed as not effective in managing the different types of healthcare data generated every day. Paper-based systems presented data quality challenges, such as data duplications and inconsistencies.

Databases infrastructures must be engineered to store and manage different types of healthcare data which includes, text, voice, images, and videos. The use of databases provides for systematic data entry, storage, and retrieval. This promotes consistencies in data management. Database systems should integrate back-up structures to enable healthcare data recovery during systems maintenance and failure.

7.4 Contributions of the research

The study went through comprehensive academic rigour, in which two socio-technical theories were employed to guide the data analysis. At the end, a Unified Architecture Framework (UAF) was developed. The UAF is proposed as a solution to improve the use of mobile systems in gathering, storing, accessing, and managing patients' big data in Namibian health facilities. This is primarily to improve efficiency and effectiveness of healthcare service delivery in the country. The contributions of the study are therefore in three-fold, namely, theoretical, methodological, and practical.

7.4.1. Theoretical contribution

There are two main theoretical contributions from the study: the UAF (Figure 6.6) and the addition to literature. The framework is presented in Chapter 6, Figure 6.6. The UAF is theoretical because it has not been tested. However, it is a huge contribution because no such framework existed either from ICT or health perspective, in Namibia. Moreover, the framework can be used in any other country, particularly developing countries, which may have similar challenges, to improve healthcare services delivery.

In literature, many studies have been conducted, but separately in the areas of healthcare data management, mobile systems as a communication tool, and architectural development. In this study, all three areas are combined. This makes the study a significant contribution to

the academic body of knowledge. The study, therefore, added to the existing literature in the areas of ICT architecture, health informatics, and mobile system for organisational enhancement.

The empirical study is therefore useful to academic, ICT, and healthcare domains, specifically to the Namibian environment. The study can, consequently, be referenced in discourses within the three domains, as well as from a developing country's perspective.

7.4.2. Methodological contribution

The use of two socio-technical theories, Structuration Theory (ST) and Technology Acceptance Model (TAM) to underpin this study, has been the primary methodological contribution of the study. It is highly methodological in the ways the two theories were used separately, and without contradiction or duplication in the study.

The way in which the two theories were employed brought a fresh perspective to the study, from the viewpoints of data analysis and interpretation of the results. To the best of the researcher's knowledge, from searching academic databases, such as .emerald, IEEE, ACM, Google Scholar and EBSCOhost, the two theories had not been previously combined in any study. Thus, the combination of the theories in this study makes a significant contribution to the field of information systems research. The use of these theories enabled the development of a solution (UAF) for the Namibian health sector, from an ICT perspective. This includes gaining a deeper understanding of the factors that impact mobile systems integration with healthcare big data to provide better healthcare services.

7.4.3. Practical contribution

In practice, the UAF can be used by the Namibian government (Ministry of Health), healthcare practitioners and ICT specialists. The Ministry of Health can be guided by the UAF in their policy development and implementation in the use of technology devices to gather, store and access patients' big data in the country. Similarly, both health practitioners and ICT specialists can employ the UAF to guide the selection, development, and implementation of Information Systems/Information Technologies solutions for healthcare purposes. This will help resolve the data management, technology monopolistic, and systems integration challenges in the Namibian healthcare environment.

Healthcare specialists and other stakeholders will benefit from the use of mobiles system as the medium through which big data is accessed. The use of mobile systems allows for instant data accessibility through systems connectivity. However, healthcare big data needs to be

protected to ensure patients privacy and data confidentiality. The UAF will promote the security and privacy of processes to ensure secure access to patients' data. Integrating security in the use of mobile systems creates a positive attitude towards mobiles systems as a communication tool.

7.5 Assessment of the study

The research was evaluated in line with the aim and objectives. The evaluation was guided by the criteria of Whetten (1989). Even though the set of criteria were established two decades ago, they are still highly relevant today, to studies such as this. The following assessment questions were based on Whetten (1989):

i. What new perspective has the research contributed?

The study has introduced the combined application of two theories, ST and TAM. The order of use was determined by the objectives. ST was used to identify technical and not technical agents, as well as the rules and resource used by these agents as they interact to reproduce in the healthcare environment. TAM was used to understand how these agents and existing structures impact the usefulness of mobile systems integration for healthcare big data accessibility and management.

The study has proposed new perspectives to healthcare stakeholders on how healthcare big data can be managed and securely accessed through the integration of mobile systems. The proposed framework can be used to guide the development and implementation of information communication and technology artefacts that are flexible and scalable according to the health facility's needs. The integration and connectivity of these artefacts will allow for ease of data accessibility enable effective collaboration among the different actors.

The UAF is intended to govern the implementation and maintenances of IS/IT solutions across the healthcare facilities. This is achieved through the development and enforcement of policies and standards that will guide both business and IS/IT activities. The architecture provides an overview of the healthcare processes and facilitates the selection and development of mobile technologies. Integrating mobile systems with healthcare big data require systems scalability and flexibility. Architecture promotes flexibility of IS/IT solutions which are critical for systems' interconnectivity. Systems are considered to be flexible if they can be re-engineered to accommodate business processes changes.

ii. What is the prospect that the study will change in current healthcare services which are provided and received, from the perspective of mobile systems?

The implementation of interconnected mobile systems will assist in reducing the costs of physical visits to the hospital by the patients to obtain medical histories and other general healthcare queries. Due to the cabinet filling systems, patients' files are often misplaced and hard to trace. Consequently, some of the medical procedures have to be re-conducted causing delay in patients' treatment. The interconnection between mobile systems and databases will reduce data discrepancies and patient's files getting lost. Patients will be able to securely access their data from any location. Additionally, this will enable healthcare practitioners to securely access other facilities source of information and share knowledge about patient's conditions. Thus, the use of mobile systems permits faster access to healthcare big data for effective and improved decision making.

Healthcare mobile systems need to be integrated with databases. This promotes ease of accessibility and sharing of healthcare data among stakeholders. An architecture will guide the design and development of database technologies that support healthcare facilities current and future data needs. Moreover, data security mechanisms are engineered into the database systems promoting data privacy through the secure access of healthcare data.

iii. How well is the study carried out?

The study was logically carried out through seven Chapters. In Chapter 1, the holistic overview is given. The research aim, objective, and questions are both presented and discussed in Chapter 1. Chapter 2 presents a review of the literature. The literature was guided by the study aim and objectives. The methodology, which represents the vehicle undertaken to achieve the study aims and objectives, is discussed in Chapter 3. Data was collected from two cases. In Chapter 4, the two cases' background, relationships, and IT division structures are documented. Analysis of the data collected from the two cases is presented in Chapter 5. Duality of structure was used as a lens to guide data analysis. In Chapter 6, the interpretation and discussion of the findings are presented. To gain a deeper understanding of the findings, TAM was employed in the interpretation. Based on the findings' interpretation, a Unified Architecture Framework was developed. Finally, the conclusion and recommendations of the research are given in Chapter 7.

iv.Why is the subject of significance to both practitioners and academia?

Healthcare services are critically important for the wellbeing of the individuals and the government of Namibia at large. However, service quality and decision making across the healthcare facilities are impacted by the accessibility and management of healthcare big data.

Thus, this study was carried out with the purpose of examining factors influencing the accessibility of healthcare big data and to provide solutions that could be implemented to enable improved healthcare services delivery.

As healthcare data keeps growing every day, there is a need for the implementation and management of Information Systems/Information Technologies (IS/IT) such as mobile systems to facilitate fast and secure access and storage of patients' data. Due to the complexity of the healthcare processes and activities, an architecture is required to guide the integration of the different components and ensure processes flexibility. The findings from the study will guide practitioners on how mobile systems can be integrated with healthcare big data. By employing socio-technical theories, it will be beneficial to the academics to critically seek a deeper understanding of the influencing factors.

7.6 Recommendations

The study's aim and objectives were achieved through data analysis and interpretation of the findings. From the data analysis and interpretation, two main gaps in current healthcare practices were identified. Recommendations for these gaps are presented below.

7.6.1 External facilities accessibility

As revealed in this study, healthcare services require collaborations among healthcare practitioners. Through collaboration, healthcare practitioners share information and work together to provide improved healthcare services.

Due to the shortage of medical specialists in the country, practitioners and patients often seek medical assistance from healthcare facilities outside the country. The study has revealed that there were no databases containing records of genuine healthcare facilities and their practitioner's contact details. As a result, patients were entrusted with the role of searching and contacting external facilities. In carrying out this, patients relied on public member's referrals and internet searches.

Searching through the internet for external healthcare facilities is not always recommended as this could lead to seeking services from illegitimate facilities. Such unrecognised facilities could endanger patients' lives. Thus, the need to have a list of legitimate external healthcare facilities, their practitioners and specialisations registered in databases to ensure reliable facility sources.

Access to external facilities can be achieved through integrated databases. However, the reliability of the information shared will depend on the security measures integrated into databases systems to enable secure access to the data. Considering that information is being shared from the databases of facilities outside the Namibian borders and in different healthcare environments, there is a need for governance to eradicate fraudulent information and protect patient's privacy.

Having access to external facilities makes patients' referral process easy. Practitioners will be able to share patient's medical history. Sharing of patients' medical histories is critical for the analysis and understanding of patients' prior treatments and conditions in order to provide improved healthcare services. By not having access to external facilities, practitioners are constrained to the local resources which are not always sufficient depending on the situation at hand.

7.6.2 Using interactive systems

The lack of online systems requires patients to always physically visit public healthcare facilities for all their healthcare services. Physical visits to hospitals are costly and inefficient as patients travel long distances. The study revealed that in some cases patients are sent back and forth when their medical results are not ready or cannot be found.

Having an interactive system would be cost effective as there will be no need for patients to always travel to healthcare facilities. Some of the healthcare services, such as appointments and general queries if offered through interactive systems, can reduce long queues currently found at the hospitals. By using interactive systems, patients will be able to access such services from any location, enabling faster access to information.

Interactive systems require flexibility to enable integration with other systems. Integration with other systems is important for seamless connection and data synchronisation. Interactive systems also need to be flexible in terms of local languages. This will enable patients to interact with the systems in their local languages. This is important considering that not all patients speak or understand English the official language. Having interactive systems that support local languages enables patients to articulate their healthcare concerns with ease.

Users can interact with interactive systems through text, voice and graphics. This enables patients to have access different types of healthcare data with ease. When interacting through interactive systems, processes are documented. Documentation of process is important for references and transparency.

7.7 Benefits of the study

Benefits of the study are twofold. The study contributes to the body of knowledge and to the domains of healthcare and ICT. Both benefits are discussed below.

7.7.1 Body of knowledge

This study will contribute to the body of knowledge by adding to the existing literature. In literature, much has been researched and written on big data. However, research on big data in the area of healthcare, especially in developing countries, have been lagging. This study will contribute to academia by filling this gap through the its findings. Moreover, the study brings forth a new perspective from the application of two different theories, Structuration Theory and Technology Acceptance Model. The complimentary use of theories is always a challenge especially their order of use. In this study, the complementary use of these two theories will help scholars in understanding where one theory ends and where the other begins to fill the gaps that the first theory created.

7.7.2 Healthcare and ICT domains

From the practitioners' view, this study, through its findings, will enlighten both medical practitioners and IT managers on the criticality of developing and implementing an architecture for data management. Importantly, this study will contribute to enterprise architecting as there are only a few studies related to architecture in the healthcare domain. The findings will also enable policy developers and decision makers to understand how mobile systems can be integrated and used as a tool for data management in healthcare. Moreover, management will benefit from the study's findings in terms of the factors that contribute to, or impact, system adoption and resistance. Based on that, management will be in a better position to assess both technical and non-technical factors before implementing information systems and supporting technologies.

7.8 Limitation of the research

Three limitations are identified from this study:

i. The study used only one public hospital situated in the city as a case. It would be insightful to study more hospital cases, including facilities from the private sector, to assess their use of mobile systems for accessing and managing healthcare data.

ii. The security features of mobile systems for healthcare big data accessibility and management were not tested. There is a need to test mobile systems' security features

to prevent unauthorised entry and ensure data privacy. Healthcare services are very sensitive matters and people would consider mobile systems as a useful communication tool if it can guarantee data safety.

iii. The developed framework has not yet been implemented and tested. The framework needs to be tested by various healthcare stakeholders and assess its usefulness in addressing data management challenges at hand.

7.9 Further research

This study has developed a Unified Architecture Framework to guide the selection and development of scalable and flexible mobile systems, and secure access to healthcare big data. Based on this framework, ICT practitioners can develop ICT solutions and governance structures for the healthcare environment. To further this research, researchers can use other social-technical theories, such as Actor-Network Theory (ANT), to study the network of actors that access and manage healthcare data., as it was revealed that employees who belong to the same group share similar attitudes towards using mobile systems as a communication tool. Thus, ANT can be applied to study the interests of the actors in using mobile systems for accessing and managing healthcare data. Moreover, further research can be carried out using other frameworks of Structuration Theory, such as the dimension of social change, to explore the impacts of change brought by integrating mobile systems in healthcare processes and activities.

7.10 Conclusion

This Chapter presented the recommendations and conclusions of the research. The recommendation is given based on the findings from data analysis and the interpretation of the results. Healthcare big data accessibility is a challenge among the various healthcare stakeholders in Namibia's public hospitals; as a result, this has contributed to the inefficiency of the healthcare services being provided. The designed framework will guide the development and implementation of integrated mobile systems that will enable ease of healthcare big data accessibility. In addition, the Chapter presented the study's contribution and benefits to the ICT practitioners, healthcare, and academia. Areas of further research, to fill the study gaps, were mentioned as well.

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APPENDICES

Appendix A: Data Collection questions

Main Question

How can a unified architecture framework which can be used to guide and enable the integration between mobile system and healthcare big data for improved healthcare delivery be developed?

Sub-Questions

i. What are the factors that influence the use of mobile systems in accessing healthcare big data for service delivery in the Namibian environment?

ii. What are the factors that can be used to guide and enable integration between health mobile systems and healthcare big data for improved healthcare service delivery?

Interview with the community members

1. Do you ever need anything from the hospital such as medication or treatments?
2. What about when you need something which is not medication? For what other reasons/services do you go to the hospitals?
3. How do you go about getting it?
4. Why do you need such things from the hospital?
5. Why do you think the hospital will give you such things?
6. Do you know anybody there? To receive such services do you go there or you call them?
   Why do you go there?
   Why do you call them?
   What challenges do you encounter?
7. Give me an example of the email you sent them?
8. What response did you get?
   Why do you think you got that response?
   How do you feel about that response?

Interview with the Healthbridge public hospital participates (nurses, pharmacists, data clerks, billing officers)

1. You have patients coming here for medication and treatment?
   How do they request for such medication? (5 -you will obtain two things –attitude +medium)
2. Do they walk in or through phones/ emails?
   Give me an example of how patients call in or email?
   How do you respond to that?
   How do you feel about it?
3. What are some of the things you work with (such as information, data) that help you to offer service to patients?
4. Do you have any computer system that you use?
5. What do you use the computer system for?
6. Have you ever have challenges with the IT system?

No> how so?
Yes > what kind of challenges have you encountered?

7. Briefly share examples of the challenges you encountered?
8. How are these challenges resolved?

Interview with MoH participants (IT technicians, database administrators, systems administrators, systems analysts, programs managers)

1. What are the computer systems that you use for hospital activities?
2. Please tell me more about these computer systems?
3. Who are the people that use this system?
4. What are some of the challenges you have at recent time regarding this computer systems?
5. Give me two examples of the challenges you encounter?(probe all examples)
   What do you think is the cause of this challenges?
   How was the challenge addressed?
   How did that challenge affect the users?
6. Do you know any system that you don't have that can be used to improve services that you provide –it can be in terms of users, nurse or doctors?
   List of systems (……..)
7. If yes: how can ***mentioned systems*** help to improve things or works doctors/ nurses do?
8. Have you ever thought of mobile systems /application? (To be asked if mobile systems is not listed by the participant before)

   Anytime they talk of process and systems. Ask about:

9. How about the security and privacy of this systems?
10. How do you protect information of the patient because many people have access to it?
11. How many databases do you have?
    Answer> 1, 2, 3> why?
    If 1> Do you mean you use 1 database for all hospital activities?
    If 2, 3, 4 databases> are these databases linked to each other?

12. Yes> why
13. No> Why are they not linked? Any particular reason?
14. Can any body such as the patient get information from databases?
15. Yes: how do they do that?
16. Why do you allow them to do that?
17. No: why not, the information belong to them??

Appendix B: Participants Consents

Consent for participation in a research interview

[Name of thesis] A unified Architecture for Healthcare Mobile Systems to Improve Big Data usefulness in a government environment

[Name of researcher]: Irja N. Shaanika

[Name of supervisor]: Prof Tiko. Iyamu

I agree to participate in a research project supervised by Prof. [Tiko Iyamu] from the Cape Peninsula University of Technology in Cape Town, South Africa. The purpose of this document is to specify the terms of my participation in the study through being interviewed.

1. The interview will be recorded and a transcript will be produced
2. The transcript of the interview will be analysed by (name of the researcher) as research investigator
3. Access to the interview transcript will be limited to the researcher and the researcher supervisor
4. Any summary interview content, or direct quotations from the interview, that are made available through academic publication or other academic outlets will be anonymized so that you cannot be identified, and care will be taken to ensure that other information in the interview that could identify yourself is not revealed
5. The actual recording will be destroyed after thesis compilation

_____ _____

Participant's Signature Date

_____ _____

Researcher's Signature Date

For further information, please contact: Prof. Iyamu [iyamut@cput.ac.za]