A BIG DATA ANALYTICS FRAMEWORK TO IMPROVE HEALTHCARE SERVICE DELIVERY IN SOUTH AFRICA

by

Sibulela Mgudlwa

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Supervisor: Prof T. Iyamu

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DECLARATION

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I, Sibulela Mgudlwa, declare that the contents of this dissertation/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.

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ABSTRACT

Healthcare facilities in South Africa accumulate big data, daily. However, this data is not being utilised to its full potential. The healthcare sector still uses traditional methods to store, process, and analyse data. Currently, there are no big data analytics tools being used in the South African healthcare environment.

This study was conducted to establish what factors hinder the effective use of big data in the South African healthcare environment. To fulfil the objectives of this research, qualitative methods were followed. Using the case study method, two healthcare organisations were selected as cases. This enabled the researcher to find similarities between the cases which drove them towards generalisation. The data collected in this study was analysed using the Actor-Network Theory (ANT). Through the application of ANT, the researcher was able to uncover the influencing factors behind big data analytics in the healthcare environment. ANT was essential to the study as it brought out the different interactions that take place between human and non-human actors, resulting in big data. From the analysis, findings were drawn and interpreted. The interpretation of findings led to the developed framework in Figure 5.5. This framework was developed to guide the healthcare sector of South Africa towards the selection of appropriate big data analytics tools.

The contribution of this study is in twofold; namely, theoretically and practically. Theoretically, the developed framework will act as a useful guide towards the selection of big data analytics tools. Practically, this guide can be used by South African healthcare practitioners to gain better understanding of big data analytics and how they can be used to improve healthcare service delivery.

Keywords: Information and Communications Technology,Healthcare, Big Data, Big Data Analytics, Actor-Network Theory.

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DEDICATION

I dedicate this to my son, Sokhana Safika Mgudlwa, whom I love dearly. May I be your guide through every milestone in life.

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ACRONYMS

ANT   Actor-Network Theory

CPUT   Cape Peninsula University of Technology

DHIS   District Health Information System

DoH   Department of Health

ETR.NET Electronic TB Register

ICT   Information and Communication Technology

IS   Information Systems

IT   Information Technology

WHO   World Health Organization

GLOSSARY

Term	Definition
Big Data	Large amounts of data that are generated daily and are ultimately presenting problems such the inability to be transferred and processed by traditional systems (Yang, 2017).
Big Data Analytics	These are computerised algorithms designed to process whole and extensive datasets (Passing et al., 2017).
ICT	This refers to all digital technologies which enable capturing, storing, processing, etc. (Gagnon et al., 2012).
ANT	Actor-Network Theory (ANT) is a theory which aims to analyses processes a within a network while instilling the notion of equality amongst all actors with that network whether human or non-human (Creswell et al., 2010; Greengalgh & Stones, 2010).

CHAPTER ONE
INTRODUCTION

1.1 Introduction

Big data has made its impact amongst various sectors; however, it has been more prevalent in business where its existence extends beyond just business (Lohr, 2012). Information and Communication Technology (ICT) has been in existence for many years; however, their adoption in the South African healthcare sector seems to encounter challenges, especially in the rural areas, as indicated by Ruxwana, Herselman and Conradie (2010). This has resulted in limited knowledge regarding data analytics and has further affected patients and the quality of healthcare service delivery. It is of importance that the current systems put in place be evaluated and be improved in the long-term. The improvement should not only take place within large healthcare facilities, but also include those situated within smaller locations. This improvement is not limited to size and location but also applies the nature of healthcare facilities because it will include clinics as they also offer healthcare services. However, those services are not offered at the same rate as hospitals; nonetheless, healthcare data is generated at clinics.

This is important to South African healthcare because the data that is generated at healthcare facilities is not used enough to reach its full potential. Through analytics, information could be gained, helping counter diseases and personalizing medication. Big data analytics enables the transformation of healthcare by providing insight to healthcare facilities, which helps with decision making (Ojha & Mathur, 2016). This will ultimately drive their focus on providing services based on accurate data. However, it seems that the current measures put in place are not up to par, bringing about the need to develop improved systems for analytics. However, improvement can only take place when a thorough investigation is done into the current processes and systems.

Due to the essentiality of healthcare, delivery of quality service is crucial (Cresswell, Worth & Sheikh, 2010). However, there have been many cases of wrong diagnosis and prescribed medications by health facilities in many countries, including South Africa (Lewandowski et al., 2017). Thus, governments of many countries employ approaches, such as big data analytics and information systems and technologies (IS/IT), in order to improve the quality and accessibility of healthcare (Sacristán & Dilla, 2015). In Fico et al.'s (2016) assessment, the advancements of IS/IT enable and support systems, which enable and assist improving health activities, such as diagnosis, medications, and treatments, from big data perspectives. Big data

has the potential to improve the quality of healthcare delivery due to its characteristics, which include volume, variety, and velocity (Priyanka & Kulennavar, 2014). The IS/IT are used to enable healthcare big data through its solutions, and to create and store data sets at unprecedented volume, variety, and velocity (Ganjir, Sarkar & Kumar, 2016). However, the various sources of big data can also create limitations to its accessibility, quality, and use, and thereby, constrains activities towards improving patients' care (Nativi et al., 2015).

Big data that are for specific purpose and usefulness require harnessing its capabilities, from both technological and human standpoints. Thus, analytics tools are needed to analyse diverse big data types, at velocity and real-time (Priyanka & Kulennavar, 2014). However, big data analytics can be a disruptive phenomenon, from privacy and standardisation perspectives (Bello-Orgaz, Jung & Camacho, 2016). This is attributed to largeness and complexity of big data, which analytics tools have so far found difficult to address at socio-technical levels (Ularu et al., 2012).

One of the challenges of big data analytics is the magnitude of data sets and the difficulties that are associated with validation of long-term predictions for diagnoses and medication purposes (Kambatla et al., 2014). According to Esposito et al. (2015), users (practitioners) have to know the details of the activity in order to properly and accurately provide service using big data. On the technological front, the challenges include the integration and analysis of a variety of healthcare big data to address impending problems (Kankanhalli et al., 2016). Thus, scalability is a fundamental challenge for big data analytics, as well as ontological extraction and semantic inference to support innovative processes (Esposito et al., 2015) in the care for patients. The analytics tools also pose challenges to both scientists and IS/IT specialists in different ways (Nativi et al., 2015). From the academic front, big data analytics is found to be a disruptive innovation, which is reconfiguring how research is conducted, and has epistemological implications on data revolution (Kitchin, 2014). From both empirical and experimental perspective, it was revealed that big data presents technical challenges to analytics tools, due to its volume, variety, and velocity (Priyanka & Kulennavar, 2014).

Patients' big data, together with other materialistic artefacts (such as medical apparatus), form networks, a state of realism, which the ontological stance focuses on (Scotland, 2012). In the course of health activities, the networks become heterogeneous, which also increases the levels of security, making it more difficult for analytics tools to produce useful and purposeful data from analysis (Archenaa & Anita, 2015). Additionally, the realistic state is that the existence of healthcare big data is independent of patients and health professionals, including researchers (Scotland, 2012). Thus, this study aims to examine and understand how healthcare big data can be transformed to increase usefulness and purposefulness, in reality.

This is guided by the interpretive epistemology from the subjectivist perspective, which is based on phenomena of reality. Epistemology focuses on the nature and forms of knowledge that can be created and gained (Tsang, 2014).

The problem is that patients and some health practitioners do not know that their big data exist, and most importantly, what to expect from the data sets. This is due to the rawness and complexity of big data evolution, which, consequently means that many health practitioners do not know how to socio-technically analyse and get an understanding of why things happen in v the way that they do with patients' big data. Thus, the objective of this study is to develop a framework, which can be used to guide analysis that can translate and transform big data into a more useful and purposeful resource for health practitioners, and thereby improving services to the patients. In achieving the objective, an ontological stance, as the means, and epistemology, as the end, through the interpretive approach are employed. Thus, the focus is on the interaction between the actors, which include health facilities, health practitioners, patients and healthcare big data, to understand how they are related, in improving care and saving lives. From this perspective, Actor-Network Theory (ANT) become crucial in examining relationships in which actors participate and influence the shape of the heterogeneous networks (Dwiartama & Rosin, 2014). Characteristically, analytics tools focus on prediction, which ANT rejects about actors and their activities and interests (Wissink, 2013). Therefore, we have to let go of the assumptions and preconceived ideas, and interpretively focus on what is reality at the time. This can also be attributed to the fact that heterogeneous components of healthcare big data do not precede their interactions but rather emerge through related activities.

1.2 Background to the Research Problem

As in many developing countries, there are limited healthcare facilities in South Africa. What is even more challenging is the functionality of healthcare and how the care is carried in some areas and parts of the country. This includes improper coordination and management of patients' data. This has led to numerous incorrect diagnoses and treatments in recent years. As a result, patients continue to be incorrectly diagnosed, and some given incorrect medications. This has been happening for many years. For instance, in 2008, at the All-Saints hospital situated in Engcobo, in the Eastern Cape Province of South Africa, an elderly woman was incorrectly diagnosed and had to be transferred to two different hospitals in order to gain proper treatment in her frail state. Additionally, some of the facilities are challenged with analysis and management of their patients' data, towards providing better care. For example, in 2015 there was a case of an epileptic patient at one of the hospitals in East London, also in the Eastern Cape Province, who had been on the same medication from when he was a teenager until the age of 29. Gradually, the seizures worsened and eventually caused further

neurological damage. Had the administration of his medication and severity of his epileptic episodes adequately been monitored through analytics, it could have been prevented.

Both incidences that are mentioned above are representative of the many risks of fatality, which manifest from lack of regular analytics of patients' data. Healthcare facilities in South Africa are not equipped with the proper measures of analysing data. Thus, many healthcare facilities in the country require improved technological assistance, as this will not only improve the state of service delivery but also reduce the mortality rates in South Africa.

1.3 Statement of the Research Problem

Data that are used within healthcare facilities continue to grow, while the sources of the data also continue to increase. The increase in size and velocity, which includes voice, image, text, and video sources, constitutes big data in the environments. The high velocity and increasing size of the big data leads and contributes to healthcare facilities' challenges, such as inaccuracy and inconsistency of patients' data. As a result, many patients are affected one way or the other, which includes lack of continuity and follow-up to patients' recovery progress. The challenges lead to other more serious problems, such as incorrect diagnoses, medications, and treatments. These problems have, for many years, contributed to the high rate of fatalities in South Africa, particularly in the rural areas of the country. The problem of incorrect diagnosis is caused by lack of analysis (or analytics) of data or reliance on only one level of analysis (or analytics), which is not always accurate and consistent.

1.4 Research Questions

The research questions were formulated based on the research problem as articulated above. The research questions are divided into main and sub as follows:

Main research question:

How can the challenges of employing big data analytics to improve healthcare services be addressed?

The main aim is to improve the quality of healthcare data usage through accuracy and consistency in order to provide better care to patients.

The sub questions:

i. What are factors that influence data analytics of healthcare big data in the South African environment?

The aim of this question is to understand the current environment, towards providing solution for improved services.

ii. How can analytics be carried out on healthcare big data in the South African environment? The aim of this question is to eradicate or reduce incorrect diagnoses, treatments, and medications, and, in so doing, improve care to health patients.

1.5 Aim and Objectives of the Research

Based on the research problem and questions as stated above, the goal and objectives of the study were formulated as follows:

The aim of the study was to propose a solution which can be used to address the challenges of employing big data analytics for the improvement of healthcare services. Once these challenges are identified and addressed, quality of healthcare service delivery may improve.

The objectives were as follows:

i. To determine the factors that influence data analytics of healthcare big data in the South African healthcare environment. This was to understand the current environment, towards providing a solution for improved healthcare services in the country

ii. To examine how analytics can be carried out on healthcare big data in the South African healthcare environment. This is intended to eradicate or reduce incorrect diagnoses, treatments, and medications, and ultimately improve care of health patients in the country.

1.6 Important Concepts

This Section presents a brief overview of the most important concepts in this study, namely information and communication technology healthcare, big data, and big data analytics. This Section also covers the theory that underpins the study. This will be discussed in further detail in Chapter Two.

1.6.1 Information and Communication Technology

Information and communication technology (ICT) consist of all digital technologies that enable electronic capturing, processing, storing, and exchanging of information (Gagnon et al., 2012). ICT is used in different ways and approaches across all walks of life and professional disciplines, including healthcare. According to Krist and Woolf (2011), ICT enables ease of use and accessibility of healthcare information. The adoption of ICT within healthcare may be beneficial as it supports traditional nursing practices such as assessment, health promotion,

clinical interventions, and organized service (While & Dewsbury, 2011). Gawanmeh et al. (2015) similarly states that ICT-based technologies decrease the healthcare system overhead and increase the quality of healthcare services.

However, the adoption and use of ICT does not guarantee quality and accuracy of data for healthcare professional use, as challenges persist (Gagnon et al., 2017).Some of the challenges include know-how, users' interest ,and the purpose of use, as revealed in a study conducted by Richardson (2012). Furthermore, some of these challenges have in recent years caused damage to human lives and activities, as highlighted by Ruxwana et al. (2010) in a study about lack of ICT adoption within healthcare. It is worse within the healthcare environment in that the processes, activities, procedures, including use of data and other equipment, require a high level of sensitivity and the adoption of ICT may take away control over those (While & Dewsbury, 2011).

Some challenges, which manifest from inaccuracy of data, are attributed to analytics. In many healthcare facilities, there are little or no analytics of the data that they continue to access and use for patient care and needs (Basu et al., 2012). As a result, there are many fatalities in developing countries such as South Africa.

1.6.2 Healthcare

In a World Health Organization (WHO) report of 2016, South Africa was ranked 175 of 190, amongst the countries with lowest healthcare systems. This indicates that provision of care to health patients is slow and poor. It also means that it is difficult to make use of data under such systems. This could be caused by different factors, such as data processing and manipulations, making the environment stagnant. The impact of stagnancy on healthcare services could also be attributed to single level of analytical methods, which does not necessarily improve data purposefulness, strategic planning, or accuracy and integrity. These are some of the factors that can possibly cause fatalities within South African healthcare services due to misdiagnoses.

Medical practitioners are placed with the responsibility of storing large amounts of patient data such as medical histories, and treatments. Yet, these are not always effectively used. Thus, research and tools are needed to harness the full benefits of healthcare data (Chawla & Davis, 2013). Moore, Evestone and Coddington (2013) attest to this by stating the benefits of big data in healthcare, which include enabling diagnosis, forecasting, and health management of the population. The application of advanced analytics techniques means that such information could be extracted, and medication could be personalised while also gaining insight into genetic and environmental causes of diseases (Chandarana & Vijayalakshmi, 2014).

However, as has already been mentioned, there are some challenges to analysing health care data. Heterogeneity is one of these challenges in data analysis as stated by Jagadish et al. (2014). Labrinidis and Jagadish (2012) state that heterogeneity, scale, timeliness, complexity, and privacy problems hinder progress in the creation of value from data. In support, Kuo et al. (2014) states that healthcare big data is so large, complex, and distributed that it becomes very difficult to maintain properly and to store using traditional systems. Nevertheless, in spite of these challenges, on a disease- ridden continent such as Africa, advanced data analytics are needed to predict epidemics which may affect the continent. Analytics will be useful across the healthcare sector, assisting in the evaluation of cost drivers and the use of geocoding in order to detect epidemics and places which are most affected by diseases (Bates et al., 2014).

New big data methods have the potential to boost the impact of observation within healthcare (Krumholz, 2014). Information technology could be used as a tool to better the quality of healthcare and also assist with co-ordination within healthcare (Osborn et al., 2012). Chawla and Davis (2013) support this by stating that taking the next big steps in personalized healthcare will require computing and analytics framework to aggregate and integrate big data in order to gain deeper insight into patients' data connectedness, which is not only derived from medical records.

1.6.3 Big Data

The textbook definition of big data is data that exceed the typical storage, processing, and computing capacity of conventional databases (Najafabadi et al., 2015). In the context of healthcare services, big data comprises of patients' medical history, diagnoses, medications, among other sources. Furthermore, Feldman, Martin and Skotnes (2012) suggest that healthcare data includes personal medical records, radiology images, clinical trial data, Food and Drug administration (FDA) submissions, human genetics and population. Clearly, in terms of the sheer volume of information available, healthcare contains big data.

In addition to size, another description of big data is that it is also unstructured in nature, thus adding to its complexity. According to Gulamhussen et al. (2013), the healthcare sector produces thousands of unlinked data which is classed in multiple categories such as clinical data, claims, pharmaceuticals, medical products, research and development data, patient behaviour, and sentiment data. Therefore, the healthcare system consists of unstructured data, which further indicates that it consists of big data.

Big data plays an important role in organizations. When utilized correctly, it proves to be beneficial. With businesses, it brings in profit; in the case of healthcare organizations, it assists

in providing patterns which may determine causes, effects, and cures. However, current tools and technologies available are unable to store, process, and analyses massive amounts of data as stated by Chandarana & Vijayalakshmi (2014). Big data in healthcare continues to grow due to the digitization of existing data and the generation of new forms of data (Feldman et al., 2012). Statistically, healthcare data has grown rapidly over the years

According to Kampala, Collies, Kumar and Gram (2014), it is difficult to estimate the current size of healthcare data, which was estimated at about 150 Exabyte in 2011, increasing at a rate of between 1,2 and 2,4 a year. Big data has proven to be beneficial to the healthcare sector. Gulamhussen et al. (2013) highlight the similarity between health data and customer information as it has become an asset that is used for analytical purposes to gain insight for better healthcare, treatment and also commercial gain. Big data continues to grow, and the existing systems are not able to handle the amounts of data being generated. This brings about the question of how to develop and design high performance and appropriate platforms and algorithms which can analyse and extract useful information from big data, especially within the healthcare system (Tsai et al., 2015).

1.6.4 Big Data Analytics

Sun and Reddy (2013) describe data analytics as the process of examining large amounts of data from different sources and in different variations in order to gain insight that can enable decision making in real or near real-time. According to Kwon et al. (2014), big data analytics are the technologies and techniques which can be employed to analyse large scale and complex data to improve a firm's performance. However, the employment of data analytics cannot be limited to just business; other sectors have to be considered as well. Big data analytics can be further described as means of helping discover valuable decisions through understanding data patterns and their relationships using machine-learning algorithms (Archean & Mary-Anita, 2015).

The descriptions of data analytics are relevant to healthcare big data, as healthcare facilities generate big data daily, and the available systems are neither sufficient nor efficient enough for proper use of Big Data, resulting in it not realizing its full potential. Definitions of big data consist of the three V's, which are Volume, Velocity, and Variety. Belle et al. (2015) deem healthcare to be the prime example of how the three V's are an essential aspect of the data it produces. Big data analytics enable the capturing of insights from data gathered from research, clinical care settings, and operational settings to build evidence for improved care delivery as stated by Nambia (2013). This benefit may be a technical challenge, however, it affects the quality of service delivery, and institutions can evaluate their current systems and find places in which they can improve using big data analytics.

1.6.5 Underpinning Theory: Actor-Network Theory

Based on the objectives as stated above, Actor-Network Theory (ANT) was selected to underpin the study. This means that the theory was used as a lens to guide the study, during data analysis and interpretation of the findings. According to Arnaboldi and Spiller (2013:645) 'ANT is a socio-philosophical approach which attempts to comprehend complex social situations by paying attention to relational elements-referred to as 'associations'. The main tenets of ANT include actor, network, and moments of translation. In ANT, actors, which are both human and non-human, are treated as equal (Kim, 2014). Möl (2010) describes an actor as something or someone who acts; in their actions, they make a difference, and should they be eliminated from a setting, they are hard to replace. A network is formed through actors which are tied according to type which ultimately links those actors (Borgatti & Halgin, 2011).

Translation within the context of ANT is a description of the process that occurs when actors (human and non-human) form connections and ultimately create links (Fenwick & Edwards, 2011). Horowitz's (2011) definition of 'translation' states that it is the association of heterogeneous entities to form a network through the assignment of identities and roles to each entity. Davies (2002) defines "translation' as sociology which forms the core elements of ANT that have been broken down into four moments, which are problematization, interessement, enrolment, and mobilization (see Figure 1.1).
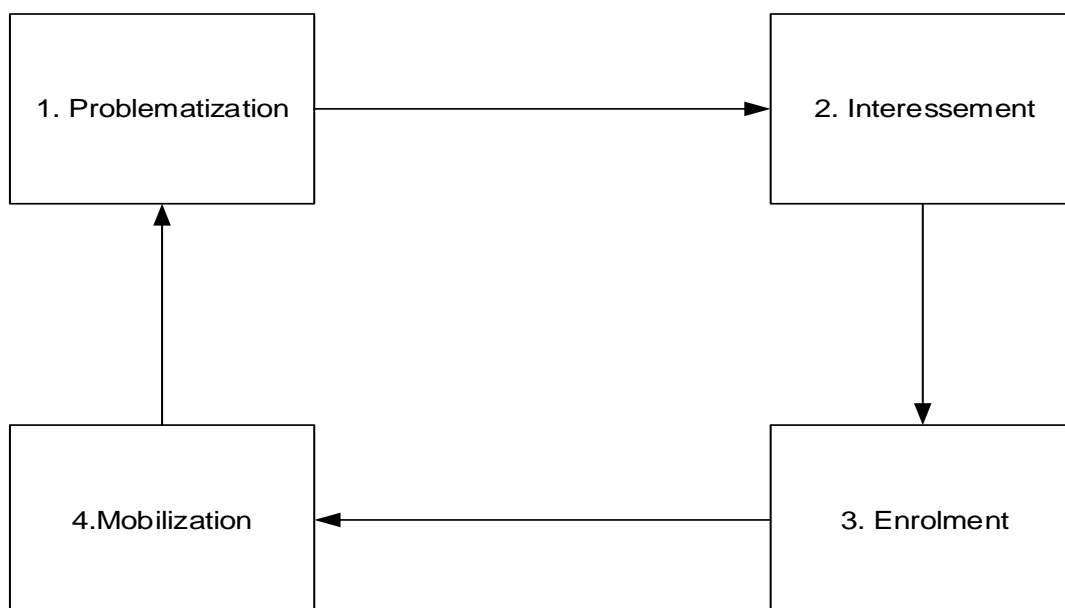
Figure 1.1: Four Moments of Translation

(Adapted from Callon,1986)

These moments of translation provide a background or foundation on which the ideas of ANT are based (Elbanna, 2012). The first moment of translation is problematization. Atkinson (2002) states that this moment occurs when powerful actors identify real world issues. To simplify this description, Kim (2014) states that problematization is defining the nature of the problem or the problem which the researcher seeks to explore. The second moment of translation is interessement. According to Zukas (2014), interessement involves the conveyance of actors to the network or a strategy that aims to stabilize the actors which were defined in problematization. The third moment of ANT is enrolment. Enrolment is the moment when actors are defined, and the translator communicates the intentions of all the actors involved (Pinto et al., 2011). The final moment of ANT is mobilization; this stage, according to Macome (2008), ensures the legitimacy of the spokesperson and then makes sure that the actors are represented well enough to secure the loyalty to the initiators. The process of translation is considered to be a complex one and involves various actors whose actions contribute to the instability of networks (Pinto et al., 2011)

The purpose of a theory is to help dissect and interpret disorganised data, it also helps in simplifying what is complicated in the social world (Pettigrew and McKechnie, 2001). ANT is described as a method that uncovers the initiation of networks and ensures their solidity and growth, while also monitoring where they fail due to reliance on third parties (Bleakley, 2012). ANT assumes that actors within a network are the cause behind social effects (Creswell et al. 2013). In support of this, Bajde (2013) describes ANT as a theory which treats all that is within social and natural settings as continuous effects of their interrelations within which they reside.

1.6.5.1 Actor-Network Theory in Information Systems Studies

In the last three decades, ANT has been used in information systems and technologies studies, from various perspectives. Some of the studies where ANT has been used include:

- Robert et al. (2010), who employed ANT to explore the knowledge about organization processes and whether new technologies have been adopted and practiced within healthcare;
- Bleakley (2012) who also used ANT to examine how it can be employed in medical education; and
- De Zoysa and Letch (2013), who used ANT in a study to build a framework of analysis which explored the sustainability of ICT for the development of (ICT4D) projects.

Furthermore, Andrade and Urquhart (2010) highlight that ANT characteristics are fully acceptable for socio- technical research, as the barrier between social and technical is seen as a negotiation process which can help researchers alleviate the rigidity between agency and structure. Additionally, Creswell et al. (2010) describe ANT as a theory which focuses on non-human entities having an effect in processes, granting them agency. Greenhalgh and Stones (2010) also state that ANT can serve as a useful lens into investigating unplanned events that might occur in technology related projects. In conclusion, ANT can be utilised to research information technology problems across various areas of interest and contexts (Teles & Joia, 2011).

1.7 Research Design and Methodology

Based on the objectives stated for this study (see Section 1.5 of this Chapter), a research design and methodology were chosen to carry out the research. This includes: a philosophy, research strategy, research design in the form of a case study, data collection, and analysis. These will be discussed in further detail in chapter three.

1.7.1 Philosophical Assumption

There are many philosophical assumptions within research (Ritchie, 2013). In relation to this study, two of the most common philosophies according to Khosrowshahi and Arayici (2012) are discussed. This includes Epistemology and Ontology.

1.7.1.1 Epistemology

According to Krauss and Putra (2005), epistemology is the philosophy of knowledge or how we come to know, and this philosophy is closely related to ontology. Saunders et al. (2009) further emphasises this statement by defining epistemology as a philosophy that constitutes acceptable knowledge within a field of study. Mustafa (2011) supports this statement by stating that epistemology is concerned with the base of knowledge, its nature and form, how it can be acquired, and how it is communicated to others.

1.7.1.2 Ontology

Ontology allows the researcher to reveal how their view on human nature affects the approach which they knowingly take to reveal reality (Bracken, 2010). According to Converse (2012), the philosophy of Ontology is more concerned with what is, and it questions what makes something different from other things. Coghlan and Brydon-Miller (2014) support this by stating that ontology covers the meaning of what exists or can be used to establish the exact stance of what lies underneath the nature of reality. In conclusion, ontology begs the question of what reality is (Byrne, 2016a).

1.7.1.3 Relationship between Ontology and Epistemology

There is a distinction between Epistemology and Ontology; however, they cannot be separated. Epistemology is somewhat dependent on Ontology as new knowledge cannot exist without it being founded on new aspects of a physical, technical, or social nature (Akehurst et al., 2011).

Even though they are close related, Ontology and Epistemology are often pitted against Ontology generates theories about what can be known, which is epistemology, how knowledge can be created and what steps can be taken to produce that knowledge, as stated by Raadschelders (2011). Mills et al. (2010) highlights how ontology questions the things that are often taken for granted, both the seen and unseen. Schraw (2013) emphasizes on the fact that epistemology and ontology are related because philosophies on how we come to know reality involve epistemological assumptions.

Based on the objectives stated in Section 1.5 above, this study followed the epistemology philosophical assumption. Research methods, such as qualitative or quantitative, can be associated with Epistemology, in terms of the type of data that is to be collected, for generating epistemological knowledge.

1.7.2 Research Strategy

A strategy is required to fulfil the objectives of the research. The strategy includes research methods. There are two main types of research methods, namely qualitative and quantitative (Mujis, 2011).

1.7.2.1 Qualitative methods

Most qualitative studies aim to provide a richer context of human experience through studying specific cases (Polit & Beck, 2010). In support of this, Belk (2013) states that qualitative studies provide more of a visual and verbal interpretation of data rather than statistical/numeric data. In summary, qualitative research method is seen and referred to as a way of studying things within one's natural settings and further interpreting them in a way that people understand (Guest et al., 2017).

1.7.2.2 Quantitative methods

Quantitative methods, on the other hand, possess four qualities, and that is to be objective, replicable, and general in findings, but also take an interest in prediction (Harwell, 2011). These methods are described as a scientific approach to social research (Richard, 2013). Quantitative

methods are deemed to be the more dominant of the two methods (Colghan & Brydon-Miller, 2014).

Based on the objectives of this research, a qualitative method was followed in other stages of the methodology, which include areas such as research design, data collection and analysis. This served the purpose of inquiring into the systems which are currently in place. The research design includes a case study, in the form of healthcare facilities, and includes facilities both large and small in size which provide healthcare service (see Section 1.7.2.3 below). Using interviews, the researcher is given the opportunity to probe into how the data analytics systems are operating and where they can be improved (see Section 1.7.2.4). Using the lens of ANT, the data extracted from interview was analysed, the theory helped to dissect the networks which are at play and to identify their shortcomings (See Section 1.7.2.5).

1.7.2.3 Research Design: Case Study
The research design that is selected for this study is the case study approach. The use of a case study helps in contributing to the knowledge of individual and organisational phenomena, amongst other things (Brown, 2008).

Crowe et al. (2011) defines a case study as a research approach that assists in gaining deeper understanding into complicated real-life issues. In support of this, Casey and Houghton (2010) highlight the fact that case studies allow researchers to focus on complex situations while also taking its context into account. A case study allows the research to conduct a deeper enquiry into entities through the examination of relevant issues and, ultimately, unveils the phenomena through the examination of the entity, within social and cultural contexts (Salkind, 2010).

For the purpose of this research, two healthcare facilities were selected as cases; one is large and situated in an urban area and one smaller and situated in a rural area. This is primarily to understand why things happens in the way that they do (Iyamu, 2015), from two different perspectives, covering all healthcare facilities in South Africa. Using two differing healthcare facilities enabled the researcher to determine similarities between the two settings and, ultimately, helped in making generalisations possible. The criteria used for the selection of these cases were based on their size, resources, and services offered. These three factors determined the amount of data they generate daily and helped provide deeper insight into the processes regarding big data and the way it is analysed and utilised.

1.7.2.4 Data Collection: Interview Technique

To meet the objectives of this research, qualitative methods of data collection were used. This is a data collection method of obtaining, recording, and quantifying or interpreting information from the real world (Clamp et al., 2004). In support of this, Polkinghorne (2005) states that data collection is conducted to provide evidence of the work that has been done. There are multiple data collection methods which can be used in qualitative research; this study made use of interviews (Petty et al., 2012).

Interviews are a data collection technique which enables a researcher to gather in-depth knowledge on particular contexts or seek to get answers to complex questions (Codó, 2008). Interviews are used in development research, as stated by Desai and Potter (2006), and for this particular reason, they were used as a data collection method for this study. According to Coghlan and Brydon-Miller (2014), there are different kinds of interviews, namely structured, semi-structured, and unstructured interviews (Mills et al., 2010). Structured interviews are defined as interviews where an interviewer has list of standard questions and the interviewee answers as naturally as possible while it is recorded (Byrne, 2016b). Semi-Structured interviews are conducted using a topic as a guide and the interviewer is at liberty to change the wording and the order of questions so as to set a free and flowing conversation (Dahlberg & McCain, 2010). Unstructured interviews are described as interviews where a topic is merely introduced to the interviewee and they determine the direction which it takes; this allows the interviewee to communicate their reality as they see it (Howell, 2013). In this study, Semi-Structured interviews were used as a method of data collection from the participants. The use of semi-structured interviews enabled the researcher to gain broader knowledge on the processes which take place regarding big data analytics within these facilities. That knowledge can only provide insight once data analysis was conducted.

Interviews were conducted with specific selected individuals and groups within these healthcare facilities, namely medical practitioners, IT specialists, administrative personnel, and patients for the interviews. The selection criteria included:

i. patients who have been undergoing treatment for at least three years at the same or different facilities; this helps in uncovering what has changed in terms of services within the chosen facilities;

ii. medical practitioners and administrative personnel that have been practicing for at least 5 years, as it is likely that the chosen participants have been part of changes (or lack of) helping provide a clear view on what lacks and what has been successful in terms of change; and

iii. IT specialists within the healthcare facility who have been there for the past three years, as these participants were able to provide a technical view on the processes and may also reveal what lacks in the technical processes and what limitations there are in regard of the systems.

Considering the sensitivity of the environment of healthcare, accessibility was a determining factor in selecting participants.

1.7.2.5 Data Analysis

Data analysis is an important part of research because of how it provides an important platform towards the gathering of data and combining those findings with bigger ideas (Hoonard & Hoonard, 2012). There are many ways to conduct data analysis; however, the way one proceeds to do so is dependent on your research design, that which is formed through the philosophy chosen (Smith & Davies, 2017).

The moments of translation from ANT were used as a lens in the analysis of the data in the following ways:

i. To examine how patients' incidents are transformed from problem to solution stages,
ii. To understand how the different networks of patients, diagnoses and medical personnel are formed, including the types of big data that are generated, and
iii. To understand the relationship and interaction that exist between the big data within the various networks.

During analysis, units of analysis were selected; these are single, undivided, entities, upon which analysis were directed (Chenail, 2012). These are the healthcare facilities, networks, and actors that were defined using ANT.

1.8 Delineation of the research

The research was conducted using healthcare facilities within Cape Town, Western Cape, South Africa and East London, Eastern Cape, South Africa. This was due to limitations such as the researcher being based in the Western Cape and their inability to reach other geographical locations.

1.9 Significance and Contributions of the Research

The significance of this research is in threefold, in that, it contributes from practical, methodological, and theoretical perspectives. From a practical perspective, this study may

assist medical practitioners and managers of healthcare facilities in managing and planning their activities towards improved services to the patients and communities at large. From a methodological perspective, the study provides a guide in the form of a framework, on how data analytics can be conducted on healthcare big data. From a theoretical perspective, the study adds to existing literature, particularly from big data analytics, healthcare and developing country perspectives.

1.10 Ethical Considerations

Due to the sensitivity of the field being researched in this study, ethical considerations were prioritized. This study adhered to the code of conduct which has been stipulated by the Cape Peninsula University of Technology. It also adhered to the policies which have been put in place by the case studies selected. Interviews were conducted on a voluntary basis where participants had the liberty to withdraw from the study and also be given the option of anonymity so as to ensure that the study is of no harm to them.

1.12 Conclusion

This chapter presented an introduction to this study. The chapter was divided into 12 Sections. These Sections include: the introduction, background to research problem, research aim & objectives, research questions, important concepts, research design & methodology, significance of the research, delineation, ethical consideration and the conclusion. These Sections present an overview of what is discussed within this study. Furthermore, it justifies the methods the selection and use of methods that lead to the results of the study. The following chapter provides a review of literature using the important concepts that are introduced in chapter 1.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter presents the review of literature that was conducted. The literature review was guided by the objectives of the study as stated in Chapter one, which include developing a two-level approach for big data analytics that aims, primarily, to improve the quality and accuracy of healthcare data to better patient care.

Thus, the areas of focus include information and communication technology, healthcare, big data, and big data analytics. Also covered in this chapter is the theory, actor-network theory (ANT), which was used to underpin the study.

2.2 Information and Communication Technology

Information and communication technology (ICT) is broadly defined as a platform which supports the processing, storing, transmission, and communication of data and information using tools such as the internet (Yu, Lin & Liao, 2017; Khan, 2016; Gagnon et al., 2012). In the context of healthcare, it is seen as a driver behind change in the environment and also a platform upon which it depends (Brand, 2012). ICT has the potential to impact largely on healthcare and can also improve the state of healthcare delivery in developing countries (Vavilis, Petković & Zanonne, 2012; Akter, D'Ambra & Ray, 2010). ICT is, in fact, a recommended solution for the improvement of access to healthcare and quality of services offered by the sector (Kapadia et al., 2015). Gastaldi and Corso (2012) highlight that in the capabilities of ICT, they offer healthcare the ability to fully utilise the assets which they currently possess, as well as the possibility of exploring new and improved ways of delivering value. Amongst those benefits, Kwiatowska (2016) states that ICT helps in providing better detection and also decreases the possibility of medical errors.

Furthermore, Yu, Lin and Liao (2017) describe ICT as an enabler and platform for technological activities, such as the transmission of data which makes it important to discuss prior to mentioning big data. Busagala and Kawono (2016) prove that within the context of healthcare, ICT is able to offer tools and technologies which ultimately improve its quality. However, it is important to highlight that it also has some challenges despite the benefits it possesses. The use of ICT and big data for healthcare improvement has encountered challenges regarding integration and the unavailability of sufficient infrastructure to maximise the benefits of big data (Mishra & Choudary, 2013; Abouzahra, 2011).

It is important to note that challenges are unique to different countries and systems too. Even though they might be unique to a certain system, there is a certain level of generalisation regarding challenges of big data within healthcare (Alaboudi et al., 2016). Some of these challenges include the size of the data generated within healthcare and the inability to link legacy data to new systems due to the different formats which they come in. Nevertheless, the existence of challenges should not hinder the progression of data analytics within healthcare. Wang, Kung and Byrd (2015) state that the exploration of big data analytics is mainly technological, whereas the area is in need of academic contribution. Theoretical contribution is just as important as the technological. In order to understand these networks, which result in the hard-to-solve intricacies of big data analytics, ANT is used as a tool to uncover the process which take place before networks are formed (Cuccininielo, 2015).

ICT and big data are closely linked states Takaishi et al. (2014) as the development of ICT has been the main contributor to the growth of big data over the years. Di Martino et al. (2014) concurs that the growth of data has escalated to a point where it is considered one of the main challenges in ICT research. From a technical perspective, therefore, big data is dependent on ICT infrastructure to support its applications (Al Nuaimi et al., 2015).

2.3 Healthcare

Healthcare is the provision of health services using methods which are scientific, social, and technological and making these services accessible to all (Bhengu, 2016). Although healthcare is a basic need in both rural and urban settings, there is a big divide in its provision (Yu et al., 2015). For instance, Zeng et al. (2015) have shown that sophisticated and reliable healthcare services are more likely to be provided to larger facilities, which are more likely to be situated in urban areas. Healthcare services in rural areas, on the other hand, may encounter challenges such as the size of the institutions and the limited resources within those institutions (Nelson, Barr & Castaldo, 2015; Andersen & Jansen, 2013). This division is especially noticeable in developing countries, such as Namibia and South Africa as they consist mostly of rural areas (Coleman & Iyawa, 2015). As a result, poor healthcare services are common in developing countries, which in turn, may lead to issues such as high mortality rates.

However, improvement is still possible using technology. Using ICT in a healthcare context, for instance, can lead to improved quality and co-ordination of healthcare (Busagala & Kawono, 2013; Bervovitz, 2013). This applies particularly to rural healthcare, as the application of ICT has allowed improvements in the capacity, quality, and performance of healthcare practitioners (Mridha et al., 2013). Due to the essentiality of health to human care, quality of its services is of utmost criticality and the delivery of quality is a goal for governments' worldwide (Dixon-

Woods et al., 2013). Thus, government in some developing countries such as India have employed ICT to help improve its quality and accessibility, and it seems to be addressing the issues that affect healthcare services (Kumar et al. 2014; Gambo &Soriyan, 2017). According to Fico et al. (2016), the advancements of ICT have enabled continuous development and improvement in systems which assist in giving diagnosis, providing treatment and overall health management. The improvement of healthcare relies heavily on the uncovering the hidden facts which lie within big data states (Ojha & Mathur, 2016).

Despite the numerous benefits that are gained from ICT artefacts, there are challenges, such as unavailability of technological infrastructures to support healthcare in rural areas (Mishra & Choudhary, 2013). Another challenge which has been highlighted by Fitzepatrick and Ellingsen (2013) is the complexity of implementing technology within healthcare settings which often lead to unintended consequences. Moreover, although there are many hospitals that employ ICT which are designed to improve the processes and activities of healthcare, the intended benefits have been achieved slowly in many areas, including which include workflow and record management (Anacleto & Fels, 2014). That being said, Almeida et al. (2014) are of the opinion that ICT undoubtedly holds the potential to change and improve healthcare service delivery.

With much highlighted benefits of ICT within healthcare, Lapão (2015) states that the current technologies still fail in fulfilling the needs of patients due to its low quality, lack of usability, and innovation. This could be attributed to different factors, such as lack of awareness and know-how. Even though there are so many potential benefits in using ICT for healthcare services, the improvement of quality and accessibility are still slow (Ud Din et al., 2017). This could be attributed to lack of awareness, either from the medical or ICT practitioners' perspective, or both perspectives, which according to Adeleke et al. (2015) is a problem that relates to the lack of access to information or the unreliability of the little that is available.

Wang, Kung and Byrd (2015) state that healthcare is not getting a return of investment on data analytics and this is attributed to factors such as lack of confidence in the system. According to Ud Din et al. (2017), the lack of awareness in the use of ICT for health-related services can also affect innovations and the overall use. Additionally, Charles and Yoshida (2016) argued that the operation of healthcare has become more complicated, due to the overwhelming data and information, which has then influenced ICT innovations that address issues within medicine and diagnoses.

Healthcare is considered to be a data intensive industry (Bhengu, 2016). Thus, it is purposely to enable health services. However, according to Monteith et al. (2015), it can also constrain

activities due to the various sources from which it is acquired, resulting to limitation in its accessibility, quality and use. The enablement is often based on ICT solutions, such as electronic health records, which create and store data at large quantity from variety of sources, also known as health big data (Kuo et al., 2014). ICT has been of great help in managing healthcare and its complexities states Hussain, Arriyachandra and Frolick (2016), healthcare practitioners have found success in the use of big data and analytics.

Sarkar (2017) states that healthcare data is sourced from different areas such as web and social media big data, machine to machine data, biometric and human generated data, which can be from either or both internal and external sources. The data sets (big data) that are generated has the potential to serve as enabler of insight for service delivery and the improvement of care (Sun & Reddy, 2013). However, Badawi et al. (2014) state that it has failed to serve as an enabler and this has restricted both, growth and improvement in quality of healthcare.

2.4 Healthcare Big Data

The definition of big data in the context of healthcare has been in debate according to Hansen et al. (2014). Based on Priyanka and Kulennavar's (2014) description, big data in healthcare is the result of digitization of healthcare data, which had already accumulated over the years but in paper form. However, generally speaking, the term Big Data is defined as a tool and technique which contains information of value but for that information to be uncovered, innovative integration has to be in place (Sathiyavathi, 2015). This definition leads to the description of healthcare big data. These are large and complex data sets, which cannot be handled with traditional systems and which consists of data such as patient information (Ganjir, Sakar & Kumar, 2016). Raghupathi and Raghupathi (2014) state that healthcare big data can easily be defined with 4 V's of big data (see Figure 2.1 below).
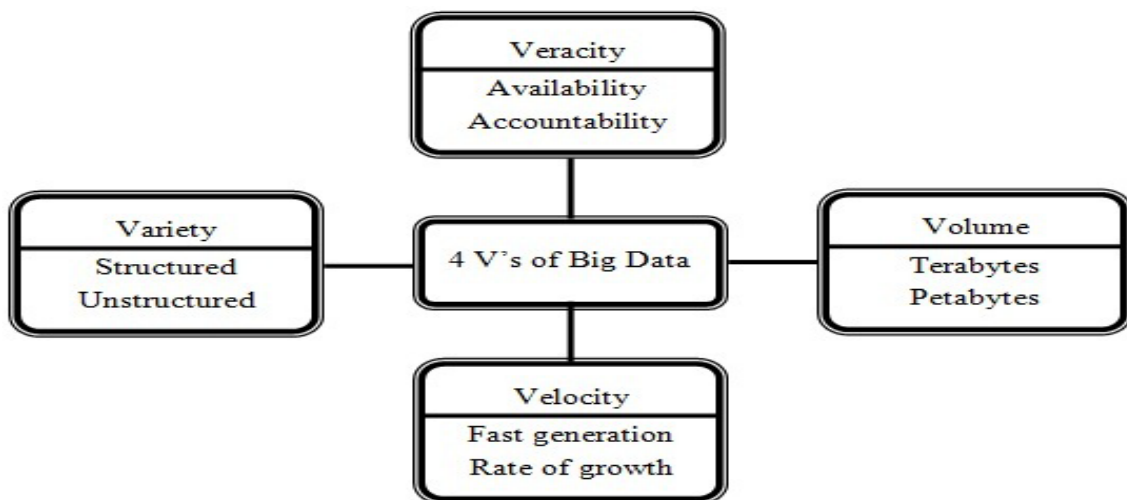
Figure 2.1: Characteristics of big data

(Adapted from Acharjya & Kauser, 2016)

Big data in healthcare has challenges, mostly related to its characteristics, which include volume, variety, velocity, and veracity (Acharjya & Kauser, 2016; Asri et al., 2015). Wang and Krishnan (2014) state that the size of data sets within healthcare affects important aspects, such as storing, processing, and analysing of data. Furthermore, Mancini (2014) states that these challenges then call for new approaches to big data. Peisker and Dalai (2015) believe that the integration and analysis of health data can actually address many persistent problems within the healthcare sector.

It is important to highlight the issues and challenges that persist when it comes to big data; for instance, Augustine (2014) points out that the biggest challenge seems to be that big data exists within a legacy system that makes it hard to relate to other data. Furthermore, Archenaa and Anita (2015) state that the challenge is no longer just a lack of information but rather lack of information which can lead to better decision making in healthcare. Additionally, Chen and Zhang (2014) purport that these challenges may result in big data becoming a gold mine that we cannot extract any value from because we lack the means to explore it. In support of this Kankanhalli et al. (2016) state that challenges in analysing data stem from the variety within healthcare, implying that the data is both structured and unstructured since it appears in various formats and from various sources.

Big data in healthcare also holds a lot of potential benefits and its ability to improve clinical decision making is one to highlight (Panahiazar et al., 2014). Other highlighted benefits in previous studies include early disease detection and overall management of health

(Giambrone et al., 2015; Ganjir et al., 2016). However, Sacristán and Dilla (2015) states the realisation of these benefits can only be fulfilled through the analysis of the existing data. Wyber et al. (2015) state that the analysis of big data can help in improving outcomes in healthcare. Additionally, Tresp et al. (2016) state that the use of technology could improve healthcare.

However, inaccuracies and lack of efficiency within data hinders its progression and the realisation of its benefits (Tresp et al., 2016).This inherently brings the need for analytics solutions which are more integrated and secure (Nepal, Ranjan & Choo, 2015). Most importantly, the analysis of this data has to be computed, as manual analysis might devalue the information sought (Shah, Rabhi & Ray, 2015). Hilbert (2015) regards the term big data as a shorter term for big data analytics as it goes as far as analysis which contributes to better decision making. The improvement of healthcare relies heavily on uncovering the hidden facts which lie within big data states Ojha and Mathur (2016); this can be done through the use of data analytics tools.

The healthcare sector has the potential to improve service delivery through their use of ICT. This would enable full utilisation of their existing assets and also find new ways of providing services (Gastaldi & Corso, 2012). On the subject of innovation, it is through ICT that health facilities are able to store and process data using solutions such as electronic healthcare records. However, these solutions lead to other challenges such as the accumulation of data at rapid speeds, resulting in big data. This brings about the need for solutions such as big data analytics.

2.5 Big Data Analytics

Big data is known to create value, states Watson (2014); however, that can only happen once it is analysed using data analysis tools or to data analytics. Elegendy and Elragal (2014) state that a simpler description of big data analytics is that it is the application of analytics techniques on big data.

These techniques can also be applied to healthcare big data. Bottles and Begoli (2014) state that studies have proven that the analysis of big data can help uncover patterns and relations in healthcare which are often new to health specialists. Earlier studies, such as that of Raghupathi and Raghupathi (2014), suggested that digitising big data through the act of integrating sources within a hospital network can help with accountability within an organisation and ultimately realise its benefits. In support of this, Eswari, Sampath and Levanya (2015) state that the analysis of big data not only helps in discovering patterns but also helps in predicting outcomes.

Karvitha, Kannan and Kotteswaran (2016) state that data analytics enables systematic review of existing medical information and informs sound decision making and ultimately improves the efficiency of service from health professionals and facilities. From the perspective of the patient, data analytics can assist in providing patients with more accurate information that can help in decision making through the analysis of their data (Sarkar, 2017). The patient also benefits from analytics in terms of care as they will receive more timely diagnosis, as well as the appropriate medication (Ganjir, Sakar & Kumar, 2016).

Big data analytics are used as a solution for their healthcare systems in many countries (Ryu & Song, 2015). The use of analytics has the potential of providing quality treatment, better surveying of public health, as well as improving responses to diseases which may affect patients (Mancini, 2014). However, with those benefits come challenges as well. In healthcare, lack of integration is listed as a challenge brought on by the different types and sources of data (Abouzahra, 2011). However, there is no standard type of challenges; each country has its own and therefore requires unique solutions according to Alaboudi et al. (2016).

In the context of healthcare, big data analytics can be used to solve the complexities which reside within their information systems (Hermon & Williams, 2014). However, big data and analytics are facing quite a few challenges according to Peek, Holmes and Sun (2014), stating that creating efficient and strong analytics methods that are essential in healthcare is a major challenge. The potential of these methods lies in the layering of analytics applications according to Priyanka and Kulennavar (2014). This would help address issues such as clinical decision support, personalised healthcare, public health, operations, and policies. There are existing systems designed to store, find, analyse, visualise, and secure data, namely, MapReduce, Hadoop, STORM, and others (Liu & Park, 2014). Even though the exisiting solutions seem to hold promise, healthcare big data still encouters challenges according to Rumsfeld, Joynt and Maddox (2016). These are presented in Figure 2.2 below.
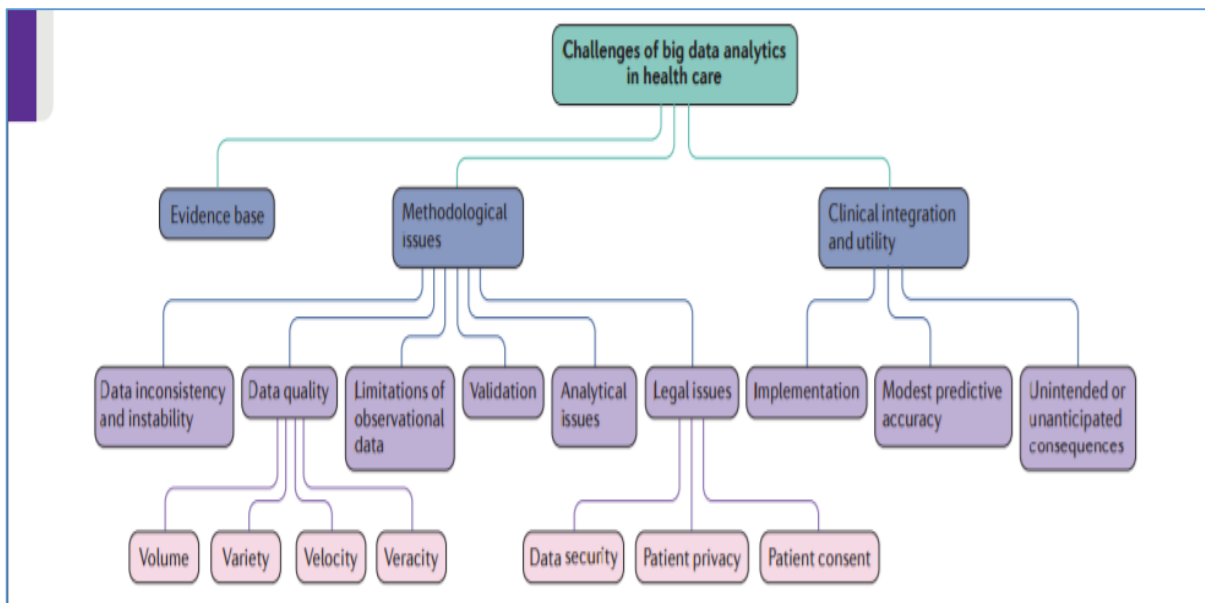
Figure 2.2: Big data challenges in cardiovascular care

(Adapted from Rumsfeld, Joynt & Maddox, 2016)

As figure 2.2 illustrates, and as supported by Kumar and Singh (2017), the challenges start from the choice of data analytics platform and the functionalities in terms of criterions, such as scalability. Another challenge which has been highlighted by Lee and Yoon (2017) is that of integration, in the sense that big data analytics be brought into practice by healthcare facilities. The traditional systems no longer suffice for big data as stated by Bare Bhakti & Kini (2017) and this has resulted in issues such as the inability to conduct decision making in real time which ultimately challenges predictive analytics.

These challenges in big data analytics limit the full potential of healthcare big data analytics as the only way to yield its value is through thorough analysis (Sarkar, 2017). Lee and Yoon (2017) state that the slow progress in the development of technology which supports big data is seen to be shocking as earlier predictions stated that the application of big data would be inevitable.

2.6 Actor Network Theory

Actor-network theory (ANT) is a sociotechnical theory that is embedded within science and technologies (Dankert, 2010). Thapa (2011) states that ANT originates from an author who believed that dividing nature and society was of no relevance while trying to understand human interaction. The core elements of ANT are the actor, network, and translation (Callon, 1986). Irrespective of the context, both actor and network cannot be independent of each other (Teles & Joia, 2010). According to Möl (2010), an actor has the capacity to make a difference. This means that an actor has the ability to act and also can alter another in its actions (Durepro & Mills, 2011). A network is defined by Borgatti and Halgin (2011) as a set of actors tied together

based on similar qualities, ultimately creating a link. Translation are discussed in detail in the next Section (2.6.1)

ANT is described as a theory which focuses on the interaction between humans and technology (Iyamu & Roode, 2012), whereas Silvis and Alexander (2014) perceive it to be both a theory and a methodology. In support, Bleakley (2012) states that ANT is a practice and method in the sense that it uncovers the forming of networks, their growth and possible success or failure.

Having been created in the 1980's, it has evolved over the years and is best known for its unconventional attribute of giving non-human actors agency (Passot & Rowland, 2010). Sayes (2014) states in the world of theory, ANT is considered to be controversial because of this attribute. However, Teles and Joia (2010) find this attribute to be a central element of ANT and further justify that by stating that from a perspective, society as a whole is made up of human and non-human networks

Within ANT, there is another factor, which is heterogeneity as stated by Leydesdorff (2010). In Mauthe and Webb's (2013) argument, ANT is not viewed as a theory but rather a method or an approach which views the world as a network of heterogeneous materials and humans are not considered as special in the network. Furthermore, Jessen and Jessen (2014) state that ANT is a method in the sense that it does not explain how or why network is formed but rather explains and describes the relations within the network. Moreover, Baiocchi, Graizbord and Rodríguez-Muñiz (2013) state that ANT is not merely about descriptions, it is about finding the basis of activities and also the assembling, disassembling, and reassembling within networks.

Despite the extensive use of ANT, it has also faced some criticism according to Alcadipani and Hassard (2010), relating to issues such as its low capability to analyse social structures, bias and morality issues, and a failure to thoroughly distinguish between human and non-human. Along the same line of criticism, Unnithan (2014) states that ANT fails to address some social structures and also its inability to explain how relationships are formed between actors during a time of change in the network.

Another problem which Sismondo (2010) highlighted about ANT in its distribution of agency, and how its analysis of key factors may result in neglect of other actors. Morover, Cresswel, Worth and Sheikh (2011) state that amongst ANT's criticisms is its lack of applicability both in theory and practically and how it is mostly effective when used with other theories. Tsohou et

al. (2015), placed ANT's lack of applicability on the fact that it has no guidelines and predetermined methods.

2.6.1 Moments of Translation

In ANT, translation is explained as a transitional process through events are carried within a network of actors (Callon, 1986). Cressman (2009) states that translation can be described as a process which aims to flatten out the differences between various aspects within technology. Translation allows for alignment between agents and institutions in order for them to meet the demands of a new idea states Haque & Mantonde (2013). According to Gad and Jensen (2010) translation is considered to be a key concept within ANT. ANT, entails four moments of translation, namely, problematisation, interessement, enrolment, and mobilisation (see figure 2.3) (Dery et al., 2013; Tanner & Chigona, 2010; Callon,1986). Each of these four moments will be discussed separately
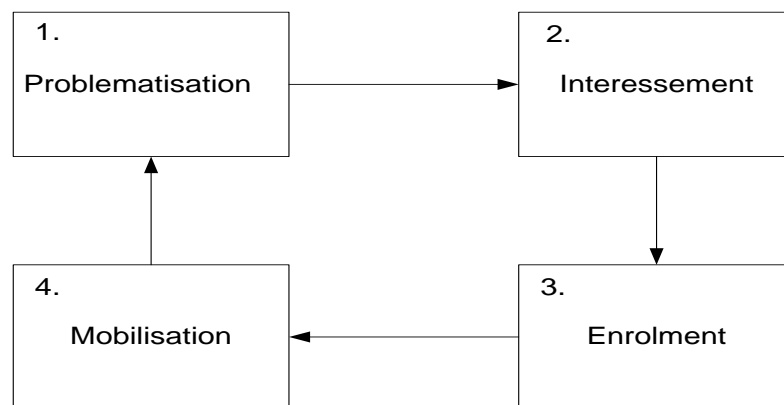
Figure 2.3: Four moments of translation

(Adapted from Callon, 1986)

- *Problematisation* refers to the forming of a problem and also the identification of roles for actors within a network (Nguyen & Nyella, 2010). Silvis and Alexander (2014) state that this first stage of translation is not only to define a problem but also to propose a solution. It is during this stage when actors, specifically the focal actor, aim to be indispensable through their defining of a problem and luring other actors into the network (Afarinkumah & Kwankam, 2013). Horowitz (2012) states that the moments which follow problematization, namely, interessement, enrolment, and mobilisation,

have one goal to achieve which is implementing the solution defined in problematisation through convincing actors to become allies.

▪ *Interessement* is described as attracting and aligning the interests of actors with those of the focal actor (Foster, 2014). Dery et al. (2013) further describe this stage as one where actors become interested in what was proposed as a solution in the stage of problematisation. In Shim and Shin'a (2015) study, interessement is when the focal actor attempts to enforce the identities given to actors during problematisation. Shin (2016) concurs by stating that in interessement, the focal actor has to convince actors on accepting the roles that have been imposed upon them in the stage of problematisation.

▪ *Enrolment* is the third stage, wherein actors accept the roles which have been stated by the focal actor and proceed to work toward obtaining the objectives of the focal actor (Tanner & Chigona, 2010). However, Song and Qureshi (2010) state that even though actors may have accepted the roles imposed upon them, it still does not guarantee actual enrolment. Enrolment happens within the life cycle of a network state (Teles and Joia, 2011); this is to ensure that the network reaches a point of irreversibility where actors cannot settle for other alternatives.

▪ *Mobilisation* is considered as a stage of success within the actor-network and it is at this stage when more actors are attracted (Effah, 2012). Song and Qureshi (2010) describe this stage as one where the point of attraction, which was identified during interessement, begins to gain wider acceptance and key actors within the networks now become spokespersons for others. Based on Dery et al.'s (2013) study, this stage is where the network shows durability, is considered to be irreversible, and the actions of the actors are now in unison. It is at this stage when the actions of actors within a network are brought together in order to achieve the overall objective which was identified prior (Fornazin & Joia, 2016)

Many studies have been conducted in the field of ICT, where the four moments of translation from the perspective of ANT were employed as a lens in the analysis of the data (Mauthe & Webb, 2013; Cordella, 2012; Cresswel et al., 2011). In Thapa's (2011) ICT for development(ICT4D) study, they problematized the lack of wireless networking, while also uncovering other issues such as lack of infrastructure and human resources as a factor which contributes to that problem. Interessement was put into practice in Andrade and Urquhart's (2010) ICT4D study, wherein the Non-Proit Organisation (NGO) responsibly sourced funding from international agencies, while also providing exposure for the project. Enrolment takes place in Afarinkumah and Kwankwam's (2013) eHealth implementation study where different actors are enrolled to pursue their similar interest which is the successful eHealth

implementation in Ghana. In Shim and Shin's (2015) 4th generation network study, mobilisation is seen to have taken place when the Chinese government had set out a 4th generation (4G) policy.

In the context of ICT, Song and Qureshi (2010) state that moments of translation can help in unfolding and understanding the processes that take place, starting from conceptualisation, development, and finally the implementation. In a study about implementing ICT into higher education, Wesley and Chitatana (2016) stated that translation finds the success of ICT to be highly dependent on the way in which the actor-network is created and gradually strengthens over time. Another aspect is the persuasion of actors, which Vogel (2016) states to be important for the sustainable use of ICT within healthcare as no individual's behaviour can be changed by the organisation alone.

However, it is important to note that the process of translation may not always result in success (Kim, 2014; Horowitz, 2012) and this is due to the unpredictability of actors within a network. Despite the possibility of failure of actual translation, Zukas and Kilminster (2014) argue that moments of translation can also assist in thoroughly explaining why some actor-networks fail and why some are a success.

2.6.2 Actor Network Theory and Information Systems

In a prior study, Tatnall (2005) critiqued socio-technical approaches for focusing on only the technical aspect and only regarding the social side as the context in which the development and adoption will take place. Eliminating that and creating equal importance between the social and technological is the belief upon which ANT is based and this is how theory distinguishes itself from other socio-technical approaches (Cressman, 2009).

In the context of ICT, ANT has been used to analyse information technology development, according to Diáz Andrade and Urquhart (2010). This is a major advancement, considering that it is no longer limited to just science and technology, but can also be applied to fields such as information systems (Garrety, 2014). Cordella (2012) states that one of ANT's benefits is its recognition of technology and how it is not distinguished from humans but rather how the two are related and equally as influential to one another.

Kumar and Rangaswamy (2013) further state that even though human and non-human actors are not distinguished, they do differ in purpose. Chinedu Eze, Duan and Chen (2014) concur that original adoption theories tend to focus on the social side, neglecting the role of technology, whereas ANT covers that aspect. Cuccininielo (2015) states that ANT can be used

as a tool of analysis in order to simplify and understand the factors that contribute to the success of technologies. In support, Wausi and Ndushabandi (2016) state that ANT is also used as a socio-technical framework which helps explain how technology is developed in society.

Lee et al.(2015) and Afarikumah and Kwankam (2013) state that ANT has been used in various information technology development initiatives with the purpose of explaining the complexity of relations within it. However, Silvis and Alexander (2014) highlight that ANT within IS encounters challenges due to its inability to state boundaries in a network which would result in unnecessary expansion. Saedi and Lahad (2013) highlight how, despite this challenge, ANT can give a clear valuation on the complexity and fluidity of networks while also showing the strong impact of technology. Albanna (2012) states that in some IS projects, ANT is used in the conceptualisation phase, to see how the product is to function when it is eventually implemented.

Heeks and Stanforth (2014) argue that ANT is hardly used in the analysis of project development and this relates to its complexity and diversity. Haque and Mantonde (2017) support this by highlighting how socio-technical issues and the relations between actors in a network are very complex and require a broad understanding. However, Iyamu, Sekgweleo and Mkhwanazi (2013) argue that these complexities are the exact reason why ANT should be applied in IS, due to its unbiased and equal support of all actors within a network. Considering that these are the basis of ANT, the theory being viewed as complicated is understandable.

There are many benefits for and critiques against applying ANT. Amongst those benefits Haques and Mantonde (2013) argue that ANT can also hold technology accountable to society, in the same way as human beings. In terms of the critique regarding symmetry in ANT, Andrade and Urquhart (2010) emphasize the fact that it is justified as theory states that even though human and non-human actors may differ in intentionality, they still have the same impact in a network. A problem, as highlighted by Silvis and Alexander (2014), is the fact that ANT offers no boundary to the growth of networks, which later becomes a challenge to the IS researcher when analysing.

2.7 Conclusion

This chapter presented six Sections including the introduction, wherein existing literature was reviewed. The main Sections include discussions on ICT, Health Care, Big Data, Big Data analytics, and the Actor-Network Theory (ANT). This was done purposely to create a structure and workflow which starts from the basis that is ICT right down to the theory that will be used

to analyse the data in this research. The research methodology is discussed in the next chapter. Wherein the theory applied, ANT, will be discussed in detail while also covering the philosophical assumption, research approach, design, data collection, and analysis.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that was applied in this study. According to Bogdan, Taylor and Devault (2015), methodology is the way in which a researcher goes about seeking answers. The methodology consists of approaches, methods, and techniques. The selection of the approaches, methods and techniques was guided by objectives of the study as presented in Chapter one. This chapter covers the philosophical assumptions, research design, data collection, and data analysis in greater detail.

In addition to the Introduction, this chapter consists of seven main Sections. The first and second Sections present discussions about philosophical assumption and the research approach, respectively. The third Section covers the research methods, followed by the research design. How the data collection techniques and data analysis were applied in this study are discussed in the fifth and sixth Sections, respectively. The seventh Section presents an overview of the ethical considerations of this study. The chapter is summarised in the last Section.

3.2 Philosophical Assumption

Conducting research is a process, which requires a substantial guidance, from one stage to others, following different procedures within paradigms. Lukka (2010) states that research paradigms assist researchers in understanding the possibilities of how to conduct research. Furthermore, Bunnis and Kelly (2010) state that paradigms are considered to be shared beliefs within research but also serve as regulatory measures in the process of inquiry in various fields. In information systems (IS) research, the two most popular philosophical assumptions are epistemology and ontology (Khosroshahi & Arayici, 2012). Scotland (2012) defines both epistemology as the nature and forms of reality and the way it is created, while ontological position is concerned with many realities. Ontology sees reality as independent of society and how they interpret it, states Wayhuni (2012). Epistemology is more concerned about the relation between the knower and possible knowledge, while also looking at how this knowledge can be communicated to others (Mustafa, 2011).

Research paradigms consist of philosophical assumptions and these are easily defined as the way a researcher views the world (Cameron, 2011). As this study uses the philosophical assumption of Epistemology (see Section 1.7.1), this Section will discuss Epistemology further.

According to Anastas (2002), choice in philosophy helps determine the kind of work the researcher is doing, it also contributes to their level of understanding of the work and how they choose to place themselves within the research.

The research philosophy is a starting point in the research process, as illustrated by Mayer (2015) through the research onion (Figure 3.1). According to Cameron (2011), the philosophical assumption is what drives the choice of research methods for a researcher. Philosophical assumptions are how we view the world, but the way in which we acquire that knowledge is called epistemology (Mack, 2010). Chia and Rasche (2010) state that the philosophy of epistemology is based on facts, theory, and knowledge and these are measured against each other in order to obtain new knowledge.
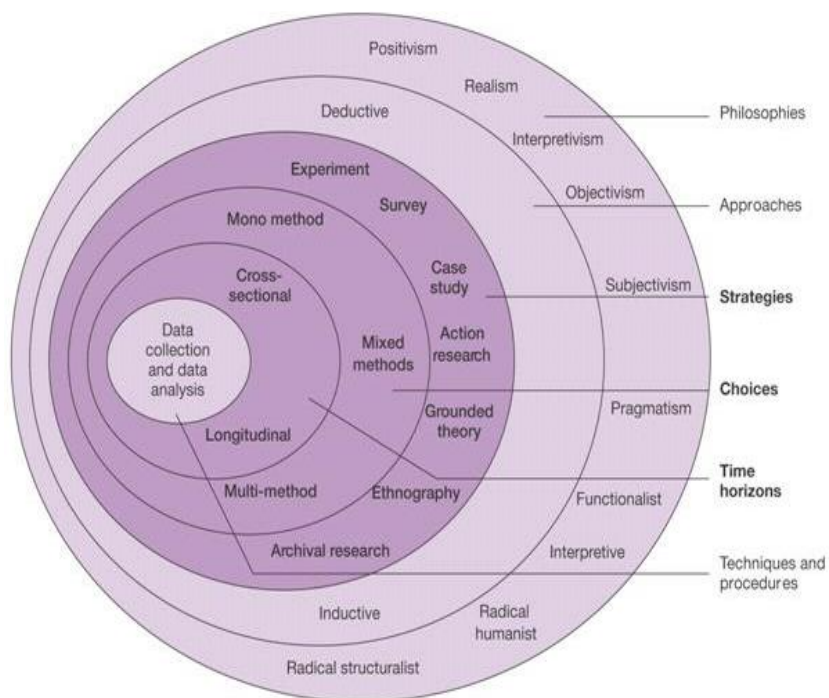
Figure 3.1: The research onion

(Adapted from Mayer, 2015)

Khosroshahi and Arayici (2012) state that there are two epistemological assumptions which exist, namely, positivist and interpretivist. Doolin and McLeod (2005) state that the ontological knowledge and constant critique of positivism birthed interpretivism. Hay (2011) states that at the core of interpretivism is the need to explain or interpret actions, as interpretive researchers believe that these interpretation guide how actors carry themselves. In that, Tuli (2010) states that interpretive researchers reject the notion of reality existing without humans. In its essence,

interpretivism allows the understanding of social realities through the eyes of those who experience them (Chowdhury, 2014). From the same viewpoint, Marshall (2016) places emphasis on the fact that the interpretive approach is based on subjective view, experience and history. According to Marshall (2016), interpretivism allows for researchers to describe and attach meaning to particular contexts and people.

Petty, Thompson and Stew (2012) agree by stating that Epistemology is theorised as what could possibly be known. In Wahyuni's (2012) argument, epistemology is viewed as way of generating, using, and understanding the knowledge, which is considered to be valid within a field. Grey (2013) purports that the philosophy of epistemology provides the researcher with the background on the decision of what acceptable knowledge is and is not. In Dick's (2013) argument, epistemology serves to justify or evaluate the beliefs around what is considered to be acceptable knowledge. Epistemology allows the researcher to question the relationship between the knower and the knowledge, how they have come to know what they know and what is deemed to be acceptable knowledge (Anti & Hamza, 2015).

3.3 Research Approach

To fulfil the objectives of the research, a research approach was chosen. Håkansson (2013) states that the research approach helps in drawing conclusions and also validating the truth in the matter. There are two types of approaches, deductive and inductive. The deductive approach is associated with quantitative research, states Krauss (2005), in the sense that it is intended to hypothesize and to test theory. Poni (2014) further states that deductive reasoning is when the researcher would gain universal perspective of the matter and later subtract to the particulars. Goswami (2010) makes a very important distinction between Inductive and Deductive by stating that deductive reasoning can provide a solution with no knowledge of the real world. Tuli (2011) denotes that the deductive approach is under the positivist paradigm which is ultimately underpinned by quantitative methodology.

While the deductive approach is linked to quantitative research, the inductive approach is linked to qualitative research (Wright et al., 2016; Bratlinger et al., 2005), wherein the research would begin with the use of data and later build up to a theory from the results. The approach chosen for this research is inductive, which Woodwell (2014) defines as going from specific to generic, by that, the researcher builds a theory based on generalisation. An inductive approach is deemed to be more suitable for qualitative studies (O'Reily, 2009). Therefore, within the interpretivist stance, the inductive approach was followed, wherein the researcher uses existing knowledge in order to gain new knowledge (Hayes, Heit and Swanson, 2012). In Yoon's (2012) comparison study of methodologies, the inductive approach is stated to enable

knowledge gain through considering all possible variables through available literature and deriving answers from that.

3.4 Research Methods

There are two main types of research methods, quantitative and qualitative (Creswell, 2013). However, the two methods can also be combined, called the mixed method (Murray, 2010; Creswell, 2013) and these are becoming increasing popular within research. Venkatesh, Brown and Bala (2013) state that the mixed methods are best used on phenomena which cannot be fully understood using either qualitative or quantitative methods. The combination of these two methods is chosen with the intention of them complementing one another states Flick (2014), in the sense that one will cover the gaps which the other fails to fill. Cresswell, Fetter and Inkov (2004) stated that combined use of both methods would produce complete results while also complementing each other.

Quantitative research is described as scientific approach, as its characteristics are fixed in design, presents numeric data, and its techniques produce quantifiable results (Poni, 2014). On the other hand, qualitative research is more descriptive, and it focuses on human experiences (Lambert & Lambert, 2012). Fossey et al. (2002) state that the core of good qualitative research is the how participants' subjective experiences are interpreted by the researcher. Qualitative research is moreover useful for this study, as it is underpinned by epistemological knowledge on interpretivism (Tuli, 2010), so it aligns with both the philosophical assumption and research approach of this study. Thanh and Thanh (2014) also highlight that interpretive research makes use of qualitative methods, as they enable them to understand, in depth, the relationship between human beings and what surrounds them.

Therefore, qualitative research methods were used to fulfil the objectives of this study. Qualitative methods assist in understanding, in depth, the social phenomena presented from the view of who is involved in the study (Szyjka, 2012). Birkishaw, Brannen and Tung (2011) highlight that qualitative methods are first-hand in nature, which is one characteristic that distinguishes it from other research methods. Allwood (2012) states that one of its benefits is that it enables the researcher to thoroughly investigate the intricacies of the social phenomena. This speaks to the objectives of the research.

Qualitative research methods are more about gaining an in-depth understanding of situations, mainly focusing on the how and why, as stated by Dworkin (2012). Qualitative methods are also relevant in sensitive areas according to Coast et al. (2012), as they reduce chances of receiving selective information from professionals or experts. According to Coenen et al.

(2012), qualitative research methods allow participants to express their views and opinions in their own words. In doing that, it also has to address the research question as stated by Beail and Williams (2014), which ultimately fulfils the research objective.

It is also important to determine which methods to employ prior to conducting a study so as to eliminate any chance of possible bias (Pathak, Jena & Kalra, 2013). Tavakol and Sandars (2014) highlight the importance of researchers putting aside their pre-conceived notions of a subject; however, it has proven to be hard to achieve as researchers may be unaware of these notions.

The reasoning behind choosing qualitative research methods by researchers is layered, as stated by Starke (2013), the most common being the inability to measure organisational change using quantitative methods. Shelton, Smith and Mort (2014) also state that for a researcher who seeks understanding of a phenomena in its most natural setting, qualitative methods are best applied. However, these benefits also come with challenges. Coast et al. (2012) purports that qualitative studies are challenging as it can be time consuming and difficult for researchers who lack experience. Nevertheless, the qualitative method was deemed appropriate for this study, as it allowed the researcher to gain in-depth understanding of the healthcare system.

3.5 Research Design

This Section discusses the research design of this study. The research design is a work plan, as De Vaus and De Vaus (2001) describe, one which enables the researcher to answer the research questions as accurately as possible. Crook et al. (2010) claim that the research design is a central element of any research. Similarly, Conrad and Serlif (2011) place emphasis on the importance of research design as it brings out what the research itself entails. Research objectives and questions guide the research design, states Wahyuni (2012), while further describing these two factors as the starting point to research design.

Mörtl and Gelo (2015) describe research design as a plan of action which creates a link between the philosophical assumption and also the methodological approach. For the research design, the case study approach has been chosen in order to fulfil the objectives of this research. Hyett, Kenny and Dickson-Swift (2014) state that the case study is moulded by the research paradigm, study design, and also the methodology. The case study is best suited for this study, as it is one of the methods within the interpretive approach as stated by Scotland (2012). Moreover, the case study approach has the potential to contribute to the improvement

of healthcare service delivery, states Baker (2011), as it can provide a more qualitative aspect to the complex processes within the sector.

Furthermore, Baxter and Jack (2008) state that the case study research method is useful when a researcher wants to answer the "how" and "why" questions within their study. Similarly, Sangster-Gormley (2013) states that there are three types of the case study, which include descriptive, explanatory, and exploratory. Of these types, the explanatory case study answers the "how" and "why" questions specifically. With that being said, the leading goal of a case study is to describe a case as completely and accurately as possible (Cronin, 2014).

Moreover, Amerson (2011) describes the case study approach as a traditional procedure within the qualitative research methods. The case study approach allows the investigation of social entities in their natural context (Easton, 2010; Houghton et al., 2013). The case study approach is best suitable when the study involves a lot of actors, procedures, and goals, which are some of the qualities Yin (2013) also states that as criteria for selecting the use of case study. According to Crowe et al. (2011), case study helps explore a phenomenon while also unpacking the causalities leading to change or development.

In their description of the case study approach, Baratt, Choi and Li (2011) state that case study research is inductive, as it focuses on building theories. Knowing that case studies are inductive, Barrat, Choi and Li (2011) highlight the importance of justification behind the choice of approach. The researcher has to provide reasoning, proving that there is a need for new theory as the ones that exist fail in explaining the phenomena. Baker (2011) argues that case studies are able to create a stronger theory which interlinks the problem, solution and the ultimate result. Furthermore, Daymon and Holloway (2011) state that the researcher is at an advantage when using a case study because it, in itself, produces sources of evidence.

Milliot (2015) states that case studies are explanatory in nature and the approach is followed with the intent to expand on the existing knowledge of a phenomena, in that, a researcher is able to draw a new theory. However, in order to do that, Crowe et al. (2011) highlight that the researcher has to first describe the phenomenon, and this will then put three things into perspective, namely, the objective, data collection methods, and also the findings. Flick (2014) states that a case study allows a thorough description of the case; however, the problem lies in deciding which case is best suitable for the objectives of a study. This can be addressed by having specific criteria in place to help narrow the search for specific cases.

In this study, for instance, the two cases were selected based on their location, with consideration of the size, as well as their accessibility and suitability for the study. The two cases selected are healthcare facilities, located within areas regarded as urban. Socio-economic factors also play a role within the selection of these cases as these facilities are regarded as public hospitals and may be regarded as less privileged when it comes to healthcare service delivery.

The first case is an approved institution whose purpose is to perform community service through the provision of medical care by medical professionals. As per Easton's (2010) definition, a case study allows for the investigation of social entities in their natural context. As such, interviews were conducted with five participants within the facility, The selection of participants was not at random, specific criteria had to be met (see Section 1.7.2.4); however, what is important to note is that all participants had some contact with hospital data. The participants that were involved in case #1 included a nurse, a doctor, a data capturer, an administration clerk, and a radiographer. Each of these participants play a different role within their occupations; however, they are all somehow involved in obtaining, processing, and/or using data.

The second case is a private clinic situated in a low-income area within Cape Town. The interviews were conducted on the premises. The selection of participants went according to the set criteria (see Section 1.7.2.4). The participants involved in case #2 included one nurse, a doctor, two patients, and the manager of the clinic. More importantly, each participant plays a role in solicitating, managing, and processing data within the facility. According to Zivkovic (2012) and Zucker (2009), what is extracted from a case study can consist of many materials, such as interviews transcripts, observation and documentation such as strategy documents, organisational planner, and financial reports.

3.6 Data Collection

In this Section, the techniques that were applied in the collection of data are discussed. In IS studies, as well as case studies, some of the techniques that are used include documentation, interviews, and questionnaires (Benbasat, Goldstein & Meid, 1987). The objectives of the study dictate the selection of the techniques, which are also aligned with the choice of the research methods, whether quantitative or qualitative, or both (mixed). Thus, based on the objectives of the study, which was to develop a two-level approach to data analytics in order to improve the quality and accuracy of health care data for better patient care, the interview and documentation techniques were selected for data collection. Each of these will now be discussed separately.

3.6.1 Interview technique

Interviews are a qualitative research technique which require individual interaction with participants in order for them to dwell on their perspective of the subject matter (Boyce & Neal, 2006). As such, interviews are the most important data collection methods in qualitative research (Qu and Dumay, 2011). Interviews also happen to be the most commonly used research method within qualitative studies (Rowley 2012). Interviews not only assist in gaining answers to the questions, but also in understanding the participants' experience (Seidman, 2013). In agreement, Cohen, Manion and Morrison (2013) state that interviews allow for a conversation between the interviewee and interviewer wherein they express their interpretation of situations, from their own view. King and Horrocks (2010) emphasise on the importance of providing a guide when conducting interviews; this ensures that all topics are outlined, while also allowing flexibility.

The interview design is imperative to the objectives and aims of the study Gill et al. (2008), as the researcher has to obtain as much information as they can from those set questions. In the critique of choosing interviews as data collection technique, Idowu (2011) highlights that the researcher may influence the answers, while participants might feel intimidated, but what is important is that the interviewer sticks to the guidelines.

Tavakol and Sandars (2014) mention that there are three different types of interviews techniques, which include the Unstructured, Structured and Semi-Structured interviews (see Section 1.7.2.4). The Structured interviews technique are best suitable for quantitative studies (DiCiccio-Bloom & Crabtree, 2006), while the Semi-Structured and Unstructured interviews are more qualitative in nature (Smith, 2015). Over a decade ago, Chapman and Zweig (2005) stated that an interview could be classed as Semi-Structured if it presented characteristics of a Structured interview but not all. In support, Cachia and Millward (2011) describe the Semi-Structured interview as one that possesses qualities of the Unstructured and Structured in the sense that it presents structure in the form of guidelines. However, the interviewer is at liberty to add more questions.

The Semi-Structured interview was selected as the data collection technique in this study. The Semi-Structured interviews technique is considered to be the most common method of data collection within qualitative studies (Jamshed, 2013). This is because it possesses many benefits, such as its ability to create rapport between the interviewer and interviewee (Smith, 2015). This is of importance to healthcare studies as it allows a sense of comfort around a

sensitive area. Semi-Structured interviews allowed for the free flow of conversation while staying within the guide the researcher had set prior to conducting the interviews.

The Semi-Structured interviews were conducted with selected participants. Turner (2010) points out that the selection of participants is crucial to the study, which is why criteria were set to select the participants within this study. These criteria included the following:

   i.   Medical personnel who have worked within the facility for at least five years
   ii.   Patients who have been undergoing treatment for the past three years
   iii.   IT and Administration who have been working within the facility for at least three years

The criteria put in place is specified according to occupation and number of years within that occupation. This was to ensure that the employee/patient has background knowledge on the facility. The participants selected are likely to have witnessed change that has taken place within the facility, capturing it from different viewpoints, ultimately granting the researcher a view of their individual experience.

3.6.1.1 Interviewees: Case 1

In order to ensure balanced views and opinions, the demographics of the interviewees were considered necessary. As shown in Table 3.1 below, the demographic of the interviewees covers both genders, major spoken languages, major health units, and professions.

Table 3.1: Case 1: Interviewee demographics

Designation	Department	Language	Gender
Doctor	Acute	Xhosa	Male
Nurse	General	English	Female
Admissions clerk	Administration	Xhosa	Female
Data Capturer	Administration	Xhosa	Male
Radiographer	X-Ray	Xhosa	Female

The facility is based in a black community, which is mainly dominated by isiXhosa speaking people. As shown in Table 3.1, the participants were made up of four isiXhosa speaking individuals and one English language speaking person. This seem advantageous in the sense that the researcher is also isiXhosa speaking. The main advantage was that it helped with the level of understanding and engagement with the interviewees. The use of indigenous language (isiXhosa) made most of the interviewees more comfortable and enabled them to speak freely, thereby increasing the richness of the data. However, it became a serious challenge as direct translation from indigenous language (isiXhosa) to English language was difficult. The

challenge was brought on by the inability to interpret some terms from the IsiXhosa dialect, as they are exclusive to the language. However, this challenge was overcome, as the researcher is isiXhosa speaking. Thus, allowing them to be able to interpret the data while transcribing,

Within the first case, five people were interviewed. The number of people interviewed was based on their willingness and availability.The interviews took place at the premises of the hospital. The interviews were conducted over a period of one week. Each interview lasted between 22-49 minutes. The interviewees allowed the use of tape recorder at the request of the researcher. The request was made in order to be able to capture the entire conversation and avoid leaving anything out. The recorded interviews were transcribed immediately after each interview. This was to ensure freshness in terms of how the interviews happened.

Each interview was transcribed word-by-word. Thereafter, the documents were cleaned, from language perspectives. Both sets of documents (data) were stored separately, for evidence purposes. Additionally, it allows reference, track and trace when and if needed. The transcripts from the interviews were combined and documented, using Microsoft Word™. The document was formatted, page and line numbered.

3.6.1.2 Interviewees: Case 2

As done in Case 1, in order to keep the balance, a varied selection of participants was made. These participants vary in title, home language and their gender. However, case 2 does not include the departments, as the facility is not divided in that manner.

Table 3.2: Case 2: Interviewee demographics

Designation	Language	Gender
Doctor	English	Male
Nurse	Afrikaans	Female
Manager	Xhosa	Female
Patient 1	Afrikaans	Male
Patient 2	Xhosa	Female

The facility used in Case 2 is based in a coloured-dominated area, where people are mostly Afrikaans speaking. However, it is a mixed community in the sense that there are also isiXhosa and English-speaking individuals. As shown in Table 3.2, the interviewees were made up of one English speaking individual, two Afrikaans speaking individuals, and two isiXhosa speaking individuals. The medium of communication between the interviewer and interviewees was English, regardless of their background. However, in some interviews, the researcher had

to rephrase and pose some questions in IsiXhosa, depending on the participant's understanding. Yet again, this proved to be a challenge as direct translation tends to be difficult when using indigenous languages.

In case 2, five participants were interviewed. The number of participants interviewed was subject to their willingness and availability. The interviews took place within the surgery premises. The interviews were conducted over the period of two days. Each interview took between 18 minutes and 1 hour 14 minutes. With the consent of the interviewee, the interviews were recorded. This was done for the purpose of referral when transcribing. Each interview was transcribed immediately after taking place.

Each interview was transcribed word by word and thereafter they were cleaned individually and later combined and cleaned. All raw and clean data was kept, for referral purposes. Using Microsoft Word™, the clean data was formatted by adding line numbers and page numbers.

3.6.2 Documentation technique

As a part of data collection, documentation was used for this research. Bowen (2009) describes this method as a thorough evaluation of documentation with the intention of extracting meaning from them. O'Leary (2004) states that documentation can be used as a primary source of data collection and as part of analysis; however, the researcher has to ensure the credibility of his/her sources.

Amongst the documents collected is the national guideline for filing, archiving, and disposing of patient records in primary healthcare facilities. This document is relevant to the study as it focuses on patient data and how it is handled within health care facilities across South Africa. The guideline is put in place to ensure that health care professionals and administration staff know what is expected of them when it comes to patient data and how it is handled. The document acknowledges important policies such as the Protection of Personal Information (POPI) act and its standards which health care facilities have to adhere to. Included in this document is a guide on how existing patient information should also be physically kept and for how long.

Additionally, the Western Cape Government Health (WCGH) issued a guideline on permission of request for access to patient data and patient information systems. This document was issued to guide healthcare workers on how to ensure that patient data is accessible but also maintaining the confidentiality of this data. This document takes into cognisance the importance of patient data and its potential to improve patient care. However, it still emphasises

that in order for this to be done, certain procedures have to be followed. These guidelines address all three spheres of government, namely, local, provincial and national. It specifies who exactly has rights to access this information and under what circumstances they can make use of this information.

The documents collected are guided and put into context by policies which have been in place for many years. These are policies and legislative documents such as the National Health Act, Protection of Personal Information Act, and the Children's Act. These documents were especially important to this study because they capture the importance of patient data within healthcare facilities. They enable healthcare workers with information on the purpose of keeping patient data and how to ensure that it is physically well kept and safe from misuse.

3.7 Data Analysis

As discussed in Section 1.6.5 and 2.6, the Actor-Network Theory (ANT) was chosen to underpin this study. This means that the theory was employed as a lens to guide the analysis of the data, in order to achieve the research objectives.

ANT is comprehensively discussed in Section 2.6. Arnaboldi and Spiller (2010) describe ANT as an approach to understanding complexities in society by paying close attention to the relations within those societies. These relations can involve both human and non-human actors and are examined under the notion that nothing exists prior to it performing an action (Fenwick & Edwards, 2011). Furthermore, Tatnall (2005) states that ANT places emphasis on the equal treatment of actors whether human or non-human. ANT is perfect for socio-technical research because it sews the divide between social and technical through perceiving it as a negotiation process rather than a barrier (Díaz Andrade & Urquhart, 2010). Teles and Joia (2010) concur by stating that ANT has proven to overcome this barrier through its ability to address technological issues across different areas, such as health.

Also covered in Section 2.6.2 is the application of ANT in IS studies, which has grown exponentially since the 90's (Fornazin & Joia, 2016). According to Song and Qureshi (2010), ANT has proven to be a useful tool in IS by providing an understanding of the interaction between human and non-human actors within a social system. From the perspective of ANT, the moments of translation are often employed for analysis in IS studies (Rangaswamy & Kumar, 2013), which have also been applied in this study based on the objectives. Moments of translation were used in the study in order to achieve the following:

i.   To examine how patients' incidents are transformed from problem to solution stages,

ii.   To understand how the different networks are formed, including the types of data that are generated, and

iii. To understand the relationship that exist between the data within the various networks.

Individually, the moments of translation were unravelled, starting from problematisation, interessement, enrolment, to mobilisation. In order to achieve the above-listed objectives, the research employed an inquiring approach in each moment, with prefix questioning of what?, who?, how?, why?, where?. These questions allowed the researcher to probe deeper and derive meaning from each moment of translation. They enabled the researcher to define first and foremost, which proved to be an important part of analysing data,

3.8 Ethical Considerations

For this research to be of quality and integrity, ethics had to be in place. This brings about the ethical considerations within the study. Fritz (2009) states that ethical considerations are there to provide regulation on the conduct of research. Ethical consideration covers a wide part of the research, mostly the interaction with participants. Ethics guide the researcher in terms of ensuring participants' safety, awareness of risk, and their rights should they agree to participate in the study. Furthermore, the researcher had to be aware of the ethical standards put in place by the Cape Peninsula University of Technology, to which they adhered.

The healthcare sector is a big part of South Africa as it deals with the well-being of its citizens. Therefore, research pertaining to the sector needs to respect the regulations which have been set. The sensitivity around healthcare is an important part to consider before pursuing research of this nature. The researcher understood the risks which come with conducting healthcare research and more importantly, the implications of not addressing those risks.

As stated in previous Sections, this study is qualitative, and therefore requires the use of qualitative methods such as interviews. This meant that the researcher had to interact with their participants. This then brings about the importance of confidentiality, as, in order to protect participants, ethical measures had to be put in place. As part of the ethical consideration, participants' and the facilities' identities were withheld. This was to ensure that the data can in no way negatively impact the establishment, its employees, and/or its patients in the long run. Ethical consideration is of importance to this study because it requires human involvement and their well-being is a priority to the researcher.

In order for this research to be considered as ethically appropriate, steps had to be taken. This was a rigorous process which included two applications consisting of different forms sent to

two places. This study had to be first approved by the faculty of Informatics and Design and the ethics board within the faculty. This application was done through submitting the FID-REC form. This form contains a brief overview of the study and details of the methodology. Since this study is health related, another form had to be submitted to the Health and Wellness Sciences Faculty within The Cape Peninsula University of Technology as they act on behalf of the Department of Health, the details of this form are similar to that of the FID-REC form and equally as important. These applications went through a panel of reviews and its approval, proved that it met the standard of ethics required.

3.9 Conclusion

This chapter presented the research methodology, consisting of eight Sections which include the philosophical assumption, research approach, methods, and design. Also included in this chapter are the Sections of data collection, analysis, and the ethical considerations. Under the Section of philosophical assumption, both Ontology and Epistemology were discussed. However, the researcher went further into detail on their stance which is Epistemology. The research approach chosen was inductive as it is said to be best suited for qualitative studies according O'Reily (2009). Qualitative and Quantitative research methods were also discussed and with this research being qualitative, the researcher went further into detail with qualitative.

Under research design, the case study was reviewed, and it was chosen, as it is most suitable for this study as it supports the research approach by being inductive (Barrat, Loi & Chi, 2011). The data collection methods chosen were interviews and documentation, and the researcher presented a detailed justification as to why these two methods are best suitable for this study. In Section 1.7.2.5 of data analysis, ANT was identified and thoroughly discussed as the chosen theory which will guide the research through analysis.

The researcher also stated the ethical considerations of this study. This was important as ethics are a very important part of this study. This was thoroughly discussed and emphasised upon in the Section 1.10 and 3.8 on ethical consideration. In Chapter four, the researcher presents a more detailed overview of the case studies that were introduced in this chapter, by discussing the cases backgrounds and organizational structures.

CHAPTER FOUR
CASE STUDY OVERVIEW

4.1 Introduction

This chapter presents an overview of the cases selected as required by the methodology stated in Chapter Three. The cases selected are of the same criteria; however, they differ in location and background. The case study consists of two facilities regarded as public healthcare facilities by the Department of Health in South Africa. These cases were selected using criteria but most importantly because of their suitability to this study. This then brings about the Sections of this chapter as it intends to provide a visualisation of the cases studied. This was done through a depiction of how fieldwork was conducted, using what kind of organisation including its structure and the state of ICT within it.

4.2 Fieldwork

As stated in Section 3.4, the methodology used in this study was qualitative in nature; this determined the methods used as the study was carried out. Using the case study method, the intention was to study a specific case in order to be able to gain a deeper knowledge of the case in its most natural context. The first case in this study is named Salem Clinic. Within the qualitative methodology, Semi-Structured interviews were conducted with five participants who are employees in the facility.

The second case in this study is named Sunnymed. Still within the qualitative methodology, Semi-Structured interviews were conducted. Five participants were interviewed, of which three were employees within the facility and two were patients.

For the purpose of data collection through interviews, the interviewer had to make use of a voice recording device. This device was used to ensure that all the participants said was captured and therefore available as evidence. Furthermore, it was used for transcribing purposes. The interviews were conducted inside the facilities, using either the consulting rooms or any venue which the participant was comfortable with. This allowed the researcher to have a look of the actual physical structure of the facility and actually see evidence of what the participants spoke of. The same process was followed during data collection in case 1 and case 2.

As discussed in Section 3.6.1, five people were interviewed at Salem Clinic which is the first case. For the purpose of the study, the interviewees were given codenames. This was done to

avoid disclosure of their personal identities and to respect the interviewees' right to privacy due to the sensitive nature of the environment. The codenames were SC_P1, SC_P2 to SC_P5. The interviews at Salem Clinic took place over a period of a week. This was due to the availability of participants. The interviews took between 22 minutes and 49 minutes.

Similarly, five participants were interviewed at Sunnymed clinic. To adhere to the ethical standards of this study, all participants were given codenames. This was to ensure that their identities remained undisclosed and their right to privacy was respected. The codenames given to the participants in the second case were SM_P1, SM_P2 to SM_P5. The interviews were conducted over the period of a week including the transcription process. The shortest interview was 17 minute 55 seconds while the longest was 1 hour 14 minutes.

Each case was discussed in greater detail as follows.

4.3 Case 1: Salem Clinic

As explained in chapter three, Salem Clinic is based in a black community, which is mainly dominated by isiXhosa speaking people. Salem Clinic is based in a township within the city of East London, in the Eastern Cape Province of South Africa. The clinic offers a wide range of health services. These services include Anti-Retroviral Treatment Services (ARVs), Tuberculosis (TB) clinic, basic gynaecology services, family planning services, pharmacy services, and X-Ray Services. The services are provided by different units which make up the organisational structure. This starts from the levels of management, broken down to the staff categories within the facility, namely doctors, nurses, IT department, and the administration department.

4.3.1 Organisational structure

The structure of the clinic consists of three main units, namely medical, ICT, and administration. This was primarily to ensure appropriate roles, responsibilities, and collaboration. The units complement each other, one way or the other. This is presented in Figure 4.1 below.
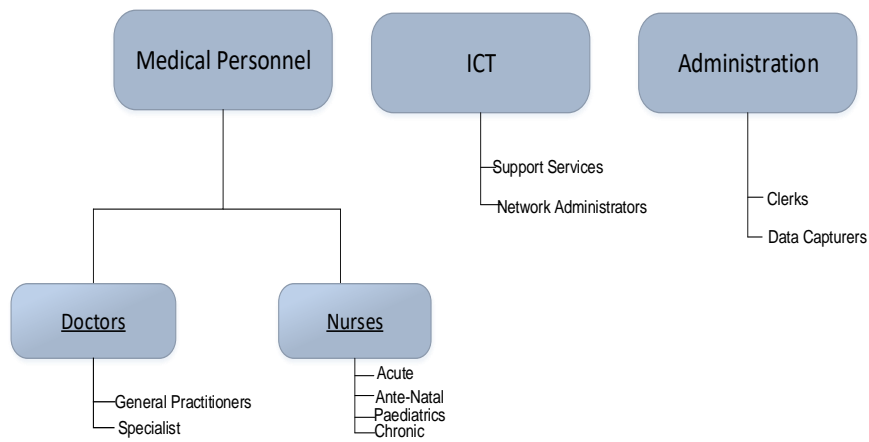
Figure 4.1: Organisational structure of Salem Clinic

Each of these units will now be discussed individually.

4.3.2 Medical unit

As shown in Figure 4.2 below, the medical unit is divided into five main departments, which include acute, ante-natal, chronic, paediatric, and pharmacy. Even though the departments collaborate and interrelate with one another, each has its specific focus areas as presented.
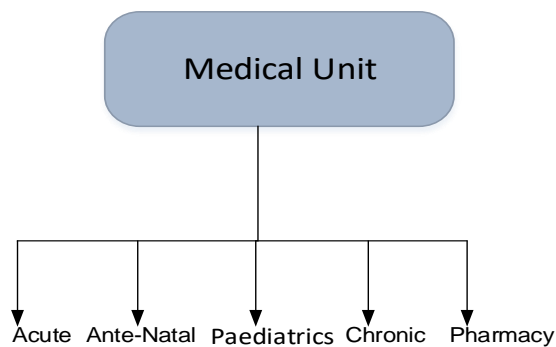
Figure 4.2: Medical unit at Salem Clinic

4.3.2.1 Acute

The acute department is a very important part of the facility. With over 600 patients coming in daily, it accommodates the majority of this number. This number is made of two different patient categories:

   i. Once off attendance to patients

  ii. Normal medical check-up

Once off attendance patients include the facility's daily patients. These are patients who are there for once-off treatment or service. The patients who come in for once-off treatments include those who come in to be tested for HIV. Depending on their results, they may come back for treatment, but the first visit is regarded as acute. This part of the facility often comes across cases which are more severe than others and need urgent medical attention; these would then be referred to other institutions. The reason behind this is the limited space within the facility and also their inability to treat patients who need to be admitted as it operates within working hours. However, there are doctors within the facility to provide first response care to those patients who need it and refer them.

This department requires the service of a general practitioner in order to deal with the different cases which occur within the facility. These doctors are also involved in other parts of the hospital, and therefore deal not only with acute patients, but with chronic patients as well. The department also hosts patients who come in for their check-ups; they are attended to in the acute Section as some are not regarded as chronic patients. These patients may include those who may not be from around the area but are in need of medication.

4.3.2.2 Ante-natal

The ante-natal department is one of the departments within the facility, and it provides care to pregnant women. It requires the services of both nurses and a doctor in the speciality of gynaecology. Patients are able to get examined, treated, and even obtain referrals if the case cannot be accommodated by the facility. Care is provided throughout; however, no deliveries are made within the facility due to the limited space and lack of resources. These patients are treated throughout the duration of their pre-natal care and these services are extended to paediatrics should they require the service.

4.3.2.3 Chronic

The chronic department is another vital department within the facility. This is due to the high level of care which needs to be provided to its patients. These patients are ones who are living with chronic diseases such as HIV, epilepsy, hypertension, and diabetes. In short, patients who are living with life-long diseases and are on medication. These patients are considered to be a priority within the hospital, as they not only have a designated Section within the facility, but they are also fast-tracked in dire cases.

4.3.2.4 Paediatric

The paediatric department of the hospital is responsible for children below the ages of 12. This department provides patient care with the assistance of nurses and also doctors. There are various services offered by this department, such as the immunisation of infants. There are also cases which need a certain level of monitoring and this is provided as well.

4.2.3.5 Pharmacy

There is a systematic process which the facility abides by. This process starts from admission to the last leg which is the pharmacy. The pharmacy/dispensary holds all medication which is issued to patients during their visit. This Section is micro-managed by the pharmacist on duty with the assistance of a nurse. Depending on the state of the patient, one can collect the medication themselves or a nurse can fetch the medication. This excludes TB patients as they are limited to a certain area within the hospital to avoid infection. The pharmacy also prioritises frail patients who cannot collect medication themselves by dispensing medication and having them delivered to the patient.

Each of the departments have dedicated personnel, which include nurses, general practitioners (GP), and specialists. Based on the essentiality of the services of the hospital, its personnel are employed full-time. However, they also have part-time staff. The primary roles and responsibilities of the medical personnel at the hospital will be discussed in the next Section.

4.3.3 Medical Personnel

The departments consist of different medical personnel. As shown in Figure 4.3, this includes doctors and nurses. The roles and responsibilities of the personnel in each of the departments differ and are discussed individually.
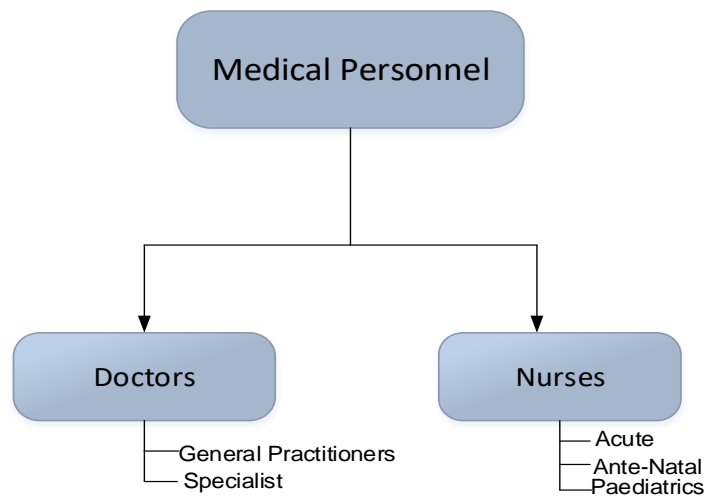
Figure 4.3: Medical Personnel

4.3.3.1 Nurses

The facility employs nurses for the general care of patients; however, they are divided, not only in their departments but also according to their occupations and positions. The nurses' role within the hospital is wide as they are the ones on full-time call at the facility. They are there to attend to patients on a first-hand basis. These nurses:

i. Act as first-aid to new patients
ii. Assist both GP and Specialist doctors

The nurses are considered to be the primary caregivers within the hospital. This is based on the interaction between the nurse and patient. Nurses are the first line of help to patients who come in. They are able to determine the reason for visit and even treat the patient. Their work extends to assisting the doctors within the hospital, with cases which a doctor may need to consult on. They are able to prep the patient and ensure that the doctor has all the patient's details before their consultation. This is not limited to just the general practitioners; they also assist the specialists within the hospital. Considering the fact that the doctors in the facility are not occupied full-time, nurses are able to familiarise themselves with the cases beforehand and update the doctors.

4.3.3.2 General practitioners

The facility has employed the service of a number of doctors, each playing a role toward patient care. These doctors are divided into those who provide general care and those within specialities, all operating within their respective departments within the hospital. The general practitioner is seen as an all-rounder within the hospital. This is mainly because their service

is not limited to one department; they are able to assist where they can. However, the general practitioner is generally located within the acute department in this facility, as this department handles cases of a different nature every day; therefore, it needs the services of a doctor who can handle that.

4.3.3.3 Specialist Doctors

As mentioned in Section 4.3.3, the facility hosts different departments, which require the service of specialists. Departments such as paediatrics and ante-natal both require the service of a paediatrician and gynaecologist, respectively. These specialists are not resident doctors within the facility but avail their services for the betterment of patient care. A specialist performs many duties in and around the hospital, paying attention to those cases which nurses cannot provide expertise on.

4.3.4 ICT: Salem Clinic

There are various factors which have to be considered when it comes to the ICT within the organisation. The size of the organisation, for instance, means it has limited IT resources. Furthermore, the facility currently has no designated team for their ICT, despite owning computers. However, there are departments which make more use of the technology than others, namely the administration department, which includes the administration clerks and the data capturers within the facility. Some of the processes within these departments are still manually conducted; however, the data, at the end of the day, is captured on computers.

4.3.4.1 Personal Computers

A number of consulting rooms have computers in the facility. These are mostly used for communication purposes, though some are used to store data collected. For these to function as they should, the facility employs the service of ICT support. This includes the installation and maintenance of these computers.

The X-ray department is another department, which makes use of a computer to generate and store images. These images are then transferred to a printer for the radiographer to print out and get a clearer picture of the patient's x-rays. However, this may soon no longer be necessary because the facility is looking to improve and go digital. In the attempt to do so, the facility is introducing a new system which can transfer the x-ray from one work station to another. This minimises the time spent on printing images and sending them to a doctor for inspection. For the facility to be able to successfully implement such, ICT and its support becomes a fundamental part of its operation.

ICT is of importance to the administration department, not only for enabling communication but to store patient data as well. The data capturers within the facility are more in need of ICT services because computers are used to capture and store patient data. Furthermore, data capturers are responsible for creating reports regarding that data and communicating them to higher management. This is a vital part of the facility's functionality as improvements are done based on the data stored in these personal computers.

4.3.4.2 Network

The facility is made of a network of ICT users, such as nurses, doctors, data capturers, clerks, radiographers, and those in management. Their communication is enabled by the network of computers, though they may also make use of telephones. Information is also transmitted between computers using the internet. ICT enables this by providing the necessary network support, ensuring that users are connected.

4.3.4.3 Software

There are various programs used by the facility, such as Tier.Net and ETR. Net, which are mainly to store patient data. These programs were implemented for the purpose of storing patient data, specifically for HIV and TB patients. These programs were introduced by the Department of Health to enable the tracking of patients. It is also beneficial to the department as they get to monitor the use of services which the government has invested in. These are computer-based programs which are enabled by ICT services, as ICT is responsible for the installation, maintenance, and improvement of these programs.

These programs have been in existence for many years, so the crucial part is maintenance and improvement. The Department of Health determines the relevant information to be captured and over the years, the facility has had to adjust to the changes suggested. It then becomes the responsibility of ICT to ensure that these changes are technically improved, making it a vital part of the functionality of the facility.

4.3.5 Administration

Administration is a very important part of the healthcare facility, because it is the primary level of patient care. It is primary in the sense that they are the first to make contact with the patient and also obtain the patient information. This department is made up of admission clerks and data capturers. The responsibility placed on this department is large, as the data gathered at this level gets to be used for various purposes.

4.3.5.1 Admission Clerks

The admission clerks are responsible for the manual capturing of patient information; this is limited to demographics and other related fields but not reason of visit. This makes them a primary source of patient information. Admission clerks work closely with data capturers as they are under the same umbrella, though data capturers are responsible for the organised capture of data in order for it to become useful information.

4.3.5.2 Data Capturer

Data capturers are also an important part of the information chain within the healthcare facilities, working closely with admission clerks and nurses. They are able to store data, making it available for use. The importance of data capturers cannot be emphasised enough, mainly because improvements within the facility are driven by what is being captured. The information which is derived from the data assists in decision making on a higher level.

4.4 Case 2: Sunnymed

The second case, named Sunnymed, is a family medicine healthcare facility. The organization is based in Cape Town, Western Cape, South Africa. Sunnymed provides general healthcare services to the community. This includes services such as family planning, gynaecology services, chronic patient care, paediatric services and HIV/Aids testing. These services are administered by the different individuals who make up the organizational structure of the facility. This includes the doctors, nurses, administration clerks and the facility manager. This is presented in Figure 4.4.
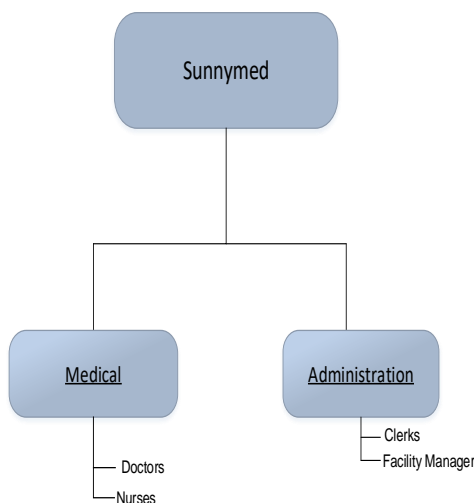
Figure 4.4: Organisational Structure of Sunnymed

4.4.1 Organisational Structure

The facility's structure is made up of two main Sections, namely medical and administration. Each of these are discussed individually.

4.4.2 Medical Personnel

As shown in Figure 4.5, the medical personnel Section consists of the doctors and nurses who are employed by the facility.

Medical Personnel

—Doctors
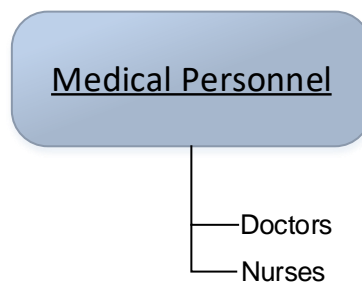
—Nurses

Figure 4.5: Medical Personnel

4.4.2.1 Nurses

The nurses within the facility play a pivotal role in the provision of health services to patients. The role of a nurse is to be a primary caregiver to the patients at Sunnymed. They are primary caregivers in the sense that they are available full-time to attend to the needs of patients. The nurses are the first line of help which patients encounter as they enter the facility. For the purpose of preserving time, patients are required to consult with the nurse as they come in. In that consultation, a nurse would find out the reason for visit from the patient and also check the patient's blood pressure and urine if need be. In cases that do not need the doctor's input, nurses are able to treat the patient without consulting with the doctor. Nurses may also be an aid to the doctors within the facility as they are able to give them a thorough description of a patient's case before they can be attended to.

4.4.2.2 General Practitioner

Sunnymed identifies as a general practice and has therefore employed the services of general practitioners. Their role is to provide care to all patients of Sunnymed; this includes both chronic and daily patients. The doctors play a vital role in the operation of the facility. They are responsible for the consultations with the patient wherein they are able to interact with them. This enables the doctor to do examinations and also to conduct a preliminary diagnosis on the

patient. From the consultation, they are also able to recommend treatment and make referrals as well.

4.4.3 Administration

The administration department of Sunnymed is the core of the facility. Before any activities pertaining to the patient are conducted, they have to get through the administrative process. The facility has divided this process into two Sections. One is where patients get to write down their details and be given a number that will be used to call out when it is time for their consultation. The second Section is referred to as the cashier's Section wherein the patients are able to make payments or present their medical aid cards. These two Sections are interconnected in the sense that the patients obligated to go through the first reception in order to get assistance from the second; however, they are both part of administration. This is presented in Figure 4.6 below


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    ┌──────────────────────┐
    │   Administration     │
    └──────────────────────┘
              │── Clerks
              └── Facility Manager
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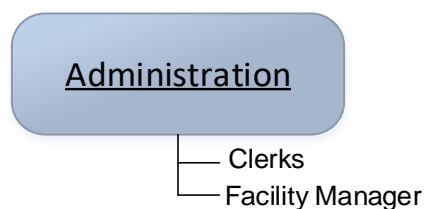
Figure 4.6: Administration

4.4.3.1 Clerks

Sunnymed has employed the services of clerks within the facility. These clerks are dispersed between the two administration areas depending on the facility manager's instructions. The role of a clerk within the facility is to ensure that the administrative process before a patient is seen by the doctor or nurse is done proficiently. The clerks are responsible for ensuring that patients provide their details. This is done for the purpose of creating a file for new patients and of ensuring that details are up to date for returning patients. There are other parties that provide services to Sunnymed and clerks are responsible for the communication between the facility and these parties. This is just an overview of the many functions of a clerk within Sunnymed.

4.4.3.2 Facility Manager

The facility manager is responsible for overseeing the administration department and the medical unit. The clerks who are employed at Sunnymed report to the facility manager. They are there to ensure that the administrative tasks are done and that patients are provided with

good service on that front. The manager also acts as an assistant to the medical unit. They ensure that the doctors employed by the facility adhere to the compiled roster. They also assist first-hand by giving reports to doctors regarding the patients and ensuring follow-ups to cases that may need one.

4.4.4 ICT: Sunnymed

Presented in this Section is the ICT within the facility of Sunnymed. This includes the sub-Sections of computers, telephones, ultrasound, and the software which enables the functionalities of this technology. Despite the use of technology, there is no dedicated ICT department for the maintenance of the technology used by the facility.

4.4.4.1 Computers

The facility of Sunnymed makes use of computers. These computers are used by both the medical and administrative unit. The administrative unit is able to conduct different activities using these computers, such as storing patient folder numbers. This helps in cutting down the time spent in the administrative process as they can find the patient folder on the computer before physically extracting it. Administration is also able to communicate with third parties with which the facility is in liaison. This includes specialists to which patients are referred, laboratories, and the medical aids whose network they are a part of.

As mentioned in Section 4.4.2, medical staff also make use of computers, to communicate internally within the facility, and to contact external parties. These external parties include doctors that they work hand-in-hand with in terms of referrals and obtaining results from those referrals. In some cases, they will refer a patient to a public/private facility of a larger scale and the transfer is done by communicating the patient case using these computers.

4.4.4.2 Telephones

As part of their ICT, Sunnymed has telephones. These are landline devices that are used to facilitate communication between staff, patients, and anyone who wishes to communicate with the facility. Using telephones, the administration department is able to set up appointments for patients who wish to visit the facility. They are also able to communicate dates on which the patients can pick up their medication and have follow-ups with their GP.

4.4.4.3 Ultrasound

Amongst the facility's technology is their ultrasound machine for which they have dedicated a room in the facility. This is used to conduct scans on the patients of Sunnymed. Through the

sonograms produced by this machine, the medical staff can document the outcome and it forms part of the patient's file.

4.4.4.4 Software

To enable the functionality of the technology of the hospital, such as their computers, software is installed. The software performs different functions depending on the needs of the facility. There are database software and operation systems software. Computers within Sunnymed have a registry system for patient folder. This software is called MangoFile patient manager. In order for administration to be able to interact with this system, this database system is installed. However, the overall functionality of the computer is ruled by the operating system software that is installed. This starts from the interface of the computer to the basic functions which enable tasks such as drawing up documents and storing of these documents.

4.5 Conclusion

This chapter provided an overview of the cases that were selected for the case study. The Sections within this chapter describe the type of organizations were used so as to give a clear view of the cases.

The organisational structures of both cases were defined. Furthermore, the researcher described the fieldwork that took place, wherein they give an overview of how the data was collected. In the following chapter, the data is analysed. This is done using the (ANT) theory which was defined and described in Section 1.6.5 and 2.6.

CHAPTER FIVE
DATA ANALYSIS AND RESULTS

5.1 Introduction

This chapter presents the data analysis, towards achieving the objective of this study, which was to develop a two-level data analysis framework for healthcare big data, in order to improve healthcare service delivery. Based on the objective, Actor-Network theory (ANT) was employed to guide the analysis of the data. The theory was discussed in Section 2.6, and its application is covered in Section 3.7.

The remainder of this chapter is divided into five main Sections. The first Section covers an overview of data analysis. The second and third Sections present the data analysis of Cases 1 and 2, respectively, including the findings from each of the cases. The interpretation of the findings is presented in the fourth Section. In the fifth Section, a conclusion about the chapter is drawn.

5.2 Overview of data analysis

In order to achieve the objectives of this study, data analysis was conducted. As discussed in Section 3.5, the case study method was chosen as suitable for this study, in which two health facilities were selected as cases. The cases are recognized as healthcare facilities by the Department of Health in South Africa. These cases were selected under certain criteria which includes their size, proximity, and accessibility, with consideration to the socio-economic state of their location.

Case 1 is a public healthcare facility, based in Buffalo City Metropolitan Municipality in the Eastern Cape South Africa. The cases within this study were presented using pseudonyms. This was done solely to protect the identity of the organizations and the participants. Case 1 was given the pseudonym of Salem Clinic. The case of Salem Clinic was then coded under the abbreviation of 'SC'. Within this case, there were 5 participants. These participants were coded as SC_P1 to SC_P5. 'P' stands for participant and the numbering was in ascending order from the first to last interviewee.

Case 2 is a private health facility, based in Cape Town, Western Cape of South Africa. As done in Case 1, this case was presented using a pseudonym. This was done in order to protect the identity of the organization and also the participants. The organization was given Sunnymed as its pseudonym. This case was then abbreviated to 'SM'. There were 5 participants within

the case. These participants were coded as SM_P1 to SM_P5. The 'P' indicates participant and the numbers are in ascending order from participant 1 to 5.

ANT was employed as a lens to guide the analysis of the qualitative data that was gathered from the cases that were used in the study. As discussed in Section 2.6, ANT was selected primarily because it focuses on the formation of networks, which include relationships and interactions between human and non-human actors. Thus, from the perspective of ANT, the moments of translation were employed to examine the relations that existed between health activities and big data including the roles of medical practitioners, administrators, and patients in analysing data towards delivering of service.

5.3 Case 1: Salem Clinic

Presented in this Section is the data analysis of Salem Clinic. Using ANT as a lens, analysis was conducted on Case 1. The theory focuses on the relationship and interactions that happen between human and non-human actors, and how they come to form heterogeneous networks. Thus, the core elements of ANT include actors and networks within which the four moments of translation take place.

In ANT, an actor must have the capability to make a difference. Actors can be both human and non-human, which together form a network based on their aligned interest. Based on the activities of actors, heterogeneous networks are formed through negotiation and translation. In ANT, negotiation and translation passes through the four moments of translation (Callon, 1996) (see chapter two).

Health activities pass through various processes in order to provide care to patients. These activities are carried out by different actors, using various methods, which often require negotiation and translation. Thus, moments of translation are employed as a lens to guide the data analysis from the perspective of ANT. A more comprehensive discussion about ANT is presented in Chapter Two. In addition, justification on why the theory was selected is presented in chapters one and three.

5.3.1 Actors

Salem Clinic is made up of different actors; these are defined as people and things which have the ability to make a difference within a setting. These actors are influential towards each other and essentially co-dependent. Presented in Figure 5.1 is a visual representation of actors and networks within Salem Clinic.
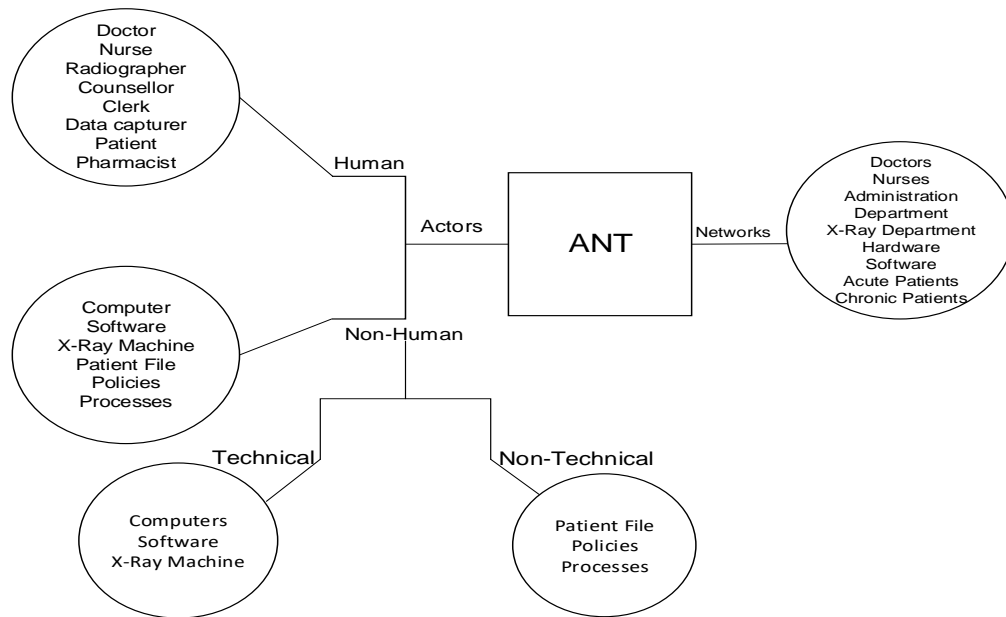
Figure 5.1: **Actors and Networks of Salem clinic**

As shown in Figure 5.1, there are different actors, both human and non-human, within Salem clinic. The health facility (Salem clinic) consists of many different employees, divided into two main groups, namely medical and administrative personnel. The group of medical employees includes doctors, nurses, radiographers, and pharmacists. The other group of non-medical personnel consists of counsellors and administrative staff. These employees are all assigned to perform in their respective roles within the facility. The medical personnel are responsible for providing care to patients, while the administrative staff are there to ensure that this is carried out efficiently using different processes. As a health facility, Salem Clinic serves the needs of the patients, making them a key player in the facility. Despite these differences, the aforementioned actors all play a role in how data are collected, accumulated, utilized, and managed.

Both medical and non-medical actors mentioned make use of different tools and techniques in fulfilling their roles and duties within the facility. The tools are also actors (non-human) from ANT perspective. These non-human actors were classified into three groups of; data (including documentation), IS/IT (such software and computer) and medical apparatus.

Non-human actors within Salem clinic include actors such as documentation. This consists of items such as headcount registers, which a data capturer within the facility describes as follows:

> *The headcount register, it is self-explanatory, it's for patient headcount and here also it's the same thing, what's in the folder is the name, surname and telephone number* (SC_P5, pg.13, 617-619).

Documentation also includes the patient file which is utilized by the nurses and doctors within Salem Clinic. This file has all information pertaining the patient, including symptoms, diagnosis, treatment, and recommendations which have been made by the nurse or doctor.

Data in the context of Salem Clinic comes in the form of voice, text, and images. Voice data is derived from staff within the clinic making use of communication channels, such as telephones, to make referrals. Text is all written data from the administrative and medical part of the facility. The administration notarizes patient visits and the details of the patients, while the medical staff is responsible for writing notes on the reason for visit and other information. The X-Ray machines produce image data, which the medical staff then use for activities such as conducting diagnosis. A radiographer within the facility describes the process as follows:

> *When we've x-rayed a patient, we take the x-ray back to the doctor, and then after the doctor has reviewed the x-ray to confirm the diagnosis* (SC_P6, pg 20:998-999).

Additionally, the facility has employed different technological artefacts, made use of by both IS/IT and medical staff, namely the computers, software and the medical apparatus. Salem Clinic is equipped with computers which are made available to employees for different purposes depending on the department, as participant one indicates:

> *There is quite a few computers, the manager has got one, there's one by the clerks and these ones and the pharmacy* (SC_P1, Pg 6: 280-281).

These technological artefacts include computers and the software. Salem Clinic is equipped with multiple computers, including those being utilized by management, medical and IT staff. These computers are functional through the use of software depending on the tasks to be conducted. This software is for a range of purposes, such as the basic functionalities of a computer, allowing the users to communicate and also to store the data being generated by the facility through different sources. The data capturer employed by Salem Clinic identifies one of the software used as follows:

> *There is a certain software used to capture that information, not one software but there is one which integrates all services called DHIS which stands for District Health Information System* (SC_P5, Pg 13: 638-640).

Moreover, non-human actors within the facility also includes the medical apparatus. This is the equipment used by medical staff to perform evaluations on patients and also to provide care. Under the category of medical apparatus, x-ray machines exist. Although they are supported

by computers and software, they are, in their own right, actors within the facility. These are used solely by the radiographers.

It is clear, then, that actors, whether human or non-human, play an equal part within the facility. Supporting this, Law (1994) states, all that you seek to explain should be approached in the same manner. Using ANT as an approach allows this as it aims to treat all actors equally which was done in the analysis of case 1.

5.3.2 Networks

Networks are formed through a linkage of actors with similar interests or qualities states Borgatti and Halgin (2011). At Salem Clinic, there were many networks. This consists of healthcare practitioners, IT and administrative personnel. The groups (networks) of healthcare practitioners include doctors, counsellors, radiographers, pharmacists, and nurses. A nurse within Salem describes this network as follows:

> *The people that have access are the nurses, the doctors, the pharmacists, the radiographers, counsellors as well if you sent the patient for counselling, we don't have a physiotherapist anymore* (SC_P1, pg 2: 97:100).

Another group of people were the patients. The patients who visit the clinic are divided into groups based on their illnesses or reason for visits. They are classed under the categories of acute patients, who are in for minor illnesses and check-ups, and chronic patients, who form a network of their own, through being on medication they are required to take throughout their lives. A nurse within the facility describes the two categories as follows:

> *We have patients that come in just to collect medication and we have patients that come in just for check-ups, we have chronic patients and then we have acute patients, so then all those patients are registered at the front desk* (SC_P1, Pg 1:11-14).

Despite the use of technology within the facility, there is no designated IT department within the facility. However, there is an availability of IT artefacts (see previous Section) that constitute a network.

Salem Clinic has also employed the services of administrative staff; these include the data capturers and clerks. This group of administrative staff share a common goal which is to capture patient information. One of the administration clerks from Salem clinic describes their job role as follows:

> *We are admin clerks and we register patients first and regular clients, when one person arrives first time, they have to produce their ID or birth certificate (for children) and*

children below age of 12 years have to bring a clinic card. Then after, we write those folders, they go to the BP and that's where they get observations done then we have parted with that client for the day (SC_P2, Pg 6: 299-303).

The medical and administrative staff both interact with the data using the different sources. Through their different contributions, data is accumulated, processed, and stored. This data is used for different purposes within the facility, but the end goal is to enable decision making. The data goes through different stages until it reaches a point of usefulness to the organization and the body that conducts decision making. This is thoroughly explained in the next Section which covers the four moments of translation.

5.3.3 Moments of Translation: Case 1

This Section presents the four moments of translation, Problematisation, Interessement, Enrolment and Mobilisation. These four moments were used as a guide through the data analysis of Case 1: Salem Clinic. Each moment of translation will be discussed individually.

5.3.3.1 Moments of Translation: Problematisation

Like other healthcare service providers, Salem Clinic collects and accumulates data from patients on daily basis, as patients visit the facility. The accumulation of data begins from two main sources, namely patients' walk-in and via technology devices, which include telephone conversation and email.

The data is used to diagnose the health conditions, and trace medical conditions and history of the patients. Therefore, it is critical that the patients provide enough and accurate information about themselves. On a patient's visit at Salem Clinic, consultation takes place, which follows two main steps: (1) inquiring whether it is the patient's first visit, or he/she is returning patient; and (2) a nurse determining the patient's purpose of visit. One of the nurses explained as follows:

If a patient is already registered with the facility, we check on the file, otherwise, the patient is registered by collecting personal information relating to the purpose of visit. Thereafter, the patient is referred appropriately for consultation with medical personnel (SC_P1, Pg 1:17-19).

Both steps are parts of problematizing a patient's presence at the facility. The patients provide information about themselves based on their knowledge. Many patients sometimes struggle to express themselves or articulate their condition clearly enough for the medical personnel to understand them. At Salem Clinic, you find cases of a patients presenting inaccurate information about their condition or visitation to Salem Clinic. This was common among the

youths that visits the Salem Clinic. One of the experienced (having served for over ten years) nurses explained as follows:

> *The information that the patients provide is often influenced by the type of disease they had. Especially the youth, we had cases where a patient had STI, which he was fully aware of, but decide to give you totally different information (SC_P1, Pg 2: 76-78).*

The initial incorrect information that some of the patients provide about themselves was influenced by culture and lack of education. Culture may affect a patient's willingness to disclose information, for instance, some male patients do not think that a person of the opposite sex needs to know about their private medical conditions. Furthermore, the patients are not always well educated to understand that medical conditions do not have boundaries of gender affiliation.

Additionally, the patients provide information based on how they are guided or the type of questions that were asked of them by the medical personnel. This is the primary reason that personnel require intensive training as an administrator or first aid personnel to the patients.

Another critical aspect is how the administrative and medical personnel gather information from the patients. This include what tools, such as language, automated system, or manual process, are used to gather information from the patients. At Salem Clinic, the majority of the patients were isiXhosa speaking Africans. However, some of the nurses and other personnel were people of other races, such as Coloured. Even though some of the personnel sometimes spoke in isiXhosa, it was never the same, in that there were always cultural differences. One of the nurses shared her experience:

> *I am not a Xhosa speaking person, even though I do understand a bit of the language. As a result, I'd rather prefer to consult with the patient in English language because I'm not very fluent in Xhosa, which is sometimes problematic (SC_P1, Pg 1: 3).*

Based on the information that is provided by the patient, medical personnel, from general practitioners to specialists, including nurses, are assigned to carry out further checks and diagnosis. Even though the medical practitioners are assigned, different factors influence their interest in the patients' health conditions.

5.3.3.2 Moments of Translation: Interessement

For each patient's condition, there are different stakeholders. This includes the patient, patient's relations, medical personnel at the Salem Clinic, and the South Africa Department of Health.

Patients visit Salem Clinic with the intention of receiving medical treatment. Their interest stems from their need for healthcare services that the facility offers, in order to better their state of health. The services are offered in different forms, which include referrals to specialists, prescriptions for medication, and actual medical care to patients with less serious conditions. These services are captured and documented with IS/IT. The documentation enables follow-up, tracking and tracing of individual patients.

Salem Clinic attends to over 6000 patients per month who are all there for one purpose, that is, to receive care. Their interest is expressed through visiting the facility of Salem Clinic and going through the treatment process. The patient may do this alone or be accompanied by people, such as relatives.

The well-being of a patient is of importance to both the patient and those close to them. Their personal relation to the patient requires them to take interest in their condition. This is evident in their efforts leading up to, or during, the treatment process, with some acting as patient escorts/porters. A nurse explains patients' relations' expressed interest as follows:

> *We have never had a case of a critical patient coming to the facility alone before. Most people come with relatives, friends, or they come with escorts* (SC_P1, pg 2: 70-71).

Medical personnel at Salem Clinic are there to ensure that patients receive healthcare services. Based on their assigned roles, it is their responsibility to carry out treatment on patients to better their health conditions. These stakeholders are required by their superiors to take interest in the treatment of patients. There are certain principles and values that they have to uphold as health professionals in order to ensure the well-being of patients. A radiographer with the facility states that:

> *Patient care must be practised whenever a patient comes into the facility. We go according to the Batho Pele (People First) principle which is making sure that the rights of a patient are respected. This is done through explaining to the patient the procedure you are going to do and making him/her comfortable* (SC_P6, Pg 22: 1085-1088)

Furthermore, the Department of Health formulates policies that guide the provision of health services to the citizens of South Africa. In order to implement the policies and achieve the goal of the department, technological solutions were implemented. These include solutions such as the District Health Information System (DHIS), Tier.Net, and the Electronic TB Register (ETR.NET). A data capturer who is employed by Salem facility explains as follows:

> *A report is compiled monthly and submitted to sub-district level. The report is the escalated to provincial then national level. At that stage, it no longer encompasses just*

the facility but all facilities within South Africa. Using DHIS, the department is able to check what facility is performing poorly and where they can assist in improving performance (SC_P1, Pg 13: 655-661)

The various interests on patients' care are influenced by different factors, which include care, availability of medications and medical apparatus, availability of qualified medical personnel, and the use of IS/IT artefacts to enable and support the activities. These interests only become materialised, produce care if put to use through participation of the associated and affected actors.

5.3.3.3 Moments of Translation: Enrolment

At Salem Clinic, participation of stakeholders in the process of patients' care was determined by different factors, which include roles and responsibilities, and rules and regulations that were put in place by the management. The primary stakeholders include the patients themselves, patients' relations, medical practitioners, administrative personnel, and the government through the Department of Health.

The medical and administrative staff of Salem Clinic take part in the process of patient care within the facility through offering their services. As medical staff, doctors within Salem Clinic are available daily to conduct their duty towards the patient by treating them. This starts with consultation, wherein they check the patients' complaint and weigh it against their medical history presented in the folder. Thereafter, a doctor is able to conduct a diagnosis, provide treatment, and advise the patient based on their findings. These activities show participation from this category of medical staff. Individually, these doctors have their roles and responsibilities; however, they are still required to work jointly with other staff within the facility. Consequently, nurses are second order to the doctors.

Nurses at Salem clinic are more accessible to the patient than doctors. This relates to the size and type of facility Salem Clinic is. Their role requires them to treat patients and also to aid doctors where possible. Amongst their responsibilities is ensuring that they are available to patients at all times. They are active participants in the process of patient care in this manner. Yet, the different roles and responsibilities of medical staff do not mean that they work in isolation. There is a systematic process that happens with patient care and this tightly links the medical staff of Salem clinic. Following this process, nurses are responsible for sending patients to the pharmacy within the facility to receive their medication. As one participant pointed out:

..everyone that is seen by nurses still ends up at the pharmacy (SC_P1, pg 1: 19-20)

Pharmacists at Salem Clinic are at the end of the patient care process at the facility. However, they are pivotal to the process because medication is administered by them to patients, as per the doctor's or nurses' instruction. Moreover, they are responsible for ensuring that patients receive the correct medication as stated in their prescription. As a primary stakeholder, their participation is driven by their job role. Another factor that motivates participation in the pharmacy department is auditing that takes place. The Department of Health (DoH) ensures that medication that is administered by the facility pharmacy is recorded. An interviewee supports as follows:

> *The nurses and pharmacists who are responsible for dispensing medication are also obligated to record what medication has been administered to patients* (SC_P5, pg 18:869-870)

Additionally, the administrative personnel of Salem Clinic are responsible for ensuring that the medical staff is able to conduct these activities in a systemic manner. Patients follow a particular process from the moment that they enter the facility. Their responsibilities are centred around the medical unit, as they have to guide the patients through the different activities that occur while receiving treatment. Their participation in patient care is measured by how smooth the process is, starting from registration to the moment they receive medication. This is motivated by their job role and the responsibility they have towards the patients of Salem clinic, that is, to ensure that they receive medical assistance as efficiently as possible.

Although this is often met with challenges, such as patients not providing sufficient documentation and information to carry out the process efficiently, all employees are still obliged to do so. A doctor employed by the facility provides an example;

> *In the case of patients losing their files, we are still obligated to provide treatment. The only thing we can do is educate them on the importance of keeping their files safe, through word of mouth and teaching* (SC_P4, pg 11:514-516).

The other group of stakeholders is the Department of Health (DoH). The DoH actively contributes to the activities and processes of healthcare in the country. Some of the key areas where the DoH participates on matters include (1) training of nurses and health workers; (2) provision of medical equipment; (3) formulation of policies that govern for both private and public health practice; and (4) formulation of policies that govern health professionals.

Through proper training of nurses and health workers, the DoH is able to ensure that patients are provided with the best care possible. The quality of care is not determined by just providing

a healthcare service but the manner in which it is provided, and this required training. When proper training is conducted and well-practised by staff, the facility benefits in two ways. Firstly, patients are exposed to better care from the facility and this increases their rating when evaluation takes place. Secondly, the DoH is able to invest more in the facility when it is evident that training has been effective. Investment enables Salem Clinic to obtain tools that help in bringing up the standard of care by the facility. These tools come in the form of skills and an advance in equipment.

Like any other organization, the availability of equipment is valuable to Salem Clinic. With proper equipment, medical and administration staff are able to conduct their duties with ease. This also contributes to the quality of care being provided by Salem Clinic. The DoH has provided this equipment such as computers and the medical apparatus within the facility. There are also plans to invest more in the technology of the hospital as it has been done in larger healthcare facilities. A radiographer briefly shares how they are using new technology to replace an old manual system that was used by Salem clinic:

> *We are upgrading and changing the way we are doing things in order to be more advanced and modernized. Everything is computerised, we are trying that and phasing out index cards* (SC_P6, pg 23: 1152-1156).

However, the DoH's participation on health matters extend beyond investment. The DoH formulates and promulgates policies to ensure that health resources are utilised correctly. One of the ways in which the DoH ensures the correct implementation of resources is through monitoring and evaluation processes. This allows some of the critical conditions of national interest, such as HIV/AIDs to be monitored. A data capturer at Salem Clinic identifies areas of prioritisation when it comes to monitoring and evaluation, namely, HIV/Aids and TB. Furthermore, they state why they are monitored:

> *HIV/AIDS and TB are considered to be the most dangerous of diseases in South Africa, therefore government pours a lot of money into them. That is why they need to know how many people are receiving this medication, getting lost in the system and the death rates* (SC_P5, pg 18: 876-878).

However, monitoring and evaluation becomes challenging, especially to those who are responsible for ensuring that it is carried out correctly. This includes data capturers of Salem clinic. In their participation with regards to providing care to patients, they have to ensure that the correct information is captured on the systems used by Salem Clinic. However, this has proven to be a challenge as patient data goes through different channels and people before they capture it. Incorrect manual capturing of patient data ultimately affects their ability to

contribute to patient care as it lowers the quality of the data on the computerised programs. An interviewee explains further:

> *Programs such as Tier.Net are affected because there are things that need to be recorded on the ACR (Adult Clinical Record), like the next visit date of the patient only to not find it on the file while the system requires it. Which is a challenge for you as data capturer, whereas it was not you who recorded that information. To those are the challenges which affect the database software used* (SC_P5, pg 17: 790-797).

The patients of Salem Clinic, both chronic and acute, have had to adapt to the processes imposed on them by the facility. Due to their need for medical care, they are required to follow these processes and to make use of the solutions introduced by the facility, specifically the chronic patients, who are registered under programs such as Tier.NET and ETR.net. As part of the policies set by the DoH, HIV/Aids and TB patients are required to register under these databases. Patients' participation is shown through their providing information to be inserted into these databases. An interview provides an example of the type of information patients would have to give out:

> *With programs such as Tier.Net, it's all about the patient. You capture their name, address, HIV status, ARV treatment and how well controlled they are* (SC_P5, Pg 17: 679:681).

There are different stakeholders enrolled in the process of patient care at Salem clinic. The medical personnel, administrative staff, Department of Health (DoH), and the patients. All of whom participate in different ways. The medical staff and administrative staff contribute through providing a service, while the DoH enables this through providing support, both financially and with technological resources. The patients of Salem Clinic stand to gain medical assistance; therefore, they are obligated to comply with the processes put in place by the facility. Be that as it may, their participation does not guarantee success and functionality of these processes and systems of Salem Clinic. Therefore, for them to be considered successful, mobilisation needs to take place.

5.3.3.4 Moments of Translation: Mobilisation

Salem Clinic encounters multiple spokespersons at various stages of the patient care process. Some of these spokespersons were elected by a higher authority, while others were self-appointed. The spokespersons responsible for mobilising other actors into participating in activities surrounding patient health were both internal and external to the organization. Internally, the elected representatives include management. As the decision makers, they can

enforce participation from the different departments within Salem Clinic. A participant states the following:

Everything is dependent on management because, as the verification committee we can only do so much (SC_P5, Pg.16: 787-789).

This may affect the facility both positively and negatively. From a positive perspective, a single point of power regulates the operation of the facility. This happens in two ways :(1) employees know who to report to; and (2) the DoH knows who to hold accountable for the on-goings of the facility. However, having a single point of power can also negatively affect productivity within the organisation.

Decisions regarding the facility can only be undertaken and implemented by the management. Therefore, in its absence, certain decisions and actions cannot be made, which can result in delays of the patient care process. Furthermore, the DoH that governs the facility places all responsibility upon Section 5.3 of Salem Clinic. This means that accountability is not shared across the organisation and this could negatively impact those who constitute management in the facility.

Like any other health facility, Salem clinic encounters emergency situations. In such cases, doctors are the elected representative of the patients in need of urgent medical care. As a smaller scale healthcare facility, there are cases they must escalate to bigger facilities that are equipped with more tools and resources. A nurse in the facility explains as follows:

If our doctors feel it's a case that needs emergency medical attention or a theatre then they refer to Frere hospital (SC_P1, Pg.6: 290-292).

In such cases, the doctor is a facilitator in the care process, starting from when they make the referral. They communicate the needs of the patient in their file, stating the reasons for referral, and how they attempted to assist them. This provides a background of the patient to the other facility and they can continue with the process from there.

This is of benefit to the patient as they may not be able to communicate at the time of referral. However, it could have negative implications because medical care is often time sensitive. This process is time consuming and a patient is not guaranteed to be attended immediately as they arrive at the other facility which could result in fatalities.

The facility encounters cases of patients who are unable to communicate their problem as they wait to be attended. This requires another party to act as proxy to the medical staff. The facility refers to those people as patient escorts. These can be relatives or friends to the patient. A nurse within the facility explains as follows:

In an emergency, we rely on an escort or file, depending on whether they have brought the file or not (SC_P4: Pg.12: 559-560, 70-72).

An escort is given the responsibility to articulate the patient's case as best as they can for them to get treated. This requires them to know the patient well so that they can give information to the medical practitioner. This is critical, especially in the absence of a patient file. With no view of the patient's history, doctors or nurses at Salem Clinic are unable to give prognosis and the treatment process is delayed. This becomes even more challenging when a patient is brought into the facility by someone who has no knowledge of them and was just there to assist. A doctor in the facility states:

Difficulty in obtaining information from a patient during an emergency is dependent on how well your escort knows you. If it's a stranger that brought you from where you collapsed or had a seizure, it's not that easy (SC_P4, Pg.12:562-563).

Clearly, the level of familiarity between the patient and their representative is crucial in the treatment process. Failure to thoroughly communicate the case endangers the patients as this requires doctors to treat patients without thorough background knowledge. Furthermore, this contributes to misdiagnosis and dispensing of wrong medication.

The DoH also elects representatives that visit Salem Clinic to ensure that the resources they provide are utilised efficiently. These resources include the medication they dispense to the organisation. This was done through the evaluation of data collected by the facility using headcount registers. A participant explains as follows:

The facility represents a catchment area with a certain number of people. This number is then recorded on the headcount register which is collected monthly. Then the department evaluates that out of this number, this many were treated. Thereafter, they can see whether you are reaching their standard (SC_P5, Pg.14: 666-670).

These evaluations ensure productivity in two areas within Salem clinic, namely Administration and the Medical Section. Administrative staff are tested on whether they are fulfilling their respective roles because they must ensure that headcount registers are done and reflect the correct information. Similarly, the doctors, nurses, and pharmacists must perform accordingly in their roles to ensure that the facility data reflects positively to the DoH. This is of benefit to the patients, as the facility should maintain a standard of decent quality patient care.

The facility often encounters challenges when it comes to patient care, due to patients' lack of commitment to the process. They came across issues such as patients defaulting on treatment and disregarding the importance of check-ups. To combat this problem, Salem Clinic employed tracers as their representatives in the community. A member of staff within the facility explains further as follows:

There is no other form of tracking available besides using the tracers and nurses available to enter patients' homes, giving medical care and check-ups (SC_P5: Pg 19: 948-949).

The availability of tracers in the facility ensures participation from the patients. However, it is not a firm solution because some patients do not insert their correct addresses on their folders, leading to the facility being unable to track them. In addition, tracers are only made available for chronic patients as they are of priority to the facility.

5.3.4 Results and discussion

From the above analysis, there are five main factors that influence the selection and use of big data analytics, for the analysis of healthcare data. As shown in Figure 5.2, this includes common health facility requirements, structure of the big data, integration of healthcare systems, availability of skilled personnel, and the availability of patients' data sets. These factors are all interconnected in one way or another.
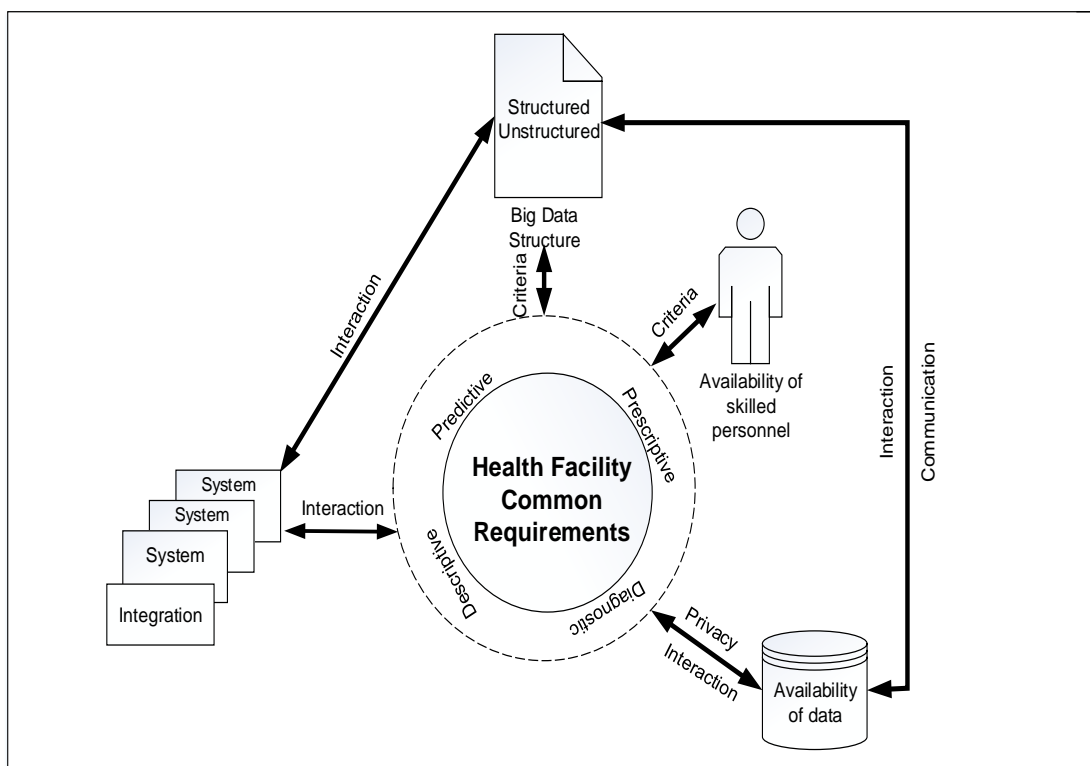

Figure 5.2: Health Facility common requirements

5.3.4.1 Structure of the big data

Salem Clinic has been in existence for many years and they have evolved in their way of handling data. However, they still use traditional methods in conjunction with technology and

both contribute equally to big data. This has resulted in structured and unstructured data. The structured data is sourced from their traditional filing systems. Their files contain textual data of the patient and these are all placed in their suitable fields. These fields contain data such as the individual's demographics and their reasons for visit. The technological tools used to capture this data are centred around these traditional systems. They are similar, but one is manual while the other is computerised; however, both generate structured data.

On the subject of technology, the facility uses different tools to carry out the patient care process. This includes computers, telephones, and x-ray machines. These tools generate unstructured data which comprises of voice, image, and video data. This data is equally as important as structured, but it often goes unattended to. This is attributed to the facility's data tools giving no consideration to them. This impacts Salem Clinic's data analytics, in the sense that there is a fundamental part of data that is not being included. This brings to question the completeness of data and its impact on the results that are yielded when it's analysed.

5.3.4.2 Data Tools

At Salem Clinic there were systems (tools), which were used to gather and store patients' data. These systems were provided by the South African Department of Health (DoH). The systems include Tier.Net, ETR.Net, and the District Health Information System (DHIS). These tools were designed mainly to store patients' data. However, the tools differ in terms of their criteria and requirements that are needed in deploying them.

Tier.Net was specifically designed to store data of patients who have been diagnosed with HIV/AIDS. This was due to the high influx of HIV/AIDS patients in facilities. The lack of infrastructure led to the facility being unable to handle patient data using only a paper-based system. However, before deploying the system, Salem Clinic had to meet certain criteria. These criteria include serving more than 600 patients and being unable to accommodate patient data using only a paper-based filing system. Considering that this is a technological solution, the facility had to migrate to using computers as a requirement.

ETR.Net is a smaller system created specifically for patients who have been diagnosed with TB and are in need of treatment. The system was designed to capture patient data from the diagnosis stage until treatment is successful. Since this is not a lifelong disease, specifications and requirements stated that a patient may only exist on the system for six months, as this is the TB treatment period. Thereafter, they would be removed from the system unless they relapse. From the facility's perspective, it was meant to improve data co-ordination with regards

to TB patients. Therefore, the only criteria were facilities who diagnose and treat patients diagnosed with TB.

The District Health Information System (DHIS) was designed to store data for all patients who visit the facility. The purpose of this system was to collect statistical data of the facility's patients' therefore, the criteria was location based. The system encompasses data of patients who reside in that catchment area. Therefore, the only requirement was that the patient seeks treatment from the facility.

These systems were deployed successfully; however, they are still flawed. Tuberculosis is an opportunistic disease that can also affect an HIV/AIDS patient. The same patient can also exist in the facility database (DHIS). This brings about issues of duplication and this has not been fully explored by the facility. These issues relate to lack of integration between the databases. Another issue is failure in establishing common requirements with regards to data analytics. The facility has not explicitly stated what they would like to gain from the data.

5.3.4.3 Health facility common requirements

The existence of big data is futile to the organisation unless they know what they seek to gain from the data. The facility has tools at their disposal; however, they have not considered the potential of their data. There are no common requirements stated with regards to big data and how it can improve the quality of healthcare in the facility. There are various options available that could be of benefit to their cause. However, the choice is dependent on the facility's common requirement, which they have not yet established. These options include (1) prescriptive, (2) predictive, (3) diagnostic, and (4) descriptive big data analytics.

As a healthcare facility, Salem Clinic lacks the necessary tools to determine which illnesses mostly affect patients that visit the clinic. Therefore, they have no knowledge on what areas to prioritise in an attempt to reduce the number of patients visiting the clinic with the same problem. There are only two areas of focus in the facility, namely HIV/AIDS and Tuberculosis. These diseases are only prioritised under the DoH's command. However, with the help of prescriptive analytics, the facility could find out what health issues are prevalent in the community. These would be specific to their patients and they would know which areas to mostly focus on.

Additionally, Salem Clinic is based in an area that is prone to health outbreaks. This is due to the living conditions of people and lifestyle. However, the facility has no foresight on these outbreaks due to insufficient use of their big data. With the use of predictive analytics, they

could view patterns based on past occurrences. These could give them a view of what could most likely happen in the future with regards to patient treatment.

Similarly, diagnostic analytics would be highly of benefit to the facility, mainly because it serves a big part of their purpose. The facility would be able to uncover the reasons behind occurrences; thus, enabling them to prevent its repetition.

Mining the data through descriptive analytics would help the facility gain knowledge on rampant issues affecting patients. Further investigation into these problems would help in improving the patient care process and standard of the facility. However, these tools can only be of use once the facility uncovers its purpose for big data. That would help in determining which data analytics tools suit the facility's goals, and this requires an explicit communication of their requirements.

This brings about the issue of integration within the facility. The type of data analytics tool to use is most likely to be determined by the medical personnel of the facility. The medical personnel know what issues they face due to lack of foresight and insight. Therefore, they should be working jointly with those who handle data in order to find a data analytics solution best suited for the facility. However, that is not possible unless integration of the different units in the facility takes place.

5.3.4.4 Integration of healthcare systems

Several issues affect Salem Clinic. These are rooted in the dispersion of resources meant to serve patients visiting the clinic. This includes the staff and technological resources of the facility. Salem Clinic lacks a properly co-ordinated patient care system. There are five different departments, all operating under the same facility but somehow, they are still disintegrated. This is from the perspective of operations within the facility and the process that data goes through.

The facility has five different departments and they all have the same purpose of serving the patient. In all these departments, a report has to be written on the patient file and it has to indicate what was conducted and the next step in treatment. In that process, the data is prone to error because many people are involved in carrying it out. By the time all data has been collected, it is difficult to trace where errors occurred.

These errors decrease the quality of data being collected in the facility. Thus, leading to analysis being conducted on data that are not up to par. This could be avoided if integration

was in place because data would be collected and updated in real time. The issue also relates to level of knowledge around data analytics in the facility. These problems cannot be raised, because no skilled personnel are available to provide input regarding data, its importance, and how it can be analysed.

5.3.4.5 Availability of skilled personnel

The facility, Salem Clinic, has been in operation for a decade. Even though the health clinic has been in operation for many years, it continues to use the same manual systems to capture and store patients' data. This is irrespective of the fact that the DoH has provided technology solutions (systems) to health facilities in the country, including Salem Clinic. The limited use of the technologies is attributed to lack of knowledge and know-how, which results to unavailability of skilled personnel.

The facility is also lacking in terms of skilled personnel to handle the data that accumulates daily in the facility. This brings the facility's management into question as they are responsible for decision making in the facility. Management has failed to address skills acquisition for data analytics. This includes education, training, and retention of staff who specialise in data analytics. This has led to the neglect of data analytics, which would help in improving the healthcare standard of Salem Clinic.

5.3.4.6 Availability of data sets

At Salem Clinic, patients' data were accessed by different personnel. This includes clerks, nurses, doctors, radiographers, pharmacists, and data capturers. As a result, patients' data were split into sets in accordance to area of specialisation and responsibilities. For example, the clerk can only have access to patient data which relates to administration, such as contact details and bio-data. This makes certain sets of data unavailable to some personnel. The unavailability of the entire data makes it difficult or challenging for the analytics approach, which somehow affects the completeness of results that are obtained from big data analysis. However, at the same time, it must be noted that the unavailability of complete data is often justified from privacy and security perspectives.

The availability of patients' data requires policy and regulation in order to manage and maintain the privacy and security. Privacy is a valued element in patient information. It creates a sense of trust between the patient and medical caregiver. This is based on the sensitivity of information shared during the treatment process. It ensures that a patient knows that any information they divulge is kept between them and the person treating them. However, this affects the completeness of data based on the fact that some information regarding the patient

is only limited to certain people within the facility. This brings about the aspect of security as well. Patient information requires a high level of security. The facility has to ensure that information shared by a patient is not accessible to anyone unless consent is given by the patient. This requires regulation, and this is done by limiting access only to those who are treating the patient. This is to avoid cases of patient data being used for malice or a data leak that could have legal consequences. Therefore, the facility can only make certain sets of data available for consumption.

There are other issues that contribute to incomplete data, such as the medical staff failing to write down full reports of patient treatment. In addition, the facility lets patients keep their own files and this leads to damage of patient files and loss of information. This affects data analytics of the facility negatively as they are now required to conduct analysis on incomplete data. These issues stem from a lack of integration within the facility. Data is only prioritised by one part of the facility, namely the data capturers, whereas, the different departments should be working in conjunction as they all contribute to big data. The facility lacks an integrated data process from the beginning of patient treatment until the last stage.

5.4 Case 2: Sunnymed Clinic

Figure 5.3 presents a holistic view of Sunnymed Clinic from ANT's perspective. The figure is presented in order to express the existence of actors, and how they are connected at the organisation. This is followed by the analysis of data from the organisation, Sunnymed Clinic.
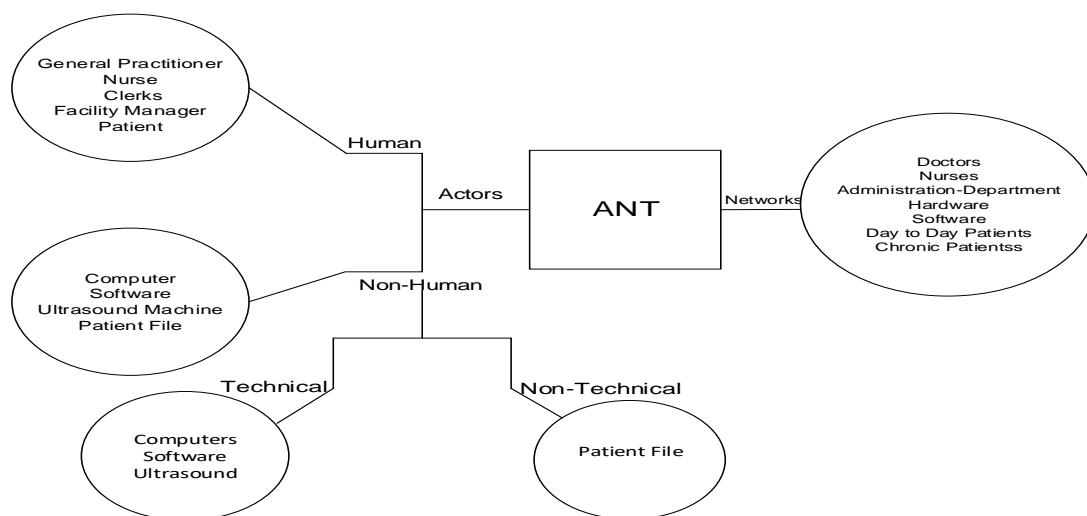

Figure 5.3: Actors and Networks of Sunnymed clinic

5.4.1 Actors

Sunnymed Clinic is made up of both human and non-human actors. The actors include employees which are classed into two categories, namely the medical and administrative units. The classification is done in order to distinguish between their roles and responsibilities, and to link them to actions that were carried out in the course of service delivery to the community. The medical staff are the general practitioners and nurses, while the administrative staff consists of the facility manager and the clerks or clerical assistants at the Sunnymed Clinic.

The medical staff are responsible for the medical treatments of patients, which include carrying out the medical care processes. The administrative Section is tasked with ensuring that the clinic functions in an orderly and timeous manner. The facility also has patients who seek the services offered by the facility and they play a major role in how Sunnymed operates. From the perspective of ANT, these role players are all regarded as the human actors.

The actors mentioned above all make use of IS/IT tools and artefacts to carry out their responsibilities. From an ANT perspective, the IS/IT tools and artefacts used at Sunnymed Clinic are regarded as non-human actors. These non-human actors include data, IS/IT tools, and medical apparatus. Data consists of patient medical files. These files contain the patients' biodata, test results, and medication prescribed to them. IS/IT tools include the computers that are used by both medical and administrative staff. The facility also conducts scans on patients and this is done using medical apparatus such as ultrasound machines. An interviewee states as follows:

> *Patient information is captured on their files among the notes made by the doctor in connection with the patient* (SM_P2, Pg 6: 238-240*).*

At Sunnymed Clinic, the employees and management accumulate different types of data. This include voice, text, and image. Voice data are sourced from telephone communication carried out by both medical personnel and administrative employees. The medical staff makes use of telephones to communicate with the patients as well as refer some of them to specialists. The facility also uses a booking system, and this is carried out by the administrative staff using telephones. Text consists of all written data from the medical and administrative staff. The medical staff writes down notes on the patient's case, including diagnosis, treatment, and prescribed medication. Administrative staff use registers to note patients who are visiting the facility daily. Both medical and administrative staff make use of E-mails to communicate with the facilities they liaise with, such as the laboratory. A participant state as follows:

> *We send blood samples to the lab, they return the results in paper and they also e-mail them* (SM_P2, pg 11: 490-492).

Image data in the context of Sunnymed Clinic is derived from scans and X-rays. These are helpful to the medical staff as they form a big part of conducting an accurate diagnosis. A participant explains as follows:

When a patient gets x-rayed, they get that CD, thereafter the doctor explains to the patient what they find in the x-ray (SM_P2, Pg 10: 445-446).

Sunnymed is equipped with IS/IT tools such as personal computers and the software they run on. These are used to support the functions of the facility, so they are used by both the medical and administrative unit. However, they use them for different purposes. The medical staff uses computers to store patient information. A doctor within the facility explains as follows:

We've got a patient manager, which is a system that allows us to capture everything including the patients' photographic images. I can access from my personal computer, which allows me write notes, and attach results and x-rays (SM_P3, pg 14:635-639).

The administrative employees use IS/IT tools differently to the medical staff. The clerical assistants use personal computers to obtain patient file numbers and extract information such as their names, surnames, and addresses. A participant explains as follows:

After you get the patients' information, you then capture it on the system. Then that's where we get the file number (SM_P2, Pg 13:555-557)

Even though the actors are both human and non-human, they play an equal role in the accumulation and use of big data at Sunnymed Clinic. This means that the actors had relations, which were formed in groups, referred to as networks in terms of ANT.

5.4.2 Networks

Sunnymed is divided into two units, the medical and the administrative unit. The medical unit is made up of doctors and the nurses employed by the facility. A participant gives a brief description of the network and how they interact:

We have four doctors employed at the facility. Two doctors work at a time so they rotate according to the roster (SM_P2, Pg 9:379-380).

The administrative unit, on the other hand, consists of clerks and the facility manager. This group is responsible for ensuring that the facility operates as it should, following a systematic process. They also act as the assistants to the medical practitioners employed by the facility

There is also a network of patients. These patients were unconsciously grouped into two, the chronic and day-to-day patients. Chronic patients were those who required treatments for long-

term illnesses. These groups of patients visit the facility regularly, for check-ups, medications and any other tests that may need to be taken. The day-to-day patients were those who visits the clinic once-off, to get specific treatment. Additionally, the day-to-day patients are not necessarily committed to the facility.

The facility currently has no IT department even though they use IS/IT tools. These tools then form a network through their aligned interests.

Both medical and administrative staff contributes to the accumulation, processing and, storage of data within the facility. This data has different purposes however its main contribution is towards patient treatment. It enables the medical practitioners to make better decisions with regards to treatment process. The next Section presents the stages that data goes through until it reaches a point of usefulness for Sunnymed Clinic. This is explained further through the four moments of translation

5.4.3 Moments of Translation: Case 2

This Section presents the four moments of translation. These consist of problematisation, interessement, enrolment, and mobilisation. These four moments were used as a guide for the analysis of Case 2: Sunnymed Clinic. Each moment is discussed individually.

5.4.3.1 Moments of Translation: Problematization

At Sunnymed Clinic, which focuses on patients' medical conditions, problematization happens through two ways: (1) patients visit the facility; and (2) telephonic and electronic mail (e-mail) communication between a patient and health practitioners. As the patients' conditions are problematized, the clinic accumulates a substantial amount of big data on daily basis. The big data consist of patients' information, which include biodata, diagnoses, prescriptions, and medications.

This stage of big data accumulation is essential in the delivery of services to the patients in that the medical practitioners' access and gain more knowledge about individuals' medical background. This makes problematization critical in providing healthcare services. This is also because healthcare-related decisions are informed and guided by the original information, and health record about the patients. Once the initial communication has been established through visit to the facility or telephonically or by e-mail, the process of accumulating big data continues in the following two steps: (1) observation and (2) consultation.

Before a patient is seen by a doctor, an observation takes place. This process is conducted or administered by nurses. Part of the process includes a urine, diabetes, and blood pressure (BP) checks. After a patient is done with their observation, the consultation takes place. This step requires the patient to share the details of their illness in depth. This is conducted by the nurse or a doctor within the facility. A participant explains as follows:

> I do the observation of patients as they visit the clinic. The observation that I do include checking of the BP, diabetes and urine, before the patient goes to see the doctor (SM_P1, pg 3:91-93).

These two steps are an important part of problematizing patients' health conditions before services are rendered. They play a pivotal role in the overall provision of healthcare services. This compels the patient to be open and honest about their illness. However, the facility encounters challenges at this stage. Patients are not always forthcoming about their illness and this affects the treatment process. A nurse explains as follows:

> There are patients that would not want to say a word and state that they would prefer to see the doctor and not me. (SM_P1, pg 3:126-127)

Such encounters are attributed to different factors such as the patients' familiarity with the staff. Most patients who visit the facility have been treated by one doctor for many years. They have built a sense of trust and loyalty with their physicians. Thus, it becomes an issue when they encounter a new person that can treat them. This affects the treatment process as some patients refuse to be treated by anyone besides the medical practitioner with whom they are familiar.

The manner in which information is collected from patients also contributes to this issue. The facility is small in size and this affects some parts of the treatment process. The staff are forced to collect personal information in the presence of other patients. Some individuals find this invasive, which leads to them not fully disclosing their reasons for visit. A participant explains as follows:

> Some people are a bit uncomfortable about the information collection process because at times, there are other people there as well. You now have to stand there and you have to ask personal information (SM_P1, Pg: 202-205).

From a patient's perspective, the approach of the medical personnel assigned to their case plays a role in how they respond and divulge information. Some patients find many of the healthcare practitioners to be intimidating, impatient, and harsh. This may lead to some patients having trouble expressing themselves about their illnesses due to the attitude of staff during the

consultation process. These perceived attitudes of healthcare staff may make it seem to patients that they are insensitive towards their conditions.

Patients often feel intimidated when they are addressed by the facility's medical practitioners. This is attributed to their attitude during the consultation as they tend to be abrupt in their approach. They neglect the importance of being accommodating to the patients and their issues. Medical care requires patience, as it is a delicate area. However, some health practitioners in the facility are not accommodating to patients who struggle with articulating themselves. Their impatience results in individuals being unable to express themselves fully. Moreover, these individuals are often harsh to the patients which goes against principles of the healthcare environment. It is the medical practitioner's duty to ensure that they address patients respectfully and pleasantly. As a result, many patients find it difficult to fully provide information about their health conditions. An interviewee states as follows;

> *Some of the new staff tend to be harsh and they don't have patience* (SM_P5, pg 32: 1451).

Some of the health practitioners are fairly new to the facility and this forms part of the challenge. They have not created any relationship with the patients yet and this contributes to their attitude towards them. This creates tension in the environment as they have not taken time to make their patients comfortable so that better communication can take place. These issues also relate to the different backgrounds of the patients and medical practitioners. Language and socio-cultural differences are a standing issue within the facility. As a result, some of the staff find it difficult to communicate with patients thus resulting in (perceived) intimidation, impatience, and harshness.

Patients who visit the facility come from various cultural and linguistic backgrounds. This affects communication between them and the medical personnel during the consultation process. Due to their differences, patients are often unable to express their problem without the presence of an interpreter. This affects the privacy during consultation as patients become wary, due to the presence of a third party. A doctor states as follows:

> *I think the challenge is one, language, because it's a diversity of cultural groups, Africans, Xhosa, Sotho. We have to get someone who understands the language to interpret or capture* (SM_P3, Pg 20: 887-890).

The information collected at this stage is utilised by the medical personnel to take the treatment process further. Diagnosis, treatment, and follow-up are all conducted based on this information. This makes full disclosure of importance during problematization. Although roles have been established at this stage, various factors come into play to determine individuals' interest in the care process.

5.4.3.2 Moments of Translation: Interessement

For each medical case within the facility, various actors took interest. These actors include the patients, patients' relatives, medical personnel, and medical aid schemes that cover individuals visiting Sunnymed Clinic. Patients expressed their interest through making appointments via telephone communication or doing a walk-in. Additionally, patients' relatives often accompanied these individuals to the facility, to ensure that they receive the health services they seek. Furthermore, the health services offered by Sunnymed Clinic come at a cost and these were often funded by medical aid schemes. As a means of displaying their interest, these medical schemes encourage their patients to visit the facility for their health check-ups. However, for each of these individuals, different factors were driving their interest in the services offered by Sunnymed Clinic

Patients were particularly interested in the health services offered by the facility, due to their need for medical care. These individuals' interests were driven by one goal and that was to treat their health conditions, through services offered by the facility. The services include patients' health assessment, specialist referrals for cases that cannot be handled by the facility and prescribing and dispensing of medications.

Patients' relatives, including friends, also had interests in the facility's health services. This was triggered by their concerns for the patients' well-being. These individuals' interest was expressed through ensuring that patients receive help from the facility. An interviewee states as follows:

> *In most emergency cases, the patient won't come alone. There are always two or three people accompanying the patient* (SM_P2, Pg 11:458-459).

Medical personnel are essential to the treatment care process of the facility. Their skills and knowledge are what is used to carry out treatment. This triggers their interest in conducting health activities. As healthcare providers, they have a duty to uphold both towards the patients and their structure of authority that governs the facility.

The majority of patients who visit the facility are under medical aid schemes, while the minority chooses to pay cash. These medical aid schemes have a devoted interest in patient treatment as they are financing the process. These stakeholders express their interest through ensuring that patients constantly go through routine tests. These are conducted to test whether patients are in a good state of health while being medically covered by these schemes. An interviewee states as follows:

Medical Aid schemes advise doctors to see chronic patients twice a year. In 6 months, patients do a blood test and other checks. When we receive the results, they are sent back to their medical aid (SM_P2, Pg 11: 503-506).

Medical aid schemes also show interest in patient care process by motivating the facility to conduct regular checks on patients. They offer rewards to the facility as means of ensuring that they monitor every patient that they cover. This helps the facility keep track of patient progress and also reveals any health care issues that may arise during treatment. Their interest is based off financial gain. When patients are regularly monitored and treated, there are less claims to the medical scheme. A doctor within the facility states as follows:

We get incentives for monitoring patient progress and that motivates us to do so (SM_P3, pg 23:1026-1031).

Different factors sway interests of the various stakeholders in the facility. Medical schemes stand to gain financially from the treatment of patients at Sunnymed Clinic; therefore, they take interest in the care process. Patients seek healthcare services from the facility in order to improve their health and this triggers their interest. The medical personnel are also obligated to take interest in patient care as this is the core of their job role. However, their interest does not guarantee participation. There are different factors that drive participation and ensure that individuals fulfil their different roles.

5.4.3.3 Moments of Translation: Enrolment

Various stakeholders participated in the gathering of big data about patients, the use of the big data to provide service, and the management of the datasets at Sunnymed Clinic. Participation from the various stakeholders was determined by different factors. These include their roles and responsibilities, health issues, and financial interests.

Patients are the core of Sunnymed, as the facility exists to provide healthcare services. Sunnymed provides services to over 70 patients daily and these individuals participate in the activities that take place at the facility. This decision is driven by one goal and that is to better their health. Their participation is in the form visiting the facility and going through the patient care process. This starts with registration wherein patients provide their personal details and ensure that they are captured on the facility's database. Thereafter, a consultation takes place, during which individuals are required to describe their condition in order for the facility to provide necessary healthcare services. However, participation is not always guaranteed, as some patients often refuse to get treated. This is due to factors such as their social backgrounds. An interviewee explains as follows:

Another issue is social background. E.g., when a man has to see a nurse. A young nurse, it becomes a problem because they can't be attended by someone they deem to be younger (SM_P3, Pg 22:977-979).

Medical personnel are invested in the patient care process. This is attributed to their responsibility towards their patients and the facility. Doctors are required to take part in providing health services as they are the main caregivers in the facility. As healthcare providers, they have taken an oath that holds them responsible for patients' health. Therefore, their participation is presented in the form of ensuring that they give patients the best medical services. That applies to consultation, diagnosis, treatment, and the follow-ups granted to patients.

The facility has a strategy that aims to ensure participation from its medical personnel. Patients are advised by the facility to provide feedback on the services they have received. Sunnymed uses the information provided to assess the areas they feel are lacking and to improve on their current processes. Through this strategy, they are able to hold those who are not adhering to the facility's standards accountable.

We conduct self-assessments based on the information given by the patients when they come. We use that to improve our services (SM_P3, Pg 26: 1166-1169).

Nurses are the first line of assistance in every patient's case. As part of their job roles, they are required to assist doctors in conducting certain tests prior to the patient seeing the doctor for consultation. Their participation in the patient care process is shown through carrying out these tests and reporting to the doctor. The results obtained from those tests are pivotal to the care process, as this information forms part of the patients' medical record; thus, making it important to treatment. The nurses' observation provides doctors with insight on the patient's case before treatment can be administered. Therefore, their participation can be monitored through having that information gained through observation align with the doctors' findings.

Lastly, administrative personnel are there to ensure that the facility runs efficiently and effectively. This starts from the registration stage until the patient leaves the facility. This unit of the facility partakes in patient care by ensuring that patients follow a process as they go through their different stages of acquiring healthcare services. They also act as a liaison between the medical staff and external associations such as the specialists, laboratories, and pharmacies that provide services to the facility. Their participation is measured by how functional the facility is. The administration unit is overseen by the facility manager. Their activity in the care process is monitored by this appointed individual. A part of their duty is to

ensure that individuals in the unit are present and participative in the facility. The facility manager explains as follows:

Every morning I must make sure that everyone is here at the opening time and that the things we use to operate the surgery, like medicine are available (SM_P2, Pg 9: 365-369).

Even though the job roles between the medical and administrative differ, they are still required to work jointly. This is to create a systematic care process that ensures delivery of the best healthcare services.

5.4.3.4 Moments of Translation: Mobilisation

As the Clinic provides services to the patients, there were spokespersons. Some of the spokespersons were representatives of the Clinic, while others were patients and relations of the patients. These representatives include the medical personnel, patients, and interpreters. The individuals mentioned were either appointed or self-appointed. Their representation was driven by different factors. These individuals were tasked with the responsibility of enforcing participation from the different units with the facility. The spokespersons were both internal and external to the organization. Internally, the medical personnel are the elected spokespersons as they drive medical activities within the facility.

As medical caregivers, they act as representatives of patients. Amongst these spokespersons were nurses and doctors. As the first line of assistance in the facility, nurses are elected as representatives of the patients. They are given the responsibility of communicating a patient's case to the doctor, using the information that was collected during observation. These individuals are there to provide a preliminary analysis of the patient's case and further explain to the doctor what the problem could be. However, this is not always the case, as some patients prefer consulting with just the doctor.

Doctors also act as representatives in the patient care process. This is done through referrals and prescribing medications to patients. In cases where patients cannot be assisted at the Sunnymed Clinic, they are referred to a larger facility to receive the services they need. Doctors at Sunnymed Clinic are responsible for carrying out the referral. They take it upon themselves to contact the facility to which the patient is being transferred and informs the individual of further steps to take. They have to communicate the patient's needs to the other party, in order to ensure that they receive effective medical care. This requires a breakdown of the patient's medical background. This is to give the other medical practitioner a clear view of the patient's history in order for them to conduct proper treatment. However, this is met with challenges, as

issues of privacy come into play. Consent is required from patients when their medical information is to be shared. This was imposed by the Protection of Personal Information Act (PoPI) and the facility is obligated to abide by this act. A doctor within the facility states as follows:

> *"The new PoPi Act states that patient information is strictly confidential" SM_P3, Pg 16: (719-722).*

The facility is also in partnership with pharmacies. This enables Sunnymed Clinic to prescribe and dispense medication. Sunnymed Clinic gives its patients the option to collect medication from their preferred pharmacies or they can collect directly from the facility. In this instance, doctors have to represent the patient. This is done through making a request for the prescribed medication to pharmacies with their network.

Representatives who are external to the organisation include the patients and the elected interpreters. The facility requires patients to present their cases themselves to the medical practitioners. This allows the individual to demonstrate and describe their reason for visit to their own accord. In this sense, patients are self-representative. However, this representation is not always effective due to challenges such as language barriers. This brings upon the need for interpreters.

Language as a challenge is a standing issue in the facility as they serve patients of different ethnicities. This makes it harder to obtain information from patients as the medical caregiver or patient struggles to understand what is being said. As a result, the facility may elect interpreters for cases where language is a problem. As one participant points out:

> *Somalians bring their own interpreters, or we have to call the neighbours* (SM_P3, Pg 20: 894-895).

As the elected representative, the interpreter has to ensure that they articulate the patient's problem as best as possible. This will enable the health practitioner to conduct accurate diagnosis and equip them with enough information to provide the proper health services. However, language and dialect are not easily translatable to the medium of communication, which is English. This leaves a dent on the information provided. This brings about the importance of patient's medical background. The medical practitioner needs to have a clear view of a patient's history. This information would allow them to link what is being said by the interpreter to previous occurrences. Furthermore, it would contribute to the solution a medical practitioner provides for the case.

5.4.4 Results and Discussion

From the above analysis of data that was gathered from Sunnymed Clinic, five factors, namely datasets, medical apparatus, data integrity, data analysis, and health organisations, were found to contribute to the clinic's big data. As shown in fFgure 5.4 these factors are the main sources, and at the same time influence facts and figure through the use of big data analytics.
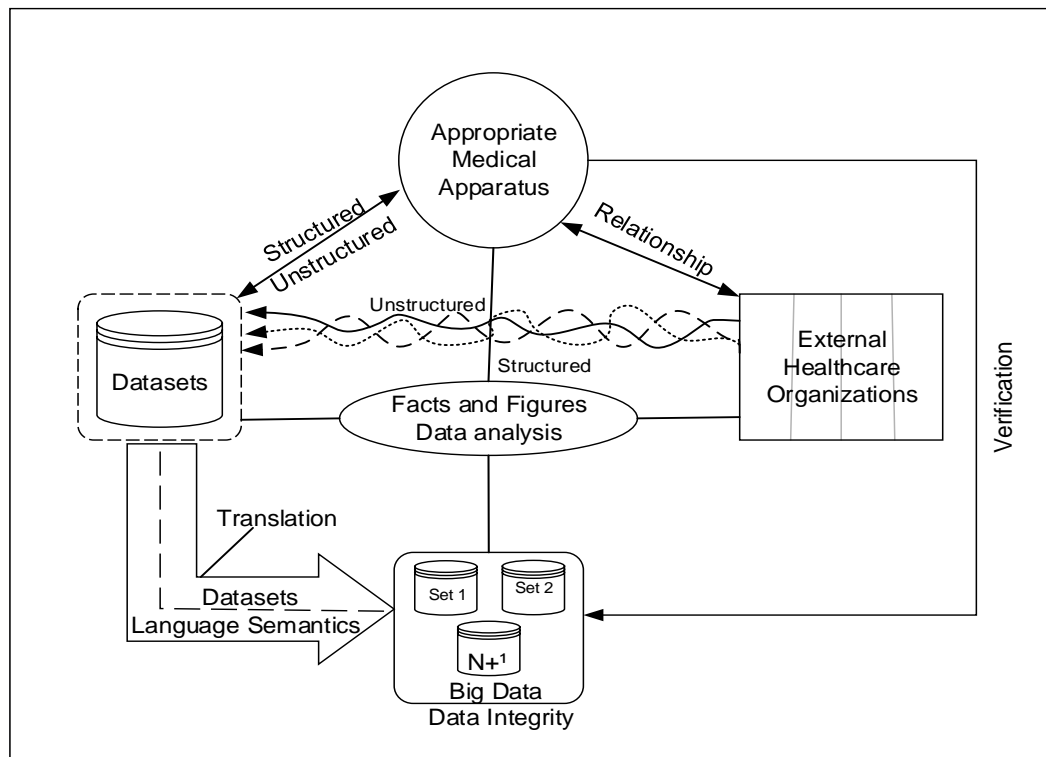
Figure 5.4: Facts and Figures

5.4.4.1 Datasets

Sunnymed Clinic as health facility accumulates big data, which consist of patients' information, on daily basis. This information was obtained during patients' visitation, consultations with medical personnel, diagnoses, and medications. A part of this big data comes from within the health facility, and others were gathered from external sources. As gathering takes place, the data was both structured and unstructured. The facility data consists of files that store all patient information.

However, the facility encounters different challenges while providing healthcare services to patients. Amongst these challenges are patients refusing to be attended to by medical practitioners of the opposite sex. This is attributed to patients' different social and cultural backgrounds. This has led to medical practitioners having to omit some parts of the treatment

process, to respect and accommodate individuals' beliefs and traditions. However, these tests are pivotal to the treatment of patients. They assist in providing thorough knowledge on the patients' cases. Furthermore, these tests contribute substantially to the facility's data. Therefore, the exclusion of some part of healthcare activities negatively affects data analytics of Salem clinic. The medical practitioners are compelled to insert data that is incomplete in patients' files. This further leads to a disjoint in patients' big data as some parts get missing. Incomplete data sets compromise the data integrity This brings about the need for translation of the facility data. The facility has ignored the importance of translating the data and this ultimately makes it hard to put it into perspective.

The different cultural backgrounds also affect the application of data analytics. The currently available tools originate and are mostly used in developed countries such as the United States of America. Therefore, they are built to suit the needs of Europeans, who may be a more westernised population. This puts African facilities, such as Sunnymed Clinic, at a disadvantage, as these data analytics tools and their application do not accommodate the cultural backgrounds of their patients. This brings about the need for customised data analytics tools, that could suit the needs of Sunnymed Clinic's patients to be neglected. This has led to collecting and analysing data, which does not work for all patients who visit the facility.

5.4.4.2 Appropriateness of Medical Apparatus

Sunnymed Clinic is classified as a small-sized facility, based on the limited health services provided. The clinic was unable to conduct certain services due to its limited access to resources, such as lack of appropriate medical apparatus and personnel. This results in the clinic delegating some of its health services to external parties who could perform the tasks. Some of these services included X-rays and other medical tests conducted on patients. This forces patients to visit medical practitioners with whom they were not familiar to get that one service or the other.

Delegating health services to external parties affects the facility's big data in different ways, from accuracy to completeness. Even though Sunnymed Clinic often briefs the facility a patient was referred to, there was no guarantee that the information received about a patient and his/her medication or medical condition is accurate. This could be attributed to limited knowledge or an understanding of the medical personnel that was involved. This compromises the facility's data as the x-rays and medical tests may present inaccurate results. Inconsistency within the facility's data is also an issue due to outsourcing some services. In addition, questions about patients' medical condition and history (including family tree and hereditary diseases) are sometimes omitted, intentionally or unconsciously. This means that the

information collected and stored in a patient's medical history may be incomplete; yet, this information is still used in the analytics of data.

Failure to conduct all-inclusive tests impacts the results, as some important issues may be missed. This further affects Sunnymed Clinic's data as these results are inconclusive and fail to provide a diagnosis that has all potential health factors considered. This causes a disjoint in the patient's data, resulting in flawed results when analysis is conducted. Furthermore, combining data from these facilities with that of Sunnymed Clinic becomes difficult as they do not coincide. This bring about the issue of verification, as the facility has no means of verifying the data coming from external sources and this further impacts its integrity. The facility's failure to verify their data means that they have to make decisions based on data that is possibly incomplete and inaccurate.

5.4.4.3 External Healthcare Organizations

Due to the limited resources and infrastructure of the facility, Sunnymed Clinic seeks services from three different organisations in order to support their daily functions. These include external laboratories, specialists' facilities within their network, and pharmacies that supply medications to the facility. External laboratories are outsourced to conduct different medical tests that contribute to conducting diagnosis. Once these tests have been conducted, they are sent back to Sunnymed, where they are used to support decision-making regarding a patient's health condition. There are also medical specialists that the facility interacts with or consult. These individuals provide specific expert opinion about patient's health condition, towards decision-making, mostly at critical situations. This is done through providing the facility's medical practitioners with deeper insight into individuals' medical issues. After diagnosis and different medical opinions have been considered, the facility attempts to treat patients through prescribing medication. However, the facility does not have a pharmacy at their disposal. This has led to Sunnymed Clinic associating itself with different pharmacies that supply the facility with medication. The entire processes and channels as described herewith contributes various types of data, which can be used for analytics.

The three organisations (external laboratories, specialist facilities, and pharmacies) all provide different services to Sunnymed Clinic at the time of this study. This also means that the organisations provide various types of datasets, from texts, videos and images at different quantities to the Sunnymed Clinic. The datasets were either structured or unstructured. This brings about two challenges, namely data dispersion difficulties in data merging. These entities were all divided, due to their different functions. This means that all their data relating to Sunnymed Clinic is dispersed when it arrives at the facility. This was a challenge because it

affects the continuity within patient information. Furthermore, it becomes even more difficult to merge the facility's data with that of these external entities.

5.4.4.4 Language Semantics

The facility has taken the initiative to use interpreters during consultations. This was to curb the language barrier between the medical practitioners and the patients. The interpreters were required to have better understanding of communication between the medical practitioners and the patients who needed interpretation. However, despite engaging interpreters, challenges still occur in some instances. The persistence of some of the challenges was caused by semantics and differences in the dialects in African languages. The implications of this include miscommunication between the interpreter and the medical practitioner and medical practitioners noting inaccurate information due to an incorrect translation of patients' interactions. This brings into question the accuracy of data collected during consultations. Furthermore, collecting inaccurate data negatively impacts analysis, irrespective of the analytics tool that was employed. The results would be flawed as they will be presenting inaccurate conclusions on the patients' case; hence many patients have been medical victims over the years.

From another perspective, the engagement of an interpreter by Sunnymed Clinic during medical consultation between patient and practitioner induces a different type of challenge, such as privacy. The South African DoH, though its policies, insists on the protection of patients' privacy. The involvement of an interpreter means that the patient had to divulge personal information in the presence a third party. Additionally, there are no non-disclosure agreements lawfully binding the interpreter to not share what was said during consultation. This puts patients at risk of having their information shared unfairly or maliciously.

In response to self-protection, some patients do not fully disclose their problems in the presence of a third party. Consequently, this may have serious implications and risks for the patient as s/he has not provided complete information about his/her health condition. Patients are treated in accordance with the information that they provide, where full diagnoses are not carried out. Even when diagnoses are carried out, it is based on the available information. Furthermore, the information collected during these consultations form part of Sunnymed Clinic's big data, which undergoes analytics. Therefore, patients' failure to disclose their problems hold consequences such as incomplete data-sets. In addition to that, the integrity of the data may be compromised, as the results from analysis may not reflect patients' real issues.

5.4.4.5 Data integrity

Sunnymed Clinic collects a substantial amount of data on a daily basis. The data is collected from both internal and external (other organisations) sources. The external organisations included the facilities that provide appropriate medical apparatus and the external healthcare organisations who support their daily functions. However, there were challenges affecting the data accumulated by the facility. These challenges include incomplete datasets. This was a challenge because it affected the integrity of the data, which were relied upon for patientcare. Moreover, the facility's data integrity was sometimes compromised, as revealed during this study. This challenge was created during translation in communication between the patients and medical practitioners and was enacted due to factors such as a lack of verification. Sunnymed Clinic fails in verifying data coming from external sources because they lacked the resources to do so. This negatively affects the data as analysis was conducted on datasets that were inaccurate and incomplete. This means that some results which influenced some decisions were based on a flawed outcome of analysis.

Sunnymed Clinic was also dependent on translation of the data. This was from the aspect of language and translation of datasets in order to put them into perspective. However, the facility encounters challenges in this regard. There was no proven method for translating data within the facility. From a language perspective, they have no means of guaranteeing accurate translation from the different South African languages to English. From the aspect of data, Sunnymed Clinic was unable to make sense of the copious amount of data encountered by the facility due to their lack of data analytics tools or means of managing the data. These factors challenge the facility's data integrity. Furthermore, it compromises patients' health as decisions are made based on data that lacks integrity.

5.5 Interpretation of results

The results from both cases, Salem Clinic and Sunnymed Clinic, were combined and interpreted. The 'influencing factors' Section of figure 5.5 shows the combination of the results from both cases that were studied. Based on the interpretation of the findings as presented in Section 5.3 and 5.4, a big data analytics framework (figure 5.5) was developed. The framework is presented and discussed in this Section.

The framework is intended to enable the analysis of healthcare big data at two different levels. The first level helps to identify, examine, and understand the networks, which consist of historical records, diagnoses, results, and medications. The second level enables identification of the factors that influence the selection of analytics tools as well as the analysis of the big

data about a patient. The discussion that follows should be read within the framework (figure 5.5), to gain better understanding about the framework and how it can possibly be applied.
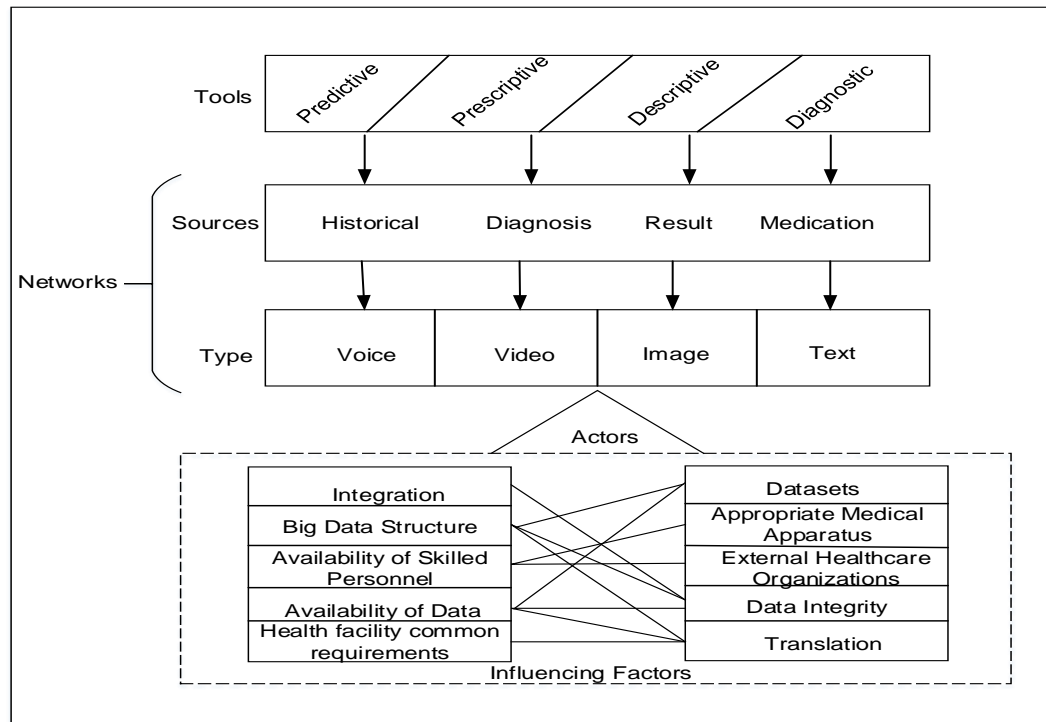
Figure 5.5: Big data analytics framework for healthcare services

5.5.1 Analytics Tools

The four most common types of data analytics tools are predictive, prescriptive, descriptive, and diagnostic (Shao et al., 2014). In the context of healthcare, Raghupathi and Raghupathi (2013) state that predictive analytics are used to anticipate risk through analysis of historical health data and patterns. According to Rumsfeld et al. (2016), prescriptive analytics are used to support medical decisions on individual cases by assessing the risk and benefits of the available solutions. Mathew and Pillai (2015) state that the descriptive analytics provide summary of the past and present data, which are used to inform healthcare decisions. Shao et al. (2014) state that diagnostic analytics help in finding out why certain things are happening.

Each of these tools have the capability of adding value to the activities of healthcare, but from different perspectives. Therefore, there should be criteria for selecting the appropriateness of the tools. The choice of tool is determined by the healthcare facility's need from the existing big data. By establishing what they intend to use the big data for, the organisation is able to narrow down what tool is best suitable for their goals. Thus, if an inappropriate or less

appropriate tool is selected, there will be risks and challenges during analysis. This potentially results in incorrect diagnoses, medications, and/or counselling.

5.5.2 Networks

As shown in the figure 5.5, there are two main categories of networks in the context framework that is developed and proposed by this study, namely sources and types of data.

5.5.2.1 Sources of data

The sources of big data within healthcare facilities are a part of the different networks that exist in the environment. In the context of Actor-Network Theory (ANT), Borgatti and Halgin (2011) state that networks consist of a group of actors who form alliances based on their similar interests. From the perspective of healthcare facilities, each source of big data consists of actors with aligned interests. The sources of big data as proposed in the framework include: historical data, diagnoses, results, and medication. Each of these sources of big data have groups of interested actors for the purposes of bettering patients' care. For instance, historical data is used to inform decisions made on patient cases. This means that diagnoses, results, and medication are based on the patient's medical history. Through analysing each patient's medical history, health practitioners are able to gain insight on individual cases, which enables better decision making.

5.5.2.2 Types of data

There are also different types of data being accumulated within the South African healthcare facilities. From the context of ANT, data can be classified as actor. This is because in ANT, an actor is anything that has the ability to make a difference, and actors of aligned interest consciously or unconsciously form a network (Callon, 1986). Thus, a set of each type of data forms part of a network. The existing networks are voice, video, image, and text data. Other actors of each of the networks include the contributors (patients) of the data, extractors (medical practitioners) of the data, managers of the data, support and enabler of the data (IT/IS specialists), and those that make use of the data.

The interest of the actors comes from their involvements from different angles such as (1) scheduling of medical appointments with patients, (2) consultations with medical personnel, (3) medical tests and treatment, (4) the use of various tools and medical apparatus, and (5) IT infrastructure and systems that are used to store, manage, and retrieve the types of data.

5.5.3 Influencing Factors

The factors that influence big data analytics for healthcare services as revealed from the two cases were combined, as shown in figure 5.5. As revealed in the combined results, many of

the factors are common to both organisations that were used as cases in the study, which help to make case for generalisation. According to Polit and Beck (2010:1451), '[g]eneralisation is an act of reasoning that involves drawing broad conclusions from particular instances—that is, making an inference about the unobserved based on the observed'. The influencing factors are both human and non-human actors because each of them has the ability to make difference, which in agreement with Teles and Joia's (2010) definition of actors.

Medical practitioners are limited in terms of the insight they can gain from an individual's health case. Currently, as revealed from this study, many medical practitioners continue to employ traditional methods of analysis, which require manual application. However, the traditional methods are time consuming, less effective, and produce less accurate results. Therefore, the continuous use of the traditional methods is an indication that the healthcare patients in South Africa stand the risk of not receiving quality care as these factors influence health services. This may have dire consequences on their health, and some cases have ended in fatalities.

The existence of these issues holds both negative and positive connotations. Currently, they are hindering the use of big data in healthcare as they have not established its potential and use. However, through acknowledging these influencing factors, they could drive health facilities towards proper selection and use of data analytics tools. As presented in Figure 5.5, by acknowledging these influencing factors, health facilities could benefit in three ways. They would be able to:

(1) put the types of data into perspective,
(2) shape their sources of data, and
(3) select the most suitable data analytics tool.

With consideration to these influencing factors, health facilities would be able to identify the types of data they accumulate daily and help put them into perspective. This way, health facilities would be able to identify the structured and unstructured types of data towards grouping it into big data. Moreover, instead of disregarding unstructured data sets in their analysis, unstructured datasets would also have a role in patient treatment and ultimately improve the standard of health provision. By putting their data types into perspective, health facilities would also be able shape their data sources. Through knowledge of the types of data, health facilities are able to trace the source or origin. This would help in having standard source of reference, when conducting health activities leading to treatment and when data is being analysed. Knowledge on their data types and sources would advise health facilities on their best choice of tool. The decision would be substantiated as they would know what data to

collect and where it comes from. This helps formulate requirements and provides clarity in the selection and use of big data analytics tools for healthcare big data.

5.5 Conclusion

This chapter presented the data analysis, findings from the analysis, and interpretation of the findings. As stated in chapters one and three, two cases were used, following the case study approach. Analysis was conducted separately on each case, but the findings were combined for interpretation purposes. This interpretation led to the development of a framework; thus, meeting the aim of the research. The following chapter presents the conclusion and recommendations of this study.

CHAPTER SIX
CONCLUSION AND RECOMMENDATION

6.1 Introduction

Chapter six presents the conclusion and recommendations of this study. This chapter is divided into eight Sections. This first Section includes a summary of the study. In the second Section, an evaluation of the study is conducted, wherein the aim and objectives are discussed. The third Section presents how the study contributes both theoretically and practically. The fifth Section discusses how the study is of benefit to medical practitioners and academics. The sixth Section presents recommendations based on the results of the study. Further research is discussed in the seventh Section, while the eighth Section presents the conclusion of the study.

6.2 Summary of the study

The thesis is made up of six chapters. Each chapter contains a detailed discussion of the subjects. A summary of these chapters is provided below:

Chapter one

Chapter one presented an introduction to the study. This included background to the research problem, problem statement, aims and objectives, as well as the methodology used to carry out the study. The chapter provided an overview of what the thesis contains, its purpose, and how the researcher went about developing the proposed solution.

Chapter two

Chapter two presented the literature review of the study. In this chapter, the researcher discussed information communication technology, healthcare, healthcare big data, big data analytics, and ANT. These are also regarded as the key components of the study as the following chapters are centred around them.

Chapter three

Chapter three covered the research methodology used to carry out the study. This includes the philosophical assumption, research design and strategy. This chapter discussed in detail, the steps that were taken in conducting this study. These included: the methods and techniques used in data collection, the theory that was used to guide analysis, and how interpretation was conducted. This chapter also provided reasoning behind the methods that were used and how they helped in achieving the objective.

Chapter four

This chapter presented the case study overview wherein the researcher broadly introduces the two cases that were used for the study. This included the background of the two cases. The organisational structure of both cases is also included in this chapter. This was to provide a view of who is part of the organisation and the roles they play in conducting the study. Throughout this chapter, the researcher was able to introduce the cases prior to conducting data analysis.

Chapter five

This chapter consisted of the data analysis, findings, as well as the interpretation of findings from the study. Chapter five included the analysis of this study, wherein the researcher applied the theory stated in preceding chapters. Using ANT as a guide, the researcher was able to analyse the data. From the analysis, findings were drawn and interpreted. The framework was developed from the interpretation. Thus, leading to the recommendations and conclusion of the study.

6.3 Evaluation of the study

This study is evaluated in accordance to its aim and objectives as stated in the first chapter of this thesis. The aim was derived from the research problem, and the objectives were formulated based on the aim. The evaluation is to establish whether the study has accomplished its aim and objectives.

6.3.1 Aim of the Study

The aim of the study was to propose a solution which can be used to address the challenges of employing big data analytics for the improvement of healthcare services.

For a solution to be proposed, it was important to first understand the current state of healthcare data and service. This was done through a rigorous process of enquiry, which included data collection through interviews, analysis, findings, and interpretation of findings. The process brought out the issue affecting big data analytics in the South African healthcare environment.

It was also necessary to examine how big data analytics could add value to the improvement of healthcare service delivery. The purpose of this exercise was to enlighten the South African healthcare sector on the possibilities that are brought on by effective use of big data. This also provided a justification of why a big data analytics solution was necessary for healthcare in

South Africa. Thus, a framework was developed to address the challenges, towards improving healthcare service delivery in the country; in Figure 5.5 presents this framework. These issues formed the first level of an approach toward big data analytics. The second level consisted of three parts. This level was formulated to highlight the importance of healthcare practitioners gaining knowledge on (1) data analytics tools, (2) data sources, and (3) data types prior to applying a big data analytics framework.

6.3.2 First objective

The first specific objective of the study was to determine the factors that influence the use of big data analytics to improve healthcare service delivery in the South African environment. To meet this objective, the healthcare sector has to understand the factors that influence data analytics, from a human and non-human perspective. From the data analysis, these factors were revealed and depicted in figure 5.2 and 5.4 (see chapter five).

The relationships that form during the process of providing medical process are what contributes to the big data. Therefore, it was important to examine the relationship that exists between humans, that is between medical personnel and patients on the one hand, and between humans and non-humans (data and medical apparatus in providing and receiving healthcare services) on the other hand. Exploring these relationships brought out the issues that contribute to big data analytics. Gaining clarity on these issues helped in proposing a solution that would be suitable for healthcare. More importantly, it helped develop a solution that considers healthcare needs in the context of South Africa.

It was of importance to also examine the interactions that happen between human and non-human in the use of patients' data in providing services. The results brought out the challenges that occur during these interactions. These challenges were rooted in a lack of knowledge around big data. Moreover, healthcare facilities have not invested in resources that support use of big data. This proves, South African healthcare is not progressing in their technology. The lack of progress negatively impacts the standard of services offered. The quality of service remains poor, resulting in medical errors that put individuals at risk.

6.3.3 Second objective

The second objective of the study was to examine how analytics can be carried out on healthcare big data in the South African healthcare environment. For analytics to be carried out successfully, it was important to understand the available big data analytics tools, as it ensured that the proposed solution provided a view of the options available to the healthcare sector. Awareness around these options also influences the choice in tool. This brought on the need to understand the factors that could influence selection of the appropriate big data analytics

tool for healthcare services. Highlighting these factors was important as it enables those who would use the proposed solution with knowledge on things to consider prior to selecting a tool. This would help in ensuring that they do not select just any tool, but one that suits their needs. This study also highlighted the implications of selecting the wrong tool. This brings out the importance of having a guide that addresses the issues behind data analytics and how analytics can be carried out in healthcare big data in the South African environment.

6.4 Contribution of the research

This Section presents the contributions of this study, from two main perspectives, theoretically and practically.

6.4.1 Theoretical contribution

This study contributed theoretically in three ways:

(1) through the use of ANT,
(2) highlighting factors that influence big data analytics, and
(3) the framework that was developed.

Without ANT, it would not have been possible to dissect the different activities that take place within South African healthcare facilities. The theory enabled the identification of different networks that exist and how they came to be. Through ANT, the different factors that influence big data analytics were uncovered using the four moments of translation as a lens. As a result, a framework was developed to be used as guide for South African healthcare.

In addition, this study contributes to the existing body of knowledge, from three main angles as follows:

(1) Information systems research,
(2) Healthcare, and specifically within the South African context, and
(3) ANT.

This study helps to address some of the challenges that are encountered in the healthcare environment from an IS research viewpoint. Thus, the study adds to existing IS literature. In theory, the study provides a useful guide for the South African environment, other developing countries with similar challenges, and to the healthcare sector in general. This is specifically in terms of having better understanding of the criticality of influencing factors in the selection and use of big data analytics for healthcare services.

Although ANT has been used in many studies, the theory has not been employed in healthcare research in the context of South Africa. The ANT contribution was therefore its assistance in exploring and examining factors from actors, networks, and stages of negotiations perspectives, in understanding and addressing the challenges of language and culture in providing and receiving healthcare services. These challenges are peculiar to the South African context, which would have been difficult to address without the use of ANT.

6.4.2 Practical contribution
Practically, this study contributes to the following domains:

 (1) the South African Department of Health (DoH),
 (2) the South African healthcare sector,
 (3) IS discipline, and
 (4) IS/IT practitioners.

The factors revealed in this study will help the South African DoH in developing policies, rules, and regulations towards addressing some of the challenges that have been encountered over the years. Some of these challenges include inaccuracy of data, inconsistency, incompleteness of the data, and lack of privacy for patients. This study would help the healthcare sector gain a better understanding of how data analytics tools can contribute towards the knowledge on how to use patient big data efficiently and effectively. The IS discipline can also use this research as case study material. Different methods of inquiry can be applied, depending on their objectives. In practice, an IS/IT practitioner can also use this study as a guide on how to select big data analytics tools and how to select and use IT infrastructure for storage, management, and retrieval of healthcare big data.

6.5 Benefit of the study
The study is intended to benefit government, medical professionals and academic domains from comes from two different perspectives; theoretical and practical.

Government: The study can be of benefit to the government of South Africa in that the framework (FIGURE 5.5) helps to empirically reveal and unpack the factors that influence health services from patients' big data viewpoint. Based on these factors, policies and regulations can be formulated and promulgated in practice.

Medical professionals: In practice, medical practitioners can be better equipped with a guide on how to use and manage patients' big data towards improved services. Applying the framework would make health practitioners knowledgeable on the issues that hinder big data analytics in healthcare. Health practitioners would also be able to gain a better understanding of patients' big data, in terms of tracing the various sources, types, and volumes for operational and strategic activities.

Academic: Theoretically, through the framework and the influencing factors, the study adds to academia in IS and Health sciences' understanding of the use and roles of big data in the South African healthcare environment. In addition, the study can be important, and of benefit, to the academics mainly because of its empirical nature.

6.6 Recommendations

A number of gaps were identified in the study. This brings about the following recommendations, primarily directed towards the healthcare sector.

6.6.1 Compliance policies

The South African healthcare environment has policies that addresses data. These policies are aimed at protecting the privacy of individuals making use of the healthcare system. However, these policies do not acknowledge big data and its potential within the South African healthcare environment. From the findings of this study, it is recommended that the governing body (Department of Health) take the use of big data analytics into consideration. However, to prevent misuse, compliance policies have to be formulated around big data. This would show prioritisation of patients' privacy and keep to the values of healthcare.

6.6.2 Knowledge evaluation

Health facilities within South Africa accumulate big data daily. However, based on the evidence, healthcare practitioners have no real knowledge around the subject. Prior to implementation of the framework, big data users (healthcare practitioners) have to be educated on the basics of big data. The framework will further guide them, step by step on how to put that knowledge into practise. This has to be enforced by the DoH. This could be monitored through evaluations that take place to test their knowledge around big data and big data analytics.

6.6.3 Implementing the framework

Implementation of this framework within the South African healthcare sector is recommended. Currently, the healthcare sector does not have a guide towards the use of big data/big data analytics. This framework would help bridge that gap through:

(1) enlightening medical practitioners on the factors that influence big data analytics in the South African healthcare environment,

(2) being a step by step guide on factors consider prior to selecting a data analytics tool, and

(3) improving the quality of healthcare through the use of big data analytics.

6.7 Further research

Based on the analysis, findings, and the interpretation, further research on this study is recommended. Since the framework has not yet been applied, future studies could focus on the application of this framework on a healthcare-based case study. Additionally, the use of different theories is encouraged.

The application of a different theory would be of benefit academics and the healthcare sector of South Africa. Particularly, the Technology Acceptance Model (TAM). The factors influencing data analytics in South Africa are rooted in backward thinking about the use of technology in the healthcare environment. TAM would be able to bring out the issues hindering full migration towards technology by South African health facilities.

6.8 Conclusion

This chapter presented the results and conclusion of this study. The study was well researched using methods that were best suitable for fulfilling the objectives. The analysis was carried out using the Actor-Network theory as a lens. From the analysis, findings were drawn and interpreted. Thus, leading to the development of a framework. The framework was developed to provide a clearer understanding of factors to consider prior to selecting and using big data analytics tools. This study highlights that successful selection and implementation of big data analytics tools requires knowledge of components stated within the developed framework.

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APPENDICES

APPENDIX A: ETHICS APPROVAL

(Cape Peninsula
University of Technology

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

Office of the Research Ethics Committee	Faculty of Informatics and Design

Approval was granted by the Faculty Research Ethics Committee, on 15 August 2017 to Ms Sibulela

Mgudlwa, student number 216025370, for research activities related to the

MTech: Information Technology degree at the Faculty of Informatics and Design, Cape

Peninsula University of Technology.

Title of dissertation/thesis:	A data analytics framework for healthcare service delivery in South Africa

Comments

Research activities are restricted to those detailed in the research proposal and a letter of consent from Department of Health is required in order to proceed.

_____	15/8/2017
Signed: Faculty Research Ethics Committee	Date

(Cape Peninsula
Unversity of Technology

P.O. Box 652 cape Town 8000 South 1012 Fax +27 21 469 1002 80 Roeland Cape Town 8001

Africa ,Tel: +27 21 469 Street, Vredehoek,

RESEARCH ETHICS COMMITTEE
INFORMATICS AND DESIGN
ETHICS APPROVAL GRANTED

1 5 AUG 2017

Cape Peninsula
University of Technology

24 August 2017

TO WHOM IT MAY CONCERN

This is to confirm that Ms Sibulela Mgudlwa, student number 216025370 is registered for the M Tech: Information Technology degree. The title of her research is: A data analytics framework for healthcare service delivery in South Africa.

Ms Mgudlwa successfully defended her proposal on 16 August 2017, which involved the reviewing of her research proposal by two independent reviewers. The Faculty Research Committee intends to recommend formal approval of her proposal by the Higher Degrees Committee as soon as ethics consent has been obtained from the Department of Health.

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

Yours sincerely

Veda Naidoo
Postgraduate Officer

APPENDIX B: INTERVIEW GUIDELINES

<u>Data Collection</u>

<u>Interview guidelines</u>

What are the factors that influence data analytics of healthcare big data in the South African environment?

1   Can you please explain to me how patients' information are captured at the hospital?

2   Where do you think information about patients are kept?

    2.1 Why do you think patients' information are kept there, and in that manner?

3   How long do the hospital management keep each patient information?

    3.1 Why do you think that they keep patients' information for that long?

4   Can you please explain the process of accessing patients' record?

5   In your view, how easily accessible is patients' information?

    5.1 Why do you think it is easily accessible?

    5.2 Why is it easily accessible?

    5.3 Who can access patients' information?

    5.4 How are the information accessed?

6   Who do you think is responsible for keeping patients' information in the hospital? Please explain the process.

    6.1 Why do you think that these persons or offices are responsible for keeping patients' information?

    6.2 What are some of the challenges that are encountered in this process?

    6.3 Why do you think the challenges exists?

    6.4 Please give me some examples, and how the challenges were addressed?

7   In your view, what are some of the challenges in the way patients' information are collected by the hospital' approach?

8   Can you please explain some of the challenges the hospital encountered:

    8.1 In the collection of patients' information?

    8.2 In the privacy of the information?

    8.3 Accessibility of the information

    8.4 In your view, how are these challenges addressed?

How can analytics be carried out on healthcare big data in the South African environment?

1 How are different information (such as diagnosis, XRay and regular checkpu) about patients kept in the hospital?

2 Can you please explain how patient information is accessed in an emergency situation?

3 How do you keep track of patients' record or history?

    3.1 Do the hospital have a system for doing this?

4 Can you please explain the process of carrying out diagnosis and treatments?

    4.1 What do you think they do with the results? Please give me an example.

    4.2 Where are the results kept?

    4.3 What are some of the purposes of keeping the results?

    4.4 For how long are the results kept?

5 In your view how are medications for chronic patients planned and managed?

    5.1 Do you know if the hospital make use of system for the planning?

    5.2 Please explain how the process of monitoring and tracking these group of patients.

    5.3 What are some of the challenges that are encountered in this process? please give an example

    5.4 How are the challenges addressed?

6 How are patients information used in the planning of the hospital activities?

    6.1 Why do you think patients' information are used for hospital planning?