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## A Framework for Accessing Patient Big Data: ANT View of a South African Health Facility

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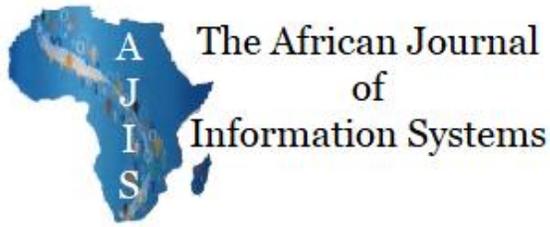
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# A Framework for Accessing Patient Big Data: ANT View of a South African Health Facility

Research Paper

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## ABSTRACT

This study was undertaken to develop a framework that can be used to guide analysis when translating and transforming big data into a more purposeful resource for healthcare service delivery in South Africa. It is intended to assist in addressing some of the challenges encountered by healthcare facilities. Qualitative data were collected, with a focus on the types of interactions that happen between actors when accessing and using patients' big data for healthcare services. Actor-network theory (ANT) was applied as a lens in the analysis of the data, to examine the relationships between actors when accessing and using big data for healthcare services. From the analysis, factors influencing the accessing and use of patient's big data were found. These factors provided the basis from which a framework was developed. The framework can be used to guide the assessment of big data and improve healthcare and service delivery to the community.

## Keywords

Actor-network theory, big data, healthcare, information systems

## INTRODUCTION

Physicians and other medical practitioners uphold the responsibility of storing large amounts and various types of patient's datasets such as medical histories, diagnoses and other health information. Over the years, many studies have been carried out toward harnessing and increasing the purposefulness of healthcare datasets (Chawla & Davis, 2013). Patient's datasets embody the characteristics of big data in that they exist in high unprecedented volume, variety (structured and unstructured), velocity, veracity and validity. Big data in healthcare are categorized, which helps to identify and examine their sources, types and velocity nature (Sahay, 2016). The benefits include enabling different types of diagnoses in high volumes and from various sources, for forecasting and managing the health of the population (Moore et al., 2013). The application of advanced analysis' techniques means that such information could be extracted, and medication could be personalized while also gaining insight into genetic and environmental causes of diseases (Chandarana & Vijayalakshmi, 2014).

One of the primary challenges in accessing and using big data for healthcare is in its analysis, which perhaps comes from the heterogenous nature of patients' datasets (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 datasets. According to Kuo et al. (2014), healthcare big data is so large, complex and distributed that it becomes very difficult to access or use without appropriate categorization. Analysis is critical in monitoring and evaluating patients' current and historical health conditions. Also, analysis is frequently needed to predict epidemics which may affect a region (Bates et al., 2014).

Big data helps to have a full-scale view of a patient's health data, from text to video and images. The analysis of big data enables the transformation of healthcare by providing insight to healthcare facilities, which helps with decision making (Ojha & Mathur, 2016). Chawla and Davis (2013) suggest that improving healthcare services will require computing and analytics (or analysis), using frameworks to aggregate and integrate big data in order to gain deeper insight into the connectedness of patients' datasets, which is not only derived from medical records. Additionally, the challenges with access and use of patients' big data could be caused by numerous groupings of data, such as administration, nurses, physicians and areas of specialization, which include surgeon, pathological, gynecology and dentistry. The different areas require specific attention and type of analysis.

The analysis of healthcare datasets is critical to improve accuracy and consistency for service delivery purposes. According to Iyamu (2018), analysis of big data helps to harness datasets for more purposefulness and improved ease of use towards proactive identification of new opportunities. In this context, actor-network theory (ANT) can be useful for analysis from an interpretive perspective. The theory is a theoretical and methodological approach to social theory where everything in the social and natural worlds exists in constantly shifting networks of relationships between actors, which are both human and non-human (such as software, computers and processes) (Callon, 1986). This means that the theory is concerned with investigating complexity in the relationships and interaction between actors in networks (Heeks & Stanforth, 2015), which can be helpful in analyzing the groupings in healthcare settings and their associated patients' big data.

The remainder of this paper presents the details about the research, which are structured in the following order; first, the study is problematized, second, a review of literature is presented, third, the methodology that was applied in the research is discussed, fourth, the analysis of the data is presented and fifth, the findings from the analysis are presented and discussed. Finally, the conclusions are drawn.

## **PROBLEMATIZING THIS STUDY**

The functionality of healthcare and how the care is carried out in some South Africa facilities is challenging. Some of the challenges result in patients being incorrectly diagnosed and some given incorrect medications (Makovhololo & Iyamu, 2020; Purkayastha & Braa, 2013). This challenge is ongoing and has been happening for many years (Purkayastha & Braa, 2013). 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. After losing consciousness she had to be transferred to two different hospitals before she regained consciousness and her life was saved. Additionally, some of the facilities are challenged with using the analysis and management of their patients' datasets to provide better care (Iyamu, 2020). In another example in 2015, an epileptic patient in East London hospital, also in the Eastern Cape Province, had been on the same medication from a teenager until he was 29 years old. Gradually his seizures worsened, eventually causing further neurological damage. Had the dataset from his medication and severity of his epileptic episodes been adequately monitored through analysis, his

deterioration could perhaps have been prevented. The challenges include those primarily caused by lack of appropriate categorization of patient's big data, which makes analysis difficult and ultimately affects accessing and use. As a result, analytic outcomes are sometimes skewed, causing detrimental effects for healthcare service delivery.

The question posed by this research was: What are the factors that influence accessing and using big data for healthcare services in the South African environment? Following from this question, the objective of this research was to develop a framework that guides an understanding of the factors that influence accessing of patient's big data in health facilities.

## LITERATURE REVIEW

A review of literature was conducted to identify gaps in the existing body of knowledge. This was done from the perspectives of the two key areas of the research, healthcare big data and actor-network theory.

### Healthcare Big Data

There are challenges of disparities of data within many health facilities in South Africa caused by dysfunction and malaise (Mphatswe et al., 2012). Leon et al. (2012) argue that data challenges in the South African health system include the complexity of ensuring interoperability and integration of big data between information systems and securing privacy of information. Big data in healthcare holds potential benefits for improving clinical decision making (Panahiazar et al., 2014). Some highlighted benefits in previous studies include early disease detection and overall management of healthcare (Giambrone et al., 2015). Sacristán and Dilla (2015) explain that the realization of these benefits can only be fulfilled through analysis of the existing datasets. Wyber et al. (2015) suggest 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 also improve healthcare.

However, inaccuracies and lack of efficiency within datasets hinder analytical progression and the realization of benefits (Tresp et al., 2016). This inherently introduces the need for analytic solutions which are more integrated and secure (Nepal et al., 2015). Most importantly, the analysis of the datasets has to be computed, as manual analysis might devalue the information sought (Shah et al., 2015). The analysis of big data contributes to better decision making (Hilbert, 2016). The improvement of healthcare relies heavily on uncovering the hidden facts which lie within a patient's big data (Ojha & Mathur, 2016), which requires analysis of their big data.

One of the challenges of big data analysis is the magnitude of datasets and the difficulties that are associated with validation of long-term predictions for diagnoses and medication purposes (Kambatla et al., 2014). It is important for users or practitioners to be knowledgeable about the details of the activity in order to provide proper and accurate services by using patient's big data. On the technology front, the challenges include integration and analysis of a variety of patients' big data in addressing impending problems (Kankanhalli et al., 2016).

Ontologically, patients' big data, together with other materialistic artefacts (such as medical apparatus), form networks (Scotland, 2012). In the course of health activities, the networks become heterogeneous, which increases the levels of security, making it more difficult to produce useful and purposeful analysis (Archena & Anita, 2015). In addition, the existence of patients' big data is independent of the patients themselves, health professionals and researchers (Scotland, 2012). Thus, this study aims to examine and help gain an understanding of how healthcare big data can be transformed to increase usefulness and purposefulness in practice.

## Actor-Network Theory

Actor-network theory (ANT) is a sociotechnical theory that has been applied in the areas of science and technologies (Dery et al., 2013). The core elements of ANT are actor, network and translation (Callon, 1986). In the context of ANT, actor and network cannot be independent of each other (Teles & Joia, 2011). An entity or person is an actor because it has the capacity to make a difference within its network (Walsham, 1997). A network is a group of actors with allied interest, which are consciously or unconsciously formed (Iyamu, 2018). Bleakley (2012) describes ANT 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. ANT assumes that actors within a network are the cause behind social effects (Latour, 2005).

In ANT, translation is explained as a four-stage transitional process that consists of problematization, interessement, enrolment and mobilization, through which events are carried out within a network of actors (Callon, 1986). *Problematization* is to initiate a problem as well as to propose a solution (Latour, 2005). It is imperative to point out that a problem does not necessarily mean something that is broken or negative, but rather an issue that needs solution, enhancement or an alternative arrangement. *Interessement* is a process where the focal actor stabilizes the identity of other actors and creates links between them. *Enrolment* is the approaches through which the focal actor attempts to define and interconnect different roles that allow other actors to relate within the network (Heeks & Stanforth, 2015). *Mobilization*, the last stage in the moment of translation is when the focal actors ensure that all representatives or spokespersons act according to what have become their aligned interests (Walsham, 1997).

The theory is concerned with network, relationship and interaction that happen within heterogeneous networks (Callon, 1986). From this perspective, ANT has been used in various information technology (IT) studies and developments (Heeks & Stanforth, 2015). Walsham (1997) argues from an IT perspective that ANT is concerned with human and non-human actors within networks, which include artifacts such as people, software, computer-networks and standards. More recently, Iyamu and Mgudlwa (2018) argue that ANT offers a different type of analysis through its focus on the relational effect that is shaped by interaction that happens between humans and non-humans in their heterogeneous networks. To be more specific, ANT has been used for the advancement of healthcare service initiatives with the purpose of explaining the complexity of relations within it (Afarikumah & Kwankam, 2013; Lee et al., 2015). Other studies include Cho et al. (2008) who applied ANT to examine the healthcare information systems implementation of a radiology network system and Bleakley (2012) who used ANT to examine how it can be applied in medical education.

## RESEARCH METHODOLOGY

The qualitative method was employed in this study because of its explorative nature (Conboy et al., 2012). The case study approach was applied in the design of the study because it allows phenomena to be studied in a natural setting as well as within context (Yin, 2017). Also, the approach creates a link between the qualitative method and data collection techniques (Mörtl & Gelo, 2015), such as the semi-structured interview.

A family healthcare facility, with the pseudo name “Sunnymed” was selected for the study, because of its size and access. Based on the objective of the study, a small-scale facility was considered most suitable. In South Africa, it was a challenge to gain access to healthcare facilities for the purposes of academic studies. Sunnymed provides general healthcare services to the community. This includes services such as family planning, gynecology services, chronic patient care, pediatric services and

HIV/Aids testing. These services were administered by the different individuals who make up the organizational structure of the facility. This includes the physicians, nurses, administration clerks and the facility manager.

The semi-structured interview technique was applied in collecting data from the facility because the technique allows instant probing and interrogation of interviewees' responses. As shown in Table 1, a total of 5 people from different units of the facility were interviewed. The criteria that were used to select the interviewees were i) medical personnel who have worked within the facility for at least three years, ii) patients who have been undergoing treatment for the past three years and iii) IT and administrative personnel who have been working within the facility for at least three years. The three-year prerequisite was applied to be absolutely certain that the participants have enough knowledge and experience about Sunnymed and its services, processes and activities. The participants selected were 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. The manager of the facility helped identify and facilitate the engagement with the individuals who fulfilled the criteria and participated in the study. The interviews were conducted in the premises of Sunnymed.

**Table 1**  
*Participants*

Participant	Codename	Years with Sunnymed
Doctor	SM_P1	8
Nurse	SM_P2	8
Pathologist	SM_P3	3
IT specialist	SM_P4	4
Patient	SM_P5	3

The participants were assigned codenames, to protect their identities and respect their privacy. The codenames assigned to the five participants were SM\_P1 to SM\_P5. The 'P' indicates participant and the numbers are in ascending order from participant 1 to 5.

The four moments of translation, problematization, intersement, enrolment and mobilization from ANT (Callon, 1996) were employed in the analysis of the data. This was because ANT is concerned with gaining an understanding of social complexities that manifest in interaction and relationships between actors within networks (Arnaboldi & Spiller, 2011). The analysis particularly focused on two angles; i) examine how patients' incidents were transformed from a point of problem (problematization) to an acceptable solution (mobilization) stage and ii) gain an understanding of how the different networks were formed, including the types of data that were generated from the networks to influence healthcare activities.

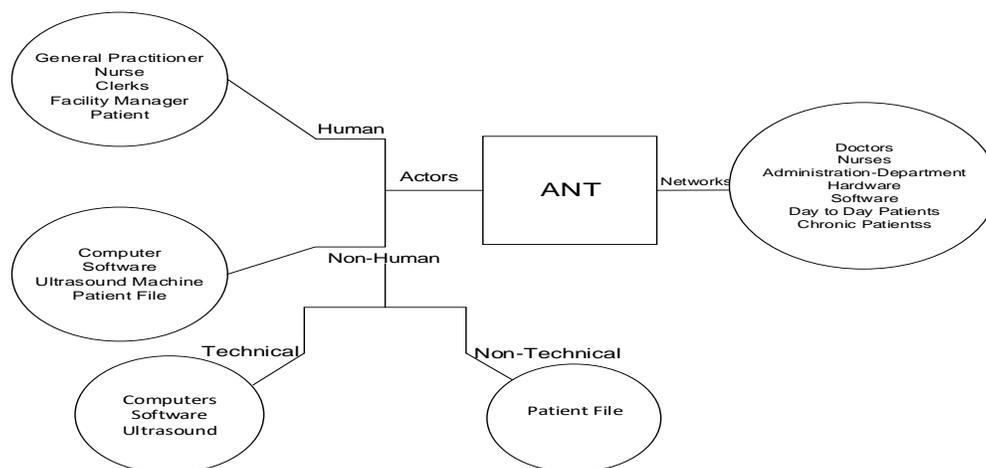
The interpretive stance (Goldkuhl, 2012) was followed, which allows a hermeneutic approach in the analysis of the data. Myers (2004) provides a clear explanation about the use of the hermeneutic approach in IS research. Based on the explanation, we considered the approach suitable for this study.

## ANALYSIS OF THE DATA

Figure 1 shows the types of actors and networks (units) that were present in Sunnymed clinic at the time of this study. This includes how the actors were connected through various networks in providing services. Within networks, the actors carried out activities, were involved in events and employed processes by using patients' big data for healthcare services. At one stage or another during the activities, events and processes were negotiated between the human actors, directly or indirectly, consciously or unconsciously. Actor-network theory refers to this as moments of translation. This enables the medical practitioners to make better decisions in providing services.

**Figure 1**

*Actors and Networks of Sunnymed clinic*



### *Moments of Translation: Problematization*

In Sunnymed clinic, problematization happened in two different ways; 1) solicitations for care and 2) documentation of healthcare processes, activities and events which happened as patients visited the facility and use of telephonic or electronic mail (e-mail) communication between patients and health practitioners. In the process of problematizing patients' conditions, big data (biodata, X-rays, diagnoses, prescriptions, medications and acceleration of responses) were gathered and accumulated. This stage was critical in gathering, accessing and using patient's big data because healthcare-related decisions are informed and guided by the original and historical information about patients. Once the initial communication has been established through a visit to the facility or telephonically or by e-mail, the process of accumulating big data proceeds through observation and consultation.

Before a patient is seen by a physician an observation takes place, which was usually administered by nurses. Part of the process includes testing of urine, diabetes and blood pressure (BP), which forms part of the patient's big data. Thereafter, consultation takes place. This step requires the patient to share the details of their illness in detail. This is conducted by a nurse or doctor within the facility. Observation and consultation were important parts 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 health conditions. However, the facility encountered challenges

at this stage. Some patients were not always forthcoming about their health conditions, which shapes the types of data sets and ultimately influences and affects care and responses.

The manner in which information was collected from the patients also contributes to problematization of healthcare. The approach was not always easy, straightforward, or conducive to some patients and health practitioners in Sunnymed clinic. For example, some patients find many of the healthcare practitioners to be intimidating, impatient and harsh in their approaches. Even though these approaches are associated with unethical behavior, the practice continued. This influenced the types of information some of the patients shared or disclosed. Some staff were compelled to collect personal information in the presence of other patients. This approach was invasive to some individuals and influenced the likelihood of full disclosure of their health conditions. A participant explains as follows “Some people were a bit uncomfortable with the manner in which the medical personnel try to get our personal information. They ask personal health related question in the presence of other patients, no privacy” (SM\_P1, Pg. 202-205).

Language and socio-cultural differences were standing issues within the Sunnymed facility. As a result, some of the staff find it difficult to communicate with patients resulting in (perceived) intimidation, impatience and harshness. It was understandable that patients who visited the facility came from various cultural and linguistic backgrounds. This affected the interaction between some of the patients and medical personnel in the process of initiating provision and receiving of care. Thus, language interpreters were often used, which removed privacy for some patients. A doctor states as follows:

I think the challenge is about language, because we are in an environment that is diverse. We have Africans, Xhosa and Sotho speaking people. We have to get someone who understands these languages to interpret or capture their information appropriately (SM\_P3, Pg. 20: 887-890).

The information collected at this stage is utilised by the medical personnel to take the treatment process further. Diagnoses, treatments and follow-ups were conducted based on the information that was gathered and stored. This makes full disclosure important during problematization. Although roles have been established at this stage, various factors come into play to determine individuals' interest in the care process.

### *Moments of Translation: Interessement*

For each medical case within the Sunnymed facility, various actors had interest. These actors included the patients themselves, patients' relatives, medical personnel and medical aid schemes (insurer). Patients expressed their interest through initiating and discussing their health conditions via telephone or walk-in. Some patients were accompanied by their relatives for various reasons (interests), such as to act as interpreter, guardian (financier), or spokesperson for the severely ill. The medical aid schemes were more interested in how and what led to the cost.

Patients were particularly interested in the health services offered to them by the facility. The services included patients' health assessment, specialist referrals for cases that could not be handled by the facility and prescribing and dispensing of medications. Patients' relatives and friends also had interests in the facility's health services with respect to the patients' well-being. These individuals' interest was expressed through ensuring that patients received help from the facility. An interviewee states as follows “In most emergency cases, the patient won't come alone. There were always two or three people accompanying the patient” (SM\_P2, Pg. 11:458-459).

Medical personnel were essential to the treatment care process of the facility. Their skills and knowledge were employed in carrying out treatment. This triggered their interest in conducting health activities and

procedures. As healthcare providers, Sunnymed clinic holds a duty of responsibility and accountability to both the patients and health governing authority of South Africa. Additionally, medical aid schemes have a vested interest in the care of patients who have policy cover with them. Thus, the medical aid schemes expressed their interest by ensuring that patients constantly undergo routine tests, to check whether patients were in a good state of health while covered by their schemes. An interviewee states as follows “Medical aid schemes advise doctors to see chronic patients twice a year. In every 6 months, patients undergo blood tests and other necessary medical checks. The results are forwarded to the medical aid” (SM\_P2, Pg. 11: 503-506).

Different factors sway the interests of various stakeholders about a patient within the Sunnymed clinic facility. Medical aid schemes stand to gain financially from the treatment of patients. Patients seek healthcare services from the facility to improve the state of their health. The medical personnel were also obligated to take an interest in patient care to uphold their professional ethics and secure their jobs. However, the interest of these stakeholders did not guarantee participation in the process of actual care. Different factors influenced participation and ensured that individuals fulfilled their different roles.

### *Moments of Translation: Enrolment*

At Sunnymed clinic stakeholders participated in the gathering and accessing of patients’ big data during the provision of services. Participation from the stakeholders were from various perspectives and determined by different factors, which included professionalism, ethics, care and financial interests. Patients participated in their own care by visiting Sunnymed clinic. This was driven by the goal to improve their health conditions which often began with registration. Thereafter, consultation took place during which individuals were required to explain their health condition or deficiency, which was captured in a database in the form of image or text. However, participation was not always guaranteed as some patients often refused to get treated, as a result of their social background or cultural affiliation. An interviewee explains as follows:

When a man requires attention for a health condition, he is selective or particular about who attends to him. If it is a young nurse it becomes a problem, because they believe that they can’t be attended to by someone they deem younger (SM\_P3, Pg. 22:977-979).

Medical personnel were wholly involved and participated in providing healthcare for patients. This was primarily because of their personal caring attitude and professional obligations as well as the ethical code of conduct. The oath promotes quality care as patients undergo consultation, diagnoses and treatments. The facility had a strategy that aimed to ensure participation from its medical personnel. Patients were advised by the facility to provide feedback on the services they had received. Sunnymed used the information provided to assess the areas they felt were lacking and to improve on their current processes. Through this strategy, they were able to hold accountable those who were not adhering to the facility’s standards.

Nurses were the first line of assistance in every patient’s case. Thus, the nurses were required to perform preliminary tests before the patient consulted with the doctor for further medical examination. The results obtained from those tests were pivotal to the care process as this information forms part of the patients’ medical record. The nurses’ observation provides doctors with insight on a patient’s case before treatment can be further administered. Therefore, their participation can be monitored through having information gained through observation aligned with the doctors’ findings.

Lastly, administrative personnel were 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. Administrative personnel's participations were measured by outcomes, namely responses from the patients. At Sunnymed clinic the administration unit was overseen by a facility manager.

### *Moments of Translation: Mobilization*

Some patients were either severely ill or could not communicate or express themselves. As a result, friends or family members spoke on their behalf when receiving treatment at the clinic. Also, there were spokespersons who represented the clinic in interactions with the patients or their representatives. The spokespersons were either appointed by the clinic or self-appointed. Their representation was driven by different factors, which included enforcing participation of individuals from the different units within the facility. The spokespersons were both internal and external to the organization. Internally, the medical personnel were delegated to speak on behalf the facility. As the first line of assistance in the facility, nurses were delegated as representatives of the patients. They were tasked with the responsibility of communicating a patient's case to the doctor using the information that was collected during observation. These individuals provided preliminary analysis of the patient's condition and presented reports to the doctor. However, this was not always the norm as some patients preferred to consult directly with the doctor.

Physicians also acted as representatives in the patient's care process. This was done through referrals and prescription of medications to patients. In cases where patients could not be further assisted at the Sunnymed clinic, they were referred to a larger health facility. Thus, the representative (spokesperson) of Sunnymed communicated with the referred facility on behalf of the patients. This was to ensure that other medical practitioner had a clear view of the patients' condition and history. However, this was sometimes challenging as issues of privacy were raised by relatives of some patients. Consent was therefore required from patients when their medical information was to be shared. This was imposed by the Protection of Personal Information Act (PoPI) and the facility was obligated to abide by this act at all times. A doctor within the facility states as follows:

The new PoPI Act states that patient information is strictly confidential, therefore we need consent before we share their personal information with other practitioners. The challenge is, sometimes the patient is in a critically bad health condition such that he or she cannot talk or write (SM\_P3, Pg. 16: 719-722).

In Sunnymed, without third parties such as nurses or interpreters, patients could demonstrate and describe their own health condition to the medical doctors. In this sense, patients were self-representative. However, this representation was not always effective due to challenges such as language barriers. This introduces the need for interpreters. Language as a challenge was a standing issue in the facility as they provided services to 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 was a problem. As one participant points out "Somalians bring their own interpreters, or we have to call the neighbors. Otherwise, communication would not be possible" (SM\_P3, Pg. 20: 894-895).

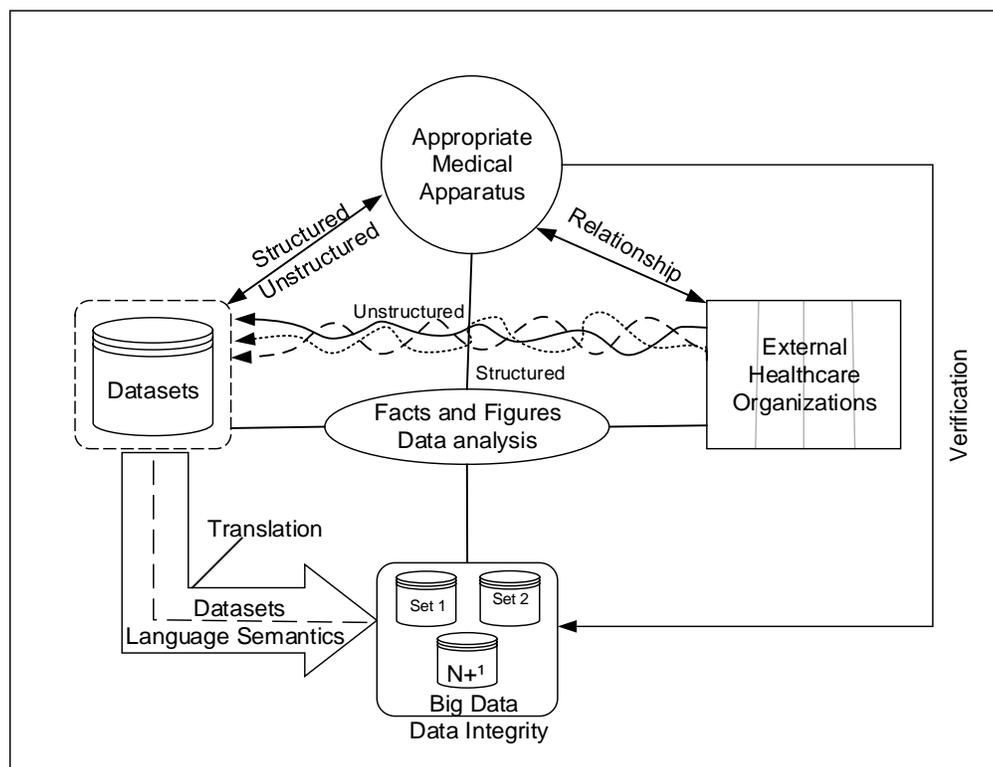
As representative, the interpreter has to ensure that they articulate the patient's problem as best as they can. This was to enable the health practitioner to conduct an accurate diagnosis towards appropriate health services. However, language and dialect were not easily translatable to the medium of communication, which was English. This leaves a dent on the information provided, which distorts the

patients' big data. The medical practitioner needs to have a clear view of a patient's history. This information would allow them to link what was being said by the interpreter to previous occurrences. Furthermore, it would contribute to the solution a medical practitioner provides for the case, which has been a challenge in South Africa for many years.

**FINDINGS AND DISCUSSION**

Subjective reasoning was employed in gaining an understanding of the factors that stand out and influence healthcare big data in the South African environment. Garcia and Quek (1997) argue that subjectivism is an essential part of human interaction as it permits deeper understanding of actors' perspectives. The subjective reasoning approach assists to provide a more precise and conceivable answers in relation to social phenomena. Based on our subjective understanding from the data analysis as presented above, five factors namely datasets, medical apparatus, dataset integrity, data analysis and health organisations, were found to influence accessing of patient's big data at Sunnymed. The factors are shown in the Framework (Figure 2) and discussed below. The discussion should be read with the figure in order to gain better understanding of the factors that influence accessing of patient's big data in a health facility.

**Figure 2**  
*Accessing Patient Big Data*



**Datasets**

Sunnymed clinic as a health facility encountered different challenges while providing healthcare services to patients. Amongst these challenges were patients refusing to be attended to by medical

practitioners of the opposite sex. This was attributed to patients' different social and cultural backgrounds and affiliations. This has led to medical practitioners having to omit some parts of the treatment process, to respect and accommodate individuals' beliefs and traditions. The issue of health practitioners having to care for patients of different cultural backgrounds poses many critical challenges to the healthcare systems. Tests were pivotal to the treatment of patients, and they assisted in providing thorough knowledge on the patients' cases. Furthermore, these tests contributed substantially to the facility's data. Therefore, the exclusion of some part of healthcare activities negatively affected patients' big data analysis. The medical practitioners were compelled to insert data that was incomplete into patients' files. This further led to a disjoint in patients' big data as some parts were missing. Incomplete data sets compromise the integrity of datasets. This brings about the need for the translation of datasets. The facility did to some extent ignore the importance of translating data. Consequently, it was difficult for some health practitioners to assess or make use of data that was not translated.

The different cultural backgrounds also affected the analysis of patient's big data. The current tools originate and are mostly used in countries such as the United States of America. In Africa, the cultural background of the patients is distinctively different from that of the people of the western world. This makes the use of analytics tools from the western world for the same purpose in Africa a challenge, as was experienced at Sunnymed clinics. It is within a similar context that Iyamu (2020) argues that the use of big data analytics for healthcare services in many African countries has become synonymous with challenges, obstacles and pitfalls. Thus, it is essential to customize the analysis (or data analytic tools), to suit the needs of Sunnymed clinic's patients and include areas that could have been neglected. This covers broader areas in collecting and analysing data for the benefit of both health practitioners and patients.

### **Appropriateness of Medical Apparatus**

The clinic was unable to conduct certain services due to its limited access to resources, such as lack of appropriate medical apparatus and personnel. Iyamu and Mgudlwa (2018) noted that it is a serious challenge that many health practitioners in the Africa continent do not know how to access patients' big data by using technologies such as mobile systems. This results in the clinic having to delegate some of its services to external parties who could perform the tasks, such as X-rays and pathological tests. This forces patients to get services from medical practitioners with whom they were not familiar.

Delegating health services to external parties affects the patient's big data in different ways, from accuracy to completeness. Even though Sunnymed clinic often briefed 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 was accurate. This could be attributed to limited knowledge or understanding of the medical personnel that was involved. This compromises the patient's data as the X-rays and medical tests may present inaccurate results. Inconsistency within the patients' data is also an issue due to outsourcing of some services. This confirms findings from Clim et al. (2019) that although the use of big data brings about new opportunities, it also introduces challenges for medical practitioners and patients. In addition, questions about a patients' medical condition and history (including family tree and hereditary diseases) were sometimes omitted, intentionally or unconsciously. This means that the information (part of big data) collected and stored in a patients' medical history may be incomplete, yet still undergo analysis.

Failure to conduct all-inclusive tests impacts the results as some important issues may be missed. This further affects Sunnymed clinic's datasets as these results were inconclusive and failed to provide a diagnosis that had all potential health factors considered. This causes a disjoint in the patient's big 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. Lack of verification of the datasets that come from external sources can further impact integrity. The facility's failure to verify patients' datasets means that they made decisions based on possibly incomplete and inaccurate data.

### **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 were external laboratories, specialists' facilities within their network and pharmacies that supply medications to the facility. External laboratories were outsourced to conduct different medical tests that contribute to conducting diagnosis. The tests were used to support decision-making regarding a patient's health condition. There were also medical specialists that the facility interacts or consults with. These individuals provided specific expert opinion about a patient's health condition, mostly during critical situations. This was done by providing the facility's medical practitioners with deeper insight into an 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 led to Sunnymed clinic associating itself with different pharmacies for medications. The entire processes and channels as described herewith contributes various types of data, which can be used for analysis.

The three external organisations provided different services to Sunnymed clinic at the time of this study. This also means that the organisations provided various types of datasets, from texts, videos and images in different quantities to the Sunnymed clinic. The datasets were either structured or unstructured. This brings about a serious challenge, namely data dispersion, which was a hindrance in data merging. These entities were all divided, due to their different functions. This means that the data relating to Sunnymed clinic was dispersed when it arrived at the facility. This was a challenge because it affected the continuity of patient information. Sahay et al. (2020) argue that lack of direct or first aid access to patients' datasets limits its completeness and usefulness. Furthermore, it becomes even more difficult to merge the facility's data with that of these external entities.

### **Language Semantics**

The facility makes use of interpreters during consultations to bridge the language barrier between the medical practitioners and the patients. Despite the intention of some practitioners, which was considered progressive, challenges remain. The persistence of some of the challenges was caused by semantics and differences in the dialects in African languages. According to Makovhololo and Iyamu (2020), some healthcare activities cannot be translated due to the challenges of language barriers. The implications of this include miscommunication between the interpreter and the medical practitioner, which manifest as inaccurate information due to 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 analysis tool that is employed. The results will be flawed, which can be attributed to the reasons some 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, namely privacy. The policies of the South African Department of Health (DoH) insist 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 were 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 poses serious implications and risks for the patient as they did not provide complete information about their health condition. The practice of healthcare relies heavily on the data that patients provide about their health conditions (Mathew & Pillai, 2015). Furthermore, the information collected during these consultations form part of Sunnymed clinic's big data, which undergoes analysis. Therefore, patients' failure to disclose their problems hold consequences such as incomplete datasets. In addition to that, the integrity of datasets may be compromised, as the results from analysis may not reflect patients' real health condition.

### **Datasets Integrity**

Sunnymed clinic collects a substantial amount of data from both internal and external (other organisations) sources on a daily basis. There were challenges affecting the datasets gathered particularly from external sources, which included incompleteness. In attempt to address similar challenges, Wang and Alexander (2019) examine the use of cloud computing to present the progress of big data in healthcare. Consequently, this was a challenge because it affected the integrity of the data, which were relied upon for patient's care. Moreover, the integrity of the facility's datasets was sometimes compromised, as revealed during this study. This challenge was created during the translation of 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 lack 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 decisions were based on a flawed outcome of analysis.

Sunnymed clinic was also dependent on the translation of the data. This was from the aspect of language and the 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 had no means of guaranteeing accurate translation from the different South African languages to English (Makovhololo & Iyamu, 2020). From the aspect of data, Sunnymed clinic was unable to make sense of the copious number of datasets encountered by the facility due to their lack of data analysis tools or means of managing the datasets. These factors challenge the integrity of the facility's datasets. Furthermore, it compromises patients' health as decisions are made based on datasets that lack integrity.

### **CONCLUSION**

The study can be of benefit to the South African government, other African countries with similar challenges and to the healthcare sector in general in that the framework (Figure 2) helps to empirically reveal and unpack the factors that influence health services from the patients' big data viewpoint. Based on these factors, policies and regulations can be formulated and promulgated in practice. 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 of the issues that hinder big data analysis in providing healthcare services. 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. Methodologically, although ANT has been used in many IS and health studies, the challenges of language and culture in providing and receiving healthcare services as revealed in this study are peculiar to the South African context, which would have been difficult to address without the use of ANT.

The application of a different theory, particularly, the Technology Acceptance Model (TAM) would be of benefit to academics and the healthcare sector of South Africa and the African continent in general. The factors influencing big data analysis in South Africa are rooted in a historical background and culture about the use of technology in the healthcare environment. TAM would be able to bring out the issues hindering full migration towards technology solutions by South African health facilities.

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