



Healthcare data management conceptual framework for service delivery

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Abstract

In the context of South Africa, what we do know is that huge amount of healthcare data does exist and that they are consciously and unconsciously scattered in bits and pieces across facilities within the country. This has directly or indirectly resulted to underutilisation of data, which affects service delivery to the community. For example, many patients have been wrongly diagnosed, and some others have been given wrong medications due to duplication of prescriptions, which were influenced by lack of real-time information. Consequently, there have been loss and damages to lives, contributing to the mortality rate in the country. This study was undertaken on the premise of these challenges, to develop a conceptual framework that can guide how data could be managed towards improved services within the South African healthcare facilities. The interpretive approach was employed. Qualitative data were gathered from existing works. Structuration theory was applied as a lens to guide the analysis of the data. From the findings, a framework was developed, primarily to guide and advance the ways in which data are stored, retrieved, managed, and used for healthcare improved services.

Keywords Healthcare data · Information systems · Qualitative methods · Structuration theory

1 Introduction

Healthcare data are generated from different sources, which include consultation, diagnoses, follow-up on medications and x-ray reports (Archenna and Anita 2015).

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According to Kaur and Rani (2015), a significant amount of data is generated from patients' medical records, treatments and billings. The data are stored, retrieved and managed differently by the various agencies and physicians (stakeholders) within the sector (Bernardi 2017). These stakeholders are duty-bound to act in accordance with their roles, affiliations and associations with the professional bodies and health facilities that hold the right of the data (Bernardi 2017). The use and management of patients' data is uniqueness because of confidentiality, security and privacy nature of the health environment (Banerjee et al. 2018).

In the providing health care, physicians and other practitioners associated with medical services encounter various challenges related to the management of data for patients care. Some of the challenges begin at the points where patients data collection points as well as the sharing of the patients' data without proper health information systems (Yue et al. 2016). Also, many health systems are often not integrated, which affects information sharing, efficiency of operations, and in turn, impedes decision-making (Assem and Pabbi 2016). This is associated with various factors. According to Viceconti et al. (2015), healthcare data is a sensitive matter, which affects shareability, and if not managed well, can cause deficiencies in services such as wrong diagnosis or incorrect medication. Therefore, it is important for healthcare practitioners to protect the privacy, security, and confidentiality of patients' data while carrying out quality services (Fabian et al. 2015).

Constitutionally, the South African government is the main stakeholder of healthcare services to the communities in the country (Coovadia et al. 2009). This mandates the government to promulgate rules through legislation and policies as well as to guide the operations and activities of agencies in the health sector (Greer et al. 2016). Based on the privacy, security, ease, and usefulness that the healthcare data require and deserve, there is a high and consistent need for rules, regulations, and resources within which patients' data can be stored, used and managed over a period of time (Andreu-Perez et al. 2015). Also, there is consistent increase in the volume, types and speed at which patients' data are used. This makes constant improvement of the managerial aspect of the patients' data critical. This include differentiation of data types, an understanding of levels of significance, and legitimization of various applicable resource, rules and regulations.

The structuration theory is employed as a lens to guide the analysis of the data. The theory focuses on agents (or agencies) and structure, but also on how they consciously and unconsciously enable and, at the same time, constrain activities within a social system (Giddens 1979, 1984). Structure in structuration theory, means rules and resources (Roberts 2014). This point is highlighted so that it is not mistaken for its literal meaning in the English language. Consciousness implies that agencies act with awareness and knowledge, which is significant in healthcare service delivery. McPhee and Canary (2014) suggest that for agents to make a difference, they must have the knowledge to use their powers consciously. In structuration theory, structures and agencies are both implicated in the production and reproduction within a social system (Bernardi 2017), and ensure their interdependency (Giddens 1984).

In a social system such as the healthcare environment, the agents (medical personnel, patients, and government representatives) employ structure (rules and resources) to guide their interactions and operations in the providing and receiving healthcare services. Indeje and Zheng (2010) explain that structures are the medium of human

activities as well as the outcome of those activities. Therefore, when agents interact to produce and reproduce social systems, they are not only enabled by the structures in place, they are also constrained by them (Vyas et al. 2017; Walsham 1993). In Giddens (1984) explanation, systems are patterns of relations that are categorised into groupings within which interactions are carried out to produce and reproduce actions, toward achieving specific goals. Healthcare being a social system it is crucial to examine the influence which the agents' interactions have on the its service delivery, in relative to time and space (geographical locations).

In undertaking this study, the question was, 'how can healthcare data be managed better in order to improve the services that health facilities provide to the communities? Based on this question, the objective of this study was to employ Giddens's (1984) duality of structure as a lens as from the perspective of structuration theory, to guide the analysis of patients' data. The study was carried in the context of South Africa health environment. There were findings from the analysis, based on which a conceptual framework was developed and proposed. The framework can be used to guide data management in order to the ease its usefulness toward improvement of healthcare services in South Africa.

For logic flow and better understanding, this article is divided into seven main sections. An introduction is provided in the first section, which is followed by a review of literature that mainly covers healthcare and structuration theory. The methodology that was applied in the research is discussed in the third section. The fourth and fifth sections present the theoretical, conceptual framework of the study and the framework for healthcare services, respectively. The conclusion of the study is drawn in the last section.

2 Literature review

Based on the focus of this study, a review of existing works was conducted from two viewpoints, namely healthcare data and structuration theory.

2.1 Healthcare data

From one sector to another, data are generally rapidly increasing across the world (Zyskind et al. 2015). This is highly likely to be the trend for a long time to come. Matthias et al. (2017) noted that in the year 2010, from the use of both internet and mobile technologies, enterprises and individuals collectively generated and stored an estimated 13 exabytes of data. This is projected to increase to 40 exabytes in 2020 (Zyskind et al. 2015). The outbreak of Covid-19 pandemic has accelerated unprecedented data voluminous (Ciotti et al. 2020). As the sets of data increases, so do their complexity, which makes it more difficult to manage. The data management influences its use in decision-making during operational or strategic activities. Such difficulty and challenges have affected decision-making during healthcare service provision in many South African facilities over the years. For example, data that were collected about HIV/AIDS patients from some facilities were considered unreliable and lacked usefulness (Mate et al. 2009).

Healthcare data provides many benefits which include insights into pandemics, diagnosis of viruses and laboratory research (Ciotti et al. 2020; Fabian et al. 2015). According to Castiglione et al. (2015), healthcare data are imperative for ensuring proper diagnosis, assessment and treatment procedures. Gebremeskel et al. (2016) adds that healthcare data are essential to identify disease patterns in patients' records. The government, as well as other healthcare stakeholders make use of healthcare data to resolve challenges such as procurement of equipment, implementing appropriate treatments for patients, supporting clinical improvements, and monitoring the safety of healthcare systems (Jee and Kim 2013). Therefore, due to the criticality of healthcare data, organisation s should ensure accurate and efficient flow of healthcare data for improved healthcare services. Srinivas et al. (2010) advised that the timely flow of healthcare data can be improved through the support of information systems tools such as data warehouses.

Data for healthcare services encounters challenges that impede healthcare service efficiency. In Smith et al. (2012) explanation, healthcare stakeholders encounter many problems due to poor data quality and this has a negative impact throughout the healthcare supply chain. Due to patients' privacy concerns, the sharing of data for healthcare service among different providers is a challenge (Groves et al. 2013). The sharing of data becomes even more challenging when the supporting systems are not integrated. Data for healthcare services are categorized as either structured or unstructured data. Kaul et al. (2015) argued that most of the patients' data are unstructured and consequently difficult to analyse. For example, due to the large size of 3D medical images, hospitals are challenged with storage capacity, processing power and slow network access (Castiglione et al. 2015). Jee and Kim (2013) assessment was that in the quest to manage and extract value from patients' data, selecting and implementing the right technologies and finding competent staffs are some of the challenges encountered by health organisations.

2.2 Structuration theory

Structuration theory is a sociotechnical theory which focuses on agent, structure, social system and relationship. In structuration theory, agents and structure are the two core constructs (Twum-Darko 2014). From the interaction that occur between structure and agents, actions are conditioned and routinized through processes, in return, create and recreate structures (Pozzebon and Pinsonneault 2005). Giddens (1984) refers to such occurrence as a reproductive system. The theory is regarded as a continual transformation of structure through the production and reproduction of social systems (Iyamu 2013). Giddens (1984) describes structure as resources and guidelines, and agents as technical and non-technical entities which exist within structure.

The interaction between agent and structure constitutes the duality of structure (Iyamu 2018). In essence, the duality of structure means that social structure is reproduced by repeated human actions while structure enables and constrains human action (Van Veenstra et al. 2014). The three dimensions of the duality of structure are signification, legitimization, and domination (Lamsal 2012). These dimensions seek to illustrate the links between the structure and the system of interaction (Iyamu 2018).

Structuration theory (ST) is a social theory based on the notion of structure and agents together with the idea of a duality of structure through which the relationship

between agents and structure is described (Englund and Gerdin 2016). The theory is seen as an endeavour to reconcile the dualism that for a long time existed between structure and actions (Bracker et al. 2017). Therefore, structuration theory helps to get a clear understanding of how social systems are created, and how both social structures and agencies reproduce these systems (Vyas et al. 2017). Thus, ST has been used by scholars in many fields including Information Systems (IS) in order to understand how the interactions between users (Non-Technical agents) and Information technology (Technical agents) develops gradually, the consequences and how to deal with them (Bernardi 2017).

The three fundamental elements of structure are signification, domination, and legitimization (Lamsal 2012). The interaction between the agents and structure is highlighted through the modalities (Mcphee and Canary 2012). Signification provides interpretive schemes necessary for communication from which human agents rely upon to see and interpret events, thus, gain the ability to make sense of their own and others' actions (Englund and Gerdin 2014). Human agents utilize power by their ability to allocate facilities such as materials, resources, and human resources, thereby creating, reinforcing, or changing structures of domination (Gao and Hua Li 2010). Legitimation is the application of norms, values, and standards which sanctions certain forms of conducts and behaviours (Feeney and Pierce 2016).

The ST is a social theory that has been applied in IS studies as a lens to interrogate and understand technical and non-technical agents in computing environments (Bernardi 2017; Jones and Karsten 2008). As technical agents of structures IS enables and constrains people as they perform their business processes (Rose and Scheepers 2001). Indeje and Zheng (2010) suggest that IS cannot be understood if it is not through the study of people, their social relationships and work practices that they are engaged in within every day. Therefore, through the tenets of the duality of structure, ST provides a good foundation for IS scholars to investigate both technical and non-technical agents and their reproductive actions as they consciously and continuously communicate and apply their skills and knowledge to select, develop, implement and use IS solutions (Iyamu 2015). Walshaw (1993) argues that the power of ST is the emphasis on the inter-linked nature of the interaction between structure and its operations through the linking modalities. The ST enables the researchers to study agents' intentionality and how agency and IS are being transformed by both intended and unintended outcomes.

3 Research methodology

Qualitative methods are known for producing descriptive data (Taylor et al. 2015). This descriptive data is produced by describing a phenomenon and understanding its interaction in a certain environment. Smith (2015) asserts a research position that qualitative methods are engaged in exploring and describing the personal and social experiences of participants. Thus, qualitative methods aim to study and understand the meanings people attach to their natural environments.

The interpretive approach enables researchers to gain a deeper understanding of the concept. According to Thorne (2014), through the interpretive approach, researchers start with what is already known about the phenomenon in question and seek some

expansion on that prior knowledge. Ritchie et al. (2013) explained that interpretations move beyond the explicit descriptions and accounts provided by individual participants drawing on researchers' interpretation. Through the interpretive approach, researchers apply their subjectivity in understanding the studied environment and its actors.

Qualitative data were collected using the document analysis. According to Taylor (2017), the technique enables collecting appropriate and relevant existing data from various sources. This can be attributed to why the technique is complementarily used with other techniques for collecting most qualitative data in many IS studies (Suryono et al. 2015). For further justification, Johnston (2014) argues that although this technique has been used many times for collecting secondary data, it offers an empirical and systematic exercise. Therefore, the document analysis can also be used as the main data collection technique. Thus, in this study, existing peer-reviewed documents, namely: journals peer reviewed articles, articles in conference proceedings, and textbooks were used. The articles were gathered from different databases, between February and May 2018. The primary keywords that were used to search for the articles included healthcare; challenges of healthcare; information systems and healthcare; structuration theory and information systems.

4 Theoretical framework for the study

Based on the used of structuration theory to underpin the study, Fig. 2 was developed as the theoretical framework. This means that the framework was used to guide data collection and analysis. For example, it steered the discussion and an understanding of the interaction that happens between agents and structures in the use of data, in providing healthcare services to the South African communities. As shown in Fig. 1, the three dimensions of the duality of structure from the perspective of ST, namely structure, modality, and interaction guide the management and use of healthcare data towards the provision of services as a reproductive system. Vyas et al. (2017) explain how ST is used to gain an understanding of how social systems are created and reproduced through social structures by human agents.

Within structure (rules and resource), the South African government or its representing agency formulates and legitimises policies that are employed to manage and make use of patients' data (Jack et al. 2015). Aspects of the policies are intended to maintain and uphold the privacy of patients' data in the process of providing and

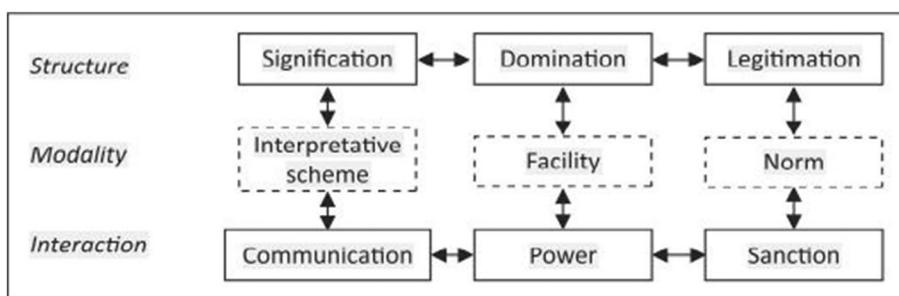


Fig. 1 The dimension of duality of structure (Giddens 1984:128)

receiving health care (Stellenberg and Dorse 2014). As shown in Fig. 2, there are different types of data, which come from various sources (Archenna and Anita 2015). This sometimes makes it difficult or affects how the policies are interpreted by the various medical personnel.

Within the healthcare sector, data are generated from text, voice, images and audio, which are either structured or unstructured or both. Through the dimension of structure, data are categorized into levels of significance, which guides decision-making at various healthcare services. This is critical in that some conditions are considered to be more serious than others. Services are result-oriented which comes from patients' care. This is a process that requires interactions, which are often influenced by interpretations and the facility employed in the categorization of the required data. Iyamu and Mgudlwa (2018) explain that the purpose in which data are employed and its usefulness require harnessing its capabilities from both technical and human agents. The harnessing of health data capabilities is guided and determined by many factors, such as availability of facilities, interpretation of policies and an understanding of the data in relative to patients' condition at the time.

Provision of health services entails a duality between data and services in that they depend on and influence each other towards patients' care (Luthuli and Kalusopa 2018). As shown in Fig. 2, the interaction between health data and services is iterative in the reproduction of patients' care. This means that data, interaction and the other facilities are used to enable, and at the same time, they constrain the processes and activities of patients' care (Mosadeghrad 2014).

In organisations, data are an important resource that organisations use to execute business processes, make informed decisions, and gain competitive advantages. ST helps to unpack the significance of data to organize activities and how people's skills and knowledge influence its application. In the context of ST, data can be categorized as either non-technical agent or allocative resource. In addition, ST brings a fresh perspective on how data gets implicated in an organisation's processes as an agent, as well as a resource. As an allocative resource, agents cognitively access, retrieve, process, and manage data to gain dominion over others.

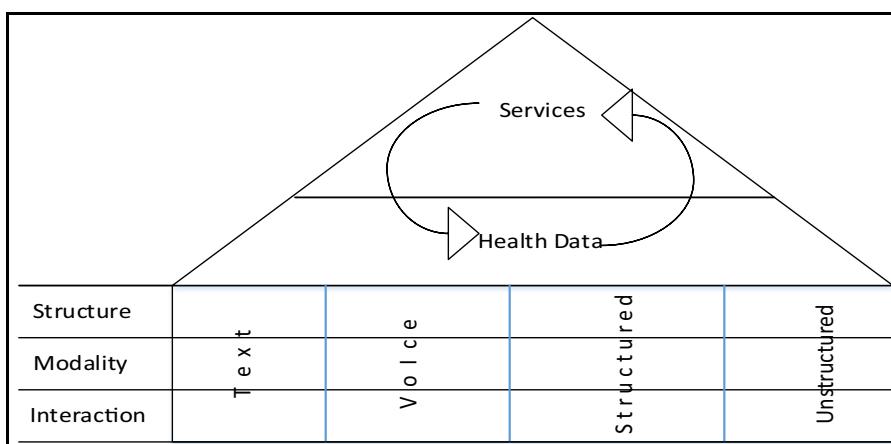


Fig. 2 Theoretical Framework (Source: Developed by authors)

Data can constrain or enable activities in the process of providing services to the community. For example, when the specific data required to produce a product/ service is not immediately available, it negatively affects its time to response or make decision. The application of ST for data enables an understanding of how data can constrain or enable agents in performing their activities.

5 Conceptual framework for healthcare services

ST is useful in gaining an understanding of how technical and non-technical agents interact with each other (Iyamu 2014). This is illuminated by the relationships and interdependence between the agents. Chang (2014) argues that this type of interaction occurs between the agents, through which activities are reproduced. Along the same line of viewpoint, Englund and Gerdin (2014) state that agents and structures do not consequently constitute independent sets of phenomena (a dualism), but represent two sides of the same coin. Thus, an agency such as health professionals and medical associations exist through the rules, which they themselves created. As a result, neither agency, nor structure can exist without the other. In the process, both agency and structure reproduce their activities as they evolve.

Based on subjective understanding, which was guided by the duality of structure from ST, a conceptual framework was developed. The framework as shown in Fig. 3 is intended to contribute to improving the healthcare services that the patients receive. The framework consists of four main components, namely structure, agency, facility, and agent. The components are interrelated in the process of providing and receiving healthcare services, through which huge volumes and various types of data are generated. The data are often reused in the course of service delivery.

However, the reuse and management of patients' data have always and will continue to be challenging to the service providers of healthcare in South Africa. This is attributed to the fact that many of the health professionals do not fully understand

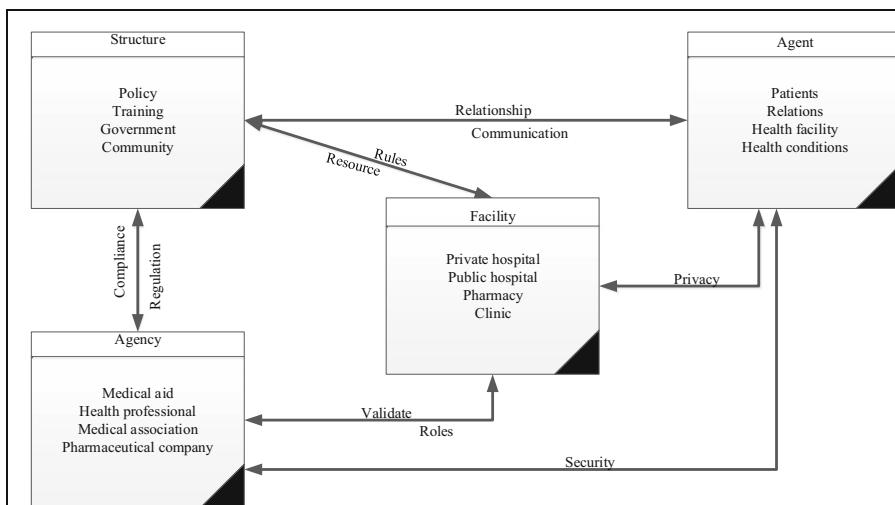


Fig. 3 Data Management Conceptual framework for healthcare services

how the factors (components) that underpin their services connect and relate with each other. The conceptual framework that is proposed in this paper reveals and explains the underpinning factors. The components enable and at the same time constrain the healthcare service delivery in the country. For examples:

In South Africa, health care workers are required to be registered with the Health Care Professional Council of South Africa (HCPCSA) in order to practice or work in the healthcare sector. If one is not registered, regardless of whether they have a qualification or not, they are not allowed to practice or provide health services to the community. This rule determines whether one is able to practice or not.

Resource enable and at the same time constrain healthcare services offered to the patients. For example, (i) the operations (such as surgical) of patients by various medical conditions are either enabled or constrained by the availability of medical specialists and devices. This alludes to the fact that some hospitals do not have medical expertise in all disciplines. Also, some of the polies can be constraining owing to the sensitive nature; (ii) Patients have the right to refuse medical treatment and for this reason, health care workers may not force any medication or procedure on them even if this may result in loss of life. The healthcare workers are required to accede to the wishes of the patient regardless of their professional opinion. If the patient is unable to decide on his/her own, the health care workers applies the professional know-how and proficiency in the course of duty. The interrelationship and interconnection between the components as shown in the Figure are discussed, as presented below.

5.1 Structure

As shown in Fig. 3, on one hand, the structure interacts with the agencies. On another hand, the same structure has relationship with human agents. The structure consists of policy, training, government, community and health professionals. These structures are used to liaise with the agency including medical aid, professionals, medical associations and pharmaceutical companies, toward providing services to the patients. The interactions that happen between the two entities, structure and agency are enclaved in rules and compliance, regulate the functioning and activities of stakeholders in the healthcare sector. Similar to other countries, the South African government publishes legislation and policy frameworks through which operations of agencies such as non-governmental organisations, pharmaceutical companies and medical facilities are sanctioned and legitimized (Moshabela et al. 2016). The sanctioning of policies, rules, and resources is primarily to communicate legitimacy, thus promoting transparency between the agencies and agents.

Government and policy-makers such as the legislators also sought to improve the interaction between themselves and the patients by integrating community-based health care programs into the national health insurance (NHI). The NHI, among other things, is intended to facilitate the interaction and communication between the healthcare service providers and the beneficiaries of healthcare in the country (Schneider et al. 2015).

5.2 Agency

The agencies within the healthcare environment include medical aid organisation s, medical associations, healthcare professionals and pharmaceutical companies. These

groups are the core instruments in the provision of healthcare services. The agencies are not independent of agents and available facilities. As already mentioned, the agencies are interrelated and interconnected with the existing structure. The agencies employ various tools and means, such as non-government organisation s, ambulance services in providing services to individuals and groups (Crush and Chikanda 2015; Mash et al. 2015). The agencies are conscious of their actions from confidentiality and security viewpoint. Owing to the sensitivity of the healthcare environment, the roles and responsibilities of the agencies are also well guided by laws and policies. Thus, the actions and activities of the agencies are validated at all times, against various facilities. The process of validation, including roles and responsibilities, are legitimated through government accreditation procedures as promulgated by the policies. The agencies operate under the guidance and watchful eye of the existing authorities, such as the government and policy-makers (Bernardi 2017).

5.3 Facility

Healthcare services are sought and provided for through facilities such as clinics, pharmacies, public and private hospitals. Fig. 3 shows the facility being somewhat integral through its interaction with parts of the framework which are structure, agency, and agents. As mentioned above, these facilities are an important feature of the healthcare sector as health is provided through these facilities whether they be private or public in their nature. The interaction between structure and facility is through the application of rules and resources. To address inequality and access to healthcare services, the South African government has sought to strengthen primary health care services (the first level of the public healthcare system), by channelling resources for the provision of free services such as antenatal care, immunizations and chronic treatment (Vearey et al. 2018). The government also has an interest in the distribution of resources for the benefit of the citizens. As the result of the apartheid legacy, where private health care was better resourced than the public health sector, the South African government embarked on a program known as National Health Insurance (NHI) to promote universal health coverage, seeking to facilitate the fair redistribution of resources between the private and public health sector (Niekerk et al. 2015).

Facility and agent interaction are characterized by the need to keep data private. Patient records held by healthcare facilities contain sensitive and personal information about patients. The healthcare data also hold huge potential for medical research and shaping public health policy, but if there's a perception of misuse and disregard of patient privacy, it may lead to distrust by the public. It is for this reason that the privacy of healthcare data should be safeguarded to ensure privacy and confidentiality are safeguarded and negative perception about the handling of healthcare data does not arise. The misuse and breach of privacy may also lead to stigmatization and discrimination of patients by the healthcare workers and the public such as those diagnosed with leprosy, HIV and other chronic diseases (Arrey et al. 2017).

In the use of data for healthcare service delivery, actions of practitioners are centred around patients' care. The people that are employed or contracted at medical facilities are often associated or affiliated to different professional associations of doctors and nurses (Mayosi and Benatar 2014). This means that even though the roles of

individuals are critical to human lives, their actions are consciously or unconsciously guided and influenced by the code of conduct of the associations that they are affiliated, or member of.

5.4 Agent

As explained throughout this article, agents consist of technical and non-technical agents (Bernardi 2017:939). This concept is demonstrated in Fig. 3, where the non-technical agents are the patients, their relatives, and health conditions, and the technical agent is the health facility. Both the technical and non-technical agents work together to ensure that healthcare services are offered effectively and efficiently. However, agents do not operate on their own, therefore, there is a dual interaction between agents and facility. For instance, patients seek healthcare services that are provided and accessed through various means, including personal visitation to the health facilities, emails, or telephonic communication.

Due to the sensitivity of healthcare data, privacy must be taken into consideration during the interaction between agents and facility. This is a two-way interaction in that, the non-technical agents such as patients and his/her relatives, are responsible for the privacy of their own data. Also, each facility such as a private and public hospital, pharmacy and clinic, must apply practical measures to maintain the privacy of patients' data. In the same way, during the interaction between facilities, the patients' data privacy should be protected.

The healthcare service providers consider the well-being and safety of patients in their care to be of great significance (El-Jardali et al. 2014). Because of this significance, patient education programs have been introduced to facilitate interaction, communication and greater awareness of patient health and privacy by the different agencies (Hill et al. 2015). The agents' interaction with agencies is based on ensuring the security of agents in a more general sense. For example, when a health practitioner performs an unethical act, the agencies are the ones that determine the punishment of the health practitioner for the security of the patient. In extreme situations, it may result in cancelling the health practitioners' license to practice in the profession. However, there can be situations where the agents interact or communicate directly with the structures, which includes the government.

These relationships or interactions between agents and structure involve reproduction of social systems such as practices or a specific pattern of behaviour between agents (Giddens 1984). This is what constitutes the duality of structure focusing specifically on how structure and agents influence each other (Roberts 2014). This influence happens through a cycle which consists of, how rules and resources are created, through actions from the interaction between agents and how agents base their behaviour on those rules and resources (Iyamu 2015).

As agents' actions reproduce themselves, they occur in an iterative manner in such a way that agents can perform certain activities over and over without knowing how to explain what they are doing (Iyamu 2018:3). Therefore, the social structures that are produced through the interaction between agents and structure are products of the reproduction of human actions (Englund et al. 2017).

6 Conclusion

Healthcare services are delicate services provided to citizens by their government, together with their health facilities. This can be attributed to the fact that poor healthcare service delivery can result in loss and/or damaging of lives. Therefore, the goal of any healthcare facility is to provide quality services to its patients. However, poor management of healthcare data hinders the process and goals of achieving quality services. Thus, the study employed duality of structure of Structuration theory as a lens to understand how different agencies use structures to improve healthcare services. As a result, a conceptual framework was developed to guide how data could be managed towards improving healthcare service delivery. The conceptual framework provides a view of how structure may influence the interactions between the role players in the healthcare sector and the government representative. Thus, healthcare facilities and government representatives can benefit from this study through its use to facilitate policy formulation. The study also contributes to the body of knowledge through its addition to existing literature.

Although the study was comprehensively covered and the objective was achieved, there is still room for further research on this topic. This includes how the implementation of the framework and measurement assessment model. Also, different theory such as actor-network theory and activity theory should be used in similar studies to ascertain if different outcome can be reached.

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