Cape Peninsula University of Technology

INTEGRATION OF MOBILE HEALTH TECHNOLOGY-ENABLED ACTIVITIES IN CLINICAL SETTINGS OF TERTIARY HOSPITALS IN SUB-SAHARAN AFRICA

by

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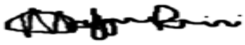
DECLARATION

I, Oluwamayowa Oaikhena Ogundaini, declare that the content of this thesis represents 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.



23rd November 2020

Signed **Date**

ABSTRACT

Mobile phone ownership and usage continues to increase exponentially throughout the world because of portability, facilitation of access to information, communication at any time and the ability to reduce or enhance mobility. These characteristics provide opportunities to integrate mobile phones into health information and communications technologies (ICTs) in order to support information accessibility during service delivery. Despite the rapid penetration of mobile-enabled technologies in lower- and upper-middle-income countries, there is limited empirical evidence of the usefulness of mobile health (mHealth) technologies and their effective use at points-of-care in tertiary healthcare settings.

Lack of sufficient evidence impedes mHealth scale up such that healthcare professionals who are principal users of health information technologies (HITs) are unable to effectively perform their work activities because of time constraints and the inappropriateness of some technologies used. Ultimately, this affects the purpose of HITs to adequately enable execution of work activities and address performance inefficiencies experienced by healthcare professionals at points-of-care. This study takes into consideration the influence of the complexity of tasks and capabilities of technology on the behavioural intention of healthcare professionals to use (or not to use) HITs at points of-care during healthcare service delivery.

The study adopted an interpretivist perspective and a qualitative approach to understand the work activities of healthcare professionals and how technology is used as an enabling tool by means of service design. The Double Diamond Model (DDM) was used to gain in-depth information from healthcare professionals. The techniques of inquiry selected were semi-structured interviews and a co-design activity. Purposive and snowball sampling were used to identify participants, who included healthcare professionals and senior managers. The qualitative data were analysed using the Activity Analysis and Development (ActAD) model as a lens to interpret findings associated with elements within the technology-enabled work activities executed by healthcare professionals in tertiary healthcare settings.

The findings of this study show that implemented HITs enable access to patient information electronically and facilitate remote consultation and communication both within and outside healthcare institutions. An additional benefit attributed to the use of implemented HITs is information accountability. However, the mHealth application, VULA, developed by a clinician and used at medical facilities, is described by doctors as being disruptive during patient consultations at clinics. Nursing work activities require continuous report writing on paper; it becomes cumbersome, depending on the timeline of the patients' journeys. The overall inference drawn from the co-design activity performed during this research, is that within the work activities of healthcare professionals in tertiary hospitals, there are touch points where machine agency influences human agency and *vice versa*. Ultimately, the study describes how the interplay between human agency and machine capabilities transform the outcome of technology-enabled clinical work activities in the process of healthcare service delivery.

Overall, this study offers key considerations in the context of preparing to implement health ICTs and making efforts to optimise implemented HITs. The study describes the interplay between human actors and technology performance as a contributing factor to the development of an applicable framework used to design and evaluate mHealth technology-enabled work activities in tertiary healthcare of sub-Saharan Africa. This study contributes to the conversations about how cost-benefit analyses of automation result in a strengthened synergy between human agency and technology performance, particularly in the context of a hospital setting in Sub-Saharan Africa. The methodological contribution to the study is informed by the use of semi-structured interviews and co-design activities as tools of inquiry in a service design strategy to develop user journeys applicable to health informatics studies. The study offers conceptual considerations to negotiate the interplay between human agency and health ICT capabilities as informed by the activity analysis and development, particularly in tertiary hospital settings of Sub-Saharan Africa.

Keywords: mHealth, agency, work activities, professionals, tertiary hospitals, ActAD

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DEDICATION

This body of scientific work is solely dedicated to humans of all kind, who have doubts in their abilities to make their ideas and dreams a reality.

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ABBREVIATIONS AND ACRONYMS

Acronym	Full Term
ActAD	Activity Analysis and Development
CUG	Closed User Group
ECM	Electronic Content Manager
eHealth	Electronic Health
ECG	Electrocardiography
EHRs	Electronic Health Records
GSM	Global System for Mobile Communication
ICTs	Information and Communications Technologies
ISPs	Internet Service Providers
HIS	Hospital Information System
HITs	Health Information Technologies
LMIC	Lower-middle-income country
mHealth	Mobile Health
NDoH	National Department of Health
NIMS	Nursing Information Management System
PACS	Picture Archiving and Communication System
RIS	Radiology Information System
SDGs	Sustainable Development Goals
SIM	Service interaction moments
SSA	Sub-Saharan Africa
SMS	Short Message Service
RSA	Republic of South Africa
UHC	Universal Health Coverage
UMIC	Upper-Middle-Income Country
WHO	World Health Organisation

LIST OF PUBLICATIONS

Ogundaini, O.O. & De la Harpe, R. 2019. Integration of mHealth technologies to support service interaction moments in tertiary healthcare of Western Cape, South Africa. *Proceedings.* CONF-IRM 2019, 18. https://aisel.aisnet.org/confirm2019/18.

CHAPTER ONE: INTRODUCTION

1.1 Introduction to the thesis

In the public healthcare sector of lower- and upper-middle-income countries, the issues of a lack of timely application and the inappropriateness of information and communications technologies (ICTs) to enable work processes, continue to inhibit the seamless delivery of quality healthcare services (Kumar et al., 2016). Ultimately, the effects of these issues may result in the failure of implemented ICTs, loss of return on investments, and erratic service delivery processes (Bardhan & Thouin, 2013). In this study, the researcher sought to engage with healthcare professionals to understand how suitable mobile ICTs could be integrated into their work activities at points-of-care during service delivery.

ICTs are digital devices such as computers and telecommunication resources that enable access, collection, storage, retrieval and exchange of information between a network of people (Mishra et al., 2013). Mobile ICTs can be considered as enabling tools in creating a more cohesive and inclusive society (Plaza et al., 2011). The majority of mobile phones are used as communication devices that use both wired and wireless networks, to enable an exchange of information with other electronic devices in the same or different locations (Hameed, 2003). Examples of wired networks include public switched telephone networks (PSTNs) and Voice over Internet Protocol (VoIP) (Gunasekaran & Harmantzis, 2007), while wireless technologies include infra-red, Bluetooth and wireless local area network technologies such as Wi-Fi (Patrick et al., 2008). These networked technologies provide the underlying infrastructure to support the use of health ICTs by healthcare professionals for service delivery purposes .

In accordance with the Sustainable Development Goals (SDGs), quality healthcare service is considered as a fundamental human right (Wu et al., 2018). This suggests that an individual, irrespective of their race, gender and religious or cultural beliefs, deserves access to quality medical services towards improved well-being conditions, i.e. universal health coverage (UHC) for all. Therefore, healthcare service delivery is primarily human-centred. It involves a set of structured, timely coordinated activities carried out by healthcare professionals to deliver care services to patients. Activities make up work processes that require a well-grounded understanding of the roles of, and the interactions between, different actors, enabling tools, resources and scenarios of an anticipated outcome (Alter, 2018).

A typical healthcare setting consists of healthcare professionals and administrative staff trained to administer and deliver healthcare services to clients or patients. To administer care, there are procedures and activities performed, either manually or digital-enabled, using the relevant tools to support and enhance the coordination of healthcare service delivery.

Therefore, healthcare service delivery can be described as time-sensitive because of the multifaceted processes of administrative duties and the urgency of clinical procedures, especially in public healthcare institutions, which mostly service a larger population than private healthcare institutions do. The eventual findings of this research contribute towards the effective use of health ICTs by healthcare professionals within tertiary healthcare settings where more specialised clinical care is provided to patients.

The introduction to this chapter provides contextual information on healthcare service delivery in section 1.1, and a descriptive background to the research problem and the rationale for conducting the study in section 1.2. The research problem is articulated in section 1.3; which is followed by the research aim and overall objective of the study in section 1.4 and the research questions in sub-section 1.4.1. The conceptualisation of key words are defined in section 1.5, while section 1.6 highlights the summarised research approach adopted, which is informed by the aim of this study. The delineation and intended contribution of the research are presented in section 1.7; the thesis outline is dealt with in section 1.8 and section 1.9 concludes Chapter One.

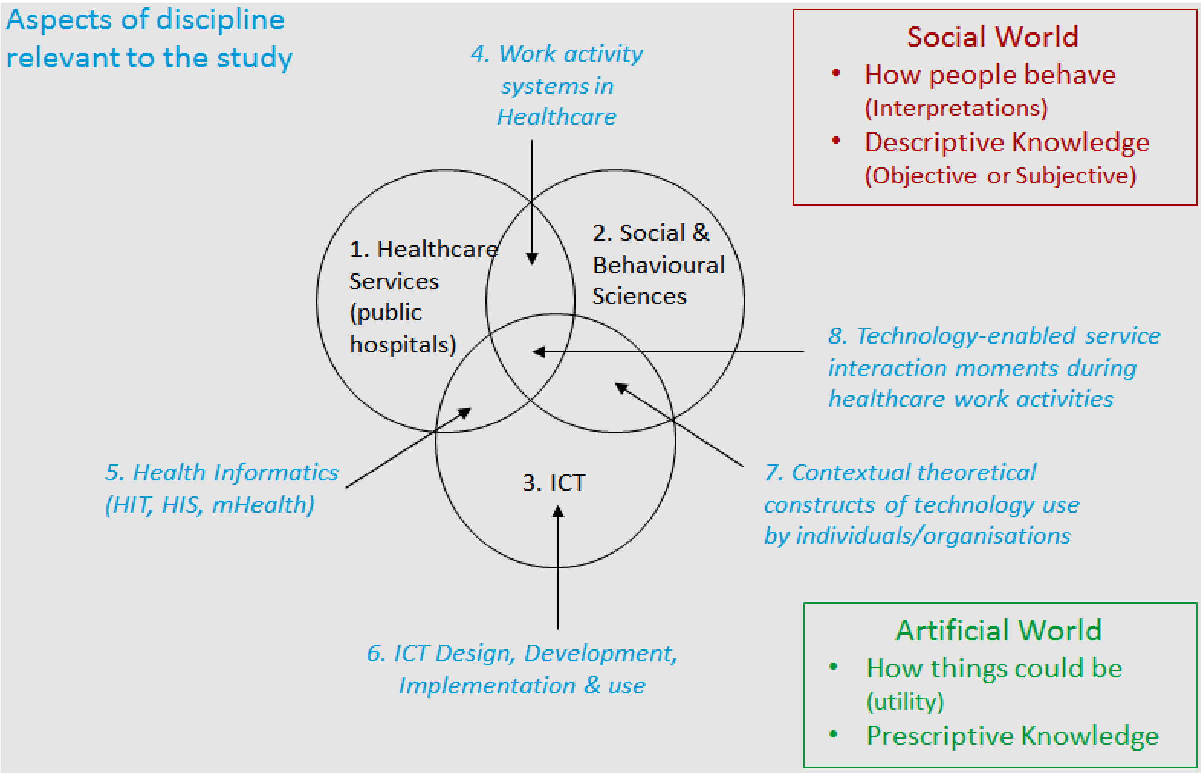


Figure 1.1: A discipline framework to illustrate position of research

In Figure 1.1, the researcher identified three disciplines that were most relevant to this study. These three disciplines are: healthcare services, social and behavioural sciences, and information and communications technology (ICT). The research focused on tertiary healthcare in public hospitals. Generally, public healthcare facilities, in the context of this study, are categorised as primary healthcare facilities, or clinics; secondary, district or state-run hospitals; and thirdly, tertiary or academic hospitals (Richards & Jacquet, 2012). The intersection between the healthcare services and the social and behavioural sciences provides opportunities to understand healthcare service delivery process through the lens of the work activities of healthcare professionals, taking into serious consideration their points of view.

1.2 Background to the research problem

Healthcare service delivery processes are complex, information driven, and beset by time as well as cost efficiencies. Because of the understanding of these aforementioned aspects, health ICTs are designed, developed and implemented to support work processes in the hospitals (Cresswell et al., 2013). Consequently, this implies that administrative and clinical staff may use technologies to assist in executing the perceived complexity of their work activities during the delivery of services to patients. A complementary interaction between healthcare professionals and technology, as a socio-technical relationship, is formed. The concept of socio-technical interaction described by Lamb and Kling (2003) includes social actors (individual or organisations), equipment, interaction such as information exchange, resource management and rules as compliance mechanisms.

To understand the complexities of contextual socio-technical interactions, considerations are given to the behavioural patterns and roles of social actors in the process of adoption, implementation and use of technology innovations (Meyer, 2006; Alter, 2018). Drawing from the preceding statement, the concept “social actors” in the context of this study refers largely to the skilled workforce in hospital settings. These include doctors and nurses, and extend to the different cadres of administrative staff. The social actors may use HITs that are perceived by them as relevant to enable the provision of the administrative and clinical work activities at points-of-care towards enhancing the process of healthcare service delivery. However, a lack of timeliness and the inappropriateness of health-related ICTs to enable mobility during the work process have led to adopt mobile health (mHealth) as an integral solution of electronic health (eHealth) to facilitate healthcare service delivery.

1.2.1 Mobile health

The nature of healthcare professionals’ work-related activities sometimes requires mobility in practice; the constraint of desktops or static technology may result in conditions that restrict access to up-to-date information and communication to aid decision-making (Nasi et al., 2015). These conditions inhibit the timely dissemination of health information to clients and restrict access to the updated information required by healthcare professionals to facilitate their decision-making processes. Consequently, healthcare provision was required to transcend time- and location-related constraints to facilitate service delivery to anyone, at anytime and anywhere (Klasnja & Pratt, 2012).

Mobile health or “mHealth” or “m-Health” was first conceptualised by Robert S.H. Istepanian in 2004 (Betjeman et al., 2013). The concept of mHealth goes beyond delocalised delivery of healthcare services. It includes the use of portable technologies (and sometimes enabled wireless communication) as a means of facilitating the processing and provision of timely information on the management of health care (Liu et al., 2019). Thus, mHealth is referred to as the use of mobile phone technologies for health-related purposes (Bloom et al., 2017). Varshney (2014) inclusively captures the concept of mHealth into research sub-areas and their respective activities (Figure 1.2).

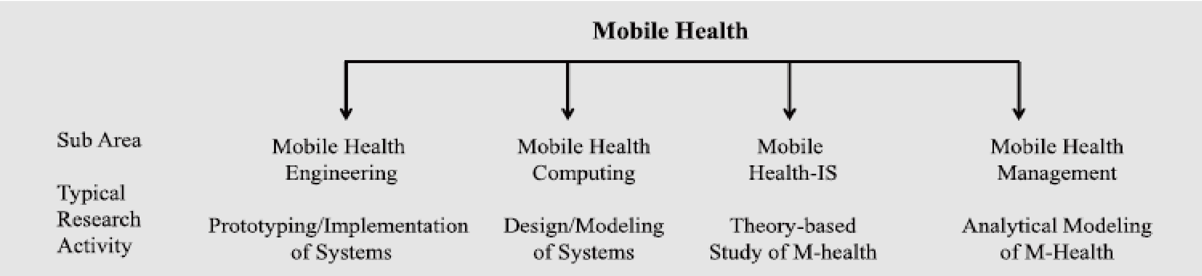


Figure 1.2: Mobile Health research areas and activities (Varshney, 2014)

Figure 1.2 shows that mHealth is made up of four broad areas which include: i) mHealth engineering, which deals with modelling, production and implementation of mobile technologies for health-related work processes (Matthew-Maich et al., 2016); ii) mHealth computing, which refers to the architectural design, usability tests and development of native software applications for mHealth-based systems (Schooley et al., 2013); iii) mHealth information systems (ISs), which describe a theoretical study all-inclusive across the previously mentioned sub-areas (Varshney, 2014); and lastly, iv) mHealth management, which deals with the evaluation and analysis of the performance of mHealth systems (Källander et al., 2013). A balance between the sub-areas is consequential to understanding how mHealth technologies could be designed to effectively enable the work activities of healthcare professionals. However, the researcher focused on the theory-based study of mHealth, as illustrated in Figure 1.2, to contribute to the existing body of knowledge on the application of mHealth technologies by end users to perform their work activities.

The definition of mHealth conceptualised by Varshney (2014) suggests a set of health-related activities and the means through which decision-making processes are effectively facilitated and delivered through automation or aided by human actions. According to the World Health Organisation (WHO) (2008) report, mHealth is described as a canopy expression that usually refers to the use of portable, wireless telecommunication and multimedia technologies, and which includes the use of medical sensors to facilitate communication and mobile computing within healthcare services. These mHealth technologies are mostly handheld, affordable and light weight devices; they usually include built-in networking protocols and sensors, and they can easily be carried around or attached to the body of a healthcare professional or patient (Favela et al., 2004; Blaya et al., 2010). Examples of these types of mobile technologies include smartphones, cellular phones, sensors, pagers, personal digital assistants (PDA), and tablet computers (Gagnon et al., 2016). These are examples of devices on which context-specific software applications are developed to provide the required enabling means for healthcare service delivery (Schooley et al., 2013).

In retrospect, this study considered mobile devices to be smartphones, tablet computers and other similar portable devices as determined by the work activities of healthcare professionals. mHealth technologies in clinical settings are used for easier management of information and communication (Ventola, 2014). For example, records, such as laboratory and medical images, can easily be electronically stored, updated and accessed by healthcare professionals who are required to move around because of the nature of their job. In addition to ease of access to, and retrieval of information, healthcare professionals can easily communicate with their colleagues, thereby reducing professional isolation with respect to timely decision-making and location constraints (Istepanian & Lacal, 2003). This creates an opportunity to facilitate remote access to information for decision-making with respect to diagnosis and treatment. Thus, it would be of considerable benefit to incorporate mobile technologies into the clinical settings of hospitals to enhance the work activities of healthcare professionals at points-of-care.

1.2.2 Rationale for conducting the research

The analysis report of mHealth projects in the Republic of South Africa in comparison to strategic objectives of the National Department of Health (NDoH) shows that there are gaps with regards to how the needs of healthcare professionals in the public health sector could be addressed (NDoH, 2015). The public health sector in South Africa services more than 80% of its population, as indicated by Hwabamungu et al. (2018); this implies a risk that the healthcare system might be overwhelmed. In instances where mHealth projects have been initiated, they either: i) remain at the pilot stage; ii) or after the implementation stage the uptake by healthcare professionals to enable healthcare service delivery is slowly emergent (Ahmed et al., 2017). This slow uptake and lack of effective use of mHealth in clinical settings served as rationale to conduct this scientific investigation as a means of contributing to efforts to address the gaps that hinder the realisation of the 2015 NDoH mHealth strategy. This study aligns with the mHealth IS sub-area in Figure 1.2 because of the theory-based findings on the knowledge process of how to incorporate mHealth technologies into the work activities of healthcare professionals in a tertiary hospital setting.

1.3 Research problem

Despite the capabilities of mobile technologies to enable connectivity and mobility, there is a paucity of empirical evidence on the effective use of mHealth-enabled technologies by healthcare professionals during service delivery (Ojo, 2018). The status quo in tertiary hospitals is such that healthcare professionals still continue to predominantly use paper and desktop computers to support the execution of tasks within their work environment while the applications of mHealth technology are relatively few (Kabanda & Rother, 2019). The execution of tasks can be likened to the interaction moments at points-of-care, particularly where healthcare professionals deliver care services. Thus, service interaction moments can be used to determine specific points at which mHealth technologies are useful to the work activities done by healthcare professionals.

Further, the continuous use of mostly paper-based systems by healthcare professionals ultimately defeats the purpose of health ICTs to provide automated support for their work activities and to enhance performance efficiencies. Also, since the nature of clinical activities sometimes requires healthcare professionals to be mobile, desktop-compatible healthcare applications may inhibit informed and timely decision-making during service delivery.

The potential of mHealth technologies to address both time and location constraints has become increasingly reputable; hence, it is essential to understand what informs its use and how it could be integrated into clinical settings of public hospitals (White et al., 2016). Therefore, it is arguable that the additional insights from this study could address the limited insights into the effective use of mHealth technologies when they are integrated to support the interaction moment of tasks performed by healthcare professionals, especially in clinical settings of tertiary hospitals (Martin et al., 2019), otherwise, the potential of mHealth technologies to productively redress the constraints of human-technology interaction during healthcare service delivery might not be realised.

1.4 Research aim

The aim of this research was to explore opportunities for integrating mHealth technologies into the work activities executed by healthcare professionals at points-of-care at selected tertiary hospitals in Sub-Saharan Africa. The research objective was to understand how mHealth technology could enable the service interaction moments of work activities of healthcare professionals by regarding the human actors and technology components as nodes within a socio-technical interaction. The main objective of the study was formulated as contributing towards enhancing the processes of healthcare service delivery in the tertiary hospitals of Sub-Saharan Africa and towards the development of HITs.

1.4.1 Research questions

The research questions, sub-questions and objectives are indicated in Table 1.1 below.

Table 1.1: Research questions, sub-questions and objectives

Research Question 1: How can mHealth technologies be used to enable interaction moments within the work activities of healthcare professionals in tertiary healthcare settings?	
a. How does the use of implemented HITs to enable work activities influence the outcomes of healthcare services?	The objective is to determine the current effect of implemented HITs on the outcomes of healthcare professionals' work activities.
b. What are the pain and gain points experienced by healthcare professionals while using implemented HITs to enable their work activities?	The objective is to identify pain and gain points experienced by healthcare professionals at service interaction moments during their work activities at points-of-care.
Research Question 2: What are the characteristics of a desired touch point required to integrate mHealth technologies in the work activities of healthcare professionals?	
c. How can the use of mHealth technologies be incorporated at the different service touch points?	The objective is to determine how mHealth technologies and human actors can be aligned for effective use at different service touch points.
d. How do the selected choices of technology by the Provincial Department of Health influence the work activities of healthcare professionals in tertiary healthcare?	The objective is to understand the role of the Provincial Department of Health in stakeholder engagement during the selection process of HITs for healthcare service delivery.

1.5 Conceptualisation of key terminologies

- ***Mobile health (mHealth)* technologies** are portable wireless telecommunication and multimedia devices, including medical sensors, used to facilitate communication and mobile computing in order to support healthcare service delivery (WHO, 2008).
- ***Health information and communications technologies (ICTs)*:** are designed to explicitly support or enable health-related activities. In this study, health information technologies (HITs) and health ICTs are used interchangeably because some of the implemented technology solutions function as more than mere tools used to collect, store and retrieve information; they are also used to facilitate communication among healthcare professionals at points-of-care during healthcare service delivery.
- ***Healthcare services*** include clinical and administrative work activities that deal with the patients' health and information in a manner that assists healthcare professionals in decision-making and care delivery (Natalia et al., 2013). In this study, clinical work activities and their respective touch points were investigated to understand specific points at which healthcare professionals require the use of mHealth technologies, as

well as the would-be functionalities of these technologies in the healthcare service delivery process.

- ***Service touch points*** are instances of transitory convergence where a network of human actors and objects perform actions towards providing a service to satisfy or produce an outcome. The outcome of touch points informs user experiences and is likely to influence the perceptions of a service. In the context of this study, work activities include touch points that consist of interaction moments where healthcare professionals may use HITs to perform their tasks during service delivery.
- ***Service interaction moments:*** HITs may be used by healthcare professionals for different activities. These activities include: communication with colleagues; collection of patient data; access to, or retrieval of, electronic or digitised records; and for decision-making. In clinical settings, service interaction moments within work activities of healthcare professionals are performed either through human-to-machine, human-to-human or machine-to-human actions facilitated by a machine for a pre-set purpose. Therefore, service interaction moments may be socio-technical in nature, wherein healthcare professionals use the functions of technology to provide services in the hospital environment.
- ***Pain points*** are defined as touch points that are tense and may cause a reduction in the value of a service (Clatworthy, 2011), especially from an end user's point of view. In this study, pain points are the instances where healthcare professionals encounter challenges with (or without) the aid of technology at points-of-care.
- ***Gain points*** are the converse of pain points described above.
- ***Service design*** is a human-centred collaborative process that aims to unpack how a set of activities unfold along a timeline, with details of active interactions designed to improve the end user's experiences and to modify or create a new service (Teso et al., 2013). In this study, service design was used as a strategy to engage healthcare professionals and to acquire informative feedback about their experiences with the use of technology and the potential of mHealth to support their clinical work activities.
- ***Points-of-care*** refers to locations or spaces in the clinical settings of hospitals where healthcare professionals perform their work activities during service delivery, as implied by Ventola (2014).

1.6 Research approach

The research approach (discussed in more detail in Chapter Four) highlights the researcher's choice of philosophy that shaped the data collection process employed to address the objectives of this study. An interpretivist approach was adopted, based on a subjective ontology; the knowledge sought to address the research problem was informed by the socially constructed and contextual reality (Walsham, 2006). For instance, the researcher addressed the research questions based on inferences drawn from perceptions, thoughts, feelings, expectations, experiences and sense making of how healthcare professionals executed their work activities at points-of-care. To explore the interpretations attributed to the socially constructed realities, a qualitative methodology was applied to collect data.

A qualitative methodology allowed the researcher to use a strategy and tools of enquiry to gain in-depth information from participants (Neuman, 2011). The researcher engaged participants to acquire information on their routine work activities, the tools used to support these activities, their experiences with the existing technologies, and the potential for integrating mHealth technologies into their work to support their work activities. Participants included doctors, nurses and information administrators. Particular attention was paid to the thoughts, beliefs and experiences of individual healthcare professionals.

The research strategy adopted was service design. The choice of service design was informed by the need for collaborative engagements with the users and potential end users of mHealth technologies, as shaped by their thoughts, perceptions, experiences and expectations. Service design was applied as a research strategy to guide data collection, which enabled the researcher to interpret what healthcare professionals say in relation to how they actually perform their work activities at points-of-care. Since the study was focused on the work activities of healthcare professionals, open-ended questions were used to engage participants in semi-structured interviews and co-design activities. These multiple techniques were used to acquire in-depth information on the capabilities of health ICTs to support their work activities, informed by the thoughts, perceptions, experiences and expectations of healthcare professionals. Subsequently, the information was used to define technology-enabled user journey maps and to explore other emergent areas of interest. The likely ethical implications of the research approach were identified and addressed, and permission was obtained from the appropriate authorities. The research design is discussed in more detail in Chapter Four.

1.7 Delineation and intended contribution of the research

The output of this study was largely aligned to the needs of the 2015-2019 mHealth Strategy of the Republic of South Africa (RSA) (NDoH, 2015). The investigation was carried out in two selected tertiary hospitals, one each from the Western Cape Province, South Africa and South West Nigeria. The research aim was addressed, research questions were answered and recommendations were made in relation to the objectives of the research. The findings were discussed in order to address the lack of timely application and inappropriateness of health ICTs for the work activities of healthcare professionals as a result of unintended consequences.

The anticipated outcome of this study is discussed in section 8.4.2 and a conceptual framework indicating the likely levels of interplay (intermediate and advanced) between the socio-technical interactions of a mHealth-assisted work activity in a public hospital setting is illustrated in Figure 8.1. The study aimed to serve as a foundation on which further studies may be built with regards to the possible design of mHealth technologies specific to the work activities of healthcare professionals in public hospitals in Sub-Saharan Africa.

The study contributed theoretically to the scientific body of knowledge with regards to the transformation process of an object into the goal of the activity using the Activity Analysis and Development (ActAD) model as applied in information systems research, particularly in healthcare. The methodological contributions of this study to the body of knowledge include the application of co-design and open-ended questions to determine interaction moments through the use of user journey maps in service design for mHealth-assisted activities in tertiary hospital settings. Practical contributions of this study relate to the abstraction of findings by government health authorities in order to develop action guidelines and the health informatics practice community towards the development of a feasible implementation framework for sustainable and scalable mHealth projects in Africa.

1.8 Outline and timeline of thesis

Research is a continuous and evolving process. In a time snapshot, the study was divided into chapters One to Eight, as illustrated in Figure 1.3 below and further explained.

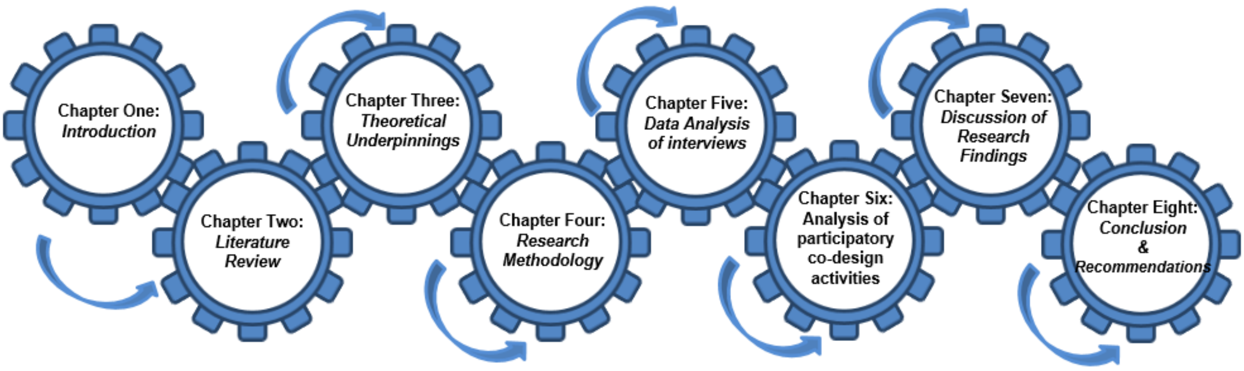


Figure 1.3: Outline of thesis structure

Chapter One: In the introduction, the researcher briefly explains the background to the research problem and the rationale for carrying out the study. This is followed by presenting the research problem, the research aim (purpose of the research) and objectives (how the researcher intended to address the aim), followed by the research questions. The conceptualisation of key terminologies in the context of this investigation is defined, followed by the delineation and intended contributions of the study, the outline of the thesis and a conclusion.

Chapter Two: A systematic analysis of the existing literature is presented in this chapter. The chapter includes a description of mobile technologies in general and mobile technologies in healthcare, with subsections that describe the application of mHealth within a clinical context and the lack of mHealth within clinical settings in lower- and upper-middle income countries. Subsequently, an overview of mHealth innovations in South Africa (an upper-middle-income country) and Nigeria (a lower-middle-income country) are provided with sub-sections in which examples of mHealth technology implementation for clinical purposes and the relevant stakeholders are presented.

Chapter Three: This chapter introduces the theoretical underpinnings of the study and the study's significance to IS research. Theories in IS research from which relevant concepts could be drawn to understand the research problem were identified and discussed. This is followed by a discussion of the preferred theory – Activity Analysis and Development (ActAD) as an analytical lens to discuss the findings of this study, with samples of existing literature where ActAD had been applied previously.

Chapter Four: The research approach is discussed in this chapter. The researcher argues his philosophical position in relation to the assumptions of how knowledge is obtained from a socially constructed reality. This philosophical stance informed the choice of research methods adopted by the researcher. Qualitative methods guided the data collection process and the techniques used to analyse the data.

Chapter Five: This chapter presents the process of data collection, including the contexts in which data were collected and a description of the thematic analysis process. The emergent themes from the transcribed data are organised and presented according to key issues of investigation in the objectives in section 1.4.1.

Chapter Six: The data collection using co-design activity is presented in this chapter. The process of the co-design activity conducted is explained, along with the resulting outcomes. These outcomes include both transcribed data and the visual illustrations of the user journeys pertaining to the work activities described by healthcare professionals. This is followed by a description of the findings from the three emergent themes, which include the current workflow, challenges and ideal situation of technology-enabled work activities. The key findings from both the contexts of co-design activity data collection are presented.

Chapter Seven: The research findings are discussed (and critiqued) in this chapter, along with the use of the theoretical model (ActAD) and the literature in order to address the research problem and to identify relationship between emergent theoretical concepts.

Chapter Eight: This is the concluding chapter. It draws on the rationale for conducting the research and how the philosophical position of the researcher shaped the outcome of the research; and it provides justification of the research findings. The chapter concludes with recommendations based on the research findings, as well as contributions to, and reflections on, the research process.

1.9 Conclusion to Chapter One

In Chapter One, the researcher introduced the healthcare context in which the study was performed and the background to the research problem. The complexity of healthcare service delivery lies in the fact that both the administrative and clinical work activities are information-intensive and, over time, have required some form of automation in order to improve their related tasks. However, the lack of timely application and inappropriateness of health ICTs do not adequately address some of the challenges faced in the performance of work activities within the healthcare service delivery process.

Because of the nature of the work activities carried out by healthcare professionals, particularly in the tertiary hospitals of lower- and upper-middle-income countries, the use of technology could be argued as an essential and enabling tool to for task accomplishment. Therefore, the empirical findings of the study indicate that mHealth technology could aid healthcare professionals to complete their tasks efficiently in circumstances affected by time and location constraints.

To this effect, the overall research objectives were to prescribe how mHealth technology could facilitate service interaction moments by considering both the pain and the gain points experienced by healthcare professionals during their work activities. An interpretivist approach was adopted to address the research questions.

In Chapter Two, the researcher provides an in-depth review of scientific literature on the concepts relevant to addressing the research problem within the context of this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction to the review of literature

The healthcare services sector is largely information-intensive and, thus, the importance of information generated before, during, and after work activities cannot be overemphasised. Healthcare professionals largely depend on information generated and stored to make informed decisions on the status of the physical and mental well-being of patients during the process of service delivery. Hence, the quality of healthcare services is dependent on the availability and accessibility to information if patient satisfaction is to be realised. Thus, in the literature review chapter, the researcher focuses on the concepts of healthcare services, enabling technologies in healthcare service provision, the experiences of frontline users and the different contexts in which these technologies are used.

It can be argued that the quality of service delivered by healthcare professionals has a direct correlation with perceived patient satisfaction of healthcare received. Thus, it becomes imperative for healthcare professionals to perform their work activities within an enabling environment in a timely manner. However, the complexity of healthcare services, the effects of time and location on the nature of healthcare professionals' activities and constraints on enabling tools, such as paper, desktops or other static technology, could inhibit efficient service delivery (Khalifa & Alswailem, 2015). Thus, it is argued that there could be a need to incorporate a fit-for-purpose mobile technology at identified points-of-care where time and location constraints cause inefficiencies to service delivery.

The research aim was to explore opportunities to integrate mHealth technologies into the work activities executed by healthcare professionals at points-of-care in tertiary hospitals, particularly for selected cases in Sub-Saharan Africa. The chapter layout is as follows: introduction in section 2.1; followed by an analysis of the status of literature review in section 2.2; while sections 2.3 and 2.4 describe healthcare services and mobile technologies respectively. The use of mobile technologies in healthcare are discussed in section 2.5; application of mHealth technologies in clinical settings is presented in section 2.6. In section 2.7, the paucity of mHealth technologies to support clinical activities in tertiary healthcare institutions in Sub-Saharan African is described, followed by an overview of mHealth initiatives in South Africa and Nigeria in sections 2.8 and 2.9, respectively. The chapter is concluded in section 2.10.

The theoretical constructs that relate to the disciplines illustrated in Figure 1.1 are discussed in Chapter Three. The theoretical constructs are discussed separately from the literature review so that the researcher clearly describes the existing theories applicable in order to explain the empirical findings in this study.

2.2 Status of literature review on mHealth technologies

After the research area was identified, the next step was to engage with existing studies that relate to the researcher’s choice of topic. This is referred to as a literature review. A literature review involves preliminary searching, reading and a continuous evaluation of the relevant background of an investigation so as to advance knowledge (Webster & Watson, 2002). Literature sources can be both digital and printed media, including publications in electronic journal databases and textbooks. The information available in these sources assists the research to understand and interpret the historical development of, and current status of investigations in, the chosen area of research. The purpose of conducting a literature review is to acquire information about what is known, as informed by studies undertaken by other scholars; what is unknown (or limitations); and how to scope a study to narrow its focus and its eventual contribution to the body of knowledge in a specific discipline (Levy & Ellis, 2006). Therefore, a literature review is conducted for different purposes.

The researcher mostly utilised electronic and online sources throughout the course of this study; however, a few printed books that are related to HITs studies were also used. Several searches were initiated on the various online journal databases subscribed to by the researcher’s institution of learning. Database examples include: Google Scholar, ProQuest, EBSCO Publishing, Springer and Elsevier, to mention a few. Access to peer-reviewed publications afforded the researcher the opportunity to read and gain insights into the research area, using relevant keywords or phrases. The key words used to query electronic databases included ‘mobile health’ and ‘mHealth’. These keywords were combined with other relevant keywords, such as ‘healthcare services’, ‘tertiary healthcare’ or ‘hospital’, ‘Sub-Saharan Africa’, ‘South Africa’ and ‘Nigeria’ – being the contexts of the research and sources of primary data.

There is a wealth of published articles on both mobile health and other health ICTs implemented to support healthcare services in the online domain in the past 16 years. One ‘m-Health’ query on Google web search yielded 6,490,000,000 results, while a query on “mHealth” yielded 5,480,000 in 0.39 seconds. These results were inclusive of high, lower- and upper-middle-income countries from both the global north and global south. Source of data included both national and provincial strategy documents. This study is exclusively concerned with published scholarly articles on past investigations in different social contexts all over the world; but particularly in the Sub-Saharan Africa region. Therefore, particular emphasis was placed on Nigeria and South Africa; the two fastest growing economies in the Sub-Saharan region.

Based on the results of query, ‘mHealth’ (or ‘m-Health’) was the constant word in the combination of keyword searches of article titles. Google Scholar was used as a secondary reference database to avoid redundancy and duplication of articles associated with initiating several queries on multiple electronic online databases. At the time of writing this section, querying mHealth publications at any time on Google scholar yielded 148,000 results including both patents and citations. Exclusion of patents generated an estimated 141,000 results, including e-books, journal articles and conference proceedings. Querying ‘m-Health’ OR ‘mobile health technologies’ yielded 17,800 results. With the inclusion of AND ‘healthcare professionals’, the query yielded a result of 5,560 links. To capture different terms used for healthcare professionals, the researcher included OR (doctors OR nurses OR physicians OR clinicians), the total result was 17,500 publications. The result dropped to 257 with the inclusion of AND ‘tertiary hospitals’. When the context of the study was added to the search query string the inclusion of AND ‘Sub-Saharan Africa’ yielded 63 results. When AND ‘South Africa’ was added to the previous string of query, the search generated 91 results; when AND ‘Nigeria’ was included and the results reduced to 71. With a drastic reduction in the results generated when queuing the Sub-Saharan Africa region, the literature search analysis suggests that bulk of the studies on mHealth are conducted in the global north. In Sub-Saharan Africa, despite the fewer results, more research studies acknowledged mHealth technology initiatives to aid the delivery of healthcare services, more so in South Africa (an UMIC) than in Nigeria (a LMIC).

2.3 Healthcare services

Healthcare involves actions carried out by entrusted professionals as frontline workers to improve the status of the physical and mental well-being of individuals towards enhancing their quality of life (Ahmad & Ud Din, 2010). These actions are performed within or outside of a designated hospital environment in order to provide curative, preventive, rehabilitative and, in some instances, promotive measures to manage the health and care needs of individuals (Khalifa, 2013). These professionals may include specialist doctors, nurses, pharmacists, allied health workers, home-based and community healthcare workers. The provision of a coordinated set of medical- and health-related activities executed to improve the health needs of an individual or group is known as healthcare services. Healthcare services are generally overseen by a constituted authority in the form of healthcare professionals, hospital administrators, a health association body and the government. Government-funded healthcare institutions are referred to as public hospitals, while there are privately funded hospitals; these constitute the services providers in any healthcare system (Fatima et al., 2018).

Healthcare service is made of activities that include administrative, clinical and research activities (Mimbi & Bankole, 2015). Administrative activities mainly deal with the admission, transfer and discharge of patients (Cline & Luiz, 2013). Other tasks within administrative activities require report generation and administering physical care. For example, an individual who requires medical attention because of their experienced symptoms of an ailment proceeds to a hospital, ideally as an outpatient. At the first point of entry into the hospital, demographics and health-related information are collected by the administrative clerk and recorded. This information is used to manage admission, discharge or transfer, depending on the patient category. Outpatients refers to the patients that temporarily visit hospitals and leave same day, while inpatients are admitted and are resident in the hospital for a certain period of time (Patrick et al., 2008). After administrative information is collected at the initial point of entry, clinical activities are carried out by healthcare professionals.

Clinical activities of healthcare professionals can be broadly categorised to include patient care and information administration (Carayon & Hoonakker, 2019). Usually, a patient is attended to by nursing staff and booked to see a doctor. The patient narrates their symptoms and experiences while the doctor takes necessary notes and determines the next step. In that step, the doctors perform further clinical examinations in order to make a diagnosis or to refer the individual to undergo pathology tests to determine the nature of the ailment.

In addition, specialist doctors tend to move around wards or the theatre within hospitals to carry out coordinated and collaborative care with other healthcare professionals, mostly in the case of inpatients (Manda & Herstad, 2015). Nurses oversee care and treatment plans, and document the procedures carried out on patients, while doctors coordinate patient consultation as well as attend to referrals from other healthcare institutions. More importantly, the work activities of nurses and doctors complement each other and are dependent on the availability of and access to information for decision making and clinical research purposes. In this study, the researcher investigated how mobile technologies can be integrated into the technology-enabled activities of healthcare professionals during service delivery.

2.3.1 Challenges associated with healthcare service delivery

The quality of healthcare services delivered to patients is largely dependent on the ability of healthcare professionals to productively execute their work activities optimally within enabling conditions. In this study, an enabling condition is interpreted as the availability of infrastructural resources at points-of-care, particularly the medical equipment needed to perform clinical examinations; and data required to make an informed diagnosis and to administer care to patients. In addition, healthcare services require the coordination of a governance structure to facilitate resource allocation and budget control to oversee a functional healthcare system. The existing literature indicates that healthcare services in Sub-Saharan African contexts are sometimes overwhelmed by challenges when the enabling conditions are less than adequate (Ladan et al., 2019). Some of these challenges include a dearth in skilled personnel to deal with the burden of diseases; unavailability of records when needed because of a loss of paper records, or offline systems in cases of digitised records;

miscommunication among professionals or across institutions; and a poorly maintained infrastructure. These challenges often result in decision-making errors and a decline in the job performance of healthcare professionals, which ultimately affects the quality of service delivered. As a result, patients experience longer waiting times during visits and, in some instances, a lack of access to healthcare services; all these influences patients' satisfaction and, in some cases, may result in their untimely demise.

2.3.2 Facilitation of technology-enabled healthcare service delivery

As a way to mitigate challenges, health ICTs are recognised and introduced to support the activities of professionals aiming to provide equitable services to the population. ICTs enable the automation of tasks performed by healthcare professionals (Carayon & Hoonakker, 2019). These tasks may include collection, storage and retrieval of information created during admission, and the consultation and monitoring of patients (Weiner & Biondich, 2006). Furthermore, there is a need to share or exchange information to assist the decision-making process regarding the status of patients' well-being. Health ICTs are software applications that are desktop-enabled or mobile-enabled, depending on the types of work activities. In this study, the researcher focuses particularly on how mobile-enabled health ICTs could be integrated into the work activities executed by healthcare professionals at points-of-care in clinical settings of hospitals during service delivery.

2.4 Mobile technologies

Mobile technologies are a subset of ICTs (Junglas et al., 2009). A mobile technology is an object that facilitates information and communication services by users, irrespective of location (Svanæs et al., 2010). Mobile technologies consist of three components: portable or hand-held device; wireless communication network; and software applications (Liu et al., 2011). For instance, mobile technologies (with exceptions of smart wrist watches and one-way pagers) support two-way communication channels, enable easy access to, and exchange of, information in real-time and eliminate time and location constraints (Patrick et al., 2008). These above-mentioned characteristics are associated with the design, a camera; technical features, such as in-built sensors; and converged data networks embedded within the device (Sarker & Wells, 2003). The converged network of the portable device enables the exchange of voice, video and text data traffic. A typical example of this is the use of social media applications platforms, which permits data (text, picture, voice and video) traffic to be simultaneously transmitted from one point to another in real time.

2.4.1 Application of mobile technologies

The advent of the Global System for Mobile Communication (GSM) and the Internet paved the way for moulding mobile and cellular technologies to aid the information and communication discipline (Sarker & Wells, 2003). This is evident in the education, business and healthcare sectors (Chen & Kinshuk, 2005; Liang et al., 2007; Ventola, 2014). For instance, in these sectors, short message services (SMSs) are commonly used to communicate with, or send notifications to, the users or potential customers of a service. Also, mobile technologies are gradually being used to facilitate buying and selling transactions on e-commerce platforms. At the beginning of the 21st century, the calibre of mobile devices, such as ‘smartphones or tablets’, has been adapted into mini-computers with customisable user interfaces and increased storage features, but with relative screen sizes and keypads (Svanæs et al., 2010). One of many innovative ways of using mobile devices in the 21st century is linked to its location-sensor feature (Kaasinen, 2005). An example of this is the use of a global positioning system (GPS) tracker on a smart mobile device to navigate while walking or driving. The next section describes the characteristics that enable the adoption of mobile technologies by individuals for different purposes.

2.4.2 Why adopt a mobile technology?

Sarker and Wells (2003) describe a framework based on the characteristics that influence the adoption of handheld mobile devices by individuals. The concepts in the framework were illustrated using a system model consisting of three phases: input, process and output.

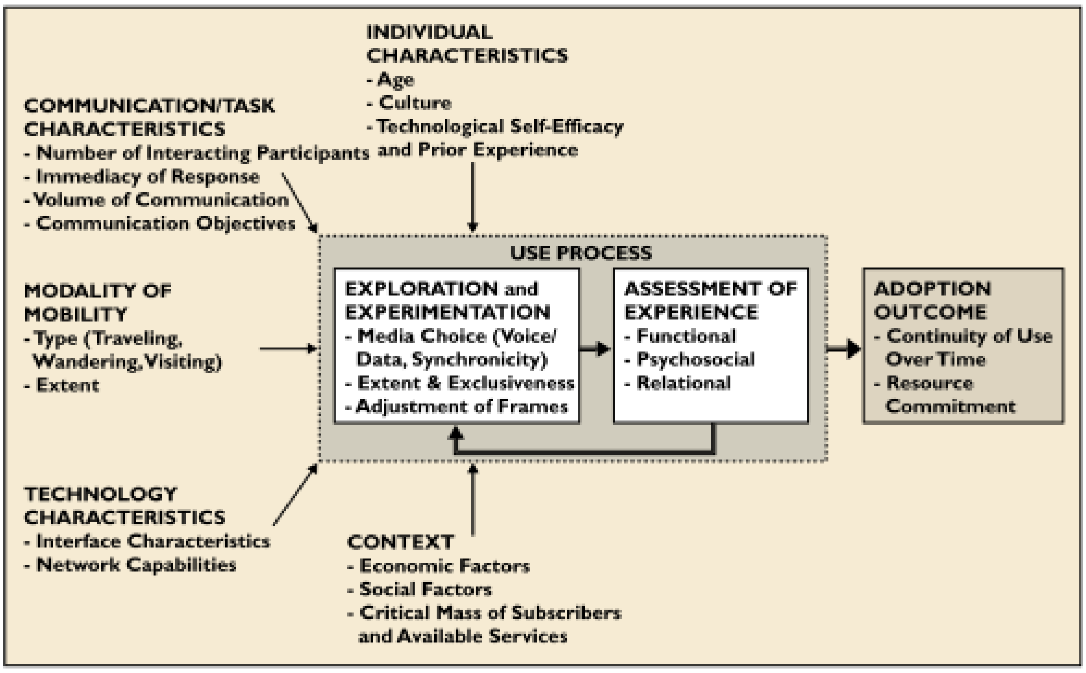


Figure 2.1: Framework for adoption and use of mobile devices (Sarker & Wells, 2003)

2.4.2.1 Individual, technology, task and context characteristics

On the left-hand side of the adoption and use of mobile handheld devices framework (Figure 2.1) are constructs such as human characteristics, technology characteristics, task characteristics, modalities of mobility and context. The individual characteristics assume that an individual would use (or not use) mobile technologies based on their age and level of confidence in using the device to perform tasks (Sarker & Wells, 2003). The age factor is relative, especially because technology is being designed to cater for the needs of different age groups (Hoque & Sorwar, 2017). According to Sarker and Wells (2003), user friendliness is a major concern to users in terms of having a simple and adaptive user interface and intelligible features, as well as reliable wireless communication and sufficient bandwidth.

Cultural backgrounds, in terms of the meanings an individual associates with certain actions, might influence their selection choice and meaningful use of mobile devices. Culture was associated to 'power distance' and gender prejudice, especially in the African context (O'Connor & O'Donoghue, 2015). These authors define power distance as the way in which a society distributes and enforces certain levels of influence among individuals; for instance, men are projected as mostly favoured. The authors suggest that the underlying effect of cultural factors may influence an individual's intention to adopt mHealth technologies. McLean (2018) argues that digital spaces enable cohesion, information sharing and a sense of community between different individuals, despite the perceived power play. In this study, the use health ICTs enables healthcare professionals to facilitate communication and exchange of information within the healthcare context in a timely manner, regardless of their location and without any gender prejudices.

Ideally, gender bias plays little to no part when healthcare professionals use, or perceive the benefits of using, technologies to enable their work activities, especially because their mandate is to deliver healthcare services (Aldosari, 2012). Therefore, the researcher argues that the use of mHealth technologies is dependent on their capabilities to enable work-related tasks in the digital healthcare context and not on the gender of healthcare professionals. Capability of a technology is characterised as the functionality or mechanism of its features that enables tasks to be performed (Vaghefi & Tulu, 2019). Capabilities complement the efforts of humans in the execution of work activities. The importance of technology capabilities is evident in the primary data collected; and is further discussed in the conceptual framework contribution in chapters Seven and Eight.

Mobile devices are somewhat suitable to carry out tasks in which there are multiple interacting participants and when there is urgency for immediate or real-time responses or feedback. For instance, voice, video, text/short messaging and e-mail could be used to communicate between individuals, depending on the nature of information or task to be conveyed by the mobile device. Hence, the importance of contextual dynamics needs to be emphasised. In this study, the researcher draws on how the input constructs of the framework in Figure 2.1 would likely influence the integration of mHealth technologies into the work activities of healthcare professionals at points-of-care in hospital settings.

2.4.2.2 Use and transformative process of mobile technologies

In the middle of the framework is the use process. This aspect of the framework considers the transformation of the input constructs. Sarker and Wells (2003) identify the exploration of and experimentation with mobile handheld devices by individuals as the initial step of the use process. Here, an individual has options to make a choice, to select a suitable platform that is comfortable for multidirectional communication, irrespective of location. Depending on its usefulness, an individual would mostly make use of mobile devices for multidirectional communication than desktop computers. For example, the users of mobile handheld devices can perform multiple functions, such as managing a calendar and sending emails or instant messaging while moving around or in between scheduled activities. This may improve the effectiveness of executing work activities and enable constant availability of information as well as reduced mobility of healthcare professionals within and across hospitals.

However, there are a number of negative implications which may result from incessant interruptions because of the social relationships of the mobile device user (Manda & Herstad, 2015). Alternatively, in a case where a mobile handheld device is customised for a specific context or work environment, the likelihood of interruptions from other social actors can be checked and reduced to the barest minimum. While individuals may feel a sense of freedom from being restricted to a fixed location; there is a contrary feeling of duress to respond in real-time to communications from significant others (Gagnon et al., 2016), not to misplace the handheld device and incur avoidable costs or lose valuable data.

2.4.2.3 Outcome of transformative process

The use process ultimately transforms into the right-hand side of the model which is labelled as the ‘output’. The output is the adoption outcome of the transformative process of the input. According to Sarker and Wells (2003), the individual’s acceptance or non-acceptance to use mobile devices is almost near complete at this point. An individual would develop a pattern of usage of mobile handheld devices based on their experience of the relational, psychosocial and functional outcomes derived from such usage. A positive experience of the use process of a wireless mobile handheld device would result in routine use, while a negative experience is bound to ensure its spatial use with a possibility of a decrease in use frequency over time.

Mobile technologies perform the computational functions of a computer workstation with an added feature – mobility, that enables access to information at anytime and anywhere in real-time. The features highlighted above support prior claims by Hameed (2003), Kaasinen (2005), Svanæs et al. (2010), Liu and Cheng (2015) on the potential associated with integrating mobile technologies into healthcare service delivery at points-of-care. In essence, gaining insights into the characteristics of acceptance of use of a mobile device could assist to describe how healthcare professionals perceive the incorporation of mobile technologies to support healthcare services.

2.5 Description of mobile technologies in healthcare

The penetration of mobile telecommunication and the acceptance of its enabling devices have been promising developments for the healthcare sector (Fortuin et al., 2016). The combination of the technical capabilities of mobile devices and their proximity to the bearer or owner enables the increase of timely access to health-related information and services for patients at any location, be it in in clinics and hospitals or even in a patient's private house (Klasnja & Pratt, 2012). For example, the PDA is a wireless device developed in the 1990s to facilitate information access by healthcare professionals at points-of-care (Liang et al., 2003). These authors argued that the PDAs are ideal for supporting the work activities of healthcare professionals by aiding timely decision-making because of their portability and processing capabilities of information and communication at points-of-care.

When designed and implemented adequately, mobile technologies in healthcare can facilitate real-time data management and the monitoring of the patients' treatment progress. For instance, healthcare professionals can access and update patient data, while attending to (or communicating with) colleagues or patients remotely, anywhere and at any time, using basic features of a mobile technology. Healthcare professionals can use their mobile phones to make calls, exchange text messages, set up diary reminders and access the Internet.

There is no single technology that is adequate for every situation because of the complex and dynamic processes in healthcare (Mishra et al., 2013). Hence, new innovations could be built on the existing infrastructure and technologies thereby reducing cost implications of implementation. Sufficient considerations need to be given to the service processes that already exist and how the integration of a new technology into other technologies would affect the status quo, with minimal disruption. With the ubiquitous penetration of telecommunication, upsurge in ownership of, and access to, handheld devices, as well as data subscription plans, mobile technologies provide a convenient way for healthcare providers to disseminate health-related information and reach patients (Milward et al., 2015). Subsequently, the healthcare sector has benefitted from the increasing adoption of mobile technologies to facilitate service delivery since 1990s (Hameed, 2003). Native smartphone software applications have been employed since 2002 to automate information exchange to inform decision-making by the healthcare professionals and workers during service delivery (Baig et al., 2015).

As at the beginning of 2017, an estimated rate of 80% mobile subscription penetration was recorded in Sub-Saharan Africa which implies that mobile technologies are well received and therein lies a prospective opportunity to support specific areas within healthcare service delivery (Adepoju et al., 2017). The preceding argument agrees with that of Snyders and van Dyk (2013) that the success rate of adopting mobile technologies to support services, especially in healthcare, could largely depend on its level of acceptance.

There is a vast array of scientific literature on the acceptance of mHealth initiatives in high-income (HI) countries and lower- and upper-middle-income countries. In HI countries, mHealth implementation studies have been largely enabled by advancements in technology and information infrastructure. The mHealth publications from HI countries focus on the development of mHealth applications for specific purposes, such as management of wellbeing and chronic diseases; emergency and ambulatory care; the design and usability testing of mHealth systems (Baig et al., 2015; Ojo, 2018); and the benefits and evaluation of implementation projects (Franz-Vasdeki et al., 2015). Similarly in lower- and upper-middle-income countries, mHealth studies mainly focus on the use of mobile-related devices and native applications for surveillance and disease-specific control management (DeRenzi et al., 2008), especially in underserved contexts. Additional mHealth focus areas include: systematic literature reviews on the potential applications of mHealth (Betjeman et al., 2013; Aranda-Jan et al., 2014); maternal health, fitness and self-management (Okuboyejo & Eyesan, 2014); and independent mHealth pilot projects (De la Harpe, 2014; Seebregts et al., 2016).

Despite efforts to implement mHealth technologies, its effective use on the eventual outcome of services delivered by healthcare professionals is hardly explored (Thomairy et al., 2015). Hence, the potential to redress inefficiencies with regards to decision-making at the point-of-care is yet to be realised, particularly in tertiary healthcare (Adepoju et al., 2017). The inefficiencies of service delivery are evident with respect to the shortage of skilled healthcare professionals; record management in terms of collection; storage and access to data; evidence-based clinical guidelines; and decision support system algorithms to facilitate delivery of healthcare services, particularly in Sub-Saharan Africa (Wolff-Piggott et al., 2018). This presents an opportunity to conduct additional research on the potential use of mHealth technologies by healthcare professionals for work activities at point-of-care.

2.5.1 Opportunities and use of mHealth technologies

The choice to take up and use of mHealth technologies has been largely informed by the need to improve the enabling means of access to, and management of, information, as well as the need for easier communication at the points-of-care (Martin, 2012). Prior to the design of health-related native applications on mobile devices, hospital information systems (HISs) mainly included paper, desktop computers and medical electronic devices (Svanæs et al., 2010). Examples of HIS are electronic medical records (EMRs), electronic health records

(EHRs), radiology information systems (RIS), laboratory information management systems (LIMS) and picture archiving systems (PACS), to mention a few (Blaya et al., 2010).

It is evident that HISs are socio-technical systems consisting of humans (healthcare professionals) who use relevant health ICTs during their work activities to aid information processing to enable service delivery. Ventola's (2014) argument is substantiated by Wallis et al. (2017) on the basis that there is a need to integrate mHealth technologies to address the constraints associated with existing HIS and electronic health (eHealth) infrastructure in hospitals. In this study, the constraints are attributed to a lack of timely application and inappropriateness of HITs to support the process of healthcare service delivery. This ultimately affects the effective use of HITs, particularly by healthcare professionals during their clinical work activities at points-of-care.

The use of mHealth technologies by healthcare professionals for their work activities has the potential to transform clinical practice. In an attempt to address the shortcomings of desktop computers, which do not support the mobility of healthcare professionals in a hospital environment, some institutions have set up portable and wireless devices (Ventola, 2014). Examples of portable devices that enable mobility are computers on wheels (COWs) or workstations on wheels (WOWs) (Junglas et al., 2009; Ventola, 2014). Additionally, healthcare professionals are provided with easier and remote access to information through their smart mobile devices such as phones or tablets, which operate medical software applications. Medical software applications are designed to support information management, real-time patient monitoring, communication with other personnel, electronic prescribing and access to medical resources at points-of-care (O'Connor & O'Reilly, 2018). This can significantly improve the anticipated outcomes of both administrative and clinical activities towards meeting the organisation objectives of healthcare institutions. Therefore, healthcare professionals can use mHealth technologies or applications for, but not restricted to, patient and information administration, monitoring; medical education and adherence to clinical guidelines.

2.5.1.1 Patient and information administration

In the healthcare service sector, patient and information administration are the foundations on which other work activities in the service delivery process are built. The healthcare sector is driven by information because of the amount of information generated and documented, as well as the level of dependency on information for decision-making at points-of-care (Cline & Luiz, 2013). Hence, there is a need for adequate management of information that operates seamlessly. Information management involves collection, storage, access, retrieval and sharing of patients' data through a HIS (Haux, 2006). There are different forms of HISs. HISs could be paper or technology based. For example, EHRs are used to manage health information which include, but are not exclusive to, patient demographics, medical history and doctor’s consultation notes. RIS and PACS are used to manage x-rays, scans and other medical images.

Healthcare professionals may access patient information in HISs on site (or remotely), depending on the set of activities being performed or based on time-sensitive scenarios (Cucciniello et al., 2015). This increases the performance efficiency of healthcare professionals towards improved service delivery. For example, when patients go into a hospital for consultations, the administrative staff collects and store their personal and demographic details (Blaya et al., 2010). A case is opened (either on paper or electronically) to manage their records. The patient is then attended to by nursing staff, who carry out a preliminary check of the vital signs of the patient before the patient consult a doctor (Mutula, 2015). Diagnosis and treatment decision-making require work processes in which a healthcare professional performs activities at points-of-care. These work processes could include monitoring the patient; a check through a patient’s medical history to understand a history of ailments or allergies; and perusing pathological and medical imaging test results to make accurate diagnosis, while adhering to clinical guidelines (Hsiao & Chen, 2019).

In an emergency case or during a surgical procedure in which a patient might be unconscious, there may be need for immediate remote access to (or sharing of) information from stationary workstations or from cloud storage in order to make an informed decision (Boulos et al., 2011). Medical software applications designed to run on mobile devices enable quicker and more secure access to the necessary information in special cases, such emergency cases, and such access is not inhibited by time and location constraints (Baig et al., 2015). Therefore, it can be argued that mHealth technologies provide a convenient means or fit for healthcare professionals to easily access, exchange and manage patient information, as well as the ability to communicate and monitor progress in healthcare service delivery. Junglas et al. (2009) explain the concept of ‘fit’ as how individuals determine the extent to which they are able to perform their tasks using mobile ICTs in healthcare settings. The authors termed their findings as attributes of ‘fit’ models that could promote efficiency of tasks performed and reduce the work load of frontline end users. The attributes of the model taken into consideration include time criticality, work flow, user comfort, patient interaction, physical, location, identification and information communication fit (Junglas et al., 2009).

2.5.1.2 Communication, collaboration and monitoring

mHealth technology provides a convenient way for healthcare professionals to easily communicate with their colleagues and to monitor their patients in real time, anywhere and at any time (Griffiths et al., 2017). In terms of communication, even though stationary computer workstations may operate software applications that allow voice and video calls, these devices still restrict healthcare professionals to specific locations and may hinder mobility (Reuss et al., 2004). Unlike desktop computers, mobile technologies, such as PDAs, smartphones and tablets, do not restrict the mobility of healthcare professionals in the initiation of voice and video calls, e-mails, text or instant messaging, which can be accomplished at their convenience, irrespective of location.

For example, in cases where healthcare professionals need to seek a third person's opinion or engage in collaborative care, provided that there is connectivity, they can always consult with multiple parties at different locations (Davis et al., 2016). This would somewhat improve the efficiency with which diagnosis and care services are delivered. In addition, the emergence of social network applications provide a useful platform for collaboration among healthcare professionals (Ganasegeran et al., 2017).

Health applications could be specifically designed to facilitate communication between healthcare professionals. This would require the extensive and continuous use of mobile phones during (and sometimes away from) work, with a consistent network signal strength and extended battery life (Boulos et al., 2011). Also, the integration of communication and consultation into clinical workflows using mHealth technologies requires adequate consideration for the data costs in the absence of a wireless local area network in the healthcare institution.

In terms of patient monitoring, treatment is a process, therefore, it is necessary for healthcare professionals to be able to locally and remotely give attention to the progress of inpatients and outpatients (Theile et al., 2017). For example, a patient can effortlessly send a picture or a video, or drop a voice note about a detected medical concern to their physician using a mobile device application. The patient may receive a real-time response, provided that the receipt is acknowledged by the healthcare professional to give advice accordingly depending on their availability. Similarly, a monitoring system can be placed at the bedside of inpatients and be connected to smart handheld devices in order to monitor and alert healthcare professionals in the event of complications (Nasi et al., 2015).

It is essential that medical software applications designed for communication should be compliant with the Health Insurance Portability and Accountability Act (HIPAA) (Ventola, 2014), and adhere to the Protection of Personal Information Act (POPI) gazetted in 2013 in South Africa (Makovhololo et al., 2019) – the context of this study. These Acts provide regulations to ensure safety, privacy and confidentiality of health-related data or information during storage and exchange between stakeholders in the health sector. Hence, it is crucial for healthcare providers and professionals to be knowledgeable on, and compliant with, statutes and guidelines of clinical practice, especially when dealing with health information.

2.5.1.3 Medical education and adherence to clinical guidelines

Based on the portability characteristics and convenience provided by mobile handheld devices, healthcare professionals can easily access evidence-based information in a timely manner to support informed decision-making at points-of-care (Zvornicanin et al., 2014). Thus, healthcare professionals are equipped to learn and facilitate evidence-based practices in reference to clinical guidelines, as well as stay informed of medical news updates at points-of-care or when performing other work-related activities.

According to Ventola (2014), healthcare professionals rely on electronic or software applications and online resources that enable diagnosis and clinical decision-making; however, they spend more time reviewing printed medical references. Subsequently, mobile health-related applications have been designed to provide the information necessary to aid clinical decision-making. It is also established that healthcare professionals use mobile devices and applications to access several medical journals, webinars and databases, such as the British Medical Journal (BMJ), PubMed and MEDLINE (Bastawrous & Armstrong, 2013). Access to these publications enables healthcare professionals to search for up-to-date medical literature and for recommendations that support decision-making at points-of-care, especially without time and location constraints. For example, some of the mobile device applications can be used to remotely access clinical decision-making support on desktop computers (Ventola, 2014).

Further, there are mobile software applications that can be used by healthcare professionals and pharmacists for drug reference and electronic prescription (e-Prescription). These drug reference applications can be used to access vital information, such as drug names, composition and after-use complications. Examples of drug reference mobile applications include Epocrates, Micromedex and FDA drugs (Ventola, 2014). Other medical software applications, such as medical calculators, can be used to carry out simple tests and collect data, such as diagnostic tests, blood pressure, glucose levels and body mass index at points-of-care, thereby reducing costs and unnecessary procedures (Matthew-Maich et al., 2016). However, the accuracy of the data obtained from the applications needs to be subjected to rigorous vetting during the design phase in order to avoid misdiagnosis and treatment, leading to unnecessary health complications.

Most mHealth technologies are used to capture information from monitoring certain types of health conditions and physical activities (Baig et al., 2015). Given the opportunities that the utilisation of mobile device and applications provide in healthcare service delivery, the established benefits include rapid remote access to required information, enabling time and cost efficiencies; use of multimedia for communication, irrespective of time and location; compliance; and evidence-based clinical practices (Kumar et al., 2013). In addition, benefits also include increased productivity, reduction in errors and the potential to improve patient care.

According to Eden et al. (2019), the expectation attributed to the implementation of HITs is effective use. The authors described effective use as the manner in which a system is utilised by an individual to achieve intended goals. The attributes of effective use are implied in the way an individual uses a technology, its capabilities and the outcome of usage, and in particular, the achieved goal as well as frequency of use. This study sought to investigate how healthcare professionals use HITs at point-of-care based on the capabilities of the technology to enable tasks (appropriateness) at points-of-care in a timely manner and the potential to incorporate mHealth technologies, where necessary.

2.5.2 User experience considerations for mHealth technologies

User experience is defined as an individual's perception that ensues from the actual use, or the expected use, of a product or service (Hassenzahl & Tractinsky, 2006). For instance, healthcare professionals might have an expectation of how HITs could aid their performance and assist them to accomplish their tasks. However, while interacting or after using HITs for a task, healthcare professionals may develop a perception of the tool based on their experiences. According to Ouma et al. (2010), the factors that mostly influence user experiences of mHealth applications at points-of-care are usefulness, usability, desirability, integration and sustainability. The next sections, 2.5.2.1 – 2.5.2.3, describe the first three factors, while additional factors are discussed in section 2.5.4.

2.5.2.1 Usefulness

Usefulness in this context can be related to the construct of the Technology Acceptance Model (TAM) (Davis, 1989). Usefulness can be defined as the degree to which a person determines that the use of a technology increases efficiency and performance of a task. It is essential for mHealth technology to be designed according to user needs. These needs ensure that mobile devices and health-related software applications have the functionalities that end users intend to utilise for their tasks (Legris et al., 2003). These functionalities aid the performance of end users and, ultimately, meet their expectations. Therefore, one of the aspects of ensuring a positive user experience is to carry out extensive usability tests on the ease of use while designing mHealth technologies.

2.5.2.2 Usability

The term "*usability*" has been defined, according to the ISO 9241-11, as the extent to which a product can be used effectively by specified users to achieve specific goals satisfactorily in a specific use context (Svanæs et al., 2010). Hence, usability of mHealth technology is function-dependent and context-based. The design of mHealth technologies enables convenience and mobility. The capability of connectivity enables communication, as well as information exchange, and can ensure facilitation of work activities usually associated with a fixed location. While there are known methods for mobile ICT usability evaluation, such as a controlled laboratory setting as well as expert-based and field studies (Karlsson, 2016), these methods usually do not sufficiently address impending usability issues specific to the use context, tertiary healthcare in the case.

Typically, the usability features built into mHealth devices are associated with input mechanisms such as screen sizes (if any), keypads or touch screens, control-button positioning, user interfaces and interaction software applications. A study by Svanæs et al. (2010) showed that the usability of mHealth technology in clinical settings is dependent, to a large extent, on how well the technology is integrated with the existing work processes. The study provides a set of evidence-based suggestions for mobile ICT usability testing within a clinical setting. The author argued that the usability of mHealth is not only determined by the graphic user interface (GUI), but that the factors for consideration include ergonomic considerations, such has having minimal hand contact with the mobile device, and the extent to which actual patient care is being interrupted. Hence, healthcare professionals can be resistant to accepting the use of ICTs because of the lack of sufficient functionality features and their potential impact on ergonomics (Grabenbauer et al., 2011).

Similarly, Ammenwerth and de Keizer (2007) identified that the interruption of patient care could negatively impact the acceptance of ICT usage by healthcare professionals. Likewise, Chen et al. (2012) found that the lack of a data exchange mechanism in multiple mHealth applications and existing eHealth web-based applications on desktop computers, coupled with inadequacy of tools or techniques to make sense of data, limit the impact of mHealth to improve service delivery. In a systematic review undertaken to investigate studies on the use of smart devices in healthcare by Lu et al. (2016), smart watches were found to be useful in a variety of healthcare applications. However, there was minimal evidence for the usability or user-centred design of smart watch applications before the implementation phase, especially within the clinical settings of hospitals.

While there are several methods for mobile ICT evaluation and testing, such as a controlled laboratory setting, expert-based and field studies (Karlsson, 2016). These methods usually do not sufficiently address impending usability issues specific to the use context, which, in the case of this study, is the clinical setting in public hospitals. One such usability issue is abrupt interruptions caused by intermittent or continuous notifications and other services while engaging with the patients at points-of-care (Ammenwerth & De Keizer, 2007). This makes the usage of mHealth technologies undesirable during clinical workflow and the delivery of healthcare services (O'Connor & O'Reilly, 2018). To address this shortcoming, Bastien (2010) suggested that methods relevant to the context of use should be developed to depict the user interface that is specific to the tasks, thereby making mHealth technology desirable to healthcare professionals.

2.5.2.3 Desirability

Ideally, technology implemented to support the work activities of individuals should provide more than technical capabilities, to the extent that user satisfaction and positive experience are the desired outcomes (Ouma et al., 2010). Therefore, when designing a mHealth technology, the technology should meet user expectations and beyond, to the point where healthcare professionals easily incorporate (integrate) the device into daily work (Mourouzis et al., 2015). For example, a user-friendly mobile device that assists healthcare professionals to obtain the vitals data of patients in order to make an informed decision about their health status irrespective of time or location challenges is implied in section 2.3.1. The ensuing experiences of healthcare professionals and patients could inform the design of mHealth technologies that are suitable for integration into work settings and with hospital information systems.

2.5.2.4 Summary of user experience considerations for mHealth technologies

With the importance of the user experience established, it is necessary to investigate how user experience influences the use of technology to perform activities win healthcare service delivery. The factors briefly discussed in section 2.5.2 correlate with achieving a positive end user experience. Thus, it can be inferred that the ensuing experiences of stakeholders, and the use of technology to aid tasks during healthcare service delivery, are mutually dependent and described as a relationship network or interaction.

2.5.3 Aligning stakeholders in mHealth technology-enabled

The transformative potential of any form of ICTs (including mHealth technologies) largely depends on its acceptance, use and experience by relevant stakeholders (including the end user) (Fan et al., 2018). The transformative potential of this study is conceptualised as the empirical outcomes realised as a result of the improvement attributed to technology use to support processes in a work environment. For example, technology and processes, when properly integrated with each other, can significantly influence the success of an implemented information system and generate positive opportunities and outcomes (Staccini et al., 2001). In this study, the researcher argues that, for time-efficient, relevant and practical outcomes, an enabling technology should be aligned to the routine services provided by healthcare professionals at points-of-care during service delivery.

In a digital context, alignment refers to the timely application of information technology (IT) in coherence with processes, needs and organisational objectives (Francisco, 2004). Similarly, Alrajeh and Elhari (2013) defined IT alignment as the application of technology in harmony with organisational business strategies, goals and needs in a timely way. These definitions suggest a blend of concepts, which include timeliness of an IT intervention and the intervention's appropriateness for work process, to achieve individual and organisational objectives. Unfortunately, it could be inferred that mHealth initiatives sometimes do not meet the requirements of timeliness and appropriateness to enable work activities because of the complexity of healthcare services (Aranda-Jan et al., 2014). Hence, it is important that mHealth technologies be designed to align with the immediate needs of the users executing activities in line with organisational objectives.

While alignment is dubbed as a continuous process, factors such as work processes; work processes and IT relationship; management support; and, essentially, stakeholders buy-in (including target end users), serve as possible enablers or hindrances of alignment (Francisco, 2004). According to Chung and Crawford (2016), the generally acceptable term for a 'stakeholder' refers to an actor (individual or group) that has an interest in, and can influence or be influenced by, or perceive themselves to be influenced by, technology interventions and their outcomes. As such, there are different individuals at different levels of an organisation who interact through technology, either through the activities of work processes or as recipients of the outcome of services.

This study presents an understanding of how mHealth technology could be integrated as part of an existing technology-enabled network to facilitate interaction moments that make up healthcare services, especially in public hospitals. Interactive network refers to the relationships between stakeholders and IT through different clinical activities. Figure 2.2 illustrates the various roles of stakeholders.

Figure 2.2: Basic illustration of stakeholders (Lønvik, 2015)

According to Ammenwerth and Rigby (2016), the development, evaluation and success of a health ICT implementation project are usually biased. The authors explain that government officials tend to make decisions on the choice of health ICTs with less than adequate consideration for other stakeholders, particularly frontline end users. The stakeholders relevant to this study include healthcare professionals (doctors and nurses), allied health workers, administrative staff and patients (or clients) (O'Donovan et al., 2015). Sometimes stakeholders, particularly healthcare professionals, are influenced by the decisions made by the relevant government body and policy makers in the health sector to adopt ICT. In addition, patients (and health information consumers) are relevant stakeholders who are also affected as recipients of service delivery. However, this study focused on the end users of health ICTs who facilitate healthcare services and not the recipients of service delivery. Other secondary stakeholders may include the government (the Provincial Department of Health), health ICT application development companies, and mobile network operators (Botha & Booi, 2016). Therefore, it is always important to identify all stakeholders at the beginning of a project and to assess the needs, expectations and likely effects of a product or technology-enabled activity, as well as recording the resulting outcomes. The identification of the relevant stakeholders in both practice and academia assists the process of designing mHealth ICTs and inform ways to manage the relationships required to accomplish positive user experiences. It is important to understand that imminent challenges will be encountered, leading to eventual implementation and use failure of projects that intended to incorporate mHealth technologies at points-of-care.

2.5.4 Challenges of mHealth technologies use in practice

Even the most effective approach to the use mHealth technologies in practice has limitations (Ventola, 2014); hence, several frameworks and models have been proposed for the development and evaluation of mHealth-based services (Sadegh et al., 2018). Therefore, the potential uses of mHealth technologies to improve the efficiencies of performance in healthcare services locally and remotely vary in complexity and context. In this study, the contextual factors were identified by the effects of these factors on the use of health ICTs during the work activities of healthcare professionals.

The possession of portable and handheld devices, specifically mobile phones, has become an integral part of the human society, especially because of digital transformation in service sectors, such as education, finance, businesses and healthcare (Harris & Cooper, 2019). However, in the healthcare sector, the possession of these devices does not imply that healthcare professionals seamlessly make use of mobile devices at their place of work (Gagnon et al., 2016). This is evident from the varying views of healthcare professionals, ranging from positive support to stern opposition, regarding the use of mobile handheld technologies in clinical practice. Therefore, it could be argued that mobile handheld devices (and related software applications) should be designed taking into consideration the service needs of healthcare professionals at points-of-care during the execution of their work activities. In the light of this argument, the researcher intended to identify the opportunities to integrate mHealth technologies into existing technology-enabled activities in relation to the work environment, and the relationship between human and technical factors at points-of-care. Similar to other HITs, concerns about implementing mHealth technologies for use by healthcare professionals are initial cost of implementation, reliability of data accuracy for clinical decision-making, a lack of security and standards that regulate the development of mHealth applications, impact on the patient-doctor relationship at points-of-care, and mHealth technologies' interoperability with existing systems (Ventola, 2014; Wallis et al., 2017). These challenges affect the integration of mHealth technologies into clinical work settings and inhibit related pilot studies from being scaled.

2.5.4.1 Reliability of data in mHealth technologies

The types of data collected or generated and stored on mHealth technologies and health-related applications are highly subjective to the adequacy of technical features (Svanæs et al., 2010; Baig et al., 2015). Attempting to maximise the use of technical features on a mobile handheld device, such as in-built sensors and camera, with health related applications could pose a challenge. For instance, the built-in camera of an mHealth technology must be high resolution to ensure that images or videos are clear and captured to detail (Park et al., 2015), otherwise a healthcare professional stands the risk of negligent decision-making errors and misdiagnoses because of omissions. Consequently, the use of adequate sensors, such as light and motion sensors, are needed to complement the use of in-built cameras in order to work seamlessly with health-related software applications. However, the use of high quality cameras and sensors would impact on other functionalities, such as the computational capabilities of device processor and battery life of a mobile device (Miah et al., 2017). Therefore, it is necessary to build purpose-specific mHealth technologies and software applications according to the complexities of tasks performed by healthcare professional at points-of-care. Ultimately, the data quality of the health ICTs contributes to the performance of work activities executed by healthcare professionals during service delivery.

2.5.4.2 Impact of mHealth technologies on patient-doctor interaction

Healthcare professionals are strongly of the opinion that their job is to deliver care services to patients, hands-on, as opposed to using HITs, even though they acknowledge the positive impact of these technologies on their work processes (Ogundaini, 2016). In a systematic review of factors that influence the use of mHealth applications, healthcare professionals indicated that the technologies could be time consuming and could disrupt their workflow (Gagnon et al. 2016). For example, healthcare professionals believe that the use of mHealth devices at points-of-care, particularly the use of smartphones or tablets to perform their clinical tasks during office hours, could be misconstrued as using these technologies for other activities such as checking emails or instant messages unrelated to work.

In order to reduce the negative impact of mHealth technologies on patient-doctor relationships, a user-centred approach is required (Katurura & Cilliers, 2018). The approach will enable designers of mHealth technologies to translate the expectations and ideally use concepts of the principal end users (healthcare professionals), in conjunction with attention to adequate security and relevant policies or standards, into a desired mHealth product (or technology-enabled service) in practice.

2.5.4.3 Lack of security measures specific to health-related data

The security and privacy issues of health-related data in HITs have remained ceaseless challenges; mHealth technologies are no different (Katurura & Cilliers, 2018). There are concerns about device loss or theft and the protection of personal health data which is stored on or during exchange between Internet work, web-based applications and software applications (Makovhololo et al., 2019). According to Baig et al. (2015), security can be further broken down into information and systems security. The author further explains that information security deals with threats such as unlawful modification or forgery of patients' medical data. However, access to the system is needed in order to tamper with information. Hence, adequate system security is required to prevent initial access to patients' medical information. While loss or theft of mobile devices can be controlled, common system threats such as denial of service and phishing are constant threats to a system's network.

Health-related standards, policies and frameworks have been established to enforce both information and system security (Adebesin, Foster et al., 2013). However, because of the constant evolution of technology, these policies and frameworks do not entirely cater for the security measures of both newly developed health-related applications and applications that were not intended for mHealth purposes, such as WhatsApp and Facebook. Measures to enforce systems security comprises physical safety, firewall and network management tools, as well as different levels of authentication and authorisation of system users for access control, while data encryption is a viable information security measure (Liu & Park, 2012). The absence of security measures, or the lack of relevant policies and frameworks to guide the implementation of mHealth innovations, leads to susceptibility of healthcare institutions, healthcare professionals and patients to cybercrimes. This could have a detrimental effect on the wellbeing of healthcare services stakeholders.

Katurura and Cilliers (2018) posit that government bodies responsible for managing the health sector should engage practitioners in the field of law in order to legislate how health-related data are used, and practitioners in the field of health informatics to establish service level agreements that guarantee the provision of an acceptable quality of healthcare service. Therefore, to mitigate security concerns in the integration of mHealth technologies into tertiary healthcare, a holistic architecture that takes into account mechanisms for information and systems security at points where and when patients' data are being stored and exchanged is needed.

2.5.4.4 Interoperability of mHealth technologies

Interoperability in healthcare describes the ability of health ICTs to interpret, share and exchange information during the process of service delivery (Adebesin, Foster et al., 2013). This is essential to the effectiveness of the decision-making process in healthcare service delivery. Interoperability between technologies or the system eliminates duplicated information, thereby reducing errors that could be associated with multiple data entry and enables the timely coordination of information by healthcare professionals at points-of-care (Meaker et al., 2018). Since mHealth technologies form an integral part of electronic health (eHealth), it is important to establish how services are being supported by existing technologies. This would help frontline end users understand the landscape of healthcare service delivery, especially, and how best mHealth technologies could be integrated into technology-enabled work activities. Integration ensures that both social, technical and data aspects of clinical activities are carefully considered by designers and implementers of mHealth ICTs to avoid suboptimal performance or imminent failure during healthcare service delivery.

However, interoperability of eHealth systems remains complex because of the fragmentation of the several and diverse hospital information systems. Unfortunately, this situation prevents standardisation of eHealth systems, which is considered a corrective measure to redress the issue of fragmentation afflicting the exchange of information in the healthcare sector (Sekgweleo & Nemutanzhela, 2018). In addition to the increasing evolution of different types of technology, the numerous available standards, and contradictory as well as inconsistencies of these standards within varying contexts, have made it extremely difficult to achieve interoperability. Hence, the adoption of interoperability standards has remained relatively low (Gleason, 2015). This implies that the use of mHealth technologies or health-related applications developed on different operating systems would impede information sharing and exchange between devices, either between handheld devices or between a desktop computer and handheld devices. Ultimately, the use of mobile handheld devices and their health-related applications by healthcare professionals as tools to complement HIS at points-of-care in clinical settings require continuous and extensive research tailored to the appropriateness of technology-enabled services.

The effects of the challenges discussed above are directly or indirectly attributed to the unintended consequences that arise as a result of socio-technical interactions between the existing workflows, organisational culture and introduction of new technologies (Behrens et al., 2019). Unintended (or undesired or unanticipated) consequences can be conceptualised as sudden events (or surprises) attributed to the use of an enabling innovation (Harrison et al., 2007). In essence, the effects of unintended consequences can either be desirable or undesirable. In this study, unintended consequences are identified as the ensuing results of an inadequate fit between technical capabilities of implemented health ICTs and the enabling infrastructure, or other contextual factors, as experienced by healthcare professionals. In the data analysis and discussion of findings chapters, the researcher identifies unintended consequences arising from the use of mHealth technologies and their impact on the work activities of healthcare professionals during service delivery.

2.6 Application of mHealth technologies in clinical settings

According to Baig et al. (2015), there are mobile-based software applications that allow for the remote monitoring of vital signs, such as blood pressure, heart rate, body temperature and electrocardiography. The software was developed in 2012 by AirStrip – a mobile health solutions company in the United States of America (USA) – and is compatible with handheld smart devices. This system allows for the continuous monitoring of vital signs and, hence, prompts the early detection of possible cardiovascular ailments. The mobility characteristics of handheld mobile devices, and the fact that smartphones have a nearly equal computing power to personal computers, provide an advantage to integrate mobile technologies into the work activities of healthcare professionals at the points-of-care.

Imaging is one of the fundamental corner-stones of evidence-based medicine practice. As such, Baig et al. (2015) reports on aspects of mHealth applications for medical imaging developed by a group of engineers in the Washington University. The medical imaging device works in a way that a USB-based ultrasound probe technology is coupled to a smartphone, thereby enabling a compact mobile computing platform. It is evident that the design of this device eliminates the constraints of movement for healthcare professionals within a hospital and simplifies clinical diagnosis, which becomes more efficient. This creates an alternative tool that saves time, where physicians can immediately create or update an electronic copy of patients' records. However, for mobile technologies to positively transform the service delivery processes of healthcare professionals, there is a need for adequate technical infrastructure on the premises of the hospital (Mburu et al., 2013).

The key features that enable the use of mobile technologies in a hospital environment include bandwidth, wireless-enabled data network generations of the third (3G), fourth (4G) and long-term evolution (LTE) generations, as well as sensors and advanced computing mechanisms (Kahn et al., 2010; Varshney, 2014). It is important to align appropriate hardware and software applications to specific activities at points-of-care in order to ease and support the workflow of healthcare professionals during service delivery.

Ventola (2014) perceives mHealth technologies as invaluable tools because of their functional capabilities that provide timely access to information at the points-of-care. The author investigated the use and benefits of medical devices the software applications, particularly for healthcare professionals. The findings show that there are software applications developed to assist healthcare professionals and workers with information management, timely access to information and communication, patient monitoring and clinical decision-making. Ventola (2014) argues that the functionalities of mHealth solutions simplifies real-time decision-making and improves patient health outcomes. To this effect, it is imperative to investigate mHealth assisted service interaction moments, to improve health information service delivery, particularly within the clinical settings in public hospitals in South Africa.

In contexts where mHealth technologies are implemented and are in use, these technologies complement evidence-based medical practices and support the decision-making process by facilitating easy access to real-time information, for example, clinical practice guidelines and electronic records (Hameed, 2003).

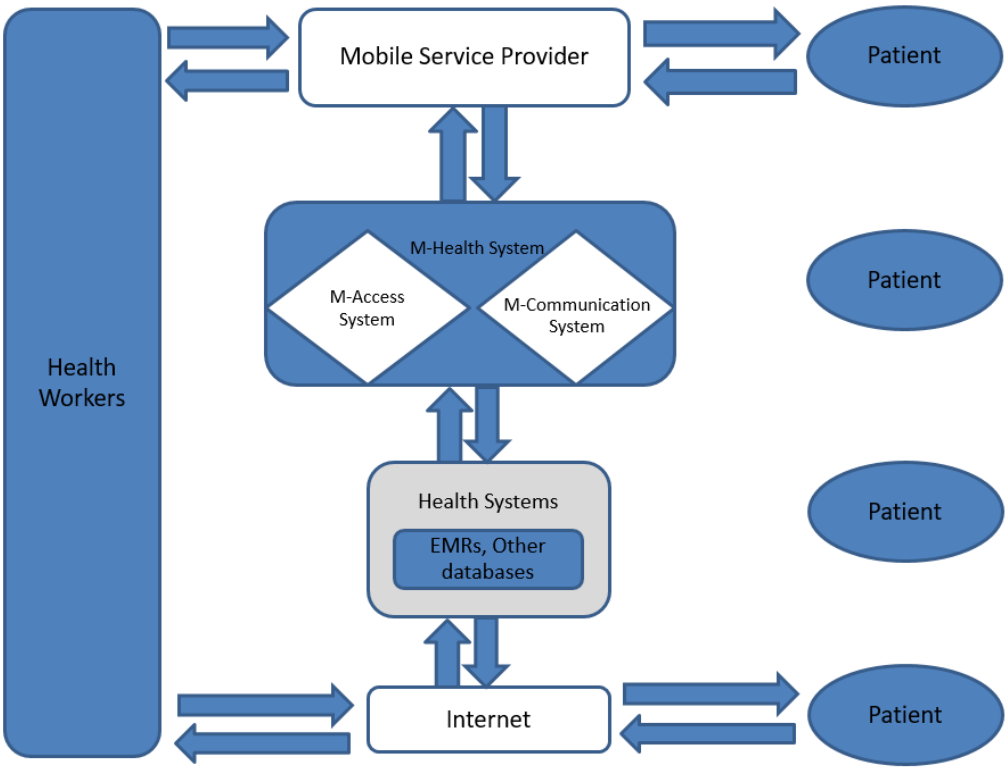


Figure 2.3: Model for 'two-way' mHealth applications (Vatsalan et al., 2010)

Figure 2.3 above represents the model of an mHealth pilot project developed in Sri Lanka (Vatsalan et al., 2010). The mHealth model was developed so that healthcare professionals could access information from an EMR system and to facilitate communication with patients that use GSM technologies. The project was built on existing infrastructure, and was driven by a lack of medical resources and the need for healthcare services to be delivered without being hampered by mobility constraints, especially in LMICs.

This mHealth innovation consists of an m-Access system and an m-Communication system implemented at two hospitals, one specialist consultation centre, and a rural primary health clinic. The m-Access system enables healthcare professionals and workers to have access to the EMR through web-enabled mobile devices, such as laptops and smart handheld devices. The m-Access system is used to exchange information. The m-Communication system enables e-Consultation and management of appointments for procedures, such as vaccinations, and for sending test dates reminders. Hence, medical professionals are easily available to attend to a large population in the shortest time possible, irrespective of their location, with limited resources during healthcare service delivery.

A survey evaluation of the impacts of such mHealth solutions indicated an improvement in cost-effectiveness and significant patient compliance. In terms of cost, patients' travels and follow-up visits to the hospital were reduced, which ultimately saved time. Patients are frequently kept up to date about clinical appointments using scheduled SMS or email reminders to facilitate compliance. It is evident that the penetration of telecommunication, cellular network services and ownership of, as well as access to, mobile devices in rural, remote and urban areas is an added advantage with respect to development and use of mHealth solutions at points-of-care and at off-hospital sites. Furthermore, using mHealth technology and applications has resulted in improvements such as the efficiency of diagnostic procedures, the prescription of medication, and compliance to medical adherence (White et al., 2016).

The role of technologies in healthcare has been researched broadly, with the conclusion that health ICTs can greatly improve the efficiencies of services delivered to patients (Kumar et al., 2013). Several innovations in health ICTs are patient-focused, while the healthcare professionals who use the technologies to provide services are often times given less than adequate consideration (Ojo, 2018). The researcher perceived the lack of involvement by healthcare professionals as major stakeholders as a likely reason for paucity of evidence of the effectiveness of mHealth technologies when implemented in the clinical settings of LMICs and UMICs, particularly in Sub-Saharan Africa.

2.7 Lack of mHealth technologies in tertiary healthcare contexts in Sub-Saharan Africa

While investigating emerging research problems in mHealth, Varshney (2014) suggested that such related technologies might not have a major role to play, especially because of the presence of wired network infrastructure and an inadequate wireless infrastructure within a healthcare institution. This might cause the need for additional multitasking on the part of professionals and several interruptions in the care processes at the points-of-care. However, Varshney (2014) advocates for continuous, extensive research on enhancing existing infrastructure of HITs used for mHealth.

In a review of literature on the use of HITs in Sub-Saharan Africa, Bloomfield et al. (2014) identified a lack of empirical evidence to support the effectiveness of mobile health solutions for the use with non-communicable diseases (NCDs). The authors reported that there were instances where mHealth served to provide decision support by using automated algorithms to assist in the diagnosis of conditions and the adherence to clinical guidelines. This argument supports the considerations for the integration of mHealth into the current public healthcare system, especially since the rate NCDs has been rising across Sub-Saharan Africa; however, little attention has been recorded in this context to date. According to Adepoju et al. (2017), the extent to which mHealth supports a shortage in personnel and how applications complement decision support systems in Africa is not well grounded.

An earlier literature study by Mburu et al. (2013) perceived failed efforts to integrate mHealth technologies into the existing healthcare system of LMICs as a result of the complexity of healthcare processes and the hands-on approach of healthcare professionals. Mburu et al. (2013) attempted to develop a conceptual framework for designing mobile technology solutions in order to address healthcare service challenges in developing countries by using a maternity mHealth-based application in Kenya as a case. The study presented a case for benefits associated with using mHealth applications for the remote monitoring of maternal care and related issues in the underserved areas of Kenya. While the framework attempts to clarify factors to be considered towards the successful deployment of mHealth solutions in developing contexts, it barely considered the integration of the mHealth application into clinical settings, hence leaving a gap for further research.

Klasnja and Pratt (2012) conducted a literature study on the relevant features of a mobile device such as a phone, used to specifically design interventions in a healthcare setting. The authors described the use of mobile phone features such as text messaging, camera, cellular call services, native applications, and automated sensing as the technical capabilities deployed in the strategies to develop health interventions. The study was limited to describing the technologies used by patients, and did not address the effectiveness of specific mobile-phone interventions and its use for work activities in healthcare settings.

A study was conducted by Wallis et al. (2017) to explore factors that inhibit the scale up of mHealth projects in LMICs. The factors that inhibit the scaling of mHealth interventions can be attributed to the lack of adequate facilitating conditions that enable the use of technologies, as well as regulatory- and user-induced challenges. The authors indicated that in LMICs, there is a scarcity of empirical scientific evidence of the acceptance, usability and clinical impact of mHealth interventions and/or applications. The authors made suggestions to address these factors in an effort to integrate mHealth interventions at points-of-care in LMICs settings.

Based on assumptions drawn from literature, it is clear that treatment and well-being have been extended out of the hospital to patients at home as a result of access to mobile technologies; however, there are limited studies on the use of mHealth technologies to enable service delivery in tertiary hospitals. While the use of mobile technologies in a clinical context by healthcare professionals has continued to gain momentum in Sub-Saharan Africa, it is only ideal to discuss efforts of mHealth technology initiatives in the Republic of South Africa and Nigeria, the contexts of this study, here.

2.8 Overview of mHealth in South Africa

As a contribution to the healthcare 2030 vision (National Planning Commission, n.d.), South Africa's NDoH developed an eHealth strategy in 2012 (NDoH, 2012) and in 2015 the mHealth strategy (NDoH, 2015). The key focus of the long-term application of ICTs and mobile communication devices in healthcare is to improve the efficiencies in service delivery and, ultimately, to enhance the quality of life of the unequal South African society. The mHealth strategy of the NDoH provides a roadmap for universal health coverage in order to develop an efficient health-information management system. Such a system should be able to support the reengineering of healthcare service delivery in the public health sector and aid decision-making on a national scale.

According to the 2015-2019 mHealth Strategy (NDoH, 2015), mHealth projects are faced with persistent challenges, such as government's absence in taking a leadership role, and the lack of a one-size-fits-all framework to evaluate the role of mHealth tools in strengthening the current public sector of the healthcare system. Additional challenges include network coverage inadequacies, security issues and interoperability concerns.

In an effort to make sense of the empirical evidence of mHealth usage to support the points-of-care decision-making process in clinical settings, Adepoju et al. (2017) claimed that there is a need to explore how mobile technologies could be fully integrated into routine practice. The authors revealed that there is a predominant focus on antenatal care and the use of mobile technologies by cadres of health workers, such as community healthcare workers, especially in resource constrained settings. Hence, mHealth-technology projects tend to be focused on addressing the most pressing health and well-being issues in Sub-Saharan Africa as part of achieving the SDGs.

In addition, it is more convenient for public healthcare providers to reach a larger population because of the continuous penetration of mobile cellular services and phones in terms of access and ownership (Hampshire et al., 2015). While underserved and resource-constrained contexts validate the suitability of mHealth technologies as a means of extending healthcare and wellbeing services, public hospitals are seldom considered as environments which could be mHealth supported, especially because they provide services to a large part of the country's population and usually get overburdened (Ouma et al. 2011). Yet, when implemented, mHealth initiatives in South Africa are mostly SMS text-based and are targeted at services in primary healthcare institutions, such as healthcare centres and clinics, in order to manage specific types of diseases.

2.8.1 Use of mHealth initiatives in South Africa

The use of mHealth technologies or health-related applications is perceived to be best suited to primary healthcare in South Africa. According to Ouma et al. (2011), tertiary healthcare may have implemented advanced computer-based applications to aid service delivery compared to primary healthcare services. However, these applications do not necessarily translate into the use of integrated eHealth and mHealth technologies in these contexts. The primary focus areas of mHealth projects in healthcare services is tailored towards the management and dissemination of maternal-care information (Kabongo et al., 2019), the collection and reporting of health-related data, health promotion, and patient adherence to antiretroviral medication (Cele & Archary, 2019).

Ojo (2018) posits that other target areas of mHealth application include the monitoring and tracking of behavioural change in respect to medication adherence, facilitating communication between the healthcare providers, point-of-care testing for patients and work planning. Some of the examples of mHealth projects in RSA include Mobenzi Researcher, Capture, Mobilise, Nompilo, SIMpill and MomConnect, to mention a few.

A major successful mHealth project in RSA is MomConnect – a software application accessible on mobile phones (Seebregts et al., 2016). MomConnect is built for affordable mobile handsets, with support for unstructured supplementary service data (USSD), short message service (SMS) texts and voice communication. MomConnect is a registration system for pregnant women attending antenatal-care institutions. It offers services that allow pregnant to women interact with healthcare providers through SMS messages, asking questions and submitting complaints in order to help improve their health and that of their babies (Wolff-Piggott & Rivett, 2016). However, the impact of the interaction of this mobile messaging service on the improvement of maternal healthcare of pregnant women has yet to be evaluated (Kabongo et al., 2019). The system is connected to a centrally located health-information exchange server for interoperability between health technologies and for data validation. MomConnect is supposedly used throughout the health system at the facility level, in all nine provinces of South Africa to the extent that it houses a national register of pregnant women. Suggestions are that the MomConnect architecture should form the basis for the development of other digital health applications (Herselman & Botha, 2016).

SIMpill is a sensor-operated pill bottle application built on cell phone technology (Betjeman et al., 2013). The SIMpill system utilises SMSes to monitor the medication compliance of patients after discharge from hospital. It works such that a text notification is received at a central server when a patient unlocks and opens up their pill bottle. In circumstances where a text notification is not received at the central server, a reminder is sent to the patient; if non-compliance persists, the patient's physician is notified to take further action. The SIMpill application is designed for remote use by patients outside the hospital environment.

Similarly, the Medical Research Council (MRC) of RSA and the University of Stellenbosch locally designed and developed a software application for use in primary health clinics (PHC) (Mars & Seebregts, 2008). The software application is built to interface with medical diagnostic peripherals, such as an electrocardiogram (ECG), a glucometer, and a mobile platform to facilitate video conferencing between users. The workstation is designed in an easy-to-use manner with a touchscreen, and it requires minimum computer expertise to operate in order to limit the time spent on the training of healthcare professionals in PHCs.

Tuberculosis (TB) is one of the most prevalent burdens of diseases in South Africa. To improve management of this disease, *Mobilize*, an mHealth solution to enable the monitoring and reporting of the treatment of TB, was developed by Yale University school of medicine, University of Michigan and the University of KwaZulu-Natal, and piloted in rural KwaZulu-Natal in 2011 (Chaiyachati et al., 2013). *Mobilize* was built for use on low-cost mobile phones to assist healthcare workers, who move around in the communities, to triage emergency cases, facilitate information exchange and communicate directly with the physicians based in local hospitals, efficiently. However, the authors acknowledged that *Mobilize* had a low user uptake and performed sub-optimally in achieving the goal of monitoring the adverse events of TB patients, despite the training and initial buy-in from healthcare professionals. This further establishes the ineffectiveness of mHealth initiatives designed to support service delivery and a need to investigate at what point such an initiative is useful to meet the service needs of the work activities of healthcare professionals.

In the cases of South Africa, eHealth initiatives are often funded by government institutions, while the research, design and development of these initiatives is mostly carried out by universities. An extensive investigation could have contributed to meaningful use of *Mobilize*, and the development of other mHealth initiatives beyond pilot phase, provided that the government was keen to promote locally designed HITs. Conversely, in high-income countries with advanced and relatively stable economies, there is keen interest to fund local innovations.

The majority of HITs in government-funded hospitals in South Africa, such as CLINICOM, an enterprise content manager (ECM) system, a radiology information system (RIS), and a nursing information system (NIMS) used by clinical staff, operate on desktop computers (Ogundaini, 2016). The desktop software application version of these HITs serves as a major limitation to the nature of healthcare professionals' daily tasks in public hospitals of the Western Cape, South Africa. This affects service delivery in the sense that the paper-based system largely remains in operation; elements of access to real-time information is hampered, which sometimes causes delays (Marshall, Lewis et al., 2013).

According to Ogundaini (2016), the causes of the limitations of health ICT usage by doctors and nurses include: i) less than adequate involvement of end users as stakeholders in the design process of HITs; ii) a lack of ICTs suitable to the Sub-Saharan Africa hospital contexts; iii) a misconception by healthcare professionals on the usefulness of systems to their work processes; iv) and preference for mobile technologies that support their work activities. Furthermore, a gap between the expectations and the lived-experiences of using HITs for work activities is pointed out (Ogundaini, 2016). Once again, this could be associated to the lack of extensive involvement of the various end users in the design and integration of HITs.

The introduction of mHealth technologies into the existing ICT infrastructure could bridge the gap between the use of paper and hospital information systems, which makes the difference to how healthcare professionals execute technology-enabled work activities in hospital settings. This relates to the claim by Liu et al. (2011) that smartphones offer context-aware features, adequate media functions and mobility features that are suitable for work process, as well as improve user satisfaction. In the context of this study, 'mobility' refers to the application of mobile computing, aided by technology, to support mobile work practices (Hameed, 2003) under which healthcare practices can be classified (Svanæs et al., 2010).

While there are evident uses of mHealth technologies or applications in lower- and upper-middle-income countries, the main focus of these technologies is largely on data capturing, disease surveillance management, personal well-being awareness and medication adherence, especially in the public healthcare system. A brief overview of mHealth trends in South Africa's public hospitals indicates minimal to no evidence of how mHealth technologies can be integrated to enable the work activities of healthcare professionals in their role as the frontline end users. While South Africa continues to make efforts to innovatively use technology to support healthcare, a country with similar economic status in Sub-Saharan Africa, Nigeria, is discussed next.

2.9 The case of mHealth initiatives in Nigeria

The Federal Republic of Nigeria (FRN) is a country in the western part of the African continent. Nigeria is home to an estimated 200 million people. which makes it commonly referred to as "the most populous black nation in the World" (Peter et al., 2019; Sulayman & Adaji, 2019). Nigeria is divided into six geopolitical zones, made up of 36 states, excluding the federal capital territory (Owolabi et al., 2018). These states are further divided into 774 local government areas (LGAs), and each LGA includes political and health districts or wards.

After independence in 1960, Nigeria was plagued by a series of political and economic instabilities, including a civil war, military coup and dictatorships, until democracy was restored in 1999. In the aftermath of these events, public infrastructure, including healthcare service delivery, has dwindled, mostly due to mismanagement and the high handedness of the political class, re-emerging infectious and non-communicable diseases and the incessant shortage of medical professionals in the healthcare system (Adeleke, Lawal et al., 2014).

The Nigerian government, through the Federal Ministry of Health (FMoH), developed and revised national health policies and strategies (Korpela et al., 1998; Owolabi et al., 2018). The first National Conference on Health Information Technology (HIT) was held in November 2011. The conference was aimed to set up a centralised national health data management system to review Nigeria's eHealth strategies and capacity building (Adeleke, Asiru et al., 2014). Subsequently, the Nigerian government developed a five-year national strategic health development plan to implement an operational National Health Management Information System (NHMIS) across Nigeria.

The NHMIS would serve as a management tool to enhance decision-making from national to local levels of government to improve public healthcare service delivery (Adeleke, Asiru et al., 2014). Thus, the National Council on Health approved the implementation of electronic health records (EHRs) across all 36 states in Nigeria in August, 2013. An extensive search of both scientific and non-scientific publications between 2013 to date yielded no evidence of implementation yet. This could be attributed to the change in government and a culture of a lack of will to action the initiatives of the previous government (Olaronke et al., 2013). These authors attribute the underlying causes of the lack of implementation evidence to corrupt practices that have plagued the government system.

2.9.1 Healthcare system in Nigeria

The healthcare system in Nigeria is divided into three levels, namely, primary healthcare, secondary hospitals, and tertiary or teaching hospitals. Primary healthcare is usually the first health facility consumers go to in order to consult on their everyday health, while secondary and tertiary level hospitals provide special care to patients (Ludwick & Doucette, 2009). The estimated number of healthcare facilities in Nigeria is 23 640, mostly primary healthcare facilities (85.8%), with secondary hospitals (14%) and tertiary healthcare facilities (0.2%) making up the balance (Owolabi et al., 2018). However, health information technology is mostly used at tertiary or teaching level hospitals (Vainikainen, 2014). The next section highlights evidence of health information technologies (including mHealth) and the context of their use to deliver healthcare services in Nigeria. The majority of the mHealth initiatives in Nigeria are pilot projects and have not been integrated into the work activities of healthcare professionals in the public healthcare system.

2.9.2 Uses of health ICT and mHealth technologies in Nigeria

According to a brief history of technology innovations by Idowu et al. (2003), ICT initiatives started as far back as the 1950s with print and electronic media, but the use of technology to collect, store, process and exchange health information started in the late 1980s in Nigeria. The use of technology started with a collaborative research initiative between the University of Kuopio, Finland and the Obafemi Awolowo University (OAU) in Nigeria, which focused on Informatics Development for Health in Africa (INDEHELA) (Korpela, 2013). The effort produced a hospital information technology called Made in Nigeria Primary Healthcare and Hospital Information System (MINPHIS), which was deployed at the OAU teaching hospital. The system was developed to manage the admission, transfer and discharge of patients (Owolabi et al., 2018). The system was designed to support administrative work activities and not the clinical aspects of healthcare services. A similar software application, State Hospital Network (SHONET), was developed in Nigeria in 2003 (Idowu et al., 2008). SHONET was developed to enable accountability and control of the allocation of human and material resources to resource-constrained regions of the country. SHONET was developed to assist budget management in hospitals; however, there are only a few published articles on the actual impact of this application on the healthcare service delivery system in the 36 states of Nigeria.

During service delivery, the healthcare professionals, particularly the doctors in a hospital environment, use their smartphones to make work-related calls, send messages, verify the details of diagnosis and prescribe medication (Yahya, 2019). The features on the smartphones assist doctors to perform the information-dependent tasks required to make an informed decision at points-of-care, while attending to patients. Thus, it can be argued that health-specific applications can be used at points-of-care in hospital settings to access and reference medical information, as well as to communicate with their colleagues.

Idowu et al. (2014) developed an outpatient appointment booking system for the National Health Insurance Scheme (NHIS) in Nigeria to address the long waiting times experienced by patients when they visit physicians for consultation purposes. The booking system was designed to enable electronic appointment scheduling, while eliminating a need for a paper-based system and some of its inadequacies. These inadequacies refer to a lack of paper and an inability of a paper-based system to act as a reminder to both patient and doctor; the authors argued that this leads to delays and missed appointments in healthcare institutions. The NHIS booking system is web-enabled for desktop computers and mobile phones. The authors envisioned that the system would assist patients to easily book, manage and be reminded of their appointment schedules via SMS/email notifications, thereby assisting physicians to manage their workload. Thus, the system has a potential to address the issues of missed appointments and long waiting times experienced by patients and physicians at clinical settings.

Similarly, Okuboyejo and Eyesan (2014) developed Voice MedAlert. Voice MedAlert is a technology-enabled alert system that utilises voice and SMS on mobile phones to notify and remind outpatients of medication usage and attendance of clinic appointments. The system was developed to improve remote management of outpatients' health outcomes by taking into account contextual conditions, such as weather and cost implications that may likely inhibit follow-up visits to hospitals.

Another independent mHealth initiative that was piloted in four Nigerian states, and has not as yet been integrated into hospital settings, is Clinical Patient Administration Kit (CliniPAK). CliniPAK was developed from a partnership between Qualcomm's Wireless Reach, a United States of America (USA) company called Vecna Technologies, the Nigerian National Primary Health Care Development Agency (NPHCDA) and Etisalat, a mobile network operator in Nigeria (West, 2015). CliniPAK is a mobile-enabled EMR tablet that assists clinicians with facilitating the tracking and reporting of patients' treatment and outcomes, particularly in the provision of maternal and infant care services. With a wireless-enabled network capability, the author indicated that CliniPAK had improved the tasks undertaken during the work activities of clinicians by eliminating repetition of tasks and records, and providing timely care to patients at clinics.

The examples above indicate how mobile technologies and mHealth software applications present opportunities to strengthen service delivery in the healthcare system of LMICs by improving timeliness and subsequently the quality of service. The Nigerian context shows that efforts are being made to incorporate HITs into the healthcare system. These studies discuss the potential of the respective systems to improve patients' health outcomes but do not present empirical evidence of their actual use. In addition, the studies were mostly tailored to patients' needs, with less focus on the impact of health ICTs on the work activities of healthcare professionals. Consequently, the majority of the mHealth initiative projects are developed without scaling use, particularly because there is a lack of evidence showing the translation of 'potential use' to 'effective use'. The next section describes challenges confronting the implementation and use of HITs, including mHealth technologies, in the public hospital environments of the Nigerian healthcare system.

2.9.3 Challenges of mHealth technologies implementation and use in Nigeria

The process of adoption and meaningful use of HITs to enable work activities within the healthcare settings is regarded as a complex exercise, and the Nigerian context presents its own set of peculiarities. The Nigerian circumstance is complex; this is indicated by the fact that authors have cited recurrent challenges from as far back as 1999 (Adebayo & Ofoegbu, 2014; Adeleke, Asiru et al., 2014; Ajuwon, 2006; Berger & Adedeji, 2013; Idowu et al., 2003, 2008). The researcher have categorised the challenges of health ICTs implementation and use into two broad categories, namely: i) infrastructure; and ii) social actors. For example, Yahya (2019) indicates a lack of reliable Internet connection and the cost of Internet data access as factors that inhibit the use of mHealth ICTs by healthcare professionals. The author further states that, because of workload of healthcare professionals, time constraints affect the optimal use of mHealth ICTs. Hence, concerns are raised about the interruption of work activities by the use of mHealth ICTs while consulting with patients at the points-of-care. In subsequent sections, the researcher will discuss infrastructure and the human experiences of health ICTs at points-of-care during healthcare service delivery.

2.9.3.1 Infrastructure

Infrastructure serves as a basic foundation on which any successful technology is built. Basic infrastructure includes power supply, the Internet, and technology devices (Patience & Toycan, 2016). In the case of Nigeria, there has been continuous erratic supply of power, especially since the country's return to democracy in 1999. The result of this erratic supply of power is regular system downtime, which inhibits the implementation and use of HITs to capture, retrieve and exchange information (Olaronke et al., 2013). The resulting effect of this downtime is that healthcare professionals become frustrated while performing their work activities at the points-of-care during healthcare service delivery.

Erratic power supply poses a risk of system damage and information loss. Unstable electric power supply will eventually damage implemented technologies and slow down the return on investment, especially when cost of investment in infrastructure has been cited as a major barrier to implementing HITs. In addition, there is a high probability of loss of information because of system damages and interruption in communication within (or across) healthcare institutions attributed to erratic power supply (Owolabi et al., 2018). This results in a drawback in work processes and causes delays in decision-making, especially in emergency cases. For instance, a doctor might need the radiology results of a patient in order to make a diagnosis and prescribe medication. This decision becomes impossible without the power supply that enables access to patients' results electronically. Similarly, loss of power during a surgical procedure is detrimental to the outcome of the procedure and to the reputation of a healthcare institution. It becomes difficult for healthcare professionals to complete these procedures and even to monitor the vital signs of the patient being operated on. The ultimate consequence is that the goal of improving healthcare service delivery is defeated and seldom realised.

Another barrier in infrastructure is the software. In efforts to take lessons from developed countries, technologies are often times not user friendly, hence it takes much effort to provide training for the healthcare professionals to learn how to use the systems (Berger & Adedeji, 2013). The result of this infrastructure challenge is that healthcare professionals may end up losing interest in electronic hospital information systems (HISs), especially because this challenge increases their workload and takes them away from the original task, namely providing healthcare to patients (Adepoju et al., 2017). The argument is that software applications are not standardised, therefore, they usually do not fit into the context of a developing country, such as the case of Nigeria. The electronic HIS may tend to disrupt the work processes of healthcare professionals and this leads to the HITs being discarded.

The Internet is an essential infrastructure on which a successful implementation of HITs is dependent especially in LMICs like Nigeria, where information and communication exchange is vital to a sustainable healthcare sector (Irinoye et al., 2013). The healthcare sector is heavily dependent on the availability and accessibility of relevant and updated information. This information could be in the form of EHRs, for example. Failure to access information in a timely manner at points-of-care has dire consequences for the execution and outcome of the work activities during service delivery. Thus, when adequate infrastructure is not put in place or is problematic, the lack of infrastructure affects the performance of human activities and the expected outcomes of these activities.

2.9.3.2 Human actors

The term ‘human actors’ is used to describe all stakeholders who have a role to play in the design, development and deployment phases of application implementation, and in the sustainable or continuous use of HITs in the healthcare system. Human actors include members of government, policy makers, investors, healthcare professionals, software developers and health information consumers (patients) (Bennani et al., 2008; Adeleke, Erinle et al., 2014). These people are accountable for their different roles, interactions and behaviours that influence successful HITs implementation projects.

The role of the government in facilitating technology-driven work environments is, essentially, the most important role played in the adoption of HITs. Since public hospitals are healthcare institutions funded by the government, the government has the responsibility to create sustainable policies that would attract investors to fund HITs projects and to employ researchers who would develop standards and implementation frameworks (Adebesin, Kotzé et al., 2013). In an ideal situation, the government should provide a business-friendly environment where software vendors can work together with healthcare professionals to design systems and create plans which involve a maintenance culture required to sustain technology systems in public hospitals. In Nigeria, there is no evidence of contributions on the part of the government to support and drive the use of ICT in public hospitals.

A common factor reported in high-income and in lower- and upper-middle-income countries is the resistance of healthcare professionals to the adoption of ICTs. Similar to the South African context, there is a concern from the health workforce in Nigeria that the introduction of ICTs would lead to job losses (Olaronke et al., 2013; Katurura & Cilliers, 2018). Hence, the adoption of HITs is met with a conflict of interest. Additionally, the thought of learning a new skill, that of using HITs, in addition to taking care of patients in an already overburdened public system, is not received with open arms by healthcare professionals; hence, new systems are not accepted or are eventually abandoned because of work pressure. The argument provided by healthcare professionals is that their main duty in the hospitals is to administer care to patients (Furusa & Coleman, 2018).

It is evident that several authors have written on the obstacles that hinder successful implementation of health information technologies. It is not enough to mention these challenges and suggest that lessons and solutions should be taken from developed countries; it is of utmost importance to study the particular case of Nigeria, where recurring challenges are still evident and practical solutions to address the challenges are yet to be investigated.

2.9.3.3 Potential solutions to address the use challenges of HITs

This section elaborates on the feasibility of practical solutions to address the recurrent infrastructure and socially-induced challenges highlighted in existing literature by focusing on recommendations suggested to redress the challenges faced by Nigeria's healthcare system.

Power generation in Nigeria remains insufficient and unstable compared to the increase in population and the output required enabling technology use to support services. There is a need for investment in alternate and affordable power supply by relevant government agencies involved in healthcare service delivery; otherwise, the ICT infrastructure will not function in a manner designed to improve services in the public healthcare sector. In addition to erratic power supply, Internet access is constrained by the high cost of data. However, healthcare professionals have easy access to the Internet using their smart mobile devices. Telemedicine could be an alternative way to explore the success of integrating telecommunication as part of a larger healthcare information system in order to provide accessible healthcare services (Adenuga et al., 2020). This approach would bypass the traditional use of stationary workstations and inadequate network coverage, and would minimise the impact of system downtime on work activities at points-of-care.

The inadequacies of existing infrastructure call for an action plan explorative study to be undertaken on the use of mobile technologies by public and private partnerships in the healthcare sector of Nigeria. In addition, there is a need to provide regular IT support, since the provision of healthcare is a continuous service, i.e. 24 hours per day, every day of the week. There is a need to encourage researchers in Nigeria to conduct extensive research, interpret the findings of these investigations, and translate these findings into practice in a healthcare context. Hence, there is a need to form a consensus between all stakeholders (including government, policy makers, medical professional bodies, software developing vendors and the end users, namely, the healthcare professionals and administrators). A viable option to ensure the success, maintenance and continuity of health information technologies is for the medical professional body in Nigeria to collaborate with a unit consisting of personnel from both the Ministry of Health and the Ministry of Information and Communications Technology to partner with a private body which would invest in local capacity. The local capacities would be responsible for the development of software in accordance with the findings of extensive research undertaken to implement health ICTs across the public hospitals in Nigeria. In this regard, job opportunities will be created locally. The representatives of healthcare professionals should be present throughout the design process, until the completed applications are piloted and reworked to fit the work processes undertaken in the Nigerian context. Another argument is that implementation frameworks should be developed after extensive research has been conducted in the public hospitals, to cater for the similarities and differences in organisational objectives and work process and for continuous and periodic evaluation. The suggestion by Ludwick and Doucette (2009) and Adeleke, Erinle et al. (2014) is that a healthcare professional should be in charge of projects in order to influence acceptance and use of technologies in healthcare institutions, keeping in mind that a collaborative effort across the end users is essential.

Awareness and training during pilot studies as well as post-implementation of HITs should be targeted to instil the argument that the benefits of HIT-implementation outweigh the stress of accepting to use HITs. For instance, an argument has been put forward by Poon et al. (2004), Ajuwon (2006), Murray et al. (2011) and Soyemi et al. (2015) that setting up eHealth comes at a high cost. However, rather than dwelling on the set-up costs and allowing these costs to be a deterring factor to investing in HITs, there are ways and means that can be put in place to gradually generate the return on investments and to make a profit over time. For example, clients (patients) who want certain services, such as electronic access to their health records or regular reminders of appointments, can be charged a fee. These charges can be determined by a regulation and by a professional body within the country, and should be used for maintenance of HITs over time. Publicity should not include social media awareness campaigns alone, but should include the development of policies that address design standards, product development, product implementation, i.e. deployment, system installation, connectivity, and an attempt to embed IT systems into work-related use. According to Idowu et al. (2008), policies should be developed and enforced to regulate importation and maintenance of ICTs by organisations and sanction culpable offenders involved in corrupt practices. This argument establishes the necessity for practical policies that ensure accountability and contribute towards enforcing infrastructure maintenance.

There have been several calls on the federal government by healthcare professionals and scholars to improve healthcare service delivery in Nigeria through the enhancement of infrastructure and the empowerment of frontline healthcare professionals, especially in public healthcare institutions. Mobile technologies have been suggested as a feasible means to this end (Idowu et al., 2008). This argument is based on the fact that Nigeria has a growing number of mobile technology users; mobile technologies are portable and facilitate ease of access to the Internet in the case of smart devices. It is, therefore, important to explore how mobile technologies could be used by healthcare professionals during their work activities.

2.10 Conclusion to Chapter Two

In this chapter, the researcher reviewed the background of mobile technologies and what makes these technologies ideal to support the work activities of healthcare professionals during healthcare service delivery. The literature review demonstrated that there is limited evidence on the use of mobile technologies and health-specific software applications, particularly by healthcare professionals in public hospitals and the tertiary healthcare system in Sub-Saharan Africa. mHealth projects discussed in literature were mostly tailored to address the health outcomes of patients and the needs of community healthcare workers in Sub-Saharan Africa.

There are instances in high-income countries where mHealth technologies have been integrated into clinical settings, particularly to monitor the vital signs of patients and to facilitate exchange of information. A more focused look at the contexts of this study showed that there are instances of implementation of mHealth technologies where SMS and voice features were used. Examples of these technology implementations include SIMpill and MomConnect in South Africa; and Voice MedAlert and an online medical appointment booking system used by patients to manage adherence to medication, health awareness and appointment bookings, in Nigeria. However, most mHealth projects are only piloted, after which they are not scaled up. In the instances where they are scaled, the purpose is specifically for data collection, health information awareness and self-management of specific ailments, and not in support of the work activities of healthcare professionals.

In the case of healthcare service delivery, both doctors and nurses are required to move around and, ideally, require a portable device to facilitate communication and the retrieval of electronic information so as to enable decision-making. The literature review discussed the prominent devices used in healthcare settings. These devices include PDAs, smartphones, tablets and computers on wheels.

The opportunities to use mHealth-specific technologies within a hospital are evident in activities such as patient administration, information management, medical education and compliance to clinical guidelines. Healthcare professionals can use mobile technologies and health applications to access, retrieve and exchange information locally and remotely. Subsequently, factors to be considered when designing for clinical settings as a form of creating awareness among stakeholders involved in m-Health projects were discussed.

Despite the opportunities to implement m-health technologies in order to enable the work activities of healthcare professionals at points-of-care, there are challenges emergent from possible unintended consequences or contradictions that are either technical or human-induced. These contradictions are categorised as primary, secondary, tertiary and quaternary by Wiser et al. (2019). The causes and effects of unintended consequences, which result from tensions between socio-technical interactions and contextual factors, present opportunities for the integration of mHealth technologies into the work activities of healthcare professionals in order to aid healthcare work activities.

In the next chapter, the researcher explores relevant theoretical constructs that underpinned the correlations between healthcare professionals (frontline end users), mobile technology, and the software applications, as well as their work activities.

CHAPTER THREE: THEORETICAL UNDERPINNINGS

3.1 Introduction to the theoretical underpinnings of this study

In the previous chapter, a literature review on the purpose for design, implementation and use of different health ICTs, including mHealth technologies, in different social contexts by healthcare professionals was discussed. The scientific literature suggests that the area of research has been in existence for a period of time; hence, socio-technical concepts have been developed and are interrelated based on empirical evidence. This informed the need to study and describe how the concepts of IS theories can be used to understand human actors and technology components as nodes of a socio-technical interactive network at service touch points.

In this chapter, the researcher discusses related models and frameworks as analytical lens through which to view the concepts of IS theory that relate to the roles of, and relations between, humans and technology within a work activity system. Subsequently, the selected Activity Analysis and Development (ActAD) model assisted the researcher to deductively understand, and offer explanations for, the potential opportunities to integrate mHealth technologies into the work activities of healthcare professionals at points-of-care during service delivery.

The layout of this chapter is as follows: an introduction in section 3.1; followed by the presentation of theories as an analytical lens in the information systems field in section 3.2; which is followed by a discussion of relevant theories in subsections 3.3 – 3.7. The Activity Analysis and Development (ActAD) model is discussed in section 3.8 and is used to conceptualise the research aim in section 3.9. The chapter is concluded in section 3.10.

3.2 Theory as an analytical lens

In adherence to the interpretivist principles of abstraction and generalisation by Klein and Myers (1999), the researcher adopted a theoretical underpinning as an analytical lens to interpret the collected data, since it offers an explanatory perspective of the relationships between different social concepts. Concepts and assumptions which are empirically tested, with established relationships, are illustrated as a model, a framework or a theory to provide an understanding of the abstract knowledge generated by scientific means (Lim et al., 2013). The researcher drew on the definitions of these relationships to interpret the empirical findings in Chapter Seven and to develop Figure 8.1. A model is a symbolic expression of relationships between concepts using shapes and directional arrows (schematics) or by numbers, letters and mathematical symbols (statistics). A framework can be defined as the logical illustration of identified key concepts of a phenomenon, and how they relate to each other (Ahlan & Ahmad, 2014). This guided the researcher to identify relationships between key concepts and ask relevant questions about an issue.

A theory refers to a set of interrelated constructs that illustrates a logical explanation and offers a descriptive analysis of events or behaviours by hypothesising relationships between variables of a contextual phenomenon (Gregor, 2002). Interrelated constructs enable the researcher to simplify complex relationships identified from measurable characteristics or variables (Bhattacherjee, 2012). These variables can be either dependent or independent. In the context of this study, the factors that enable or inhibit the intention or preference of healthcare professionals to use HITs for their work activities are the independent variables. The dependent variables are the outcomes or consequential effects of the work activities of healthcare professionals in healthcare service delivery. The variables emergent from the findings are discussed in Chapter Seven using an analytical model, as described in section 3.8.

Theories refer to a systematic representation of coherent ideas and relationship patterns that shape the understanding (or knowledge) of a social phenomenon (Bernath & Vidal, 2007). In IS research, a theory describes different types of knowledge accumulated over time, organised in a logical manner to show the correlation between events, as observed. In essence, theories are abstract and not topic-specific in the sense that they reflect general ideas that are characterised by distinctive terminologies to articulate key aspects of the contexts in which they were developed or applied (Gregor, 2006). Consequently, it is essential to delineate the level of generalisation by specifying boundaries in which a theory holds, and when it is expected to be refuted, by using modal qualifiers such as “some” or “all”. In this study, the researcher particularly focused on the work activities and opinions of healthcare professionals in selected tertiary hospitals in Sub-Saharan Africa as a way to contextualise and delineate boundaries of generalisation.

Theories are characterised by their assumptions or propositions and can be classified from the following interrelated perspectives: Theory of analysis; Theory of explanation; Theory of Prediction; and, lastly, Theory of Design and Action (Gregor, 2006). This study adopted the theoretical perspectives of analysis and explanation in order to explore opportunities for integrating mHealth technologies into the work activities of healthcare professionals at points-of-care during service delivery in tertiary hospitals.

3.2.1 Theory of Analysis

The theoretical underpinning selected in this study was used as an analytical lens to make sense of the variables that influence the integration of mHealth technology into the work activities of healthcare professionals in order to enable the interaction moments at touch points while these professionals deliver care services. The theoretical underpinning adopted by the researcher provided elements to describe healthcare professionals, the motives that drive their work activities, and the tools used to perform tasks at points-of-care.

The theory of Analysis describes *“what is”* as opposed to trying to test, predict or provide explanations with regards to a phenomenon. This theory describes the distinctive characteristics of individuals (or groups), circumstances and events by summarising the commonalities informed by longitudinal observations (Lawrence & Tar, 2013). In addition to stating basic descriptions to analyse the most important attributes of a phenomenon, a theory specifies the compositional and associative causal relationships between attributes (Gregor, 2002).

3.2.2 Theory of Explanation

Primarily, this type of a theory provides reasons for the occurrence of a phenomenon. The Theory of Explanation is characterised by “*how*” and “*why*” descriptors in specific contexts and is therefore often regarded as the theory of understanding or enlightenment. The theory does not account for constructs to make future predictions. Examples of explanation theories (and models) are mentioned and discussed in subsequent sections of this thesis. The knowledge contribution by the Theory of Explanation is based on the discovery of unique insights, credibility, consistency and generalisability of ensuing arguments, save for specific cases of interpretivist research, because of its subjective nature (Lim et al., 2013).

In natural settings, an explanation is merely an act to show the derivation of something in a logical way. Nevertheless, offering a logical derivation of the occurrence of a phenomenon or an event can be viewed from two perspectives. Firstly, something can be explained using tested scientific laws or principles that govern its occurrence. A principle is a set of facts on which a law is established (Gregor, 2006). Secondly, the Theory of Explanation is derived from observing the cause and effect relationships between two or more constructs, temporal precedence, meaning the cause must be measurable over time and, finally, testing and refuting alternative hypotheses (Bhattacherjee, 2012). The derived explanation usually provides insights into the existence/ occurrence of a phenomenon.

This study combined the analysis and explanation attributes of the selected theoretical underpinning to explore *“what exists”*, *“how to”*, *“why”* and *“who is”* of integrating mHealth technologies into the work activities of clinical settings to support service delivery at points-of-care in a hospital environment. In the discussion of findings section of this study, a theoretical underpinning was used as lens to make sense of the interactions between healthcare professionals and the technology features that enable the execution of work activities.

3.3 The use of theories in information systems research

Given the perspectives of theories explained above, it can be stated that theories are formulated by natural sciences or social sciences. The social sciences are categorised into sociology, economics and behavioural science (Bhattacherjee, 2012). Theories in information systems research are constructed based on longitudinal and systematic studies of human actions and behaviour. The majority of behavioural theories in social sciences mostly originated from the Theory of Reasoned Action (TRA) developed by Fishbein and Ajzen (1975), and the Theory of Planned Behaviour (TPB) (Ajzen, 1991). A further example of a behavioural theory is the Technology Acceptance Model (TAM) by Davis (1989). This model is an extension of TRA, and focuses on two main determinants, namely perceived usefulness and perceived ease of use, when introducing a new technology innovation into a specific context. TAM has extended versions as a result of the development of TAM2 in 2000 by Venkatesh and Davis, and the development of TAM3 in 2008 by Venkatesh and Bala (Lai, 2017). In addition, in 1962, Everett Rogers developed the Innovation Diffusion Theory (IDT), based on the assumption that adopters learn about the potential of innovation through relevant communication channels in a specific context. An aspect of TAM was considered in the study to discuss how healthcare professionals as actors perceive the usefulness and the ease of use of health ICTs to execute work activities at point-of-care during service delivery.

Furthermore, theories about behavioural and social sciences have been applied extensively to investigate acceptance and use of technology in adoption and implementation studies. These include the IS Success Model introduced in 1992 (DeLone & McLean, 2003), which was modified by Hellstén and Markova (2006) in order to include intent to use and benefits. In 2003, Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT), which has been applied extensively and was modified into UTAUT2 in 2012 by Venkatesh, Thong and Xu (Dwivedi et al., 2017). Other theories that take into account factors other than the resulting acceptance by individuals to the use of a technology innovation in the IS research field include: Structuration Theory (Giddens, 1984); Technology-Organisation-Environment (Tornatzky et al., 1990); Task-Technology Fit (TTF) (Goodhue & Thompson, 1995); Actor-Network Theory (ANT) (Latour, 1996); Information Infrastructure (Hanseth & Monteiro, 1998), and Socio-Technical Interactive Networks (STIN) (Kling & Lamb, 1999).

3.4 Socio-technical interactions in IS research

The term ‘socio-technical’ involves interactions between human actors and technology innovations (Kling et al., 2000). Technology innovations are developed to enhance the tasks of skilled individuals to meet the pre-set goals of an organisation or to facilitate the provision of services to customers. For example, in healthcare contexts, doctors can communicate with patients over a long distance to collect information, make informed decisions and offer medical advice through the use of ICTs, otherwise known as teleconsultation. Such socio-technical interactions address the inefficiencies associated with long-distance service delivery by saving costs that relate to time and space resources in the healthcare system.

Consequently, the shaping of socio-technical interactions could develop into a network of both social and technical elements. Socio-technical interactive networks are dynamically established in an environment where human actors with skills and the non-human objects such as technology are necessitated to act as influenced by their shared interest under certain conditions, such as rules or policies (Kling et al., 2003). For instance, the development of ICTs in healthcare practice is done to address the inefficiencies associated with service delivery and requires an underlying infrastructure, which may include electronic devices, desktop, handheld mobile computers and an enabling network infrastructure. On the part of human actors, the skills and coordination required to interpret the input and the output functions of ICTs are necessary if the experiences and outcomes are to be favourable.

Socio-technical interactions are either human-machine networks (HMN) or machine-aided human-to-human interactions (Engen et al., 2016). For instance, the interaction between human actors facilitated by ICTs, or by human-ICT interactions, is informed by a purpose, which ultimately transforms into an outcome beneficial to the human part of the socio-technical network. Despite outcomes that are beneficial to the social (human) component of the network, the researcher agrees with the arguments that machines are not passive; they play an enabling role in socio-technical interactions.

Consequently, the researcher drew from relevant socio-technical constructs of existing theories and models in the IS field that are similar to the variables of the research aim as analytical lens in this study; particularly, the Actor-Network Theory (ANT), Task-Technology Fit (TTF) and Activity Theory (AT) are discussed. Aspects of these theories informed the explanatory part of this study, which will be dealt with in Chapter Seven. These theories were partially aligned to the study with the reasons provided in sections 3.5 – 3.7.

3.5 Actor-Network Theory

Actor-Network Theory (ANT) was developed by European sociologists Bruno Latour, Michel Callon and John Law (Walsham, 1997). ANT is considered to be a socio-technical approach that views human and non-human actors (or actants) as equals in a social environment, since non-human *things* may transform or mediate social relationships. An actor can be defined as the cause or source (provider or receiver) of an action, either a human or non-human action in a particular context (Cresswell et al., 2010). ANT is based on three principles, which include agnosticism, generalised symmetry, and free association (Latour, 2005). The key notions of ANT are to explore the constructs of how actors (human and non-human) come together to form a network, identify the different types of relationships that exist within the network, and the dynamism and tensions of the network. Also, the ANT investigates clusters from within a whole network, how and why a network achieves stability (or instability), and lastly, the effects of actors opting out of a network at a specific snapshot in time.

Each actor can be viewed in relation to, and not separately from, other actors or parts of the network (Cresswell et al., 2010). In essence, actors do not act outside of a network. The assumption is that ANT makes no distinction between social, technological and natural associations, irrespective of heterogeneity, when constituting a network. Emphasis is placed on claims that the stakeholders, who could be either or both human and non-human actors, work towards achieving similar interests. For instance, in this study, actors refer to healthcare professionals such as doctors, nurses and allied health workers, while the non-human actors are the technology tools, processes, roles and routines applied to healthcare provision. Healthcare professionals may use technology tools to support and automate activities within their work processes, thereby improving their efficiencies in delivery services at points-of-care of patients. Actors do not operate independently from each other but complement each another to achieve a common purpose or interest.

ANT focuses on how networks are constructed and managed. In other words, actors may enrol in and opt out of a network, given certain conditions, while at the same time, actors may belong to different networks based on their interests. Based on this assumption, ANT argues that human and non-human actors or actants are perceived to have agency, resulting in the instability (or stability) of the networks formed. Giddens (1984) describes agency as the ability of an actor to deliberately take action to achieve an expected outcome or transform their environment. In other words, actors choose to exercise their power based on their interests.

In the context of this study, the interaction moments are said to be socio-technical and transitory points of convergence, where healthcare professionals may tend to make use of enabling tools within the tenets of their work practice. ANT offers explanations of how technology is accepted and integrated into a social context. Even though human and non-human actors possess independent identities and interests, according to ANT, HITs are primarily designed according to the perceived needs of healthcare professionals. HITs enable the facilitation of work activities to improve healthcare service delivery to patients in alignment with the mandate of healthcare systems. However, the experiences of healthcare professionals can be attributed to apparent flaws in HITs, which result in a design-reality gap that influences the work activities performance and ensuing satisfaction. The design-reality gap describes the scenario in which a health ICT designed by vendors to enable a function or task of a work activity does not adequately perform and produce the desired result to the satisfaction of frontline end users at the points-of-care during service delivery (Heeks, 2006).

Despite insights given by ANT into the development, heterogeneity and (in)stability of socio-technical relationship networks, the theory has been criticised by several scholars (McLean & Hassard, 2004). The key limitations of the theory are highlighted as follows: One of the foremost points for criticism of the theory is that ANT argues that non-human and human actors have agency in a network in the sense that their actions have an influence on each other (Jackson, 2015); however, related claims have been refuted in lieu of the position that non-human actors (such as technology and rules) can be described as inscriptions necessitated by the needs of social or human actors to coordinate their functions.

Orlikowski (2000) argues that technology artefacts are instituted by human agency and, therefore, they constitute human practices. For instance, in the context of this study, a desktop software application specifically designed to manage patient information within a clinical setting cannot, by itself, upload the data it stores nor make an informed decision. Any forms of updates are only possible on condition that the software application is programmed with features of artificial intelligence and Internet connectivity, or alternatively, a healthcare professional makes sense of the data to assist the process of informed decision-making.

In addition to the intentionality of human actors indicated in this argument, the discrepancy level of power dynamics between human and non-human actors is reflected, which disproves ANT claims of equality (Engen et al., 2016). ANT does not wholly account for the relational power dynamics between both human and non-human actors. Subsequently, there are claims that ANT gives prominence to a descriptive perspective of the roles of each of the actors in a network, rather than providing constructs that offer explanations for the enrolment and withdrawal of actors in a network (Alcadipani & Hassard, 2010).

Lastly, ANT barely takes a substantial provision on defining the network boundaries, hence, the number of human and non-human actors to analyse could be infinite, as they enrol in and opt out of a (un)stable network (Cresswell et al., 2010). Cresswell et al. (2010) suggest that the limitations of ANT could be addressed by incorporating the theory with other theoretical underpinnings to provide a holistic insight into, and establish the interactions between human and non-human actors in a social network.

ANT offers insights into how human actors and non-human actors independently enrol in (or opt out of) a network, with suggested aligned interests in an interactive socio-technical network. These insights assisted the researcher to give cautious consideration to the influence of human agency and how actants exercise perceived agency or performativity on work activities. Based on the limitations attributed to ANT, the researcher further considered Task-Technology Fit (TTF) and Activity Theory (AT), both of which offer constructs that are relevant to the development of ISs suitable for use within an organisational context.

3.6 Task-Technology Fit

Task-Technology Fit (TTF) is the extent to which a technology is adequate for performing a specific task (Goodhue & Thompson, 1995). TTF is a model used as an analytical lens to investigate how a technology should be designed in reference to the requirements or attributes of a particular task. TTF was developed on the premise of technology *utilisation and fit*. In essence, TTF can be used to predict technology usage in relation to how well it enables a user to perform and complete a particular work activity (Lai, 2017). For instance, a healthcare professional might access patient history that is managed by a software application mounted on a desktop in order to make an informed decision. However, in an emergency, where the healthcare professional is out of office and away from the desktop, it would be difficult to carry out the same task of accessing the same patient history, except if the records are accessible using a portable mobile device (mHealth technology). This implies that in order to access patient information anywhere and at any time, the healthcare professional would always have to carry around a portable mobile device without it hindering the performance of other activities unrelated to the technology. In this instance, a portable mobile device includes: a personal digital assistant, smartphone, a tablet, and sometimes other handheld devices.

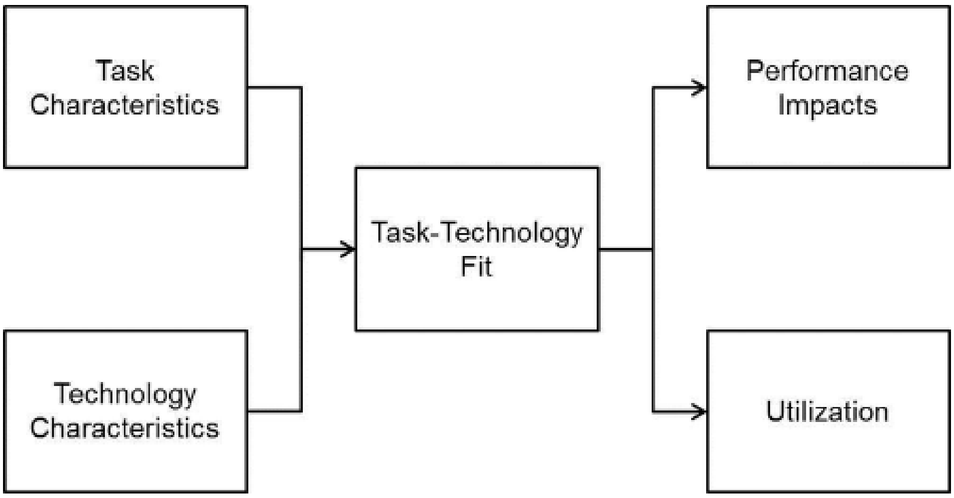


Figure 3.1: Task-Technology Fit model (Goodhue & Thompson, 1995)

The constructs of TTF are task characteristics, technology characteristics, performance impacts and utilisation. A task can be defined as a purposeful action carried out by an individual to achieve a specific outcome, while technology is a tool used as a means to carry out tasks (Isaac et al., 2017). Thus, the assumption of TTF is that the extent of a user's perception of a technology's suitability to enable tasks would increase utilisation of the technology with an overall performance impact (Howard & Rose, 2019).

In efforts to integrate mHealth technologies into the existing health information systems to support the work activities of healthcare professionals, it is essential to consider the attributes of the work actions of the healthcare professionals. Doing this could guarantee utilisation and usefulness of the technology, to a certain extent, as well as having a positive impact on the timely completion of tasks.

While the TTF model offers insightful constructs on which to design a suitable technology appropriate to support specific tasks, this study intended to do more. In addition, the researcher also considered the interplay between healthcare professionals' experience and expectations, actions of their work activities, technology features and the social contexts of technology use. Hence, the researcher sought to explore the different service touch points in relation to the interactions between human and non-human actors within an organisational context. In other words, the researcher needed to understand how health ICTs could enable interaction moments of tasks during the work activities of healthcare professionals. Consequently, the researcher considered the AT as an alternative means employed to understand the social context of work activities executed by healthcare professionals.

3.7 Activity Theory

The historical background of Activity Theory (AT) is grounded in the activities of human interactions in relation with their relevance to the context in which they occur, and to the eventual outcome of social transformation (Vygotsky, 1980). These activities of human interaction are social, and are underpinned by a need to achieve a change through some form of mediation within a particular environment (Engeström, 2000a). Ultimately, an activity can be viewed from the perspectives of the subject (human actors), the purpose for which actions are being undertaken, the tools that facilitate actions and the outcome. Engeström (2000b) suggests that tools can be studied as an integral component of human functioning within an activity system, otherwise described as internationalisation. Hence, the assumptions of AT are that knowledge can be mediated through the use of tools, and that the unit of analysis of social transformation is an activity. This implies that tools used by an actor to perform a particular action should not be separated in relation to the other elements within the activity system and from the goals of the activities.

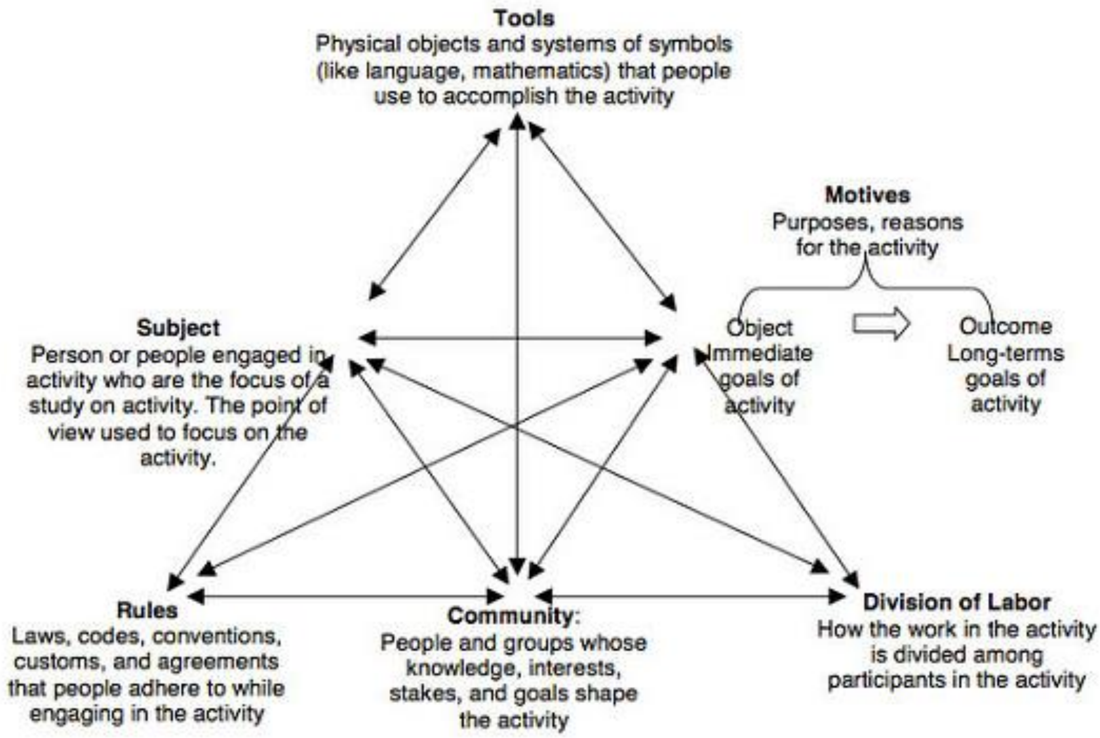


Figure 3.2: Illustration of work activity in an activity system (Engeström, 2000b)

Figure 3.2 shows the constructs of AT, which include subject or actor, community, division of labour, tools, rules, object or motives for activity and outcome of activity (Engeström, 2000b). For social transformation to take place in an activity system, the subjects, such as healthcare professionals, use HIT tools to facilitate a goal-oriented work activity, such as clinical decision-making, to achieve an intended outcome (service delivery). In the context of this study, a community consists of different stakeholders that are affiliated to service delivery in the health sector. These include healthcare professionals, patients, hospital managers and other support staff, while the rules are the guidelines for the implementation of the medical practice and healthcare services (Arnaboldi & Spiller, 2011). Emphasis is placed on the healthcare professionals because they are the principal users of the tools that enable their work activities during delivery of care services. Division of labour represents distributed tasks assigned to the actors of the community in an activity system (Engeström, 2000b).

A systematic literature review was conducted by Wiser et al. (2019) to address limitations attributed to the use of AT to analyse and obtain more insights into socio-technical systems in healthcare. The authors found that it could be difficult to keep a historical track of how a set of activities change over time, since AT does little to suggest design recommendations and lacks a holistic inclusion of the organisational context. This study was intended to enhance the usability of AT to analyse activities in healthcare contexts and to manage the contradictions that appear in the activity system. Consequently, the researcher adopted a design-oriented approach by using a modified version of AT to explore opportunities to integrate mHealth technologies into the work activities of healthcare professionals at points-of-care.

AT provides a framework that can be used to analyse the interrelationships between the subjects or actors (individual or group), motives, actions, tools, rules, division of labour and stakeholder community within the organisation environment (Wolff-Piggott et al., 2018). While AT focuses on the process of transformation, as informed by socially constructed human interactions in a context, it is not entirely tailored to the IS field. The Activity Analysis and Development (ActAD) model as a suitable theoretical lens through which to address the aim of this study will be discussed in the next section.

3.8 The Activity Analysis and Development model

The modification of the AT into the ActAD model provides a holistic approach to understanding information systems development (Korpela et al., 2004) (Figure 3.3).

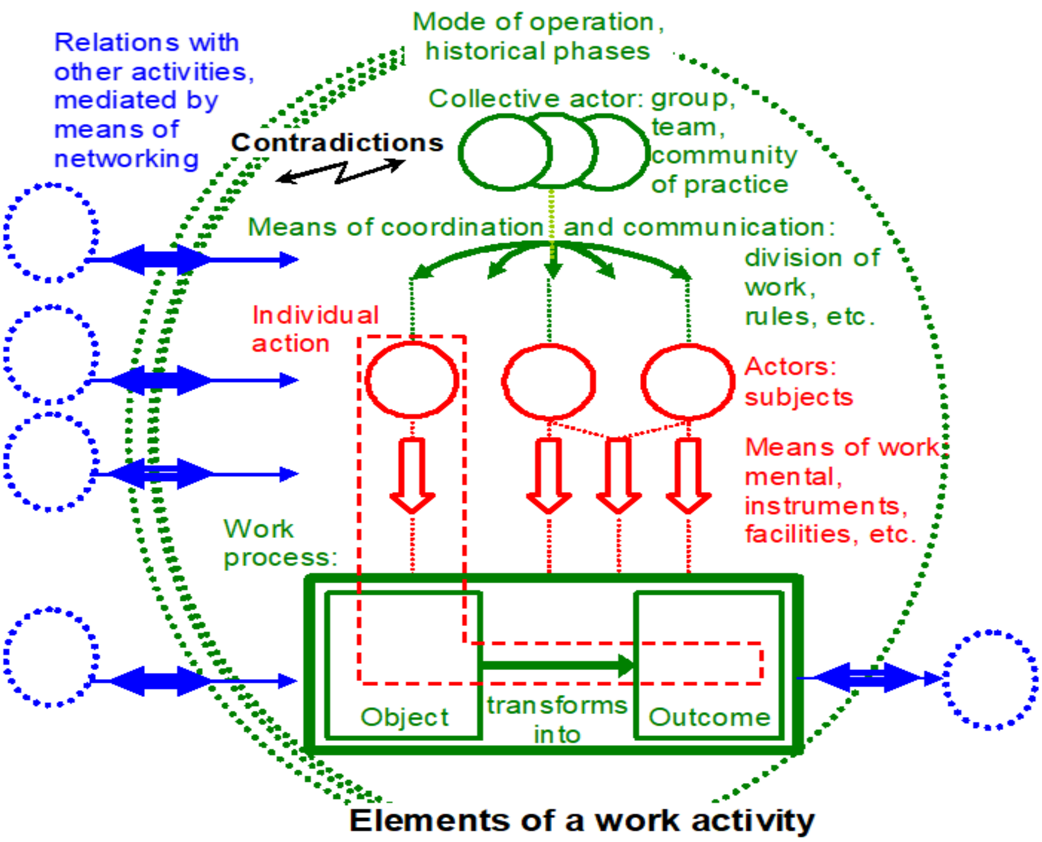


Figure 3.3: Activity Analysis and Development model (Korpela et al., 2004)

ActAD is a theory-based approach used to describe the elements of work activities and to understand how their interactions inform the development of IT tools. The model illustrates the relationship between the elements of a work activity and assumes that the transformed outcome/goal of an activity becomes the object of action for the next activity. A work activity comprises subjects or actors (individual or group) that use tools (means) to perform actions on an object as informed by the motive (purpose) of activity for transformation towards the intended outcomes in organisational contexts (Mursu et al., 2007). In the context of healthcare, healthcare professionals and administrative staff of a hospital use tools that are aligned to their professional skills to aid work activities during service delivery. The researcher further argues that the interplay between the characteristics of human actors and non-human objects, such as technology, influences the transformation process

3.8.1 Unpacking concepts of the ActAD model

Drawing from Figure 3.3, ActAD assumes that work-oriented activities are social activities that are purpose-driven and context-based (Mursu et al., 2007). Work-oriented activities are defined as actions performed by human actors according to a set of rules, for a particular purpose (motive for the activity) (Korpela et al., 2000). In essence, an activity occurs when an individual (or a group) performs an action in an attempt to achieve a specific outcome. Under ideal circumstances, actors will use tools (means of action), while being guided by policies or standards and procedures (rules) to execute actions during an activity (Korpela et al., 2004). Tools such as HITs, including mHealth technologies, can be used to enable actions, such as access to and retrieval of records, exchange of information and communication between healthcare professionals, during service delivery. These actions of healthcare professionals and their experiences while using HITs at points-of-care were studied within the context of tertiary hospital settings as a social systemic entity.

To understand a systemic entity, this research drew from the contributions of Korpela et al. (2004) on the elements of a work activity, and of Alter (2018) on the composition of a work system. In this study, the interpretation of a systemic entity focused on a comprehensive analysis of the independent interactions or relationships between actors, tools, object of activity, the transformation process, rules and outcome in a work activity system. Actions, such as access to patient records, information management and interactions facilitated by technology, are enacted on the object of the activity and performed by the actors. The actors are guided by the rules or standards of their profession, and use mediating tools for their daily work activities. However, the concept of a mediator transcends descriptively beyond physical objects, such as building facilities and types of technology, to more abstract concepts attributed to human actors that either enable or inhibit the transformation process. The processes which describe transformative actions include the assigning and coordinating of tasks among actors, the utilisation of tools, and the translation of policies or standard procedures within a work activity system.

Ideally, the momentary convergence of mediating (enabling) factors results in a desired outcome (Wolff-Piggott & Rivett, 2016). The reverse is the case when mediating factors are inhibitors of actions within a work activity. When inhibiting mediators are identified, organisations could manage the expectations of actors and set up facilitating conditions to realise organisational objectives, namely the delivery of quality healthcare services.

3.8.2 Application of ActAD model in similar socio-technical studies

The ActAD model has been used in the IS field, particularly to acquire in-depth insights into socio-technical interactions and work activity systems within the education and health informatics disciplines. In this study, the researcher deliberately drew on the assumptions and established claims in the conclusions of the studies in order to understand and aid the interpretations offered in the discussion of findings in Chapter Seven.

The ActAD model was explored as an analytical tool by De Freitas and Byrne (2006) to develop a decision support information system for an anti-retroviral treatment (ART) clinic in South Africa. Through analysing the existing work activities, the authors were able to realise the need for change and that IS enables improvement in data quality and, ultimately, decision making. Furthermore, introducing IS in an existing work process helped to establish the roles of stakeholders and a need to provide continuous support to frontline end users. The authors concluded that in a technology-enabled context, work activity and IS complement each other and influence the quality outcomes of a work process. In a similar study by Häkkinen and Korpela (2007), the ActAD model was applied to investigate information management practices within maternal care in Finnish clinics. The authors claimed that the ActAD model assisted to understand: i) the multi-faceted system in which information exists; ii) user information needs; and iii) how users engage information within a primary healthcare setting. The study recommended an integrated approach to the development of IS to address social and technological issues that are not independent of one or the other.

The ActAD model was used by Mlitwa (2011) to investigate the mediating factors that influence the patterns of use (or non-use) of e-Learning technologies to support academic activities at universities in the Western Cape Province of South Africa. The author used elements of the ActAD model to develop an e-Learning work activity framework. The framework was developed to enable future studies to analyse teaching and learning work processes that are supported through e-Learning in higher educational institutions.

To understand the complexities associated with information and communication processes during the intrapartum period of childbirth in maternal service provision, M'Rithaa (2015) adopted the ActAD model to analyse the activities of different healthcare practitioners in a midwifery obstetric unit and in a referral hospital. The author developed a Feasibility, Availability, Acceptability and Safety (FAAS) framework to evaluate factors that should be considered to ensure an effective information and communication process during the intrapartum period. One of the authors' recommendations suggested that doctors require a mobile device that can be used as a point of contact and to facilitate retrieval of patient information.

In a study by Hwabamungu et al. (2018), the ActAD model was used as a theoretical lens through which to assess the influence of stakeholder interactions in the implementation of IS strategy in public hospitals in two provinces in South Africa. The authors viewed strategy as the object of an activity that is transformed into strategy elements, which is conditioned by contextual factors and contradictions of stakeholder relations.

The propositions established in the studies discussed above provided a logical rationale for the researcher's choice and appropriateness of applying ActAD in order to understand the work activities of healthcare professionals. The elements of ActAD were contextualised within the healthcare service-delivery process so as to identify opportunities that could be serviced by mHealth technologies at points-of-care.

3.9 ActAD and technology-enabled service interaction moments

In the context of this study, healthcare service delivery is an activity system viewed as a series of interconnected socio-technical interactions that are transformed into improved healthcare service delivery. It is argued that a work activity can be synonymous to the different touch points of a service delivery path. Each work activity, or service touch point, is made up of tasks with interaction moments (as described in section 1.6). The proposed means of action are HITs that include a mHealth technology, while the shared object of networking is the information object, such as patient records. The researcher explored the dynamics of different service interaction moments to identify opportunities to integrate a means of action to execute tasks and to access to the shared object of networking.

Based on the assumptions of the ActAD model, the goal of an activity (outcome) is dependent on the alignment of the work activity, such that the actors adhere to rules and use a suitable means of action while attempting to achieve the purpose of the activity. In this study, the pain and gain points experienced by healthcare professionals at each service touch point were explored to understand HITs (including mHealth technologies) and interaction moments performed by healthcare professionals at the points-of-care. The ActAD model and other salient constructs of theories discussed in the previous sections informed the initial conceptual framework used to execute the research aim.

3.9.1 Conceptual framework of mHealth-supported service interaction moments

The conceptual framework presented in Figure 3.4 below shows the relationship between the research problem and the formulated issues of investigation (research questions). The conceptual framework shows the original assumption that challenges experienced at service touch points could be improved with the integration of mHealth technologies into the work activities executed by healthcare professionals at points-of-care. In other words, the current use of implemented HITs by healthcare professionals to perform tasks during work activities can present opportunities for the use of mobile HITs. This study sought to identify those opportunities at points-of-care in tertiary healthcare and the peculiarities of a desired mHealth technology-enabled work activity.

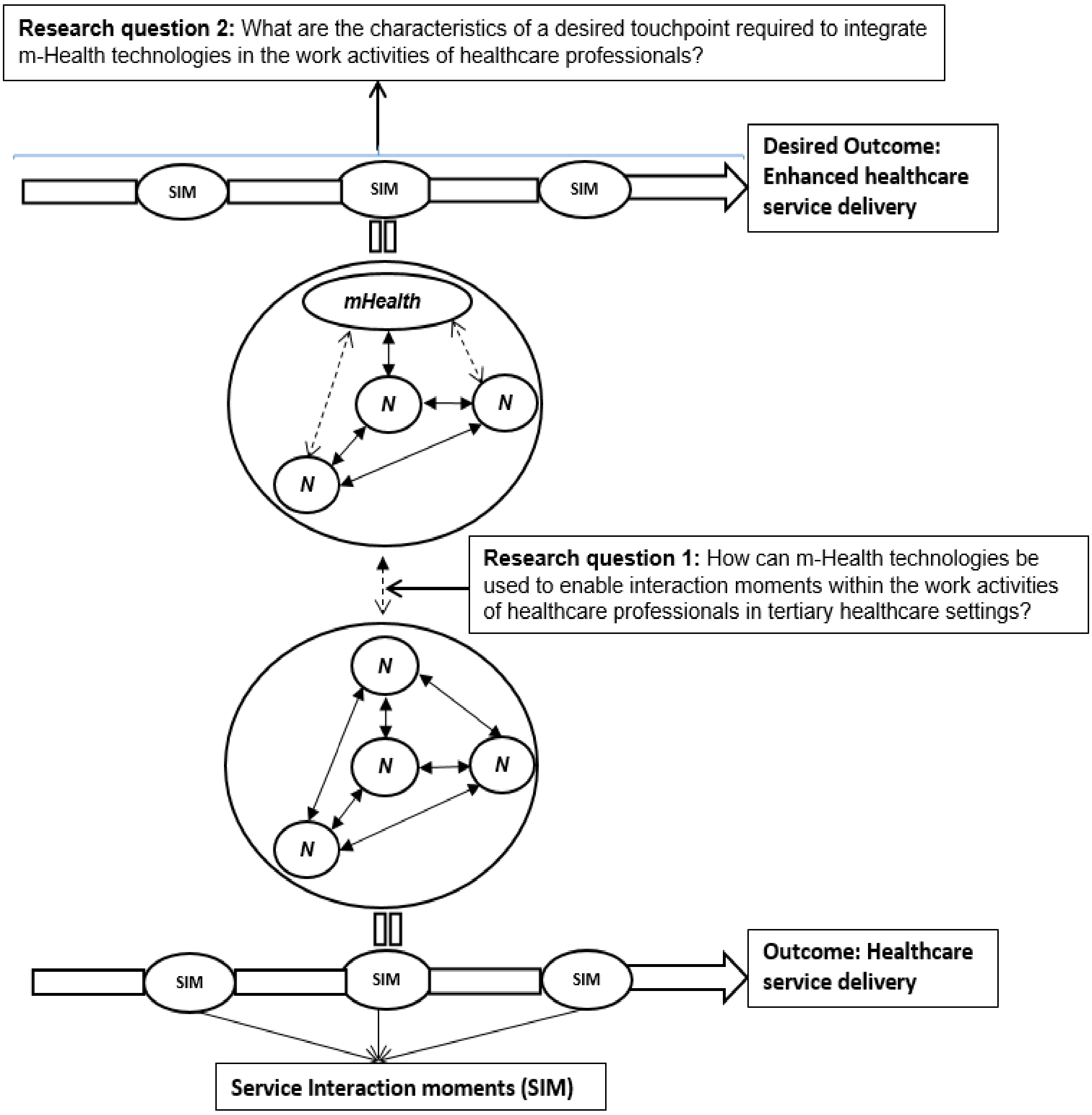


Figure 3.4: Preliminary mHealth-supported service interaction moments (SIMs) conceptual model

The lower part of Figure 3.4 above illustrates the current situation of healthcare service delivery in tertiary healthcare settings, showing the service interaction moments (SIMs) of tasks within technology-enabled work activities as touch points. The interaction moments depict a momentary convergence of nodes ***N***, which could be attributes externalised by human or technology features at points-of-care. For example, there could be healthcare professional interaction with patients, or healthcare professionals interacting with other healthcare professionals and technology-enabled interaction between the different human actors. The outcome of each touch point (series of interaction moments) leads to another touch point with similar or different interaction moments. This study is underpinned by the argument that mHealth technologies can be integrated into the work activities of healthcare professionals at points-of-care to enable interaction moments of tasks, with particular focus on tertiary hospital settings.

3.10 Conclusion to Chapter Three

This chapter highlights the theoretical underpinnings supporting this study, especially because the design-reality gap of HITs influences work activity performance and the satisfaction of users. The study aimed to understand the work activities in healthcare services, particularly from the perspective of healthcare professionals. Thus, the researcher considered prominent IS theories. However, the researcher's choice of theory was one of the adaptations of AT used to understand IS development. The ActAD model was used to understand the interactions between elements of a work activity and how this is transformed into an outcome or goal. To get clarity on the application of ActAD and its appropriateness for this study, the researcher reviewed past literature to grasp the meanings associated to each element in similar contexts.

This study identified healthcare service delivery as an activity system. This activity system consists of both administrative and clinical activities. These activities may include, but not be restricted to, patient and information administration, care coordination and communication between different healthcare professionals or with patients. The purpose of each work activity is known as the object of the activity, while the tools are the means of action. For instance, during patient and information administration, healthcare professionals (actors) may use HITs to access electronic records. Subsequently, the outcome or goal of the work activity of this action is information acquisition to aid decision-making. The application of the ActAD model is extensively discussed in Chapter Seven. The next chapter (Chapter Four) presents the approach used by the researcher to engage actors and understand their work activities during service delivery.

CHAPTER FOUR: RESEARCH APPROACH

4.1 Introduction to the approach that informed the research design

Subsequent to the discussion of theoretical underpinnings in Chapter Three, in Chapter Four the researcher elucidates the choices made that informed the processes of how data were collected, analysed and interpreted as empirical evidence. The techniques and tools were selected to meet the research objectives and ultimately, to provide answers to the research questions.

A research approach can be categorised as deductive or inductive (Bhattacherjee, 2012). This author posits that a deductive approach is conducted when hypotheses are drawn from a theory, followed by methods designed to test the variables, after which observations are made and the hypotheses are either validated or invalidated. Conversely, an inductive approach involves the collection of data on the issue of investigation, using the designed methods and instruments, and the data are analysed without a preconceived notion. This study adopted an inductive approach based on the research aim, and data were collected from participants using relevant techniques to identify emergent themes. Afterwards, the key elements of the ActAD model were used as a lens through which to discuss the findings associated with each emergent theme.

The study was designed to be exploratory, as informed by the research problem in section 1.3. Hence, the researcher adopted an interpretivist approach because of the subjective nature of socially constructed realities by different healthcare professionals that use (or do not use) health ICTs during execution of their work activities at points-of-care. Subsequently, a qualitative strategy, including multiple techniques, specifically semi-structured interviews and co-design activities, were used to engage the participants who were selected using non-random sampling. The multiple techniques enabled the researcher to gain in-depth information to understand the work activity system of healthcare service delivery, particularly the interactions between the healthcare professionals and the capabilities of health ICTs implemented at points-of-care. Afterwards, the qualitative data collected from the healthcare professionals were sorted using thematic analysis.

Chapter Four includes an introduction in section 4.1; followed by a description of research design in section 4.2; and a discussion of research designs in sections 4.2.1 and 4.2.2. After that, the philosophy that shaped the scientific process is discussed in section 4.3, which is subdivided into sections 4.3.1 and 4.3.2. The research methods and techniques adopted for data collection are explained in section 4.4, which is subdivided into sections 4.4.1 and 4.4.2. The sampling technique is presented in section 4.5, followed by ethical considerations in section 4.6; and the chapter is concluded in section 4.7.

4.2 Research design

A research design is a comprehensive blueprint that guides the formal process of adopting philosophical convictions to collect and analyse raw data in a scientific enquiry (Neuman, 2006). Thus, the research design was informed by philosophical convictions to justify choosing the methods and tools that shaped the strategic planning and execution of this study. In this study, selected methods and tools informed how different participants from whom data were collected were identified, selected and engaged. To investigate the research problem, the study was exploratory in nature, in the sense that the researcher sought to unpack opportunities to integrate mHealth technologies to facilitate service interaction moments in the clinical settings of public hospitals. The research was designed according to the aim of the study (section 1.4). The choice of a research design was influenced by the nature of the research problem and the aim of the study. Nevertheless, scientific research can be designed to explore, to describe or to explain a natural occurring or social phenomenon (Neuman, 2011).

4.2.1 Exploratory research design

An exploratory research design is structured to discover new ideas and knowledge about a social phenomenon in order to provide relatively novel insights (Creswell, 2003), for example, seeking information about the characteristics or factors affecting an entity or attempting to provide ample information about the way things happen in different contexts. Exploratory research is the basis on which basic information is used for both descriptive and explanatory investigations. According to Neuman (2011), exploratory research can be conducted in order to gain a well-grounded understanding of an area of interest, to test the feasibility of extending an investigation where little is known, and to develop specific contextual frameworks.

An exploratory study is characterised by asking a combination of **how** and **what** questions in order to unearth and provide basic information on problem solving. In this study, the researcher argued that there is limited evidence to show how mHealth technology could adequately enable interaction moments, i.e. at which specific points are mHealth technologies useful in public hospital settings in Sub-Saharan Africa. Hence, the aim of the research was to explore opportunities to integrate mHealth technologies into the work activities of healthcare professionals during service delivery at points-of-care.

4.2.2 Descriptive research design

The purpose of descriptive research design is to build upon an exploratory investigation. The aim of descriptive research is to provide precise information that describes an entity, the state of the entity or a social phenomenon using different types of observations (Babbie & Mouton, 2001). While a descriptive research is similar to an exploratory study, it is used to describe a topic or phenomenon in more detail. For instance, the description of the findings in this study described the context of investigation, namely the clinical settings in tertiary hospitals, the participants who were engaged, their work processes, and the implemented technologies.

The discussion of the research findings consisted of a detailed report on the aim of the study to inform explanations on the causal relationships between the described variables of the issue of investigation. Thus, it can be argued that elements of descriptive research are present in both exploratory and explanatory studies. An explanatory research design is underpinned by the knowledge created from exploratory and descriptive investigations (Creswell, 2007). The core of explanatory research is to provide an account of reasons for an event, or to determine the level of cause and effect relationships between the variables of a specific phenomenon (Bhattacherjee, 2012). This approach is used to answer **how** and **why** questions. Hence, the output of an explanatory study would ultimately be the proffering of a solution to address an existing or recurring problem.

Since this study aimed to explore opportunities to integrate mHealth technologies into work activities executed by healthcare professionals at points-of-care, an explanatory research approach was not adequately suited for this purpose. Nevertheless, the researcher applied elements of explanatory design in terms of asking questions in order to gain clarity on specific reasons for the kind of responses obtained during the data collection process. The selected choice of exploratory research design was guided by research philosophies that explain the forms in which knowledge exists, its acquisition and the appropriate methodology, respectively.

4.3 Research philosophy

A research philosophy guides a researcher’s assumptions and thought processes on the existence of a reality and on knowledge acquisition (Mack, 2010). The field of IS has adopted the use of philosophical paradigms to investigate the various forms in which knowledge exists and how knowledge can be acquired, regardless of its reality. Therefore, research philosophies are guided by paradigms that shape the logical process of conducting scientific investigations, with the aim of discovering scientific truths and the nature of knowledge (Krauss, 2005). In essence, a paradigm can be conceptualised as a basis on which knowledge claims are discovered and formulated by means of justified methods. The philosophical paradigms are broadly categorised into ontology and epistemology (Burrell & Morgan, 1979). Discussions on the choice emergent from the research philosophy, leading up to the eventual research methodology, are represented in the Figure 4.1 below.

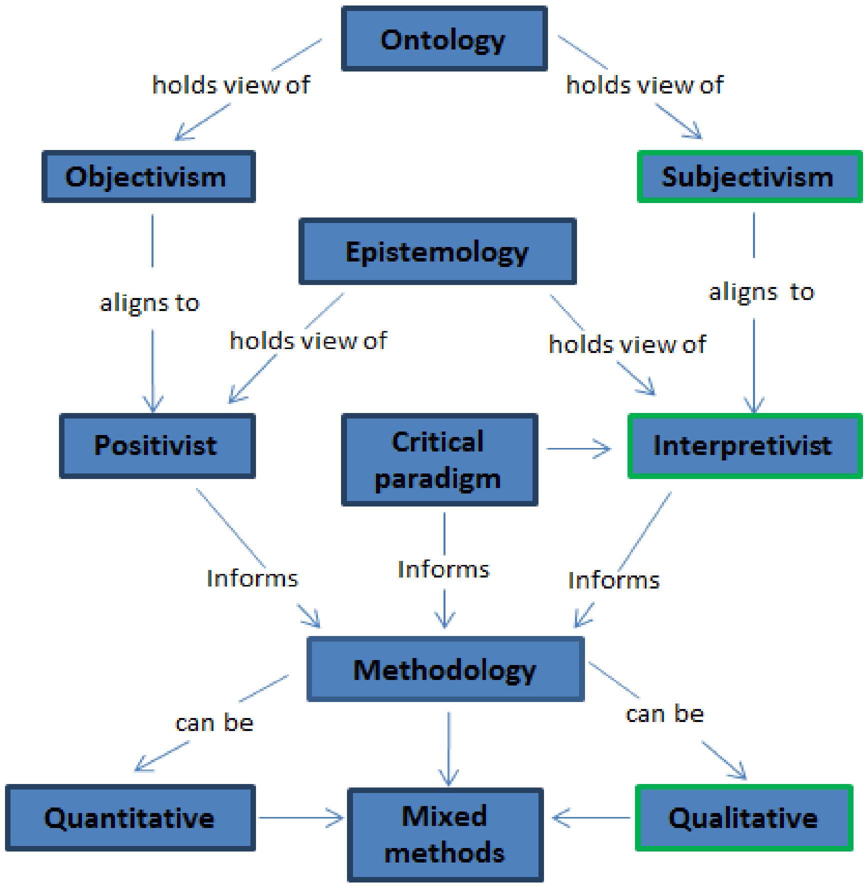


Figure 4.1: Informed philosophical views

4.3.1 Ontological assumptions

Ontology is a branch of philosophy that deals with the study of how knowledge is perceived by social actors in reality; hence, ontology reflects our view the world or how knowledge is 'being' represented (Guba & Lincoln, 1994). For example, ontological assumptions are perceived as what social actors *think* or *feel* is happening in contrast to what is *actually* happening (Crotty, 1998). Thus, ontology can be classified according to how realities are perceived by social actors, which include objectivism (objective reality) and subjectivism (subjective reality) (Scotland, 2012).

Objectivism assumes that the knowledge obtained from a reality is independent of social actors (Gruber, 1995). Usually, this assumption aligns with the natural sciences or an empiricist approach to knowledge claims (Wahyuni, 2012). For instance, it can be argued that naturally occurring phenomenon (such as gravity and weather conditions) that are perceived by humans to exist independently of our interpretations, cannot be manipulated since it is a scientific truth. In contrast, subjectivism assumes a position that the form of knowledge in a reality is dependent on social actors and their resulting actions, i.e. that knowledge is socially constructed (Walsham, 1995). Therefore, the form of knowledge in this paradigm is perceived as a reflection of the interpretation given to a reality by social actors;

hence, it aligns with the field of social sciences (Bhattacherjee, 2012). For example, social actors give interpretations to a reality with respect to their understanding of **how** and **why** they think things happen. The human consciousness often influences the formations of traditional and cultural connotations attributed to a social phenomenon over time (Mack, 2010).

It can be established that ontological assumptions shape how a reality is perceived by social actors and, ultimately, influences the approach in which knowledge acquired is presented. In this study, the knowledge of the reality or context of research and the issue of investigation are socially constructed, based on the interactions between healthcare professionals undertaken to carry out their work activities with the aid of technology, thereby, resulting in a socio-technical relationship network. This argument supports the ontology of the activity analysis and development theory that the social actors (healthcare professionals), the tools (technology artefacts), and the object of the activity (clinical activities) derive their characteristics from the purpose-driven activity (Wolff-Piggott & Rivett, 2016).

Because of the socio-technical nature of information systems, technologies can be described as the inscriptions of its designer's understanding of its potential use(s) in practice and, as such, can be regarded as a social construct, i.e. mHealth technologies can be regarded as a node within an interactive network of stakeholders. A node, in this context, refers to an entity (either an object or a being) which exists independently and could also be part of a network through its interactions with other nodes (De la Harpe, 2014; O'Connor & O'Donoghue, 2015). Therefore, it is imperative to discuss how knowledge is understood in ontological paradigms. For this reason, the researcher adopted a branch of philosophy that seeks to acquire knowledge in the form in which it exists, namely, the theory of knowledge.

4.3.2 Epistemological assumptions

The branch of philosophy called epistemology originates from the Greek words *epistêmê*, which refers to "knowledge" and *logos* meaning the "study of" (Krauss, 2005). This philosophy deals with the acquisition of knowledge, i.e. the understanding of a perceived reality from a social actor's point of view. For instance, how can social actors make sense of an entity, or a naturally occurring phenomenon, that is independent of their thinking, or how are realities created from individual interpretations studied? The questions arising are addressed by the eventual choice of a research methodology.

Therefore, epistemology can be described as the link between ontology and methodology in the sense that while ontological assumptions argue about existence of reality in relation to social actors, methodology provides methods and techniques that are most applicable to acquire perceived knowledge from a social reality (Bhattacherjee, 2012). Epistemology explains how knowledge is acquired from objectivist or subjectivist ontological assumptions of reality in the world view (Becker & Niehaves, 2007).

The objectivist draws on the argument that existence of a reality, independent of social actors, can only be studied through observations (Venkatesh et al., 2013). Conversely, the subjectivist builds on the contextual, subjective and interpretive way of studying a reality, based on the perceptions, thoughts and experiences of social actors (Walsham, 2006). The selection of an epistemological stance was informed by the research objectives which align to subjective ontological presuppositions of socially constructed knowledge. The researcher discussed the rationale for taking an interpretivist stance based on the arguments of Orlikowski and Baroudi (1991).

The positivist paradigm is a branch of philosophy that is aligned to the natural science of getting to know what social actors sense as a scientific truth. The positivist paradigm assumes that knowledge, that which is the truth or fact, can be known and verified by conducting experiments to take measurements of the phenomenon being observed (Mack, 2010). The positivists argue that the reality of one’s world view is constructed independently of human actors. This study focused on acquiring knowledge based on the interpretation about socially constructed and a context-based phenomenon. Therefore, a positivist paradigm was an unsuitable approach to explore opportunities of integrating mHealth technologies to enable interaction moments based on the experience of healthcare professionals during their work activities.

Alternatively, a critical theory paradigm offers its critique of the assumptions of knowledge acquisition in either of the objective and subjective ontological points of view (Mingers & Standing, 2017). Critical theory argues for a complementary balance between testing and validating a naturally occurring phenomenon, while at the same time recognising the interpretations given by social actors as to the way they perceive a social reality, to change the existing system of things. The critical theory paradigm is based on the need to change society or the social environment (Reeves et al., 2008). This paradigm supports the nature of subjective reality because it acknowledges the existence of generative mechanisms of socially constructed beliefs, which include cultural, religious, and other social factors (Mingers & Standing, 2017).

The critical theory paradigm can be used to understand why events occur and advocates for a change in the status quo of socially constructed contexts (Williams & Wynn, 2018). Even though this study sought to precisely explore opportunities emergent from the lived-experiences of healthcare professionals with respect to the use of health ICTs during their work activities, it was necessary to critique the research findings of this study. Ultimately, this informed the decision to select and discuss the interpretivist paradigm.

4.3.2.1 Interpretivist paradigm

Interpretivism is based on the assumptions that knowledge which is dependent on social actors can be understood through direct observation and perceived experiences that shape their realities (Walsham, 1995). Ultimately, the assumptions are that knowledge acquisition is socially constructed, and subjective with respect to the social actor and context (Becker & Niehaves, 2007). The interpretivist paradigm assumes that the most suitable way to study realities that are dependent on social actors is through interpretation of experiences or perspectives (Bhattacherjee, 2012). Hence, the nature of this study is subjective in the sense that the researcher focused on providing answers to the research questions informed by the feedback acquired from the healthcare professionals. This feedback aided the researcher in interpreting and building an argument around how they perceive mHealth technologies could support service interaction moments during healthcare service provision, and not critiquing the clinical practice within public hospitals. The researcher’s interpretation, in itself, is subjective and based on his capabilities to make sense of the participants’ responses. Consequently, this position addressed the rationale influencing the researcher’s choice to adopt the interpretivist paradigm, rather than critical theory, in this study.

The critical theorist paradigm is suitable to explore a social phenomenon as interpreted from the experiences of various social actors in relation to the factors that are independent of human experiences. For example, critical interpretivism can be used to understand the level of influence that contextual and historical factors have on the perceptions, thoughts and experiences of social actors (Mingers & Standing, 2017). For the purpose of this study, the interpretivism paradigm helped the researcher to understand the varied use-experiences of healthcare professionals in order to identify opportunities to integrate mHealth technologies into the work activities executed by healthcare professionals at points-of-care. This paradigm was informed by the set of seven principles of interpretive research (Klein & Myers, 1999). These principles in relation to this study are discussed below.

i) The Hermeneutic Circle Principle

To make sense of meanings associated with the issues of the investigation, the hermeneutic circle places emphasis on iterative interpretations between the variables of a phenomenon in relation to a larger context (Klein & Myers, 1999). For instance, this study drew on the lived experiences of healthcare professionals and the interaction moments of tasks in order to understand the work activities in existing healthcare service-delivery processes. In chapters Five, Six and Seven, the researcher deals with the analysis of the technology-enabled work activities and how explanations from healthcare professionals of the influence of implemented HITs on the outcomes of service delivery within tertiary healthcare settings were sought. The hermeneutics circle takes into account iterations of the interpretations given to the subjective experiences of participants in relation to a context.

ii) Contextualisation Principle

Social or human actors are a product of their environment and interpret knowledge based on their lived-experiences and perceptions (Klein & Myers, 1999). The contextualisation principle claims that participants should be engaged in their usual social, cultural and historical settings. This principle was inscribed into the data collection process by taking into account the contextual factors, such as any social, technical and organisational factors that influences the work activities of healthcare professionals at points-of-care during service delivery. The process of data collection led to a series of interactions between the researcher and the participants to understand and draw from their experiences and expectations.

iii) Principle of Interaction between the researcher and participants

This principle suggests an in-depth reflection on the clarity of how data collection methods and tools of inquiry are selected and conceptualised to aid comprehensive interaction between the researcher and selected participants (Klein & Myers, 1999). In line with the objective of this study, this principle draws on the ontological beliefs of the researcher to reflect an understanding of participants’ experiences. For the purpose of this study, the researcher focused on touch points and the interaction moments of tasks within the work activities of healthcare professionals at points-of-care. This enabled the researcher to identify both the gain and pain points that result from interaction moments experienced by healthcare professionals. The identified pain points suggest opportunities to integrate mHealth technologies to enable interaction moments and to address the issues of lack of timely application and inappropriateness of implemented HITs. Subsequently, this principle aided the researcher to select an appropriate strategy and tools with which to engage participants.

iv) Abstraction and Generalisation

The principle of abstraction emphasises the application of a theory as an analytical lens through which to make sense of the research problem or issues of investigation (Klein & Myers, 1999). In essence, a theory is essential to support the interpretation of the findings obtained from the data in relation to general concepts that describe socially constructed realities (Gregor, 2006). For instance, numerous theories have been developed over time to aid interpretive research in the IS field. Examples of such IS theories include Diffusion of Innovation (DOI), Unified Theory of Acceptance and Use of Technology (UTAUT), Actor-Network Theory (ANT), Activity Theory (AT) and Social Network Analysis (SNA) theory, among others. This study draws on the concepts of AT (Engeström, 2000b; Korpela et al., 2004) to analyse the work activities of healthcare professionals.

v) Dialogical Reasoning

The principle of dialogical reasoning suggests objectivity between the predefined set of concepts of a theory and the emergent research findings (Klein & Myers, 1999). The researcher was careful to avoid preconceived ideas of the phenomenon, allowing the actual meanings of the findings to emerge so as to prevent any form of data constraints. Hence, the tools of enquiry in this study were chosen to let the participants express their different experiences and beliefs as individuals (and as a group) on the research problem (Walsham, 2006). This principle informed the potential interpretations attributed to the technology-enabled tasks within the work activities of healthcare professionals.

vi) Multiple Interpretations

This principle emphasises the need to identify the differences in interpretations tied to the same order of events, but from the multiple narrative perspectives of the participants (Klein & Myers, 1999). For instance, the researcher should be able to deduce the social, historical or cultural reasons behind different interpretations from the subjective narratives of each participant (Klein & Myers, 1999). In line with the objectives of this study, the researcher engaged with the participants to understand their lived experiences during the execution of their work activities at points-of-care. These included interactions with technology and interactions with other healthcare professionals, as well as how they dealt with circumstances that influence the process of healthcare service delivery. Therefore, this principle required the researcher to consider the multiple views of the participants and the motives (social, historical, complexity of work activities and historical reasons) to their responses. Thus, it was deduced that the principle of contextualisation and the principle of multiple interpretations are correlated, which enabled the researcher to clarify what influences the different points of view, which was done in Chapter Seven when discussing the findings.

vii) The Principle of Suspicion

This principle requires neutrality from the researcher in respect of biases and distortions in the responses observed in the primary data collected, especially with regards to the subjective nature of interpretive studies (Klein & Myers, 1999). In this study, the researcher operationalised the concepts of the research objectives outlined in section 1.4.1, to reduce the likelihood of false arguments or responses associated with interpretive research (Walsham, 2006). Hence, the researcher adopted multiple techniques to engage with participants, as discussed in section 4.5, and reported mixed reactions evident in the data. In this study, the emergent research findings were not described at face value, but critiqued through a theoretical framework, according to the principle of abstraction and generalisation.

These sets of principles were adopted by the researcher to explore the opportunities to integrate mHealth technologies into the work activities executed by healthcare professionals at points-of-care as informed by their experiences, beliefs and expectations. Subsequently, the ActAD model was used as an analytical lens to understand and make sense of findings from the investigation, and a suitable methodology was adopted to acquire information on technology-enabled work activities from selected participants.

4.4 Research methodology

Research methodology can be likened to a structured guideline that informs the scientific process of discovering new knowledge within a particular context. According to Neuman (2006), research methodology is a collection of methods adopted, particularly in a scientific enquiry, to address problems. Research methodology guides the process of selecting and applying the most appropriate techniques and tools to facilitate collection and analysis of data in order to obtain new insights into, or generate novel knowledge about, the issue of investigation being studied. A research methodology can be categorised in terms of methods used to collect data as quantitative, qualitative or mixed methods (both quantitative and qualitative) (Creswell, 2007). The objective of this study was to understand how mHealth technology could enable the interaction moments of healthcare professionals' work activities by regarding the human and technology as nodes in a socio-technical interaction. Therefore, a choice between qualitative and quantitative methods was influenced by the difference in strategies, which has a major influence on the nature of collection and analysis of data.

Quantitative research methods are applied in scientific investigations to test hypotheses; to evaluate, measure or quantify evidence; and to establish relationships between different variables of a phenomenon (Babbie & Mouton, 2001). Quantitative research methods do not sufficiently provide the techniques necessary to accomplish the objectives of this study because it deals mainly with statistics and requires a large sample size to produce generalisable results. Because of the exploratory nature of investigating work activities carried out by healthcare professionals, alternative qualitative research methods were considered, in the understanding the participants and an issue are fused in a social context (Wahyuni, 2012).

4.4.1 Qualitative research methods

Qualitative methodology is a systematic approach of applying relevant methods and/or techniques to observe and understand human experiences and the meanings associated with a phenomenon through the collection and analysis of non-numeric data (Babbie & Mouton, 2001). A qualitative methodology was selected by the researcher because it enabled the exploration of different interpretations given to individual (or group) experiences, particularly on a phenomenon or social issue. For instance, in this study the researcher sought to explore the current work activities of healthcare professionals and the use of HITs at points-of-care within tertiary healthcare settings.

Using qualitative methods and techniques enables new areas of an issue of investigation to emerge for further exploration while engaging with the selected participants (Walsham, 2006; Wahyuni, 2012). The type of field data obtained provided the researcher with ideal cases to establish the need for mHealth technologies and how these technologies could adequately fit the current workflow of end users. Based on the interpretivist approach, the researcher sought to understand the thoughts and perceptions of human actors and how they make sense of their work activities, as shaped by their interactions with technology or *vice versa*. The knowledge of work activities being sought from healthcare professionals is subjective because of the different interpretations that are socially constructed by individuals, and may differ between different individuals.

In qualitative research, the researcher becomes the instrument in the sense that they ask questions to participants and can probe further in order to interpret the meanings given to a research problem by the participants, as opposed to performing controlled experiments and handing out survey questionnaires to gather data. Consequently, the researcher used multiple data collection instruments, as explained in section 4.5.1. Qualitative methodology can be approached using strategies of enquiry, including grounded theory, narratives, phenomenology, ethnography, case study and service design (Sandelowski, 2000; Creswell, 2007). For the purpose of this study, a service design strategy was adopted because it involves a practical approach for engaging users in the design of an intervention, especially to either create a new or improve an existing product or service.

4.4.2 Service design research

A *service* is described as a coordinated set of activities carried out to satisfy a demand or need (Romslo, 2015) while *design* was conceptualised by Herbert A. Simon in 1969 as an approach that seeks to find out the actual needs of users and, by extension, their expectations. Hence, a service is considered from two points of view: the service provider and the patient. Each of these views is influenced by the chronological order of both human and non-human factors which converge in the course of the service delivery process. While the receiver of the service is considered the beneficiary, their experiences are based on how the provider renders the service. This study focused on healthcare professionals as a principal user of technology to provide services that cater for the health needs of patients in tertiary healthcare institutions.

Service design creates the avenue to develop an easy-to-use and desirable solution that has substantial value to people (Touloum et al., 2018). The concepts of service design consider the work processes, individuals with the prerequisite skills to perform activities within processes and the resources that must be aligned to result in the desired outcome (Goldstein et al., 2002). The service design concept involves shaping the service experiences of both the service provider and the receiver to adequately suit people's needs and meet their expectations. Therefore, an existing service may be modified or a new service may be created.

In this study, a service design was adopted as the research strategy because it is a human-centred collaborative process that aims to understand how a set of activities unfold along a timeline, providing details of active interactions and transformation outcomes within the service (Yu & Sangiorgi, 2014). Therefore, this investigation engaged healthcare professionals in their work setting to make them comfortable; a setting where they could discuss their current work activities and experiences with the use of technology. The study focused on the interaction moments enabled by technology at different service touch points, i.e. points of contact where healthcare professionals attend to clients at points-of-care. This strategy assisted the researcher in addressing the research objectives.

The Service Design Double Diamond Model (DDM), developed by the United Kingdom's (UK) Design Council in 2005, was adopted in this study. The DDM is categorised into four phases which are: **DISCOVER, DEFINE, DEVELOP** and **DELIVER**, as illustrated in Figure 4.2. Different techniques were applied in the phases of this study to articulate the research problem, to understand the current clinical work activities of healthcare professionals, and to identify opportunities to integrate mHealth technologies at points-of-care. The intended outcome of adopting this strategy was to prescribe the characteristics of a technology that could enable clinical work activities in tertiary healthcare in Sub-Saharan Africa.

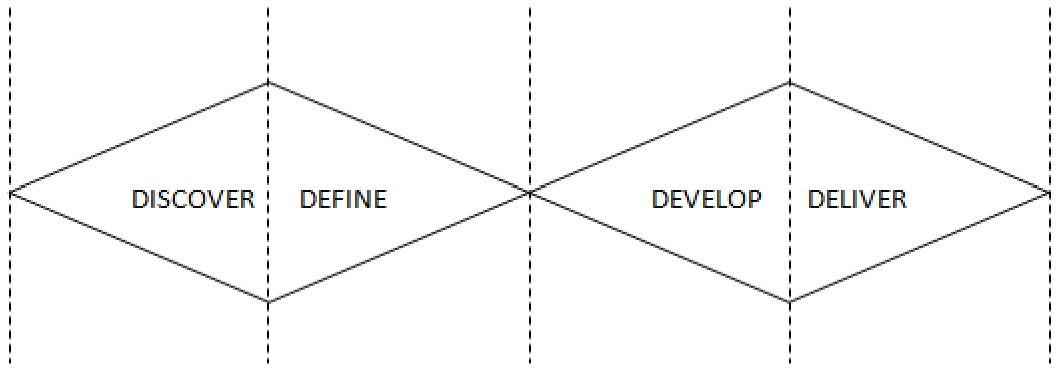


Figure 4.2: Service Design Double Diamond Model by UK Design Council

During the first quarter of the DDM, the **DISCOVER** phase, the objective of the researcher was to identify the defined research problem and possible opportunities to integrate mHealth technologies into the work activities executed by healthcare professionals at points-of-care.

During this study, the researcher uncovered limited empirical evidence on mobile-technology-supported interaction moments, i.e. situations where a momentary network is formed between different actors and the actions at a service touch point. As a result, this study aimed to explore the opportunities to integrate mHealth technologies into the work activities of healthcare professionals at points-of-care in hospitals. This exploration involved engaging healthcare professionals as stakeholders at service interaction moments in order for the researcher to acquire a definite understanding of how mHealth technologies enable work activities.

During the second quarter of the model, the **DEFINE** phase, the researcher analysed the data gathered from primary and secondary sources in order to make sense of the data so as to address the objectives of the first phase. The objective of the researcher in this phase was to focus on the service touch points and interaction moments in the work activities of healthcare professionals in order to identify and analyse the gain and pain points that could be serviced by mHealth technologies.

After the data were collected and analysed in the second phase, the objective of the third phase, **DEVELOP**, was to create a prototype solution and to get the prototype tested and refined, if necessary. In this study, the researcher engaged participants using a co-design activity to brainstorm how the implemented HITs could be improved or integrated to enable the interaction moments of their work activities at points-of-care. The first, second and third Diamond quarters are usually re-iterative processes, where ideas that originated from the findings need to be continuously refined and improved on.

The fourth and final phase of the Double Diamond Model, the **DELIVER** phase, is where the prototype solution developed in the third phase is transformed into a finished product or service and deployed to a live site in order to address the problem identified in the first phase. The objectives of this phase are to undertake a pilot test of the finished product or service, to get feedback from the target end users and to do an evaluation of the designed mHealth ICTs. However, because of financial constraints and the administrative processes involved in getting approval from the Provincial Department of Health, this study was restricted to the first, second and third phases of the DDM. The next section justifies from whom data were collected, how data were collected, and how the plan to analyse the qualitative data was implemented during the research process.

4.5 Data collection and analysis processes

In this section, the researcher presents the rationale for how data were collected from both secondary and primary sources. The techniques that guided the sampling of the research population, tools of inquiry and follow-up analysis of the qualitative data are discussed in details in sections 4.5.1 – 4.5.2. Subsequently, the application of these processes to the research contexts and the ensuing outcomes are described in detail in chapters Five and Six.

4.5.1 Data collection

The initial phase of the data collection process involves the identification and selection of appropriate participants from among a research population. The process is referred to as sampling, while the selected participants are referred to as sample size. For the purpose of this study, a non-random sampling, viz. purposive and snowballing sampling techniques, were adopted to collect primary data. The techniques were chosen to enable the researcher to identify a sample size that would provide in-depth information that aligns to the research objectives. Purposive sampling is based on biased judgement, particularly in selecting participants who are perceived to have a comprehensive understanding of the knowledge gap being studied (Creswell, 2007). This sampling technique is combined with snowballing, where the engaged participants suggest colleagues who possess the required knowledge of the issues under investigation.

In a similar study conducted by Furusa and Coleman (2018) to determine the factors influencing eHealth implementation by medical doctors in selected public hospitals of Zimbabwe, qualitative methods were adopted to collect data. The researchers considered multiple case studies and selected 20 medical doctors by applying purposive sampling, using semi-structured interviews as tool of enquiry. The hospitals were selected because of the high number of people they served and because they catered for the highest number of referrals in Zimbabwe. This is an example of studies conducted in Sub-Saharan Africa, and they used similar research methods and sample size that were applied in this study.

During this study, the researcher identified and approached tertiary hospitals with a sample of clinical departments in which healthcare professionals use (and do not use) HITs to enable the tasks undertaken in their technology-enabled work activities. The clinical departments, from which a sample size of participants was selected, provided specialised care in medical imaging, diagnosis, treatment and reporting. The clinical departments include: Orthopaedics, Ophthalmology, Radiography, Intensive Care, Trauma and Theatre. Two tertiary hospitals were considered in the two Sub-Saharan African countries with the largest economies and development. For the purpose of this study, the sources of data collection were divided into two categories, namely secondary data (literature review) and primary data (participants). The review of literature was a continuous activity from the beginning to the end of this study. Table 4.1 provides a description of issues investigated, sources of data, techniques used to gather information, selected units of analysis, and units of observations.

Table 4.1: Sampling table

Issues of Investigation	Data Sources	Tools of Enquiry	Units of Analysis	Units of Observation	Number of Participants
Research Question 1: How can mHealth technologies be used to enable interaction moments within the work activities of healthcare professionals in tertiary healthcare settings?					
Background, methodology	• Literature	• Read, analyse, write	• Books, journals, Internet sources, print media on application of ICTs in healthcare services	• Journal and conference papers on health information technologies and mobile technologies in health – from libraries and online sources or databases	Tertiary-level healthcare hospital **H1** and **H2** Doctors (including specialists), Nurses and Information administrators
The effects of implemented HITs on the outcomes of healthcare professionals' work activities	• Literature • Tertiary hospitals	• Interviews	• Clinical departments • Touch points of clinical activities	• Healthcare professionals already using (or not using) any form of technology in their workflow processes • Information managers • Interaction moments	
Identify pain and gain points as experienced by healthcare professionals at interaction moments during their work activities	• Tertiary hospitals	• Interviews • Co-design activity	• Clinical departments • Touch points of clinical activities	• Healthcare professionals already using (or not using) any form of technology in their workflow processes • Interaction moments	
Research Question 2: What are the characteristics of a desired touch point required to integrate mHealth technologies into the work activities of healthcare professionals?					
Determine how mHealth technologies and human actors could be aligned at service touch points	• Tertiary hospitals	• Interviews • Co-design activity	• Clinical departments • Touch points of clinical activities	• Healthcare professionals already using (or not using) any form of technology in their workflow processes • Interaction moments	
The role of the Provincial Department of Health (DoH) in stakeholder engagement during the selection process of HITs for tertiary healthcare services	• Tertiary hospitals	• Interviews	• Hospital Administrative Official/s	• Information managers	
					Depends on the minimum number of participants required to reach saturation point

4.5.1.1 Purposive sampling of research contexts

According to a study on e-readiness of African countries conducted by Ifinedo (2005), South Africa and Nigeria ranked within the top five countries in Sub-Saharan Africa. In the study, the author conceptualised e-readiness in both African countries as availability of infrastructure and technology innovation to enhance a networked economy and economic growth. Health and the quality of healthcare service delivery contribute to skills and the well-being of human resources required towards developing and sustaining economies. A study by Abyaomi et al. (2017) on the factors that enable or inhibit behavioural intention of doctors to use clinical informatics, selected Nigeria and South Africa as leading economic power houses in Africa that attempt to promote the use of ICTs in order to enable healthcare service delivery. Therefore, in this current study, the researcher considered Nigeria and South Africa as two countries with comparable economic growth to explore the opportunities to integrate mHealth technologies into the work activities of healthcare professionals at selected tertiary hospitals in Sub-Saharan Africa.

The public healthcare systems in South Africa and Nigeria are tiered systems that consist of primary healthcare, secondary level hospitals, and tertiary level or academic hospitals. For the purpose of this study, tertiary hospitals were considered as the empirical cases because they cater to referral patients from other levels of the healthcare system that are in need of specialised clinical care such as radiology, pathology and surgery procedures. In addition, consideration for hospital selection was given to the extent to which HITs had been (and not been) implemented in the clinical departments of tertiary hospitals.

In this study, the units of analysis were the clinical departments of tertiary hospitals and the touch points of clinical work activities within these clinical departments. These clinical work activities may have been technology-enabled or manually performed. The units of observation were the healthcare professionals who use (or do not use) technology and the interaction moments of tasks performed in clinical work activities. Additional units of observation were the information managers involved in the HIT selection and implementation process. Consequently, the researcher adopted the prescribed techniques of the service design DDM to engage the participants and to collect data from the primary sources.

4.5.1.2 Application of the Double Diamond Model in data collection process

In order to address a research aim, the service design DDM can be used with visualisation techniques (Yoo et al., 2015). Visualisation techniques enable the service designer to understand the current service as experienced by either the service provider or the service receiver, and how the service can be improved to an expected or ideal situation. Visualisation techniques include service blueprints, storyboards and user journey maps (Yu & Sangiorgi, 2014). They are developed through contextual inquiries and co-design or co-creation activities. Besides visualisation techniques, prototyping techniques can be used to design and test artefacts in service design research (Lee, 2016). Prototyping techniques include desktop walkthrough and role plays performed by current or potential users of an artefact.

Based on the account of Lee (2016), a service blueprint is a visual technique that shows the backend, otherwise known as the underlying resources, on which service provision is executed. The author stated that a service blueprint does not explicitly highlight relationships between actors, nor does it utilise artefacts within different contexts of use. Storyboards and user journey mapping are recommended as alternative suitable tools to describe the holistic interactions of the actors as they perform their activities in a service process. However, the author highlighted the fact that storyboards are time consuming because the participants are tasked to give a detailed illustration, as it occurs in a sequence within the service. Given the category of participants involved in this study, healthcare professionals in public healthcare institutions usually have a busy schedule in LMICs; hence, they have little or no time to engage in a storyboard activity. Therefore, this visualisation technique was not adequate for this study.

A user journey mapping technique is more concise and was thus adopted for the purpose of this study. User journey mapping is used to visualise the actions and interactions of specific users while utilising a product or service (Touloum et al., 2018). Mapping helps to identify the current situation and to suggest future opportunities where user experiences can be optimised to achieve relative satisfaction. Consequently, a comprehensive user journey map includes user roles, user actions, user motives, user interactions and user experiences while performing individual or organisation-related activities. In this study, the researcher engaged with participants in order to visualise the tasks within their work activities so as to get an in-depth understanding of how and why they use technologies at points-of-care during healthcare service delivery process.

One of the tools of inquiry used was semi-structured interviews. Semi-structured interviews are conducted using open-ended questions to collect in-depth information about a research problem and to provide opportunities for new areas to emerge for further exploration (Myers & Newman, 2007). The researcher set out to engage as many participants as possible who could provide in-depth information, until a saturation point was reached. At saturation point, no additional information is disclosed or the researcher has observed redundant feedback from at least 12 respondents (Marshall, Cardon et al., 2013). However, grounded theory studies may require engagement of more than 12 participants. In this study, the saturation point was defined as the point at which the researcher noticed similar patterns of response and frequency of occurrence attributed to same words in the answers given to the open-ended questions. To ensure that theoretical and methodological triangulation of the data could be done, visual illustrations representing actors and tools used in a typical clinical work activity were used to further engage participants in a co-design activity. The additional co-design method assisted the researcher to guarantee some degree of validation of the quality of data.

A co-design activity entails the facilitation of tasks to engage users or potential users of a service or product to express their lived-experiences and expectations creatively, so that the researcher or designer can gain insights into use contexts (Steen et al., 2011). This technique allows participants to take ownership of prospective solutions as influenced by their current experiences that they perceive as counterproductive. For instance, participants in this study illustrated their current workflow at the different points-of-care within a hospital, highlighting specific contexts of use. The researcher analysed the feedback received from participants and the generated user journey map to recommend opportunities for the integration of mHealth technologies into the work activities performed by healthcare professionals during service delivery.

Multiple data collection techniques allowed the researcher to have holistic insights into the user experiences and expectations and to easily identify the specific user requirements for a suitable mHealth technology at points-of-care. The study included contexts within Sub-Saharan Africa, as it was of particular interest to investigate how countries with a relatively high rate of mobile technology penetration have taken advantage of their telecommunication infrastructure to support healthcare service delivery.

The research questions were validated by testing the parameters in a once-off session with volunteer professionals and peers in the field, and adjustments were made where necessary. To test reliability, interview questions are conceptualised, where the main concepts are defined to extract the independent variables, and operationalised in order to breakdown identified variables into relevant attributes. However, it is somewhat difficult to test the reliability of research questions in qualitative research since the responses are subjective and particularly dependent on the actions, lived experiences and perceptions of the individuals concerned (Saunders et al., 2009). At the end of the data collection, a qualitative technique was used to sort, organise, and infer research findings from the participants' responses, as informed by the objectives of the study.

4.5.2 Qualitative thematic analysis

The qualitative data that were collected for this study had to be analysed to extract meaningful information in order to provide answers to the main research questions and address the objectives accordingly. Qualitative data analysis techniques include grounded theory, discourse analysis, content analysis and thematic analysis (Tong et al., 2007). For the purpose of this study, thematic analysis was used to organise the data acquired from the respondents.

Thematic analysis is suitable for emerging qualitative research that have textual data obtained from observation notes and semi-structured interviews (Kondracki et al., 2002). In qualitative studies, thematic analysis is suitable to unpack and analyse data to develop meaningful information in categories and themes (Hsieh & Shannon, 2005).

In the course of analysis for this study, the first step was to transcribe the voice data to text; this allowed the researcher to easily group the data into themes. When grouping data into themes, the researcher used descriptive codes to tag the emerging attributes, namely key words or phrases in relation to the issue being investigated, and to categorise the themes. The processes through which emerging attributes are identified are known as conceptualisation and operationalisation. The process of thematic analysis enabled the researcher to determine the frequency of the attributes and to develop the categories and themes for each of the research objectives.

The process of conceptualisation entails defining the variables of the research questions, after which the variables are operationalised. Operationalisation refers to defining possible attributes, which are the words or phrases that characterise variables (Creswell, 2003). Consequently, descriptive codes are assigned to the data by a process called coding, which precedes the eventual categorisation of emergent themes (Saldana, 2009). The coding process is divided into open coding, axial coding and selective coding. Open coding involves identifying key concepts hidden in textual data, which are hypothetically related to the phenomenon, while axial coding involves identifying key concepts and assembling them into causal relationships that explain the phenomenon being studied (Bhattacherjee, 2012). For the purpose of this study, open and axial coding was applied in alignment with the objective of this study. Coding requires allocating different words or phrases to identify key responses in an iterative process. Ultimately, this enabled the researcher to sort and organise the data collected from the interview transcripts and the co-design activity, presented in chapters Five and Six, respectively. The findings using the ActAD model are discussed in Chapter Seven.

The findings from the themes presented in chapters Five and Six are discussed in relation to the elements of the ActAD model, as described in section 3.8. The discussion of the findings presents explanations for the interpretive narrative of analysis conducted on anonymised direct quotes from participants during interviews, which are supported by the user journey stories developed during co-design activities. The findings from both contexts in which data were acquired are articulated, discussed and validated with existing literature to complete the analysis and address the research aim.

4.6 Ethical considerations

Ethics are crucial to scientific investigations. It is important that the research process is safe and free of harm to the selected participants, the researcher and the environment. The researcher was not interested in the data captured within the technology, but rather how the technology could be used optimally for more efficient service delivery in clinical settings in public hospitals. Furthermore, the study did not seek to initiate a change to the standard work practice of healthcare professionals, but sought to suggest a conceptual model to evaluate the effectiveness of mHealth technologies to perform tasks within the current service delivery processes.

Ethical clearance was obtained from the University faculty's ethics review committee, to approach the Western Cape Department of Health (WCDoH), South Africa (Appendix A) and the tertiary hospital in Nigeria. Permission for data collection was granted by the relevant authority in the healthcare sector to engage the selected tertiary hospitals (Appendix B and Appendix C). An information sheet that described the research aim, and how collected data would be utilised, was provided to the participants in both tertiary hospitals (Appendix D). Informed consent letters requesting approval of individuals' participation to collect data were sent to prospective participants via email and via face-to-face contact (Appendix E). The letter informed participants that participation is voluntary, that the interview and co-design activities would be recorded as evidence of data collection, and that they are entitled to withdraw at any point in the study, if they wish. Informed consent letters also indicated that there would be no misinterpretation of the participants' responses. The participants signed the consent form before data collection commenced, and in some cases after the data collection was concluded.

The researcher ensured confidentiality of participants by using pseudo codes to anonymise their personas and by removing any form of identifier that could reveal the identities of the participants. For security purposes, the data (voice, picture or text) obtained from the participants were stowed away in a password-protected folder on a secure computer workstation on the university premises at all times. The participants' choice of how their data should be used was adhered to, and a copy of the completed thesis will be made available to the relevant bodies on request.

4.7 Conclusion to Chapter Four

The philosophical underpinning of this study is interpretivism in the sense that knowledge attributed to how technology enables the work-related activities of healthcare professionals can be socially constructed and is subjective. In other words, even though work activities are uniform for specific types of healthcare professionals, resulting perceptions according to their experiences could differ for each individual. The interpretivist viewpoint informed the methods, strategy, tools, and type of data collected. A service design strategy was adopted to allow the researcher to broadly engage with the users on the technology employed to aid healthcare services according to their needs, expectations and experiences. This enabled the researcher to collect two sets of qualitative data from the selected research contexts.

The choice of semi-structured interviews and co-design activity aided the researcher to collect in-depth information, relevant to the research objectives, from the participants. As a best practice for responsible research, the researcher made sure to consider and address the ethical issues associated with this study, for accountability purposes. Essential permissions were obtained before data collection commenced. During the data collection process, the researcher did not engage in any act that would put the participants directly or indirectly in harm's way. The environment and dates were as advised based on the availability of the participants. After data collection, the researcher ensured confidentiality by anonymising the identifiable information of participants during the data analysis process. In the next chapter (Chapter Five), the researcher provides a detailed presentation on the data analysis process, the emergent themes and the research findings.

CHAPTER FIVE: PRESENTATION OF RESEARCH FINDINGS FROM INTERVIEWS

5.1 Introduction to presentation of the research findings

The aim of the research was to explore opportunities for integrating mHealth technologies into the work activities executed by healthcare professionals at points-of-care in the clinical settings of hospitals. In this chapter, the researcher presents the application of methods and techniques used in this study, based on the qualitative strategy adopted by the researcher to address each of the research objectives of the study.

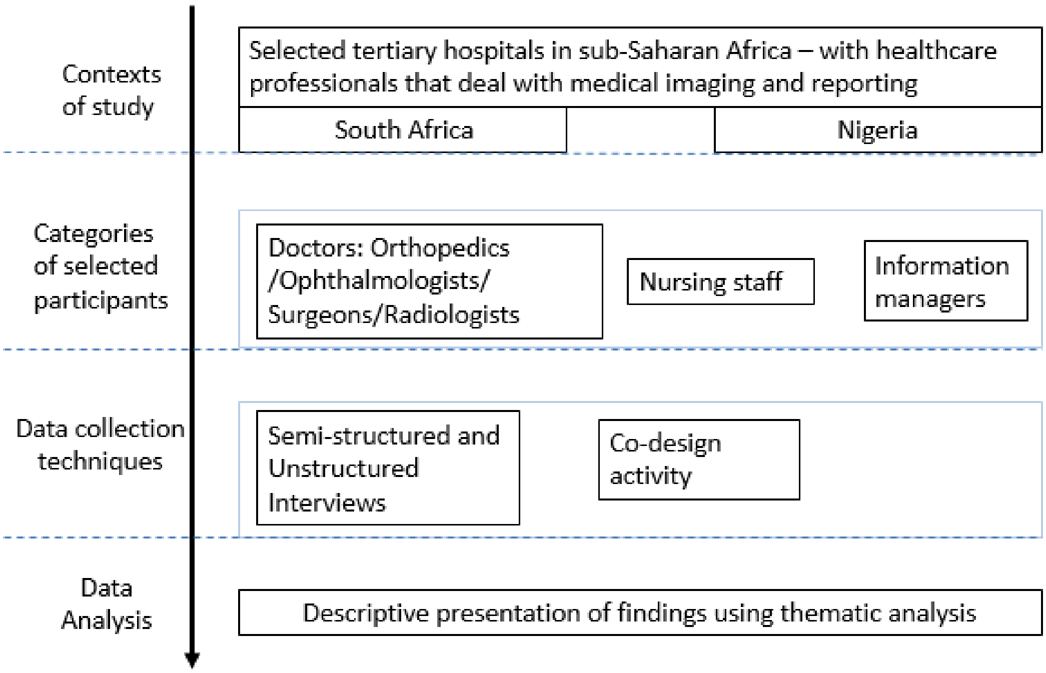


Figure 5.1: Illustration of sampling and analysis application

In Chapter Five, the researcher provides a description of research contexts in section 5.2, which include the selected tertiary hospitals in South Africa and Nigeria; while section 5.3 highlights the analysis process of the qualitative data. The evidence of how thematic analysis was applied in each context and the emerging themes are presented in section 5.4; followed by a descriptive presentation of the findings from the semi-structured interviews undertaken in the research contexts in sections 5.5 and 5.6. The chapter is concluded with a summary of findings in section 5.7.

5.2 Research contexts

The study was conducted in two tertiary healthcare institutions, one in the Western Cape Province of South Africa and the other in the South Western region of Nigeria. In compliance with the ethical clearance undertaking signed by the researcher, from here on the hospitals sites where data were collected are referred to as **H1** and **H2** for the purposes of anonymity. These hospitals are described in more detail in sections 5.2.1 and 5.2.2. The researcher purposively chose to investigate the workflow activities of healthcare professionals involved in medical imaging and reporting to inform their decision-making. The type of workflow selected involved the coordinated care of different types of healthcare professionals and the use of a form of digital or electronic system. The two contexts comprised contrasting situations: one of the tertiary hospitals had implemented and used health ICTs in its clinical setting, while the healthcare professionals in the other hospital largely used a paper-based system.

5.2.1 Hospital H1 – Tertiary healthcare in South Africa

Hospital **H1** was purposively selected as a representation of public hospitals in the Western Cape Province of South Africa because it boasts notable progress in the implementation of eHealth and mHealth information systems. **H1** is referred to as an academic hospital that provides training for higher institution doctors and promotes research. In addition, **H1** provides specialist care services that include day surgery; ear, nose and throat (ENT) care; mental health care; open heart surgery; radiation and oncology care; kidney transplants; postnatal stress disorder care; and neonatal intensive care, to mention a few of the services provided. Since 2016, the hospital is run by an estimated 4 441 administrative and clinical personnel, made up of management staff (26), administrative and support services staff (1,585), and healthcare professionals (2,830).

Hospital **H1** caters for at least 3.4 million people, while more than 599,885 persons visit the hospital per annum as either in- or outpatients. This implies that one healthcare professional renders care services to more than 212 persons annually. In terms of infrastructure, the hospital accommodates more than 1 350 inpatients. There are at least 65 wards, 100 intensive care units and up to 29 operation theatres. Hospital **H1** has adopted and implemented HITs for both clinical and administrative purposes. The HITs comprise hospital information systems such as the CLINICOM patient administration system, Radiology Information System (RIS), and a Picture and Archiving Communication System (PACS) to capture, store and retrieve various forms of medical images. Another system in the hospital is a Nursing Information Management System (NIMS) which is used to manage both nursing staff and to take stock of nursing needs.

5.2.2 Engagement of participants in research context – Hospital H1

The application for ethical clearance to collect data from hospital **H1** was submitted to the Western Cape Provincial Department of Health in March 2018. The researcher was contacted by the manager of hospital **H1** on completion of the deliberation by the provincial and the hospital's ethics committee, who indicated that all ethical concerns had been mentioned and would be addressed. Consequently, the researcher was granted ethical clearance for data collection in July 2018. Afterwards, emails were exchanged between the researcher and heads of clinical departments of hospital **H1,** in an attempt to explain the purpose for which the research was to be conducted and to get buy-in from the top management of the hospital. Ultimately, a total of 14 participants out of all the prospective individuals who were contacted, responded and participated in this study. Respondents included two information managers, two specialist doctors from the department of ophthalmology, six specialist doctors from the orthopaedics department, and four nurses who manage the trauma care wards, intensive care units (ICUs) and theatre wards.

Several attempts to reach other healthcare professionals through the official channel by making contact with the heads of department as prescribed by the hospital managers, eventually proved futile. There were no responses from some of the heads of clinical departments and some of the referrals suggested by participants. The main reason attributed to the nonresponse from healthcare professionals was the busy schedules of healthcare professionals, who are overwhelmed in the public healthcare sector. A study by Kabanda and Rother (2019) evaluated a mobile application for healthcare professionals, designed to make an informed diagnosis on acute pesticide poisoning in South Africa. The authors claim that mHealth applications can be useful when integrated to support an overburdened healthcare system where healthcare professionals have busy schedules and have to be at multiple locations. To address the engagement of healthcare professionals in a busy setting, the authors used a web-based survey tool (SurveyMonkey®) to administer questionnaires in order to consider the nature of healthcare professionals' work activities.

However, to gain an in-depth understanding of a phenomenon in research settings, there is a need to develop a feasible methodology to engage with participants in a context where time sensitivity is taken into account. Because of the time constraints experienced in engaging with participants in this study, the researcher resolved to use two data collection techniques in order to acquire as much in-depth information as possible from the participants. This information helped the researcher to develop a clearer understanding of the hospital contexts and to present how the lived experiences of healthcare professionals during the execution of their work activities at point-of-care affect their performance and quality of the service delivered.

As earlier indicated in the sampling table, participants in this study were selected using purposive and snowballing sampling techniques. Both techniques were applied to identify healthcare professionals who could provide a detailed account of their daily clinical work activities and the tools used to support specific actions within the process of care delivery. The healthcare professionals selected in hospital **H1** included eight doctors, four nurses and two administrative staff in their capacity as information managers. The left-hand column of Table 5.1 below presents the clinical and administrative departments from which participants were selected; the middle column of the table lists the position that the participants held in their respective departments; while the right-hand column lists the pseudonyms used to anonymise each participant for privacy purposes.

Table 5.1: Profile of participants in H1

Department	Position	Participant Code H = Hospital
Ophthalmology	Registrar	Opht1_H1
Ophthalmology	Registrar	Opht2_H1
Orthopaedics	Consultant	Ort1_H1
Orthopaedics	Registrar	Ort2_H1
Orthopaedics	Registrar	Ort3_H1
Orthopaedics	Registrar	Ort4_H1
Orthopaedics	Registrar	Ort5_H1
Orthopaedics	Registrar	Ort6_H1
Nursing	Deputy Nursing Manager	DNM_H1
Nursing	Trauma Unit Nursing Manager	TrNM_H1
Nursing	Theatre Nursing Manager	TNM_H1
Nursing	Intensive Care Unit Operational Nursing Manager	ICUNM_H1
Information Management	Manager of Information Management at hospital **H1**	MIM_H1
Provincial Department of Health	Director for Information Management	DIM

Before moving on to discuss the data analysis process, the second research context, that of the tertiary healthcare facility in Nigeria, is presented below.

5.2.3 Hospital H2 – Tertiary healthcare in Nigeria

A tertiary hospital in South West Nigeria was purposively selected for this study. This hospital is referred to as Hospital **H2** hereafter. This hospital was selected because of its notable achievements in healthcare service provision and its attempts to digitise care service delivery. While there are long-term plans to extend the ICT pilot projects to other tertiary hospitals with the optimistic desire to drive the implementation of a standardised health ICT across Nigeria, there are was no evident progress made in this regard beyond 2007.

The left-hand column of the table below presents the clinical and administrative departments in hospital **H2** from which participants were selected. The positions occupied by the participants within their respective departments are presented in the middle column of Table

5.2, while the right-hand column presents the pseudonyms used to anonymise each participant for privacy purposes.

Table 5.2: Profile of participants in H2

Department	Position	Participant Code H= Hospital R= Response
Radiology	Registrar	RR1_H2
Radiology	Registrar	RR2_H2
Surgery	Senior Registrar	SRNS_H2
Surgery	Consultant	SC_H2
Orthopaedics	Consultant	OrtC_H2
Nursing	Assistant Director of Nursing Services	ADNS_H2
Nursing	Orthopaedics Nursing Specialist	ONS_H2

An ethics clearance certificate was applied for and obtained from the Director of Clinical Services and Training of hospital **H2**. Between November 2018 and January 2019, the researcher visited the hospital to make contact with healthcare professionals and to conduct interviews with professionals from different clinical departments. During the interviews, the researcher observed that work activities were largely manual and paper-based since the doctors and nurses did their writing on paper; no desktop workstations were visible in the consultation rooms. It was later confirmed by the healthcare professionals that their work activities were paper-based. During the interviews, there were several interruptions caused by doctors having to change the venue of the interviews, because it was shared with their colleagues, or they were called away for work purposes.

The researcher observed that there were no designated offices for healthcare professionals and the doctors worked a busier schedule than experienced in the South African context. It could be inferred that the human and material resources are stretched in the public healthcare systems of both countries. During the co-design activity, some of the doctors suggested that the researcher visually capture their work activities while they preferred to describe the answers to questions. The researcher could infer from the suggestion that the co-design activity was an unfamiliar method of engagement to the participants in hospital **H2**. However, in hospital **H1**, healthcare professionals embraced the purpose of the co-design activity and showed a keen interest to visually represent the workflow of their daily activities. The next section presents the data analysis process undertaken by the researcher to make sense of the data and, subsequently, to identify the emergent themes and research findings respectively.

5.3 Data analysis process

Data collection was carried out using a series of interviews and co-design activities. In other words, the researcher collected two sets of data. The purpose for collecting two sets of data were to compare the similarities and differences between *what participants say* (in semi-structured interviews) and *what they actually do* (observed during co-design activity). This section presents the steps the researcher took during the thematic analysis of the interview data and the findings emanating from the emergent themes. Data from the interviews were considered as part of the **DISCOVER** phase of the service design DDM, the phase which aimed to gain insights into the *as is* situation.

The technique used for analysis was informed by the collected qualitative data. The collected data were then carefully analysed using the thematic analysis technique to identify the attributes that adequately implied the key words or phrases in each of the research objectives. This technique was guided by conceptualisation and operationalisation. The conceptualisation process involves identifying and defining key words or variables embedded within the phenomenon being investigated. To further simplify the analysis process, the attributes that determine or quantify each variable are identified from the data transcripts; this is known as operationalisation.

The semi-structured interviews and co-design activities occurred in comfortable locations selected by the participants. The recorded data collected from participants were transcribed from audio to verbatim text. Each interview lasted between 30-45 minutes and the follow-up co-design activities lasted for 60 minutes. The transcriptions enabled the researcher to inductively identify attributes of the identified variables in each of the research objectives. The words or phrases were assigned descriptive codes in a process known as coding. The coding process can either be selective coding, axial coding or open coding (Neuman, 2006). For the purpose of this study, open coding was applied to the transcribed qualitative data. It involved identifying keywords or concepts that could be inferred from the textual data, and which were hypothetically related to the phenomenon. In this study, coding was performed in several iterations to exhaustively sort the qualitative data according to the hermeneutics circle prescribed for interpretive studies by Klein and Myers (1999). The following set of figures shows the chain of evidence as sample snapshots of the initial stage of the coding processes, where the researcher extracted words and phrases from the data transcripts.

1st ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
The effect of implemented technologies on the outcomes of healthcare information service delivery *activities within service delivery that require information *technologies been used *influence of the technology on the activities	OO: Can you describe your work activities at the hospital? Step by step Ort1_H1_R: Our mornings start at half past 7, **we all get together and then do hand-over rounds** so we go through all the admissions of the previous day, trauma admissions as well as some elective admissions then we discuss the plans for each patient. We also as well **go through the lists of patients that would be operated** on that day – trauma patients. So that **the person that is on call has an idea of what he's plan to do and what he needs to do for those patients**. And after that, everybody would disperse for their **ward rounds** and **start their clinics**	Morning meetings to do hand-overs Go through the lists of patients that would operated Information for planning Ward rounds Start their clinics
	OO: Please describe your work activities on a typical day in the hospital? Ort3_H1_R: **Morning handover meeting** and round, **organize ward list for the day**. **Attend outpatients clinic**, **sort out any ward patient issues. Prepare theatre list for call or extra trauma lists. Other days I am in theatre 8-4pm or on a 24 hour theatre cutting call.**	Morning handover meetings Organize ward list Attend outpatient clinics Ward patient issues Prepare theatre list for planning In theatre Call
	OO: Can you describe your work activities at the hospital? Step by step Opht2_H1_R: A typical day consists of **ward rounds**, **consulting patients in the outpatient clinic and theatre**. In between we have **academic meetings and presentations.**	Ward rounds Consulting outpatients in clinic and theatre Academic presentations
	OO: Please describe your work activities on a typical day in the hospital? Ort4_H1_R: **Orthopaedic clinic/ out patients, Trauma theatre/ minor theatre, Academic meetings, Student teaching, Trauma referrals screening/ accepting**	Orthopaedic outpatients clinic Theatre Academic meetings Trauma referrals
	OO: Can you describe your work activities at the hospital? Step by step Opht1_H1_R: we start early in the morning so **we see outpatients** before **ward rounds**, **we do academics on Monday and Thursday mornings, on Friday afternoon we also do academics**. The rest of the day depends on where -- in which firm you are but you will either have a clinic or you will be **in theatre**. And **you get one day that you're doing on call**	Outpatient clinic Ward rounds Academic meetings Theatre Call
	OO: Asides referrals how do you use the VULA App? Opht1_H1_R: ...there are **a few colleagues outside, especially outside**	Colleagues outside of the hospital Ask advice

Figure 5.2: Sample 1 of descriptive codes (as presented in Appendix H)

1st ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
The effect of implemented technologies on the outcomes of healthcare information service delivery *activities within service delivery that require information *technologies been used *influence of the technology on the activities	OO: Asides referrals how do you use the VULA App? Opht1_H1_R: ...there are **a few colleagues outside, especially outside of the hospital that maybe just ask advice** via the VULA App. They can **send a picture** and then **basic questions get asked** and then **they ask what the management** or whether or not **they need to refer the patient**.	Colleagues outside of the hospital Ask advice Send picture Ask questions Refer patient
	The participant continued that... Opht1_H1_R: it has a **chat application**, yes. There's a photo, **send the picture -- the name of the patient through, you take photos of the patient's eyes**, you do -- **the visual acuity is also built into the app**. So, the doctor gives you the basic visual acuity of the patient. Then he also can **give a short history and what the problem is, the duration of the history** and then -- the clinical question, whatever the clinical question might be -- and **then I have to or the doctor that accepts** the VULA **need to speak to or I'll get the opportunity to ask the doctor questions relating to the patient** and which **helps you to decide whether or not you need to see the patient** or it can be treated outside the facility.	Chat application Take photos Send picture Name of patient Visual acuity short history Ask the doctor questions Communication Decide whether or not you need to see the patient
	Opht1_H1_R: so that the **patient doesn't have to come all the way say from very far**. I think the **thinking was to save the states or the government some money** to **not send the patient for -- unnecessarily or** -- and **also to maybe teach the doctor something**	Patient doesn't need to travel very far Save government money Teach the doctor
	OO: Asides the VULA app are there other ICTs that you support probably for information exchange or access to patient information? Opht1_H1_R: we've got a system, **the ECM system** -- which is quite a good system where **all the notes and everything about the patient**, the **documentation gets scanned in**... It **helps you to quickly access** the patient's folders and previous notes, previous history of the patient and it **speeds up** especially when you see **the patient on follow up** it speeds up because you know **and immediately access**.	ECM system Store patient information Scanned documents Quick access Speeds follow-up with patient Immediate access
	OO: Are there ICT tools used to support healthcare related activities in the hospital? If yes, can you please describe these technology tools? Opht2_H1_R: **ECM** is our **electronic patient database** where **all notes on patients are being stored**, **theatre lists** and **waiting lists are booked**	ECM system Electronic patient database Store all patient information Store theatre list

Figure 5.3: Sample 2 of descriptive codes (as presented in Appendix H)

1st ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
The effect of implemented technologies on the outcomes of healthcare information service delivery *activities within service delivery that require information *technologies been used *influence of the technology on the activities	OO: In what ways does the use of these ICT tools affect the process of services delivered to patients? Opht2_H1_R: *It has a very positive effect on service delivery.* ***With ECM*** *it is* ***easy to access patients' information*** *from* ***any computer*** *at* ***any time***. ***VULA app*** *makes it* ***very easy*** *for a* ***healthcare worker in the periphery*** *to* ***get in contact with the doctor on call***, *to* ***refer patients*** *and to* ***get valuable feedback on management of patients***. ***Trackcare system*** *allows us to* ***access all laboratory information*** *on a patient* ***even if it was done at another hospital/city***. ***ISITE*** *gives us* ***access to all radiology*** *that was done on a patient in our hospital.*	ECM Easy access to patient information Any computer Any time VULA app Very easy Healthcare worker in the periphery Contact with doctor on call Refer patients Get valuable feedback on management of patients TRACKCARE Access to patient lab examinations in public hospitals ISITE Access to all radiology
	Opht2_H1_R: *The* ***amount of patients accepted by us is much less*** *now as* ***many unnecessary referrals*** *can be prevented.*	Amount of patients accepted is much less Unnecessary referrals
	OO: Why was the VULA app introduced? Ort1_H1_R: *It was* ***hoped that we could try and lessen the trauma burden on our emergency department and for orthopaedics***. *Because* ***we saw that lot of times, people were referred here that didn't need to be referred*** *here; that* ***could be managed at a primary or secondary level hospital.*** *I think* ***we have achieved that, to try and limit unnecessary referrals****…. That* ***has helped a lot***	Lessen the burden of trauma in emergency and orthopaedics department We saw that lot of times; people were referred here that didn't need to be referred Achieved to limit unnecessary referrals Helped a lot
	OO: If I may ask, how has the PACS and VULA helped your work activities compared to when it was paper based or hard copy systems? Ort1_H1_R: *It* ***has helped, just to have it always available***. *I remember when I worked here before all of this…before PACS and the VULA, we had the* ***hardcopy X-rays***. *And they* ***would get lost or misplaced*** *somewhere or* ***you would want to discuss a case here and then the X-rays would be in the ward***. *So just* ***to have the PACS on any computer***, *you would have the Xrays available and then of course* ***you could do your planning*** *and everything as well. And you could* ***draw your lines*** *or* ***do your templating*** *on the PACS itself… You* ***can't lose the X-rays***	Helped to have it always available PACS VULA Hardcopy X-rays Lost or misplaced Unavailability of hardcopy X-rays anywhere and any time Have PACS on any computer X-rays available Do planning Draw your lines Do your templating

Figure 5.4: Sample 3 of descriptive codes (as presented in Appendix H)

2nd ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
Identify pain and gain points as experienced by healthcare professionals during their work processes *inquire about the positive experiences of healthcare professionals at points-of-care *inquire about the challenges associated to the use of technology as experienced by healthcare professionals at points-of-care	Opht1_H1_R: *I would say half of them aren't emergencies and those people want an answer now because they've got a patient sitting in front of them but* ***I've got 50 patients sitting outside and now I need to answer about something elective and they push you for it***	Need to answer requests/questions
	OO: kindly describe the specific point/time during your work activities you encounter these challenges Ort3_H1_R: *iSite PACS is* ***slow and does not work properly***	iSite PACS is slow
	OO: at what point is it or instance where you're trying to diagnose the patient's issue is or at what point during the care delivery do you use the VULA app? Opht1_H1_R: *During the day it actually* ***interferes*** *and* ***slows you down massively***. *Definitely because you* ***have a lot of patients that you need to see*** *that's in the encore room,* ***you need to answer the phone***, *the phone at ER,* ***you need to answer your bleeps*** *and then* ***you also get VULA referrals***	VULA referrals interferes slows down massively See lots of patients Need to answer bleeps and referrals
	Opht1_H1_R: *I think it's mixed feelings but* ***most people are quite negative about it*** *because it gets abused.* HOW? *You know, doctors will ask you elective questions at night. Because -- they've got access -- you are answering them 24 hours they think that is all that we do; sit with the app to answer their questions but it is not.* CONSEQUENCE: *I know it's actually been stopped at other instances because of this*	Negative sentiments
	Opht1_H1_R: *… you get a lot of, a lot of questions, you get a lot of --* ***you need to explain yourself a lot*** *and* ***it takes so much time to type explanations*** *and management and ask the questions.* CONSEQUENCE: *it's* ***more beneficial for the patient*** *yes, but* ***definitely not for the workload***	you need to explain yourself a lot it takes so much time to type more beneficial for the patient, definitely not for the workload
	OO: Will you say there's any challenge to use the ECM? Opht1_H1_R: *The only challenge that I have experienced is when the* ***ECM is down***, *when the system is down then it's a big problem because then* ***you basically can't go on with your work***. HOW? Opht1_H1_R: ***You can't book a patient for any surgery***. For example, *if you've got the cataract clinic bookings, if you haven't screened your patients yet you need to access that information then you will* ***run into trouble but then you have to see the patient again***. *It's the same -- then it's basically the same as* ***falling back onto the***	when the ECM is down can't go on with your work You can't book a patient for any surgery then you have to see the patient again falling back onto the paper system rare occurrences of ECM downtime downtime is sorted out quickly

Figure 5.5: Sample 4 of descriptive codes (as presented in Appendix H)

2nd ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
Identify pain and gain points as experienced by healthcare professionals during their work processes *inquire about the positive experiences of healthcare professionals at points-of-care *inquire about the challenges associated to the use of technology as experienced by healthcare professionals at points-of-care	OO: At which specific point/time during your work activities do you encounter these challenges? Opht2_H1_R: ***The ECM database** has a **waiting period of more or less 2 months before it is scanned in**, so if I see a patient within a month or two, the last notes will not yet be on the ECM. **It is possible to request the notes** then, but **it wastes time as it takes a few hours to be found/ scanned in**.*	waiting period to scan paper into ECM Place request notes to be scanned Time-consuming process to get clinical notes scanned impromptu
	CONSEQUENCE ***The biggest challenge with the VULA app is to be able to find time during patient consultations to also answer on referral doctors questions**, it **takes a lot of multitasking** and **when disrupted by calls and VULA referrals** it **takes much longer to complete a consultation with a patient**. It also **sometimes feels unprofessional to be busy on your phone answering VULA referrals, while a patient is sitting in front of you**.*	Find time during consultations Lots of multi-tasking Consultation disrupted by VULA referrals Increase in consultation time with patient Feels unprofessional to attend to VULA referrals during consultation
	OO: how would you prefer that the VULA app function? Opht1_H1_R: *Maybe just **for emergencies during the day** and not in your personal time or at -- in the middle of the night sort of story. So, maybe just putting a specific hour to do it, working hours but then also **you will only be on your phone the whole day then, then you won't see any patients***	On phone whole day without attending to patient
	OO: If I may ask what are the shortcomings of using a paper based right now -- paper based system right now? DNM_H1_R: ***Some documentation gets lost during movement of patients. It is time consuming** because whenever -- whatever procedure is completed the nurse got to come down and do the right thing afterwards. The paper, **it's illegible** at many a times due to the fact that peoples' handwriting differs so in a court of law you will have a clearer record of what is happening. ...we do have different handwritings and which makes it sometimes difficult especially if you have a complaint -- from family members or whatever and you need to analyse their handwriting so that will solve the problems.*	documentation gets lost Time-consuming Illegible handwritings
	Opht2_H1_R: ***I have an app on my phone where I take a photo of each patient's last notes when I've seen him. In this way I always have the latest notes of a patient on my phone** and **don't waste time waiting for notes to be found**.*	Take photo of patient's last notes Have latest notes of a patient on phone Don't waste time waiting

Figure 5.6: Sample 5 of generated descriptive codes (as presented in Appendix H)

3rd ISSUE of INVESTIGATION	RESPONSE QUOTES	CODES
Determine how mHealth technologies and human actors could be aligned at service interaction moments during service delivery process *identify the points within work activities that could be supported by mobile technology *suggestions on the ideal mobile technology	OO: how would you prefer that the VULA app function? Opht1_H1_R: *Maybe just **for emergencies during the day** and not in your personal time or at -- in the middle of the night sort of story. So, maybe just **putting a specific hour to do it**, working hours but then also you will only be on your phone the whole day then, then you won't see any patients.*	For emergency cases during the day putting a specific hour to do it
	OO: And when you say you would like technology to be introduced at all points which kind of technologies would you like to -- what will be the characteristics of an ideal technology for nurses? DNM_H1_R: *At the moment like I say we're using paper and a pen so at all **entry level points it would be nice** to have **a system where you can just with a click of a button enter patient details** and whatever is wrong with the patient.* *If a **patient gets transferred from the entry point**, say for instance to theatre, it would just be by the **click of a button** that you transfer that patient to the theatre. From theatre if the patient for instance goes to ICU just with a click of a button, you know, that follow through of a patient from entry until the patient exits the institution*	Entry point Enter patient information Patients get transferred from the entry point Click of a button
	OO: What functions do you think are critical to the work of nurses in the hospital? DNM_H1_R: *Functions that would be critical would be **a function to write a continuous report** on that, **a function to register patient details**, a function to -- like **a Dropbox that says to which departments the patient went to**, a Dropbox for instance for what investigations a patient went to, a kind of a Dropbox to say to which department the patient went to from a certain department* DNM_H1_R: *You see in the departments that report to me, time is of the essence. So, you need something that doesn't go long routes and for me **touchscreen is just a quicker way of doing some things***	write continuous report register patient details dropdown option (TRACK PATIENT MOVEMENT) you need something that doesn't go long routes touchscreen is just a quicker way of doing some things
	OO: how do you feel that ICT would play a major role in terms of removing these paper based processes in support of the work activities of	

Comment [m2]: EFFICIENT DATA CAPTURING
Ideally, an ICT tool that enables the collection of patient details and grants access to patient records at the first or initial point of contact with the patient is required. Such a system is desired in order to improve the current method of data collection. This response implied that there are likely deficiencies in the existing paper-based methods used to monitor or track patient movement within units in the hospital from the instant they are put on admission till they are discharged

Comment [m3]: Due to the nature of Nurses' jobs that require accompanying patients to specialist units. It might be necessary to have a mobile device that assists them to log patient details and track the movement of the patient through the different specialists' department.

Comment [m9]: WHY TOUCHSCREEN - TIME EFFICIENCY

Figure 5.7: Sample 6 of generated descriptive codes (as presented in Appendix H)

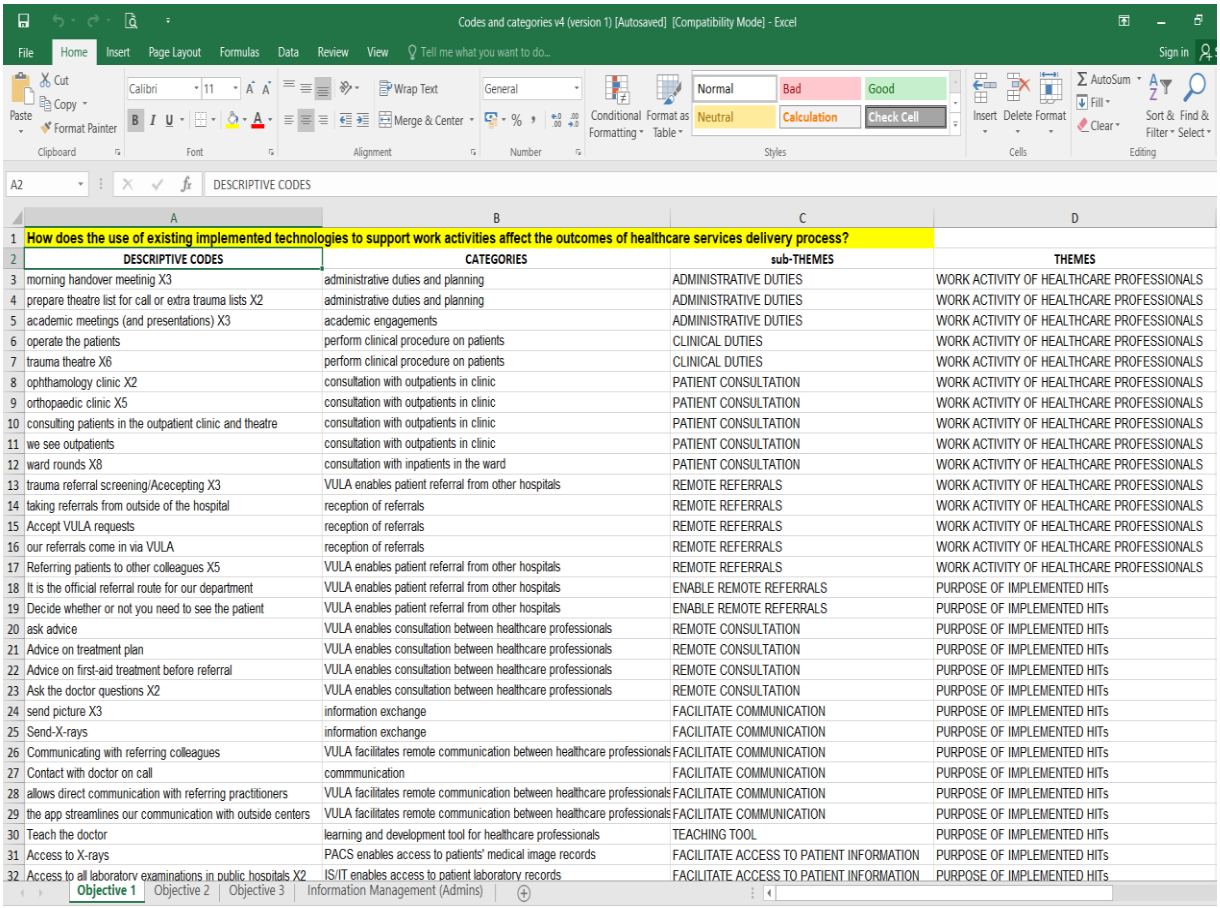
OO: When you procure these systems or when you develop the systems, to what level do you involve either patients or healthcare professionals or the services?	**We moving slowly but surely towards patient interaction** where we request from the patient, **what is it that you will require**? Do you want your discharge summary? Do you want more information on your…the services that you received from us?	Moving towards patient interaction Request for patient needs
	So we've got a process… **UXD – user experience design so we use that framework**	Use of UXD framework
OO: What about healthcare professionals' involvement?	you need to **locate yourself within the service where you say as a clinician, I'd like X for this outcome…to enable this outcome so that when we review it, we get story points. Those story points then become either a specification or potentially an application on its own**	Engage clinician Review the engagement Extract story points Story points become specification or application
	we don't determine which cadre needs to be engaged, **the service heads would inform us to speak to Dr A, B, C or to Mr A, B, C at the frontline** or you know so…they determine who, where and when we engage	Service heads inform the user engagements of business analysts
OO: I went on line and saw the e-Health strategy and the m-Health strategy, I don't know if strategies and policies are used interchangeably or there's policy that informs strategy, could you explain?	we've got **an IT vision**. Now the reason why we call it a vision; it is something we aspire to get to	There is an IT vision
	How I do it is the strategy. So every **strategy must have an implementation plan**. So the implementation plan would span the lifetime of the strategy. each **implementation plan would then have an operational plan**	Strategy accomplished the vision Strategy has an implementation plan Implementation plan is subdivided into operational plans
	our vision is aligned to the e-Health and m-Health strategy. **Our vision is aligned to our healthcare2030 thinking and to the healthcare 2030 thinking of the National**	e-Health and m-Health strategies are aligned to the National healthcare 2030 thinking
	So the why is your vision, why are we doing this…the how is the strategy and the what is the	

Figure 5.8: Sample 7 of generated descriptive codes (as presented in Appendix H)

5.4 Application of thematic analysis to data collected from Hospital H1

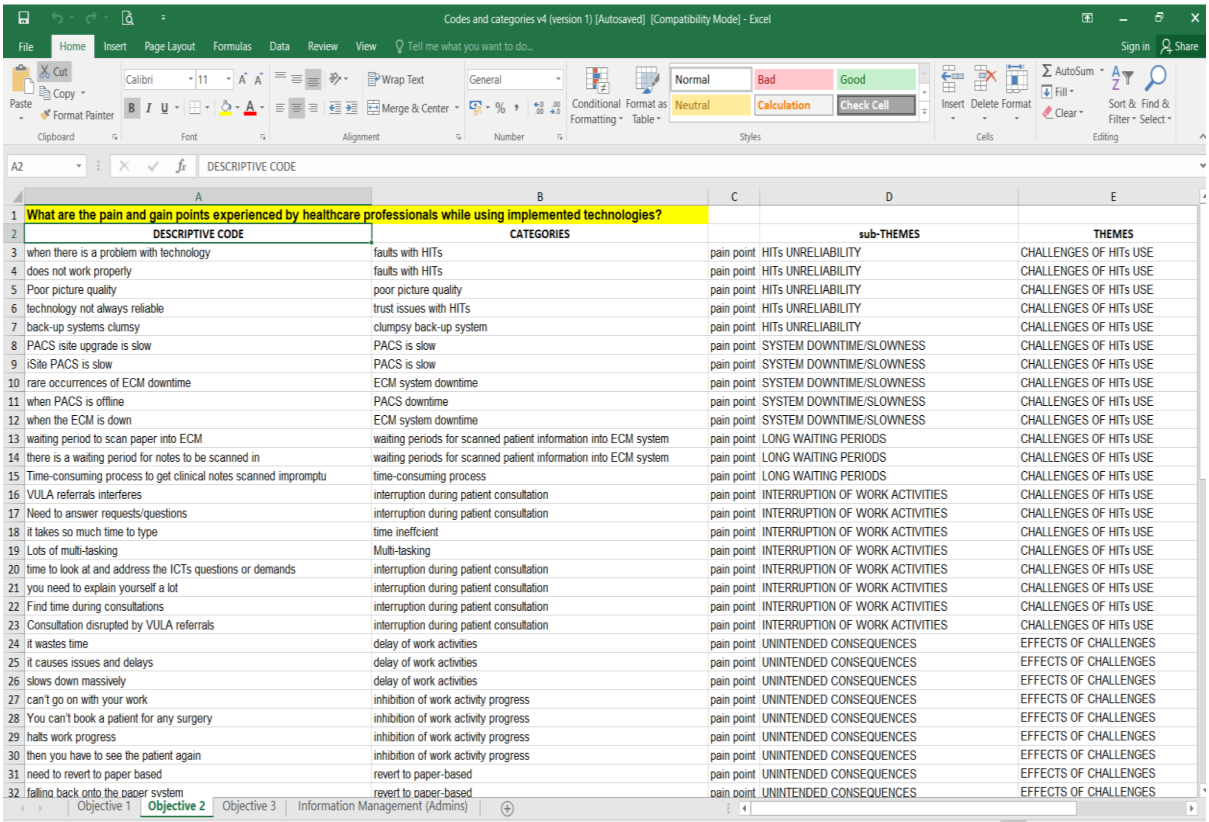
In this section, the researcher provides a chain of evidence describing the categories generated from the descriptive code words that represent attributes of the variables in each objective, derived from the conceptualisation and operationalisation processes. Subsequently, these categories were grouped into themes based on the relationships and patterns as observed by the researcher in an interpretive hermeneutic circle.

Figure 5.9 is a sample of the descriptive codes or attributes related to the variables that were used to determine how implemented HITs at the time affected the outcomes of healthcare professionals' work activities. The total number of codes is 84. Subsequently, the researcher grouped the codes into 34 categories. These categories were then grouped into 19 sub-themes. A total of three main themes emerged. The themes described i) the work activities of healthcare professionals, ii) the purpose of implemented health ICTs or HITs, and iii) the ensuing outcomes of work activities. These themes are discussed in section 5.5.1.



	A	B	C	D
1	How does the use of existing implemented technologies to support work activities affect the outcomes of healthcare services delivery process?			
2	DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
3	morning handover meetinig X3	administrative duties and planning	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
4	prepare theatre list for call or extra trauma lists X2	administrative duties and planning	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
5	academic meetings (and presentations) X3	academic engagements	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
6	operate the patients	perform clinical procedure on patients	CLINICAL DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
7	trauma theatre X6	perform clinical procedure on patients	CLINICAL DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
8	ophthamology clinic X2	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
9	orthopaedic clinic X5	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
10	consulting patients in the outpatient clinic and theatre	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
11	we see outpatients	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
12	ward rounds X8	consultation with inpatients in the ward	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
13	trauma referral screening/Acecepting X3	VULA enables patient referral from other hospitals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
14	taking referrals from outside of the hospital	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
15	Accept VULA requests	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
16	our referrals come in via VULA	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
17	Referring patients to other colleagues X5	VULA enables patient referral from other hospitals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
18	It is the official referral route for our department	VULA enables patient referral from other hospitals	ENABLE REMOTE REFERRALS	PURPOSE OF IMPLEMENTED HITs
19	Decide whether or not you need to see the patient	VULA enables patient referral from other hospitals	ENABLE REMOTE REFERRALS	PURPOSE OF IMPLEMENTED HITs
20	ask advice	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
21	Advice on treatment plan	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
22	Advice on first-aid treatment before referral	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
23	Ask the doctor questions X2	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
24	send picture X3	information exchange	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
25	Send-X-rays	information exchange	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
26	Communicating with referring colleagues	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
27	Contact with doctor on call	commmunication	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
28	allows direct communication with referring practitioners	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
29	the app streamlines our communication with outside centers	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
30	Teach the doctor	learning and development tool for healthcare professionals	TEACHING TOOL	PURPOSE OF IMPLEMENTED HITs
31	Access to X-rays	PACS enables access to patients' medical image records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs
32	Access to all laboratory examinations in public hospitals X2	IS/IT enables access to patient laboratory records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs

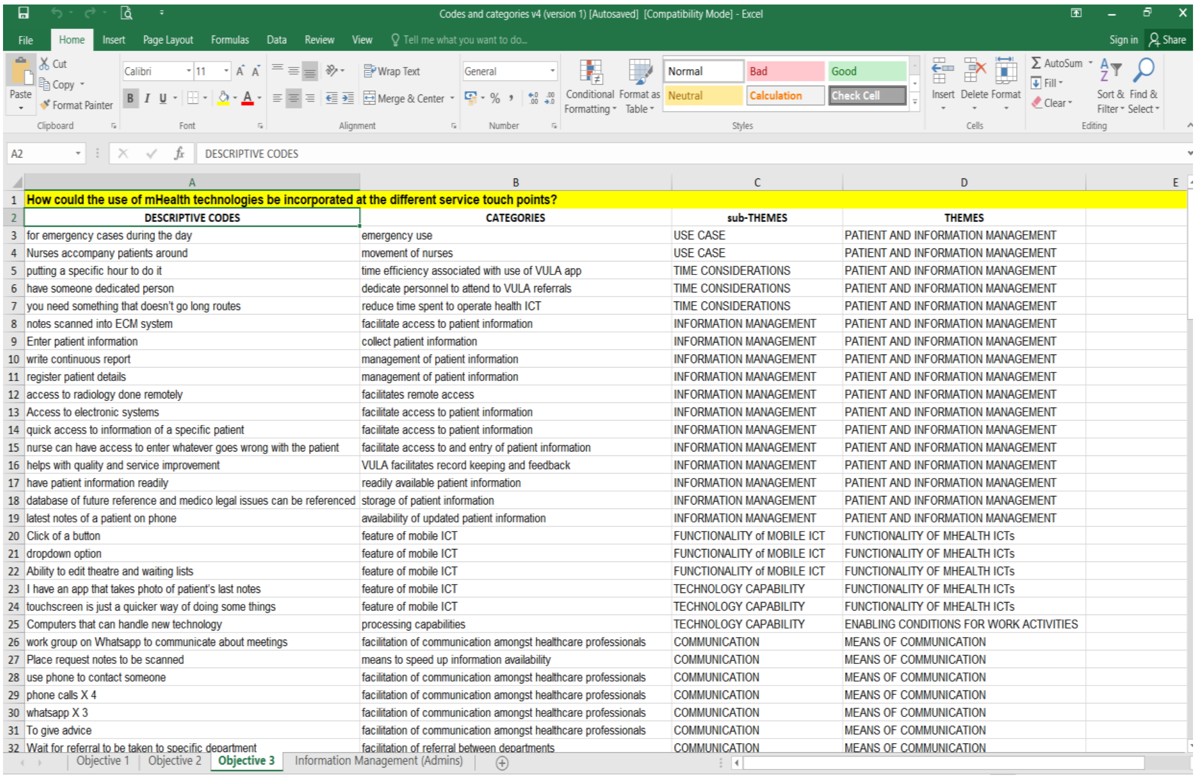
Figure 5.9: Thematic analysis of objective 1 (Appendix H)



	A	B	C	D	E
1	What are the pain and gain points experienced by healthcare professionals while using implemented technologies?				
2	DESCRIPTIVE CODE	CATEGORIES		sub-THEMES	THEMES
3	when there is a problem with technology	faults with HITs	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
4	does not work properly	faults with HITs	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
5	Poor picture quality	poor picture quality	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
6	technology not always reliable	trust issues with HITs	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
7	back-up systems clumsy	clumpsy back-up system	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
8	PACS isite upgrade is slow	PACS is slow	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
9	iSite PACS is slow	PACS is slow	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
10	rare occurrences of ECM downtime	ECM system downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
11	when PACS is offline	PACS downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
12	when the ECM is down	ECM system downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
13	waiting period to scan paper into ECM	waiting periods for scanned patient information into ECM system	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
14	there is a waiting period for notes to be scanned in	waiting periods for scanned patient information into ECM system	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
15	Time-consuming process to get clinical notes scanned impromptu	time-consuming process	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
16	VULA referrals interferes	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
17	Need to answer requests/questions	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
18	it takes so much time to type	time ineffcient	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
19	Lots of multi-tasking	Multi-tasking	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
20	time to look at and address the ICTs questions or demands	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
21	you need to explain yourself a lot	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
22	Find time during consultations	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
23	Consultation disrupted by VULA referrals	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
24	it wastes time	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
25	it causes issues and delays	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
26	slows down massively	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
27	can't go on with your work	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
28	You can't book a patient for any surgery	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
29	halts work progress	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
30	then you have to see the patient again	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
31	need to revert to paper based	revert to paper-based	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
32	falling back onto the paper system	revert to paper-based	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES

Figure 5.10: Thematic analysis of objective 2 (Appendix H)

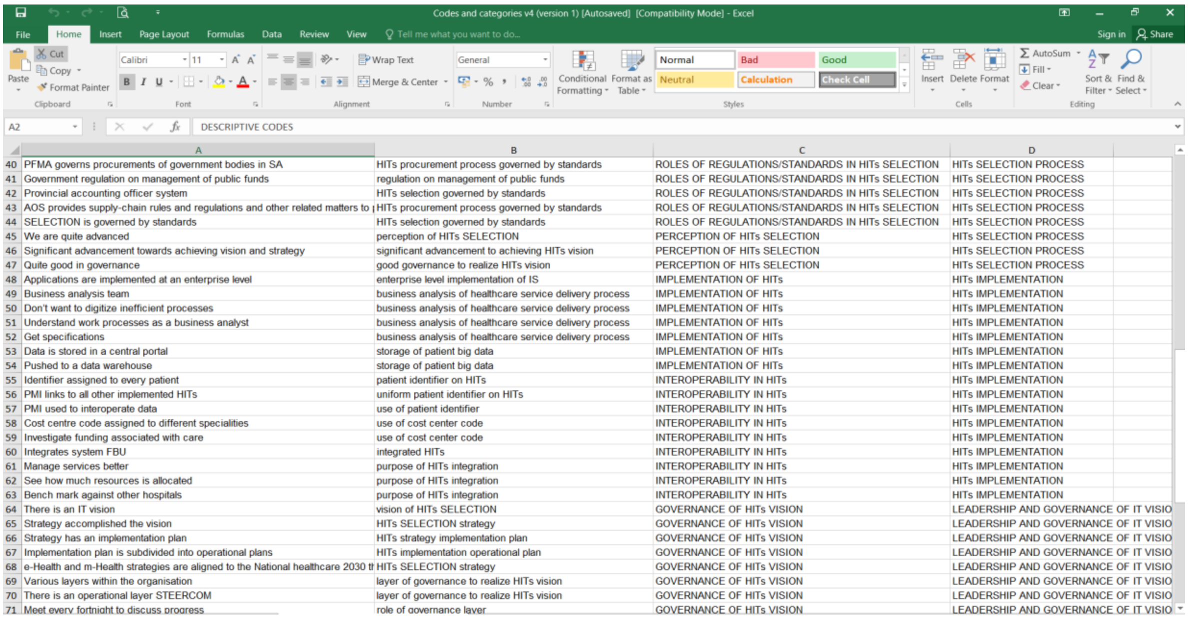
Figure 5.10 is a sample of the descriptive codes or attributes related to the variables used to identify the pain and gain points experienced by healthcare professionals during their work activities. The total number of codes is 65. Subsequently, the researcher grouped the codes into 34 categories. The categories were grouped into 14 sub-themes, and four main themes emerged from these sub-themes. These themes are: i) enhanced work activities; ii) challenges of work activities, identified in section 5.5.1; iii) challenges of HITs use during work activities; and iv) the effects of these challenges on the performance of healthcare professionals and HITs-use. These themes are discussed in section 5.5.2.



	A	B	C	D
1	How could the use of mHealth technologies be incorporated at the different service touch points?			
2	DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
3	for emergency cases during the day	emergency use	USE CASE	PATIENT AND INFORMATION MANAGEMENT
4	Nurses accompany patients around	movement of nurses	USE CASE	PATIENT AND INFORMATION MANAGEMENT
5	putting a specific hour to do it	time efficiency associated with use of VULA app	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
6	have someone dedicated person	dedicate personnel to attend to VULA referrals	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
7	you need something that doesn't go long routes	reduce time spent to operate health ICT	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
8	notes scanned into ECM system	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
9	Enter patient information	collect patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
10	write continuous report	management of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
11	register patient details	management of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
12	access to radiology done remotely	facilitates remote access	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
13	Access to electronic systems	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
14	quick access to information of a specific patient	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
15	nurse can have access to enter whatever goes wrong with the patient	facilitate access to and entry of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
16	helps with quality and service improvement	VULA facilitates record keeping and feedback	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
17	have patient information readily	readily available patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
18	database of future reference and medico legal issues can be referenced	storage of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
19	latest notes of a patient on phone	availability of updated patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
20	Click of a button	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
21	dropdown option	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
22	Ability to edit theatre and waiting lists	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
23	I have an app that takes photo of patient's last notes	feature of mobile ICT	TECHNOLOGY CAPABILITY	FUNCTIONALITY OF MHEALTH ICTs
24	touchscreen is just a quicker way of doing some things	feature of mobile ICT	TECHNOLOGY CAPABILITY	FUNCTIONALITY OF MHEALTH ICTs
25	Computers that can handle new technology	processing capabilities	TECHNOLOGY CAPABILITY	ENABLING CONDITIONS FOR WORK ACTIVITIES
26	work group on Whatsapp to communicate about meetings	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
27	Place request notes to be scanned	means to speed up information availability	COMMUNICATION	MEANS OF COMMUNICATION
28	use phone to contact someone	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
29	phone calls X 4	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
30	whatsapp X 3	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
31	To give advice	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
32	Wait for referral to be taken to specific department	facilitation of referral between departments	COMMUNICATION	MEANS OF COMMUNICATION

Figure 5.11: Thematic analysis of objective 3 (Appendix H)

Figure 5.11 is a sample of the number of descriptive codes or attributes related to the variables that were used to determine how mHealth technologies and human actors could be aligned at service touch points. The total number of codes is 42. The researcher then grouped the codes into 24 categories. The categories were grouped into eight sub-themes and a total of four main themes emerged. The themes indicated the points where mHealth technologies could be useful, and their purpose within the work activities of healthcare professionals. The themes included i) patient and information administration, ii) functionality of mHealth ICTs, iii) means of communication, and iv) enabling conditions for mHealth supported work activities. These themes are further discussed in section 5.5.3.



	A	B	C	D
40	PFMA governs procurements of government bodies in SA	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
41	Government regulation on management of public funds	regulation on management of public funds	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
42	Provincial accounting officer system	HITs selection governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
43	AOS provides supply-chain rules and regulations and other related matters to	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
44	SELECTION is governed by standards	HITs selection governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
45	We are quite advanced	perception of HITs SELECTION	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
46	Significant advancement towards achieving vision and strategy	significant advancement to achieving HITs vision	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
47	Quite good in governance	good governance to realize HITs vision	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
48	Applications are implemented at an enterprise level	enterprise level implementation of IS	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
49	Business analysis team	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
50	Don't want to digitize inefficient processes	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
51	Understand work processes as a business analyst	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
52	Get specifications	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
53	Data is stored in a central portal	storage of patient big data	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
54	Pushed to a data warehouse	storage of patient big data	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
55	Identifier assigned to every patient	patient identifier on HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
56	PMI links to all other implemented HITs	uniform patient identifier on HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
57	PMI used to interoperate data	use of patient identifier	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
58	Cost centre code assigned to different specialities	use of cost center code	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
59	Investigate funding associated with care	use of cost center code	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
60	Integrates system FBU	integrated HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
61	Manage services better	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
62	See how much resources is allocated	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
63	Bench mark against other hospitals	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
64	There is an IT vision	vision of HITs SELECTION	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
65	Strategy accomplished the vision	HITs SELECTION strategy	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
66	Strategy has an implementation plan	HITs strategy implementation plan	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
67	Implementation plan is subdivided into operational plans	HITs implementation operational plan	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
68	e-Health and m-Health strategies are aligned to the National healthcare 2030 tl	HITs SELECTION strategy	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
69	Various layers within the organisation	layer of governance to realize HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
70	There is an operational layer STEERCOM	layer of governance to realize HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO
71	Meet every fortnight to discuss progress	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISIO

Figure 5.12: Thematic analysis of Provincial Information Manager (Appendix H)

Figure 5.12 is a sample of the number of descriptive codes or attributes related to the variables that were used to understand how the governmental body of health manages stakeholder engagement when selecting HITs. The total number of codes is 90. Subsequently, the researcher grouped the codes into 30 categories. The categories were grouped into eight sub-themes. A total of three main themes emerged which included i) the selection of HITs for the work activities of healthcare professionals, ii) implementation of HITs for the work activities of healthcare professionals, and iii) leadership and governance of the provincial IT vision. These themes are further discussed in section 5.5.4.

After the coding process, the researcher articulated the key findings within the emergent themes of each research objective and the responses of the participants as empirical evidence, followed by descriptions to address each issue of investigation. The data analysis process is concluded with a discussion of the findings through the application of the ActAD model as a theoretical lens, in Chapter Seven.

5.5 Descriptive presentation of findings in hospital H1

The first quarter of the Service Design Double Diamond model, the **DISCOVER** phase, was applied to understand the contexts in which the research problem exists. Hence, the aim of the research was to explore the work activities of healthcare professionals. The intention was to establish how implemented HITs were used and the need for mHealth technologies at points-of-care during the healthcare service delivery process.

The researcher conducted semi-structured interviews by asking contextual questions in order to gain useful insights into the current work activities of healthcare professionals and personnel responsible for the choice of technologies used in tertiary healthcare. From an interpretivist stance, the knowledge sought by the researcher on the likelihood of mHealth technologies being integrated into the work activities of healthcare professionals, is socially constructed. In other words, tasks are performed by healthcare professionals during work activities and it can be argued that their subjectivity influences how some actions are performed (Klein & Myers, 1999; Walsham, 2006). In addition, the researcher took into account his own subjectivity to interpret the responses from participants about their work activities, the type of tools used to support the work activities, and the effects of implemented HITs at points-of-care during service delivery. The findings of the semi-structured interviews with healthcare professionals in the research contexts are presented according to the variables and attributes of each objective related to the research questions in Table 1.1.

5.5.1 Effect of implemented technologies on the outcomes of healthcare information services

To understand how the use of technology has influenced the intended outcomes of work activities accomplished by healthcare professionals in hospital **H1**, the researcher sought to establish the actions performed at point-of-care during service delivery. Healthcare information services comprise both administrative and clinical work activities. In this study, the work activities consisted of a structured set of sequentially related and consistent actions performed by healthcare professionals in administering care to patients. The actions were tailored towards diagnosis and treatment to improve the state of patients' well-being. The transcripts data were subjected to an application of the hermeneutic circle and the emergent themes of this section included the work activities of healthcare professionals, the purpose of implemented HITs, the benefits of implemented HITs, and the limitations of the HITs. The following sections provide a description of the emergent themes and consequent findings.

5.5.1.1 Work activities of healthcare professionals

The researcher asked participants to describe their daily work activities in hospital **H1**. The evident findings show that the types of work activities executed by healthcare professionals can be categorised into administrative and clinical care duties. These duties can be divided into patient consultation, attending to remote referrals, and determining treatment plans at points-of-care. It can be inferred from the findings that the work activities accomplished by healthcare professionals are structured and consistent. The administrative duties include a handover meeting and discussion of patients' treatment plan, preparation of theatre and trauma lists and academic presentations. These activities are dependent on the days of the week. For instance, one of the participants interviewed at hospital **H1** mentioned the following:

> "We start early in the morning…we see our patients before ward rounds, we do academics on Monday and Thursday mornings, on Friday afternoon we also do academics. The rest of the day depends…you will either be in the clinic or you will be in theatre. And you get one day that you're doing on call, that we see emergency patients or patients that's been referred" (Opht1_H1).

Another participant replied that, "a typical day consists of ward rounds, consulting patients in the outpatient clinic and theatre. In between we have academic meetings and presentations" (Opht2_H1). The administrative duties appear to be a constant set of work activities even during the execution of clinical duties at the theatre when performing clinical procedures on patients. At the outpatient clinics, healthcare professionals are involved with patient consultation and attending to remote referrals from outside of the hospital.

> "A typical day for us at the moment will be one of two things, either a theatre day where we would go to theatre, after our morning discussion, operate the patients and after the case is in theatre we do a ward round. Like today for example, we will have our morning meetings where after we go to the clinic where we see our patients after which we would also do a ward round of the patients we have in-hospital and obviously we have the days that we are on call for the hospital as well" (Ort2_H1).

Other work activities include doing ward rounds to attend to inpatients after performing the clinical procedures. From these responses, it is evident that the work-related activities of healthcare professionals are highly regimented in the sense that the actions carried out daily or weekly are routinised. Healthcare professionals do a handover of previous patient management plans, examine outpatients at clinics, perform clinical procedures, do check-ups on inpatients in the wards and attend to emergency cases on specific days of the week. The work activities described above do require administrative tasks, particularly documentation of patient information, which could be either newly generated or modified.

A participant from the nursing department mentioned that "when it comes to physically taking a patient from point A to point B the nurse is still required to do that" (DNM_H1). It is inferred from the responses that the nature of healthcare professionals' work activities would require them to move between different locations, from the wards to the clinics to the theatres, within the hospital. Consequently, it is sufficient to argue that the sensitive nature of clinical work-related activities requires healthcare professionals to be available and accessible while, at the same time, have access to the necessary resources that would empower them to carry out their work activities. For example, it is necessary for healthcare professionals to have instant access to patients' records in cases of emergency, scheduled follow-ups or unscheduled visits, as well as a means of communication. These work activities require enabling tools to perform tasks effectively at points-of-care during the service delivery process. Hence, HITs were implemented to serve specific purposes related to the work activities of healthcare professionals.

5.5.1.2 Purpose of implemented HITs

The work activities described previously are performed locally within hospital **H1**; however, the healthcare professionals are also involved in remote consultations and communications with their colleagues from other healthcare institutions. The researcher sought to establish efforts in the form of digital transformation, such as the implementation of health information communication and technologies (ICTs) in hospital **H1.** Some of the implemented HITs are introduced to automate the tasks of work activities described by healthcare professionals. The health ICTs described by healthcare professionals include iSite Picture Archiving and Communication System (PACS), Enterprise Content Management (ECM) system, TrakCare, Nursing Information Management System (NIMS) and VULA (DNM_H1, Ort1_H1, Ort2_H1, Ort3_H1, Opht1_H1, Opht2_H1 and MIM_H1). Subsequently, the participants focused more on PACS, ECM and VULA, with lesser attention to CLINICOM and TrakCare. It could be inferred that the focus on PACS, ECM and VULA was because these were the most frequently used health ICTs by healthcare professionals to execute technology-enabled work activities at points-of-care on mobile devices.

When asked if there were health ICTs used to support their work activities, participants indicated that they “use the VULA app” (Opht1_H1). The VULA application was described as “an application that was designed by one of the registrars who worked here in ophthalmology”. The participant continued that “there are a few colleagues…especially outside of the hospital that…ask advice via [the] VULA app” (Opht1_H1). VULA enables healthcare professionals from other healthcare institutions to send “a picture and then basic questions get asked…they ask what the management [sic] or whether or not they need to refer the patient” (Opht1_H1). The responses included that the interaction moments appropriated by healthcare professionals while using VULA are the taking of medical images, sending the pictures, performing visual acuity, chatting to a referring doctor, and checking for the patient and doctor information. One participant (Opht1_H1) further explained that the consulting or referring doctor can give “the basic visual acuity of the patient …a short history and what the problem is, the duration of the history and then… the clinical question”. Consequently, the participant indicated that they “or the doctor that accepts the VULA need to speak to or…ask the doctor questions relating to the patient and which helps you to decide whether or not” diagnosis is done remotely or if patient needs to be referred to hospital **H1**. When asked how VULA operates, participant Ort2_H1 responded that:

> "…it's a smartphone based app where doctors and healthcare professionals, that includes more than just doctors, can use this app to have direct communication with the on-call doctor or orthopaedics person, to ask for advice and or refer patients to us and that's by a means of a list of questions that we ask or that's asked on the app as well as photos of x-rays that can be sent through to us".

This response shows that healthcare professionals are ideal to champion innovation of ICT tools based on their needs to accomplish their work activities in a satisfactory manner. For instance, VULA is a software application designed by a healthcare professional that identified the need to enable remote consultation and communication between healthcare professionals from different institutions. Thus, VULA is described as a referral management tool. Additionally, VULA is designed such that healthcare professionals can ask clinical questions relating to their patients through the chat feature, include details of patient history and take/send pictures, if necessary. Therefore, VULA can be described as a tool to facilitate communication between healthcare professionals.

Participant Opht1_H1 mentioned that the "ECM system…is where all the notes and everything about the patient, the documentation gets scanned in". Opth2_H1 described the ECM as the hospital's "electronic patient database where all notes on patients are being stored". Other information stored and accessible on the ECM system includes "theatre lists and waiting lists". Participant Opht1_H1 mentioned that:

> "In our clinics, for all patients that are seen notes are also made by hand and those notes as well as all referrals goes into a patient's folder. All those notes are sent to the scanning department. And all notes get scanned into our ECM. All those notes eventually do become available on a computer as well; they are physically scanned into the computer".

According to MIM_H1, the "ECM is the enterprise content management that deals with electronic filing of documents". Then, there is TrakCare, which is the "NHLS system where…access to all laboratory examinations that was done on a patient in any public hospital" is stored and "iSite is the database of radiology" (Opht2_H1). Other participants mentioned additional systems or tools, such as PACS, which is the x-ray digital picture archiving system.

> "In our clinics, for all patients that are seen, notes are also made by hand and those notes as well as all referrals go into a patient's folder. All those notes are sent to the scanning department. And all notes get scanned into our ECM. All those notes eventually do become available on a computer as well; they are physically scanned into the computer" (Ort1_H1).

The interaction moments attributed to the use of the PACS and ECM systems on the desktop computer by healthcare professionals include writing notes (including referrals), information retrieval, planning, templating, booking requests and retrieval of results (x-ray, scan and blood tests). The user journey illustrations from the co-design activities were further used to verify the interaction moments of tasks during work activities of healthcare professionals at points-of-care, dealt with in Chapter Six.

One of the participants from the nursing department confirmed that, “there are ICT tools being used in the hospital environment” (DNM_H1). The NIMS is used by nurses to “register patients as they are being admitted… to transfer patients…to take patients off the system if they are discharged or die in the hospital, we use it to order food, we use it to order stock in the hospital environment” (DNM_H1). The findings suggest that nurses make use of implemented ICTs for patient administration during their work activities.

Other tools described by healthcare professionals that assist their work activities include computers and bleepers. The computers enable access to the HITs mentioned earlier in the section. The key motives for the implemented HITs in hospital **H1** are to enable remote consultations during referrals, to facilitate communication between healthcare professionals, to enable decision-making, and to aid with access, storage, retrieval and exchange of information. The participants in hospital **H1** mostly recounted the benefits associated with the use of implemented HITs with respect to documentation and availability of electronic patient records and improved referral process.

5.5.1.3 Outcome of HITs use for work activities

The outcomes of the use of HITs by healthcare professionals are mostly associated with the benefits accruing from the perceived value-added to the execution of their work activities at points-of-care. The motivation associated with digital transformation *vis-à-vis* implementation of HIT tools is to improve the effectiveness and efficiency of work processes. Hence, evidence of a transformed work process is usually evident in the benefits and satisfaction that the user derives during and after the use of implemented HITs. Hence, the findings show that the implemented health ICTs have improved the referral process, timeliness of tasks during patient consultation, availability of patient records, and the development of a treatment plan.

For instance, healthcare professionals stated that activities are executed faster because of quick access to patients’ information stored electronically. When asked how the ECM system assists work-related activities, a participant responded that “the system helps to quickly access the patient’s folders and previous notes; previous history of the patient and it speeds up especially when you see the patient on follow up” (Opht1_H1).

Similarly, Opht2_H1 mentioned that ECM makes it “easy to access patients’ information from any computer at any time”. Also, the TrakCare system enables healthcare professionals to “access all laboratory information on a patient even if it was done at another hospital/city” (Opht2_H1). The iSite PACS provides “access to all radiology that was done on a patient in our hospital” (Opht2_H1). Clearly, from this response, it can be observed that there is a sense of satisfaction attributed to the use of implemented HITs to access patient records which are stored electronically.

With regards to the PACS and VULA applications, another participant mentioned that “it has helped, just to have it always available…So just to have the PACS on any computer, you would have the x-rays available and then, do your planning as well; and you could draw your lines or do your templating on the PACS itself” (Ort1_H1).

The responses imply that the use of ICT tools has transformed work activities of the healthcare professionals’ in tertiary healthcare settings based on the ease of performing activity tasks. For example, clinical notes that are handwritten on paper can be documented electronically on the ECM system in hospital **H1**. This means that patients’ records are readily accessible and retrievable digitally, regardless of a healthcare professional’s location within hospital **H1**. At the same time, the digitisation of the paper record into the electronic system reduces the susceptibility of paper records to loss or damage from incessant handling, and the instantaneous availability of records is not restricted.

The findings show that the management of patient referrals has improved in the sense that the process is simplified and the number of unnecessary referrals has been reduced. According to Ort1_H1, the VULA app was introduced to:

> “…lessen trauma burden on our emergency department and for Orthopaedics. Because we saw that lot of times, people were referred here that didn’t need to be referred here; that could be managed at a primary or secondary level hospital. I think we have achieved that, to try and limit unnecessary referrals…. That has helped a lot”.

In reference to the VULA application, a participant mentioned that “I think it has simplified the referrals process”, providing additional explanations as follows:

> “When I started working here, you had a bleeper that you carry it on you and you get a bleep from a switchboard and then you’d have to phone switchboard and get put through the person that is referring to you. Then they have to try and explain x-ray on the phone of what they see, whereas with the VULA they can write a referral, they can send us a clinical photo as well so if it is wound or an open fracture and they can send us x-rays as well, you can immediately see what you dealing with and

> then you can say if it can be managed at your hospital or say this is what you need to do before sending the patient here" (Ort1_H1).

Clearly, mHealth ICT interventions such as the VULA application have reduced the time and cost implications related to mobility for patients and healthcare professionals. The use of VULA by healthcare professionals for remote consultations saves the patient on costs of transportation related to long distance travel and on hospital bills, if referred to the tertiary hospital **H1**. Furthermore, healthcare professionals are able to communicate directly with each other to view necessary medical images remotely, and to save time on patient diagnosis and treatment decision-making. The availability of digitised medical images enables easier communication and consultation.

> "VULA makes it easier to make clinical decisions without seeing patients personally. It's often difficult to determine if a patient can be seen as an outpatient or do they need urgent referral, and using the VULA app with clinical pictures helps with this decision making" (Ort4_H1).

In addition, findings show that implemented HITs improved how healthcare professionals communicate with each other, both locally within hospital **H1**, and remotely with other colleagues. A participant mentioned that the VULA application "makes it very easy" for healthcare professionals from other healthcare institutions "to get in contact with the doctor on call, to refer patients and to get valuable feedback on management of patients" (Opht2_H1). Another participant confirmed that VULA "allows direct communication with referring practitioners" (Ort5_H1). The use of VULA and PACS facilitates remote communication between the clinics and the radiology department within hospital **H1** before patients physically get to the point of scan. Consequently, once the scan is complete, it is made available electronically to the referring doctor, who then continues with the decision-making process on the HIT system. "If all referral hospitals use the app, record keeping, response times, feedback given etc. help with quality and service improvement" (Ort4_H1).

It is evident in the accounts given by healthcare professionals who implemented HITs that it has been beneficial to their work activities in terms of quicker access to information; information is always available and the referral process is simplified through remote communication and the decision-making process is improved. These benefits are evident as an improvement on the limitations of a paper-based system, as experienced by healthcare professionals. The next section presents the pain and gain points experienced by healthcare professionals at the points-of-care during the process of healthcare service delivery.

5.5.2 Identifying pain and gain points experienced by healthcare professionals during their work processes

In the previous section, the researcher described how the use of implemented technologies by healthcare professionals influenced the outcomes of their work activities in relation to the collective objective of service delivery. This section describes the perceived experiences of healthcare professionals at different touch points during their work activities and the use of technologies to perform tasks. The researcher sought to establish the specific points where use of HITs is perceived as either useful or an impediment to work activities of healthcare professionals in hospital **H1**. To identify these points, the researcher made enquiries about the individual perceptions and experiences of participants on how the mentioned HITs are being used to support their work activities. The application of the hermeneutic circle generated the following emergent themes: i) enhanced work activities; ii) work activities challenges; iii) challenges to HITs use during work activities; and iv) effects of the aforesaid challenges on work activities.

5.5.2.1 Enhanced work activities

The findings indicate that the gain points experienced by healthcare professionals during the use of implemented health ICTs enhanced their work activities at points-of-care. These gain points are evident during patient consultations and remote referrals. The participants believe that the use of health ICT has improved communication and accountability during consultations. One of the participants explained the impact of the use of the VULA application during the process of referral from other healthcare professionals and during consultation with patients at points-of-care. The participant explained that VULA application has helped with the acquisition of information during referrals:

> “What it has always helped us significantly with, is accountability. Whereas patients would come here before with a paper referral and you won’t be able to read the name of the doctor that referred the patient to you…or how you want to get hold of that doctor…with the VULA app, all referring doctors need to register on the system, so you have their contact details, their names and mp numbers; so there’s a way of tracking where that patient came from if you need to give feedback or if it was a medical referral…” (Ort1_H1).

Another participant mentioned that:

> “When referring a patient with the VULA application, the referring doctor must give a lot of important information about the patient to us that include a photo of the eye and then we can have a conversation with them to get a better idea of the problem. This way of referring is much more comprehensive than a telephonic referral…” (Opht2_H1).

One of the participants, Ort2_H1 explained that they are able to determine the referring doctors and their locations. However, there are sometimes discrepancies in the exact location of the referring doctor:

> "There is a massive advantage in terms of the electronic systems. One is that, it's obviously traceable. So, firstly is that I know who is sending me the referrals, I know where the referral is coming from. One thing we have picked up with regards to where referral is coming from is sometimes the name of the referring healthcare worker comes up but also their location but that location is what they put in. It's not a location that is picked up by the smartphone…so it doesn't give you a location at that time but it's a location is filled in" (Ort2_H1).

When implemented health ICTs enable the work activities of healthcare professionals, the systems provide a level of accountability to the process of healthcare service delivery. While the responses above indicate the accountability attributed to the use of the VULA application, there is an inconsistency in the geo-tagged location and the location filled in by the referring healthcare professional. This raises concerns when healthcare providers attempt to locate the exact institution of the referring healthcare personnel.

It is evident from the responses that the use of HITs enables accountability with tracking the referral source and receiving comprehensive feedback on consultations. As established earlier, the VULA application enables healthcare professionals to remotely communicate and access real-time information (including text and images). It could be inferred that the benefits of the implemented health ICTs are closely associated with their fit-for-purpose or perceived usefulness when performing work activities. The researcher asked participants *why* doctors use the implemented HITs in their daily work activities. A participant claimed that using the VULA application "saves time than having to take phone calls" and they have the option to respond to the referral notifications when they have a chance (Ort3_H1).

With regards to the enterprise content manager (ECM), participants stated that the ECM facilitates quicker access and retrieval of patients' records by healthcare professionals, which speeds up follow-up visits of patients during consultation at points-of-care. "It helps you to quickly access the patient's folders and previous notes, previous history of the patient and it speeds up especially when you see the patient on follow up it speeds up because you know and immediately access" (Opht1_H1). The response was supported by the manager of information management, MIM_H1, who said that the ECM enables healthcare professionals to gain quicker access electronically to patient information documented in the traditional paper-based system:

> “We still have the old system where we put the patients’ documents in a file in the patient administration but in order to access it quickly, those documents are being scanned now onto ECM. So, the doctors or the nurses or whoever has to go and basically get the patient information, have access electronically to go fetch and look up data” (MIM_H1).

In addition to usefulness, another concept that influences the extent of technology use by individuals is the perceived ease of use, a concept drawn from the Technology Acceptance Model (Davis, 1989). This study defines ease of use as the extent to which healthcare professionals perceive the difficulty level to use HITs to simplify their daily work activities.

With regards to the VULA application, another respondent mentioned that “it’s very user friendly, very easy to use, it’s very basic; I don’t think you need to be technologically trained to be able to use it. So, I think anyone can actually use the app; it’s quite simple” (Ort2_H1).

The response shows that healthcare professionals perceive the VULA application as user friendly and easy to use, with little training required. The motivation for these responses and the effects of the ease of use of the mentioned health ICTs on the work activities of healthcare professionals are discussed in Chapter Seven.

> “VULA makes it easier to make clinical decisions without seeing patients personally. It's often difficult to determine if a patient can be seen as an outpatient or do they need urgent referral, and using the VULA app with clinical pictures helps with this decision making” (Ort4_H1).

The response indicates that healthcare professionals perceive the VULA application to be suitable to manage remote referrals. The functionality of the VULA application that enables the receiving of clinical pictures helps healthcare professionals make urgent decisions in the absence of patients and this, ultimately, simplifies the referral process of outpatient clinics and trauma referrals. However, the participants’ responses included challenges experienced during their work activities and use of HITs.

5.5.2.2 Work activity challenges

The findings were informed by the lived experiences of healthcare professionals during the execution of their daily work activities. The challenges were categorised as size of patient population, time inefficiency of some processes, inadequacy of paper-based resources, and insufficient computers. While expressing their frustrations on the challenges attributed to the use of implemented health ICTs, one of the participants said that:

> "You need to answer the phone, the phone at ER, you need to answer your bleeps and then you also get VULA referrals. And some of them, I would say half of them aren't emergencies and those people want an answer now because they've got a patient sitting in front of them but I've got 50 patients sitting outside and now I need to answer about something elective and they push you for it" (Opht1_H1).

Another participant, Ort2_H1, mentioned that, "If we can't see x-rays and you've got a clinic full with 40 patients, it's actually a nightmare. I think that's the biggest challenge".

The participants made reference to an estimated number of patients that doctors might see on a daily basis. In addition to the population size, the inappropriateness of required tools adds to the already strained work activities. One of the participants mentioned that:

> "Some documentation gets lost during movement of patients. It is time consuming because whenever – whatever procedure is completed the nurse got to come down and do the right thing afterwards. The paper, it's illegible at many a times due to the fact that peoples' handwriting differs…" (DNM_H1).

Paper has always served as a means of recording and storing relevant information obtained from the work activities of healthcare professionals; however, there are associated challenges that sometimes inhibit the efficiency of task completion. The findings show that the paper (or hardcopy) of patient information can be misplaced and restricts multiple use, when required.

> "Before all of this…before PACS and the VULA, we had the hardcopy x-rays. And they would get lost or misplaced somewhere or you would want to discuss a case here and then the x-rays would be in the ward" (Ort1_H1).

The response shows that the limitations of paper or hardcopies are addressed with HITs in the sense that copies of patient information can readily be made available in an electronic format and the information can be accessed multiple times, simultaneously.

> "What normally happens currently is if there is a need for a patient for a certain department, the doctor writes a formal referral to that specific department… currently it happens on paper, you need to wait for somebody to take the referral to that specific department…it can happen that the physiotherapist or the radiologist or whoever needs to get a referral, only receives the referral 12 hours after it's been written" (DNM_H1).

When paper is used to facilitate referrals, it is a time consuming and inefficient process. The response explains how using handwritten referrals and the dependency on a third party to deliver the pieces of paper are ineffective. However, some participants prefer the use of paper more than the use of HITs for certain work activities. In reaction to the concerns shared about system downtime and the consequent inhibitions to work activities, a participant said that, “I prefer paper based for note taking but IT based for outside referrals. The problem with technology is that when there is a problem with it and we need to revert to paper based work it causes issues and delays; it’s all good until the ICTs fail” (Ort3_H1).

It is evident that some of the healthcare professionals are aware of probable system failures based on experience or expectation. Hence, healthcare professionals consciously prefer using different tools for different tasks in the execution of their work activities. The likely causes of the challenges mentioned, and the extent of their effects, are discussed in further detail in Chapter Seven. The next section describes the challenges associated with the use of HITs by healthcare professionals at points-of-care.

5.5.2.3 Challenges of HITs use for work activities

In an attempt to acquire information and understand the pain points attributed to the use of implemented ICT tools described, the researcher asked healthcare professionals whether there are any challenges experienced at specific points during their work activities. The findings show that the VULA application interrupts during consultation with patients, the HIS is not reliable and that the ECM and PC systems are slow or sometimes offline. Healthcare professionals experience long waiting periods to access digitised paper records on ECM.

The findings show that healthcare professionals experience an extended waiting period when electronic systems are offline or faulty. This may result in dire consequences, given that healthcare services are complex, largely information intensive and dependent and, in some instances, time sensitive.

Participant Ort1_H1 indicated that, “the only challenge would just be if the system…I’m talking about the PACS now for some reason isn’t available or offline, then because we’d have nothing to work with”. This response is relatable from the perspective of participant Ort3_H1 who stated that “most of our work is reliant on PACS”. The responses suggest that there are certain instances when the Picture Archiving and Communication System (PACS) and the Enterprise Content Manager (ECM) system are defective. Similarly, Opht1_H1 mentioned that:

> “When the ECM is down then it’s a big problem because then you basically can’t go on with your work. You can’t book a patient for cataract surgery…or for any surgery. If you haven’t screened your patients yet; you need to access that information, then you will run into trouble but then you have to see the patient again… then it’s basically the same as falling back onto paper system”.

This situation of PACS or ECM downtime impedes workflow in the sense that healthcare professionals are unable to perform tasks that depend on the use of electronic systems for completion. Consequently, doctors revert to a paper-based system to facilitate the progress of their work activities in the hospital. One of the inferences drawn from the responses above is that implemented HITs embedded for intended purposes to enable the tasks of healthcare professionals can enable or inhibit execution of work activities. The details of the causes and effects of delays are discussed in Chapter Seven. In addition, participants indicated that situations where electronic systems were temporarily unavailable for information access, such as x-rays, while attending to several patients affects job performance.

> "With regards to the PAC system, the negative part to that is not all computers always work. You get to a computer where you can't log in to your x-rays or you can't see the ones you actually put in a folder for your film. I think it came with a period of getting used to essentially. I think that's the biggest challenge, is when electronics don't work. Then it's a massive irritation, if we can't see x-rays and you've got a clinic full with 40 patients; It's actually a nightmare" (Ort2_H1).

It is clear that there is a sense of frustration when doctors are not able to use implemented HITs, such as PACS and ECM. For example, MIM_H1 stated that "the other thing also I think is with the ECM. It is electronic so it is easy to access but you know when it is not available and they have to go back to the old system then I think they get frustrated".

The implications of the downtime of the implemented HITs on the work activities of healthcare professionals are further discussed in Chapter Seven. Four out of eight doctors expressed the notion that using their mobile phones during patient consultation is disruptive to their work activities and could make them be perceived as unprofessional. Findings reveal that the VULA application causes several interruptions; it is time consuming to use and may give patients a perceived negative impression of the professionalism of the healthcare professionals. When asked how the VULA application fits into their daily work activities, participants stated that the referral notifications interfere with their work during the day and, to some extent, after working hours, as well.

> "During the day it actually interferes and it slows you down massively. Definitely because you have a lot of patients that you need to see that's in the encore room, you need to answer the phone, the phone at ER, you need to answer your bleeps and then you also get VULA referrals" (Opht1_H1).

It is clear from this response that specialist doctors have an increased workload because they have to multitask while seeing a large number of patients. Participant Opht1_H1 continued that the VULA application sometimes gets abused in the sense that "doctors will ask you elective questions at night because they've got access…you are answering them 24 hours they think that is all that we do; …you need to explain yourself a lot and it takes so much time to type explanations and management and ask the questions". Another participant, Opht2_H1, described the biggest challenge associated with VULA as follows: "The biggest challenge with the VULA app is to be able to find time during patient consultations to also answer to referral doctor's questions; it takes a lot of multitasking and when disrupted by calls and VULA referrals it takes much longer to complete a consultation with a patient".

The impression gained from the concerns of healthcare professionals surrounding the use of the VULA application is that there is no ideal mechanism that controls the receipt of referral notifications, considering that healthcare professionals could be occupied, either on or off duty**.** This is an unintended consequence of the use of the VULA application. With regards to the ECM, one of the participants mentioned that "ECM can be accessed on a mobile phone but cannot be edited. It will be nice to be able to edit theatre lists, waiting lists on your mobile phone as I'm not always near a hospital computer to do this" (Opht2_H1).

The inability of healthcare professionals to edit lists on the mobile version of ECM restricts the functionality of the system, mainly because this influences the satisfaction of its users. The format in which information is stored in ECM limits the ability of the ECM to support the work activities of healthcare professionals. This can be referred to as an example of the unintended consequences, and is partly the reason why most mHealth projects do not scale beyond the pilot phase in clinical settings. To understand how nursing activities are being supported by ICT tools in hospital **H1**, the researcher asked a participant to compare and contrast between the use of paper, a desktop computer and a mobile device. The findings show that paper-based systems are time consuming and handwriting could be illegible; there is a need to access and update patient records during movements, and there is restrictive user access to desktop computers.

> "At our admission points…patient goes for certain investigation…so the patient moves around and most of the times they are accompanied by the nurse wherever they go ... It would be important to have a mobile device, you know. So, whatever happens at a certain point, not in the trauma or at the emergency unit, if the patient…goes to x-rays, at the x-rays department or at the scan department that the nurse can have access to enter whatever goes wrong with the patient at a certain point" (DNM_H1).

At the moment in hospital **H1**, it could be inferred that from the point of admission, nurses move around escorting patients from one location to another with an inadequate means of accessing and updating patient records during the time of movements. Hence, one participant advocates for the need of a mobile device to update patient records. The researcher asked respondent DNM_H1 how ICT tools could influence the removal of paper-based processes to support nursing activities. The respondent said that:

> "There is operational manager who is in charge of a certain area, that person unfortunately has access to a computer and that person most of the times have access to emails. So, emailing from that person's PC is used quite frequently but actually once some kind of information system…where everybody within the unit can have access that it isn't just a certain person and when that person is not there you don't have access to that. If that person is there or not there that people working within that area must be able to communicate with other professionals or services within the hospital to speed up processes and procedures regarding the patient" (DNM_H1).

It is clear from this response that the nursing department seems to be under-resourced with desktop computers, to the extent that only the operational manager in a unit has access to the computer. Consequently, if the operational manager is not available on site, the use of HITs is restricted. The effect of this is discussed in Chapter Seven, where the researcher deals with the causes and effects of the emergent findings.

Nonetheless, it was indicated by participants that the process of digitising handwritten clinical notes by scanning them into the ECM system wastes time. For instance, one of the participants mentioned that "the ECM database has a waiting period of more or less 2 months before it is scanned in, so if I see a patient within a month or two, the last notes will not yet be on the ECM. It is possible to request the notes then, but it wastes time as it takes a few hours to be found/scanned in" (Opht2_H1).

This response shows that specialist doctors make use of paper to capture handwritten clinical notes. Subsequently, the clinical notes get scanned into the ECM system to create an electronic copy. Ideally, the ECM system should enable healthcare professionals to gain quicker access to the past clinical notes during follow-up visits by patients; however, this is not always this case. The participant indicated that handwritten clinical notes are not always available immediately and it takes an estimated eight weeks before they are scanned into ECM system. Furthermore, the participant mentioned that they are able to make requests for the handwritten clinical notes but that it takes time for the notes to be found and scanned into ECM system.

In addition, the findings show that handwritten information can sometimes be illegible and this does not afford healthcare professionals the opportunity to make further enquiries in the event of a referral.

> "It is legible [sic] and we've obviously could ask certain questions which we think is pertinent whereas in paper-based system, there's no question on a paper-based system. So, the referring healthcare worker who might have a little bit of experience specifically in orthopaedics might not be sure of what exactly we want to know that's pertinent to a specific condition, so that's the nice thing about electronic systems" (Ort2_H1).

Another participant confirmed that paper referrals are problematic and may truncate the process of healthcare service delivery: "Whereas patients would come here before with a paper referral and you won't be able to read the name of the doctor that referred the patient to you, you won't know who referred them or how you want to get hold of that doctor" (Ort1_H1).

When asked about the inadequacies attributed to use of paper-based systems for nursing activities, DNM_H1 stated that "some documentation gets lost during movement of patients" and "it is time consuming because whenever a procedure is completed the nurse got to write down and do the right thing afterwards". Also, the participant pointed out that "paper is illegible at many a times due to the fact that people's handwriting differs…. which makes it sometimes difficult".

It is evident from the responses that some information management tasks are facilitated using mostly paper-based systems in nursing activities. There are vulnerabilities associated with paper records, which include the fact that paper records may get lost, completing paper-based records is time consuming to organise, and that there is an issue with illegible handwriting, which is likely to cause human errors.

The findings suggest that the work activities of healthcare professionals are influenced by timely information acquisition and the ability to communicate, both remotely and locally, in order to make decisions with respect to a diagnosis and treatment plan for their patients (or clients). While the findings show the typical types of work activities performed by healthcare professionals, the forms of HITs used to execute the activities and their effects on the outcome of work activities, and the personal experiences of using the technologies at points-of-care, were also considered.

5.5.2.4 Effects of work activities and HITs use challenges

The effects of work activities and HITs use challenges are associated with timeliness and unintended consequences that inhibit the progress of work activities at points-of-care. There are mixed narratives when it comes to the timeliness of implemented HITs to perform tasks at points-of-care. Participant expressed positive and negative views on the timeliness of the use of HITs to enable work activities. Therefore, timeliness is a significant factor that influences how humans perceive the usefulness and appropriateness of technologies used to execute their tasks to completion at points-of-care during the service delivery process.

As a result of the interruptions during patient consultations, the healthcare professionals mentioned that giving attention to their phone might make them seem unprofessional. For instance, two of the participants mentioned that “it also sometimes feels unprofessional to be busy on your phone answering VULA referrals, while a patient is sitting in front of you” (Opht2_H1). Similarly, Ort3_H1 expressed the same concern that, “I feel that it seems unprofessional to constantly be looking at your phone screen whilst consulting patients”.

The trend of these responses shows that the use of the VULA application by healthcare professionals increases their workload, obligating them to multitask by consulting and examining patients physically and, at the same time, responding to remote consultations with their colleagues from other public and private hospitals. Consequently, VULA referrals could be negatively disruptive to healthcare professionals’ work activities and could give the wrong impression to the patients. This is discussed in further detail in Chapter Seven, where the researcher adopts the ActAD model and the Double Dance of Agency (DDA) model to make sense of the research findings and, subsequently, address the research questions.

Based on the long waiting times, participants mentioned that there is a delay in their work activities. There are reported cases where doctors attempted to access patients’ records at points-of-care during patient consultation on follow-up visits but the digitised paper records were not available. Opht2_H1 indicated that “it is possible to request the notes then, but it wastes time as it takes a few hours to be found/ scanned in”. Despite the advantage of easier accessibility to scanned paper records offered by the ECM system in hospital **H1**, these records are not made available electronically in a timely manner. At the end of a treatment plan, healthcare professionals usually have to wait for an extended period of time to gain access to patient records. When asked how the challenges experienced by healthcare professionals while using HITs impact on the execution of work activities, participants responded that “late trauma referrals have significant complications in the acute and long-term setting”.

The response indicates that a delay in attending to trauma referrals in a timely manner is detrimental to the health and wellbeing of patients. Opht1_H1 expressed the opinion that the use of health ICTs is “more beneficial for the patient yes, but definitely not for the workload” of healthcare professionals at the points-of-care, especially during patient consultation. Multitasking during patient consultation, VULA interference, systems downtime, and reverting back to paper all prolong the time it takes healthcare professionals to accomplish their work activities. The effects of implemented health ICT use challenges during the work activities of healthcare professionals are further discussed in Chapter Seven.

The responses seem to indicate that there are more pain points than gain points; however, it is clear that implemented health ICTs assist healthcare professionals to execute their work activities in a beneficial manner; hence, there is continued use of the implemented health ICTs. There are positive experiences associated with gain points during the use of health ICTs for the work activities of healthcare professionals. Healthcare professionals feel a sense of accountability in terms of information exchange and accuracy to aid decision-making, as well as an improvement in the time it takes to perform tasks. Unfortunately, there are contextual factors in the hospital settings that influence the experiences of healthcare professionals and associated unintended consequences resulting from the use of health ICTs during work activities at points-of-care. Based on the participants' responses and the interpretation of these responses by the researcher, the likely reasons for the causes of unintended consequences, and their effect on service delivery, are addressed and discussed in Chapter Seven. Based on the findings in this section, the researcher proceeded to analyse how healthcare professionals could use HITs perceived as suitable in a timely manner to execute tasks at different touch points.

5.5.3 Alignment of mHealth technologies and healthcare professionals at service touch points

In this section, the researcher indicates how mHealth ICT tools could be best suited to the work activities of healthcare professionals at points-of-care. The challenges discussed by the participants are used as a focal point by the researcher to pose questions about what could be an ideal use situation for mHealth technologies. To address the objective of this section, the responses from the healthcare professionals on how they execute their work activities, and the enabling tools, informed the researcher's interpretation of the current situation*, 'as-is',* to a proposed *'could-be'* situation. The hermeneutics circle was applied to the analysis of the data transcripts. The emergent themes include i) patient and information management, ii) functionality of mHealth ICTs, iii) means of communication between healthcare professionals, and iv) enabling conditions for mHealth-enabled work activities.

The researcher presents findings on how healthcare providers in hospital **H1** suggested that mobile ICT tools could be utilised in a timely manner, when appropriate, at points-of-care. The researcher asked participants how they would prefer the VULA application to function so that the pain points or challenges identified in the previous section could be addressed using Information for future designs of mHealth technologies in tertiary healthcare. A respondent replied that the VULA application is well suited to manage referrals but emphasis should rather be placed on use for emergency conditions, otherwise the application prevents healthcare professionals from giving adequate attention to their patients during face-to-face consultations.

> “Just for emergencies during the day and not in your personal time or… in the middle of the night ... So, maybe just putting a specific hour working hours but then also you will only be on your phone the whole day … then you won’t see any patients” (Opht1_H1).

The response shows that one of the unintended consequences of VULA referrals is that they intrude on the personal time of healthcare professionals, on the time dedicated to patient consultation and on the provision of medical care. However, another participant mentioned that “during the day, it is managed by a trauma team and after hours by the person who is on call, they don’t specifically need to be part of the trauma team. But for the afterhours services, they manage that” (Ort2_H1).

The responses suggest that VULA application referrals should be attended to by dedicated personnel and made active only for specific periods of time. The suggestion informs the usability considerations of mHealth ICTs for the work activities of healthcare professionals. In the next section, participants indicate how mHealth technologies could be suitable to enable the tasks of their work activities at points-of-care.

5.5.3.1 Patient and information management in clinical settings

Information is a key component in the work activities of healthcare professionals and is at the core of decision-making in the process of healthcare service delivery. The findings show that information is generated at each point-of-care where patients are attended to in the hospital. All patient information is recorded on paper before it is stored electronically. Thus mHealth technologies are ideal to reduce the time healthcare professionals spend on writing notes, and accessing and updating electronic patient records, with reduced dependency on desktop computers. A participant said that:

> “In our clinics, for all patients that are seen, notes are also made by hand and those notes as well as all referrals go into a patient’s folder. All those notes are sent to the scanning department…and get scanned into our ECM. All those notes eventually do become available on a computer as well” (Ort1_H1).

Another participant indicated the benefit of using mHealth technologies as follows: “So the advantage is obviously that it does help with time. It makes it easier for the referring doctor; It’s something visual that I can see and its instant. We all love having something that’s instant these days” (Ort2_H1).

The participant expressed the opinion that the VULA application is ideal for referrals, as it is time efficient and enables access to visual information during communication with their colleagues. When asked about the process of communication between nurses and healthcare professionals, the respondent explained that:

> "What normally happens currently is if there is a need for a patient for a certain department, the doctor writes a formal referral to that specific department. And that is where this electronic system could also assist because if a doctor writes a referral currently it happens on paper, you need to wait for somebody to take the referral to that specific department. So, that would also help to speed up the patient's length of stay in the hospital. Because it can happen that the physiotherapist or the radiologist or whoever needs to get a referral, only receives the referral 12 hours after it's been written" (DNM_H1).

The evidence in the response shows that the use of paper to facilitate referrals is not time efficient. Electronic referrals, on the other hand, have the potential to be time efficient and might reduce the time patients wait to receive the necessary attention and service. The VULA application seems to be a model on which electronic referral could be institutionalised in the clinical departments of the tertiary hospital.

When asked to describe how the use of desktop computers might restrict some of the work activities of healthcare professionals, compared to having access to information through the use of mobile ICT tools in hospital **H1**, a participant mentioned that, "it'd probably make it a whole lot easier. So, if you were at home and planning for your elective surgery the next day. Just to have a tablet or a mobile phone, just to quickly open up the x-ray and have a look. It'd definitely help…if you could access from outside or at home but I do not think it is a necessity" (Ort_H1). According to participant Ort_H1, access to patient records on the HIS is localised to the hospital. Consequently, healthcare professionals are not able to access electronic and digitised records when offsite, away from the hospital intranet. The respondent implied that it could be possible for healthcare professionals to work around the existing system by staying behind on site to perform their management plans before the next working day. However, in the case of emergency consultations, a lack of timely access to the necessary patient records may inhibit the decision-making process. In this study, when the healthcare professionals perceived some form of inappropriateness with the use of HITs for information management, they resolved this by using alternative means that met their expectation or an enhanced result. This is known as a workaround (Yang et al., 2012; Barrett, 2018).

5.5.3.2 Functionality of mHealth ICTs

In the context of this study, usability of HITs is the extent to which ICT solutions can be used effectively by healthcare professionals to perform their tasks efficiently at points-of-care during the service delivery process in tertiary healthcare. The findings indicate that the capabilities of health ICTs indicated by healthcare professionals are attributed to the time efficiency of performing work activities. When asked what the ideal technology to support the work activities of nursing staff in hospital **H1** would be, a participant stated that the nurses currently "use paper and a pen…so at all entry level points it would be nice to have a system where you can just with a click of a button enter patient details and whatever is wrong with the patient" (DNM_H1).

The response from the nursing participant shows that the nursing process involving collection of patient history and examination is usually paper-based, i.e. information is recorded on paper and put in a paper folder. The participant suggested that the use of a technology which is time efficient and easy to operate would be ideal, given the current work-related activities of nurses. Participant DNM_H1 gave an example that, "for instance to theatre, it would just be by the click of a button that you transfer that patient to the theatre. From theatre if the patient for instance goes to ICU just with a click of a button, you know, that follow through of a patient from entry until the patient exits the institution". When asked to suggest the critical functions that would be ideal for a technology that supports the work activities of nurses in hospital **H1**, DNM_H1 stated that, "a function to write a continuous report…, a function to register patient details, a function…like a Dropbox that says to which departments the patient went. For instance for what investigations a patient went to, a kind of a Dropbox to say to which department the patient went to from a certain department".

The response suggests that nurses require a device with features that include on-click buttons and should have a selection dropdown menu, which could quickly assist nurses to log patient details, write reports and digitally track patient movement as they are transferred through different clinical departments within the hospital.

> "VULA is currently working well for new referrals. ECM can be accessed on a mobile phone but cannot be edited. It will be nice to be able to edit theatre lists, waiting lists on your mobile phone as I'm not always near a hospital computer to do this" (Opht2_H1).

The findings show that some of the implemented HITs are accessible on mobile devices but in read-only format. Read-only format is a limitation of electronic scanned copies of patients' records in the ECM. This limitation of scanned patient records on a mobile device prompted healthcare professionals to suggest the possibility of writeable operations on the scanned electronic copies of patient records. It is evident that the nature of work activities that require mobility, within or outside hospitals, would require healthcare professionals to access and edit information at their convenience. A mobile phone is indicated as a device that could enable quick access to information since the availability of computers is restricted, thus indicating that the number of computers in the hospital is not sufficient to support and serve healthcare professionals when needed for their work activities.

5.5.3.3 Means of communication between healthcare professionals

The findings suggest that there are instances when healthcare professionals do not rely on the implemented HITs to enable their work activities at points-of-care. In such instances, healthcare professionals become innovative. One of the healthcare professionals expressed a desire to access patient information from outside the hospital when planning for the next work day.

> "Now that I think about it, for consultants being on-call, if you get called for an opinion by the registrar on-call, it'd be nice…if they call about a fracture or an injury that they want an opinion on; if you could while you are at home on the phone, just quickly check on the PAC system on a tablet and then give advice as well, it'd probably make it a whole lot easier" (Ort1_H1).

The response indicated that mobile technologies specific to health-related purposes can be a means for healthcare professionals to easily communicate remotely and to also exchange the clinical images and texts required to offer an expert opinion, particularly in cases of emergencies. Opht_H1 mentioned that doctors use their personal phones to communicate frequently:

> "Within the department, obviously everyone's got a work group on WhatsApp, so that's to communicate about meetings. And then sometimes you just pick up your own phone…if switchboard takes too long to speak to someone… unless you don't have the doctor's number then you have to wait for switchboard. I use my phone actually; we do use our phones a lot".

Healthcare professionals use their personal phones to make calls and to use WhatsApp as a means of communication and coordination for departmental meetings. In addition, having a personal mobile phone helps healthcare professionals to locate their colleagues, especially when the official communication medium (switchboard) takes a long time to reach that person. It is evident that the convenience of having a mobile device enables healthcare professionals to easily communicate and locate each other within a hospital setting.

Participants Ort2_H1, Ort3_H1 and Opht2_H1 were of the opinion that the instant messaging feature on mobile phones is more beneficial than being able to make phone calls. Instant messaging enables doctors to respond to messages seeking clinical advice in real time, or at a later time, while phone calls require immediate attention, which might not be possible at a particular moment.

> "I think it also helps, it takes away running after phones and waiting for phone calls to go through compared to instant messages you are getting on your phone and you can actually answer it and manage the referral while you're actually walking from trauma to a ward or from theatre to trauma" (Ort2_H1).

It is clear from the responses that the convenience of having a mobile technology facilitates quicker communication between healthcare professionals and eliminates any restrictions associated with mobility in hospital clinical settings. Thus, it is imperative that there are enabling conditions to support the mobile technologies. The next section presents the facilitating conditions required by healthcare professionals to make use of mHealth technologies to enable their work activities at points-of-care.

5.5.3.4 Enabling conditions for mHealth supported work activities

The findings show that healthcare professionals resort to the use of their own personal devices to facilitate communication with their colleagues, both within and outside the hospital. For example, one of the participants explained that the VULA application is installed on the personal mobile phones of healthcare professionals. When asked whether it is obligatory to have the applications and about the cost implications of data, they responded that "we don't get an allowance or anything extra for that. I believe they felt obliged because the person that designed the app worked here so I think that's why we will always have it" (Opht1_H1).

The response indicated that the VULA application used to enable clinical activities is supported at the expense of the doctors. The response suggests top-down implementation of the VULA application since it was championed by a healthcare professional. Hence, it seems as though other healthcare professionals feel obliged to carry the costs, without resistance. When asked if there were complaints about the disruption of the VULA application, Opht1_H1 stated that "no one really complains". The continued use of the VULA application, despite its challenges, indicates that doctors have found a way to adapt to the use of the application during their work activities. The implications of this response are further discussed in Chapter Seven.

When asked about the resources needed for healthcare professionals, Opht2_H1 mentioned that "mobile data or Wi-Fi access" is essential to the use of mobile ICTs in their work activities. Another participant indicated that, "if our hospital can provide Wi-Fi that can ensure that urgent trauma referrals get seen to ASAP without delay if there is no reception" (Ort4_H1). This suggest that the network signal from mobile network operators received on personal phones is usually not reliable and that there is the need for the signal to be supplemented with wireless networks so that there is adequate coverage in all the points-of-care within the hospital. Similarly, Ort3_H1 stated that “faster Internet connection; up to date computers that can handle the new technology” are the necessary facilitating conditions required for doctors to use health ICTs at points-of-care. “Time to look at and address the ICT questions or demands, in the case of referral app… reliable Internet connection” (Ort5_H1).

It is evident from the responses that the enabling conditions are tailored to the timely application and resources for mHealth ICTs to support the work activities at points-of-care. Ultimately, the researcher drew on challenges experienced by healthcare professionals to understand how mHealth ICTs could align with the work activities at points-of-care. Healthcare professional currently use mobile data at their personal cost; there is a suggestion for the implementation of wireless Internet connectivity with sufficient bandwidth and computer systems with the processor capacity to support technology-enabled tasks of work activities. Thus, the next section provides the emergent findings on the role of the Provincial Department of Health in efforts to support the work activities of healthcare professionals to support the process of healthcare service delivery.

5.5.4 The roles of the Provincial Department of Health in the selection of technology solutions for tertiary healthcare services

The use of technology is preceded by its adoption. Adoption of technology is characterised by a process that includes identifying the need to address a particular problem with technology-based solutions and the acceptance to use a selected system (Cresswell et al., 2013). Furthermore, this can be broken down to include adequate planning, framing strategies to engage with relevant stakeholders, implementation of selected technology systems and investment in an enabling infrastructure. In the context of this study, the choice of selecting health ICTs is informed by the need to improve public healthcare service delivery by the Western Cape Provincial Department of Health. Thus, health ICTs are implemented to aid the administrative and clinical work activities of healthcare professionals at points-of-care towards improving the health and well-being of the populace.

This section draws on an interview with the provincial information management director to present findings about with the role of the Department of Health in the selection of technology to support tertiary healthcare service delivery. The emergent themes resulting from the application of the hermeneutics circle are i) the selection of HITs for the work activities of healthcare professionals, ii) implementation of HITs for the work activities of healthcare professionals, and iii) leadership and governance of an IT vision.

5.5.4.1 Selection of HITs for the work activities of healthcare professionals

Cresswell et al. (2013) argue that the selection of HITs for implementation and use in a healthcare system is informed by a thorough understanding of the issues that inhibit seamless service delivery and through reaching a consensus on the selection with the different stakeholders. In the context of this study, the issues are characterised by a lack of timely application and inappropriateness of health ICTs to aid the work activities of healthcare professionals in hospital settings. Therefore, the researcher sought to learn how healthcare professionals are engaged, as primary stakeholders, in the selection of HITs to enable work activities in hospital **H1**.

According to Chung and Crawford (2016), a ‘stakeholder’ refers to an individual (or group) that has a vested interest in, and can influence or perceive themselves to be influenced by the outcomes of a decision related to achieving organisational objectives. Consequently, there are multilevel interactions between various stakeholder groups in the hospital settings that necessitate participatory engagement to reach consensus on the HIT selection process (Hwabamungu et al., 2018). Therefore, it becomes important to thoroughly understand the needs and expectations of each individual (or group) in each of their respective roles and work activities. The findings indicate that a business analysis team is tasked to engage and identify the needs required by healthcare professionals to perform their work activities.

> “We’ve got a business analysis team; they go out and engage with the different service cadre and get what the service need is. We implement according to service need” (DIM).

The response indicates that the business analysis team is responsible for gathering information from the end users of the adopted technologies. The participant further explained the details of the type of information required from the end users (healthcare professionals). This information is tailored towards how the hospital staff members can effectively manage their work activities, and enhance the attention given to patient care and the kind of technology support that would be required. “It is more to…what do the staff require to manage their workload or patient throughput and what systems do we need to put in place to enable that” (DIM).

The researcher further enquired about how healthcare professionals, in particular, are involved in the selection process of HITs. The participant responded that the business analysis team engages with the healthcare professionals to understand what their tasks are, how they perform the tasks, and the expected outcomes of these tasks. “We don’t determine which cadre needs to be engaged, the service heads would inform us to speak to Dr A, B, C or to Mr A, B, C at the frontline or you know so…they determine who, where and when we engage” (DIM). The participant’s response indicates that senior hospital staff members, such as the head of a department, suggest to the business analysis team the appropriate individuals to engage with. It could mean that the set of suggested individuals are usually the active or a representative sample that would provide relevant information about the work activity, as required. “So, the people we engage are mostly people on the frontline services, not necessarily the patients, so we haven’t gone to patient engagement yet” (DIM).

The findings imply that the hospital staff members responsible for delivering healthcare services to customers or patients are referred to as frontline end users. It is evident that healthcare professionals and related staff members are consulted in the process of selecting health technology solutions. This shows that priority is given to the users of technology to provide services, before due consideration is given to the receivers of the service. The participant further explained:

> “So, we’ve got a process… UXD – user experience design so we use that framework. You need to locate yourself within the service where you say as a clinician, I’d like X for this outcome…to enable this outcome so that when we review it, we get story points. Those story points then become either a specification or potentially an application on its own” (DIM).

The response shows that the engagement of staff members at the frontline is facilitated in a systematic manner. The business analysis team uses a framework described as ‘user-experience design’ to acquire information about the needs of users, as determined by the tasks of their work activities. The expected outcome of the work activities is used to develop an application or to assist the business analysis process to design the specifications of health technology solutions. Once a consensus on user requirements is reached by both the business analysis team and frontline service providers, a decision to either develop or purchase the choice of HIT solutions is made. This is the initial interaction in a series of stakeholder engagements at the different phases of the choice of HITs selection process.

In the process of adopting technology solutions, it is essential to establish a need for HITs, especially because investment in such systems is costly (Ajami & Bagheri-Tadi, 2013). While high cost of investment has been mentioned by several scientific publications as one of the major barriers to the adoption of HITs, this creates the option to either develop alternative solutions locally or allocate sufficient funds for the procurement of health systems. Findings show that the HITS adopted in the Western Cape Province of South Africa are either procured or developed by resident software developers. The respondent further explained the rationale that guides the choice between the two methods used for adopting health technology solutions. The main rationale guiding adoption is attributed to the complexity of work activity for which the system is used.

> "We would either procure a software solution if there's one out there or we would develop something in-house depending on the complexity of the solution. So, if I take, given an example, we've got a patient administration system which we've gone out to procure because of the complexity of the billing and all of that at the hospital level. But at the primary healthcare level, we felt all we want to know is the registration of the patient, to register the patient, to document the ADT-admission, discharge or transfers, as well as the reason for visit. That was pretty simple to configure but in the context of a primary healthcare system" (DIM).

The findings suggest that the procurement or in-house development of HIT solutions is determined by the complexity of the work activities to be supported during service delivery. At the primary healthcare level, systems for the registration of patients to manage the processes of admission, discharge and transfer (ADT) are developed locally. However, at levels higher than primary healthcare, patient administration systems used to manage a complex process such as billing and the payment for clinical services are procured from HIT-industry vendors.

> "If we go out for a radiology solution, we won't be able to develop those by ourselves; there are industry leaders like ACFA, Philips, GE. Say with pharmacy, there's a lot of regulations linked to pharmacy solutions, so we won't develop it ourselves we go out and develop it according it the specification that meets the service needs" (DIM).

From the response above, HITs solutions for managing clinical procedures such as medical imaging, and other related activities such as dispensing of medication, are highly regulated, which prohibits local development of such systems. It shows that the Provincial Department of Health is aware of, and adheres to, the standards that govern the procurement of technology solutions in the healthcare sector. Additionally, the response indicates that procurement is based on identifying specifications that meet the service needs of frontline end users, with whom the business analysis team have engaged.

The findings show that other than the complexity of work activities, there are other factors that influence the selected choice of HITs for the work activities of healthcare professionals. For instance, the participant indicated that choice of HITs is influenced by the need to digitise inefficient work activities within the process of service delivery. "We are quite advanced; there are still some systems that are manual so we need to digitise those processes but I am also conscious that I don't want to digitise inefficient processes" (DIM).

In addition to realising the need to digitise manual processes, the participant explained that funding is a major factor that enables or inhibits the choice of selected HITs. There is a positive perception and confidence expressed by the participant with regards to the strides made by the Provincial Department of Health to digitally transform work activities in the public healthcare system. However, funding influences the type of health technology solutions the provincial Department of Health is willing (or not willing) to invest in, in order to assist during service delivery.

> "So then funding becomes an issue. So, it also then determines what is it that you are willing to procure and to what value. So, all of these things are obviously factors that play a role in terms of achieving your vision or strategy" (DIM).

In addition, findings show that there are regulations that govern the procurement of selected HITs solutions in South Africa. The participant explained that:

> "We are guided by the SITA act – the state information technology agency, they came out with an act that governs how we should be procuring software in South Africa as a government entity. And there's obviously PFMA – Public Finance Management Act which also governs how we should be doing procurements" (DIM).

The State Information Technology Agency (SITA) and the Public Finance Management Act, No. 1 of 1999 (PFMA) were mentioned as the guidelines that govern how various sectors of the government do procurement. Although, the participant mentioned that the Provincial Department of Health has customised the PFMA to suit the needs of its public healthcare institutions. The Western Cape Department of Health has formulated "the accounting officer system (AOC) which basically also talks to supply-chain rules, delegations and all" (DIM). According to the participant, AOC combines "PFMA and other provincial treasury regulations into… one document so that you do not have to go look at various policies and processes; it's all in one document that guides you how to…" (DIM).

It is clear that the Western Cape Department of Health plays an important role in managing the consensus process used to select health ICTs, as guided by service needs and the complexity of the work activities undertaken by healthcare professionals. HITs that are developed in-house are used to manage administrative activities during patient administration. However, the more complex clinical activities require the procurement of HIT solutions. The next section presents the mode in which HITs are implemented in public hospital settings.

5.5.4.2 Implementation of HITs for the work activities of healthcare professionals

Once the decision has been made to adopt any health technology solutions, the business analysis team engages with end users and then the next phase is the implementation of HITs for the work activities of healthcare professionals in public healthcare institutions. According to DIM, the adopted systems are implemented at an enterprise level. "The applications are normally implemented at an enterprise level so it is not institution-based implementation" (DIM). The response indicates that the HITs implemented at different healthcare institutions in the province are connected in a distributed system model; in other words, the services are centrally controlled, but each client can access the systems independently in the individual institutions. Furthermore, at a management level, the other purposes for which HITs are implemented include storage and processing of hospitals' big data used to inform decisions.

> "We've got systems like I said that's centrally hosted. So, the data would come into a central portal, we would then push that into a data warehouse and then the normal BI [business intelligence] processes would then follow ... the ETL – extract, transfer, load, we create data matching and from those data match, we create reports" (DIM).

The findings suggest that HITs are adopted with the intention to enable interoperability of data generated at the healthcare institutions in the province. For instance, the participant stated that there is a distinct patient identifier which integrates all the data generated on an individual patient visiting the healthcare institution.

> "To an extent that we share patient information … so we have what is known as a PMI – patient master index, a uniquely identified number that's assigned to every patient that's in our facility. That number is shared with all the systems that we implement. So PACS would have an image linked to a PMI, they'd have a report linked to a PMI, our pharmacy system also has medicine dispensed against a PMI, so we have that and we also have bloods, so when we send bloods away to the lab – NHLS, the results that come back is linked to a PMI" (DIM).

Participant DIM further explained that the interoperability of data enables the Provincial Department of Health to analyse and manage funding of the public healthcare institution as well as resource allocation, where necessary.

> "That is pivotal to us then interoperating data at a later level which is the BI. So, at the business intelligence level, our primary key is in the PMI but we even go one down, which is the cost centre code. So, each of the various hospitals have various specialties and each specialty have a cost centre code, so that we can then start looking at the funding associated with care and also the resource allocation to each of these various areas" (DIM).

The response above correlates with the feedback received from MIM_H1 that the hospital **H1** has sections that deal with the aggregation of statistics and the management of cost centres for the allocation of the budgets applicable in the hospital. The participant clarified that there is a statistics department that deals with "all sorts of clinical data use in the hospital. We collect them, prepare them, submit and we send them to head office". The data collected are used “for decision-making and also for future projects to see how and monitor what is going on the hospital”. With regards to the budget allocation within hospital **H1**:

> “Another section is the cost centres. This is basically how budget are allocated to the different cost centres. So, when people spend money in terms of procurement, ordering stuff from the stores, that expenditure and that quantity is allocated to a cost centre. Throughout the hospital is different cost centre and the cost centres falls under a system called the FBU – functional business unit” (MIM_H1).

The implementation of HITs at an enterprise level facilitates the aggregation of data reports from different public healthcare institutions in the province at a central point to enable decision-making at a managerial level. Hence, it is necessary to manage the execution and maintenance of projects, such as the implementation of technology to support the delivery of healthcare services. Thus, the Department of Health has included leadership structures to govern technology projects implemented towards the realisation of the provincial IT vision.

5.5.4.3 Leadership and governance of the provincial IT vision

Based on the established need to selected HITs, leadership and governance structures are set up for the purposes of achieving vision healthcare 2030 by the Provincial Department of Health via “the health normative standards framework that was enacted in April 2014” (DIM). The researcher made enquiries in order to understand how the Provincial Department of Health has aligned itself to the national eHealth (2012) and mHealth (2015) strategies. The findings show that there is an IT vision guided by the healthcare 2030, which is tailored towards “access to person-centred, quality care” (DIM). The role of the collective stakeholders is to “find out what mHealth initiatives there are in South Africa at the provincial level and then aggregating that across South Africa”. The participant explained that the aggregation of mHealth initiatives is to “determine which of these they can actually use from a national context and which of these are genuinely only provincial…” such as not to “duplicate exactly what is already in existence” (DIM).

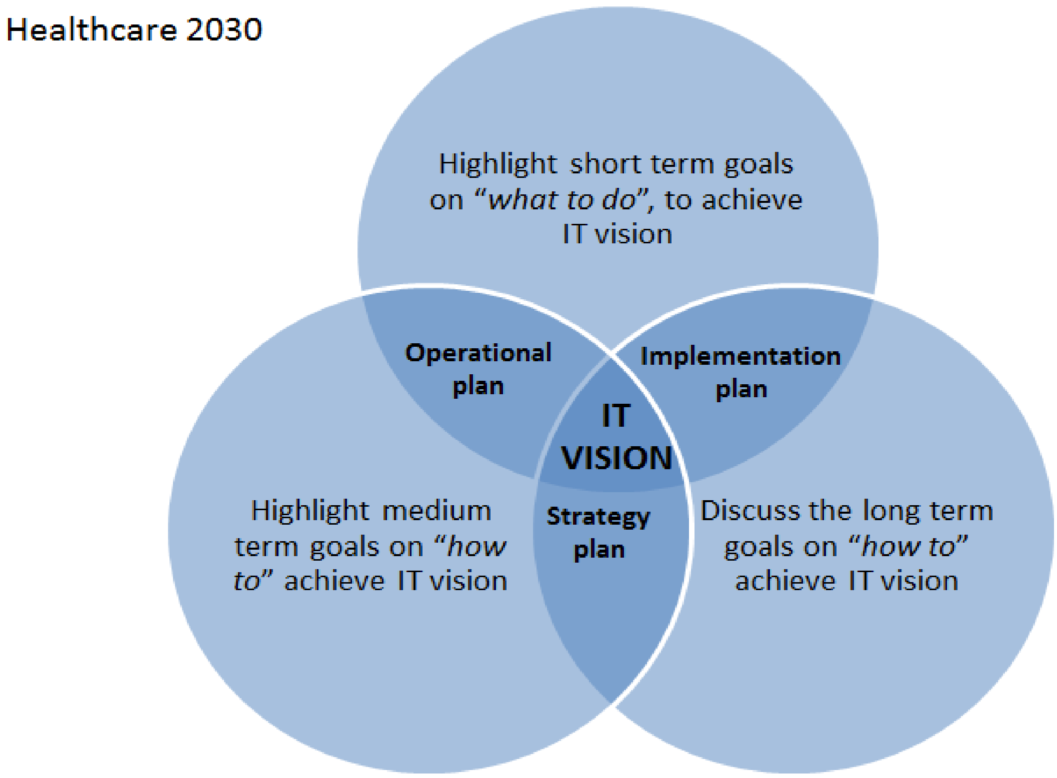


Figure 5.13: IT vision informed by National Healthcare 2030 vision

Figure 5.13 illustrates the correlation between the activities set up by the Provincial Department of Health towards achieving the healthcare vision 2030.

> "We've got an IT vision. Now the reason why we call it a vision; it is something we aspire to get to… our vision is aligned to our healthcare 2030 thinking and to the healthcare 2030 thinking of the national as well" (DIM).

The participant revealed that the province's IT vision represents the anticipated goal. Consequently, there is a need to deliberate on how to achieve the goal. Therefore, an implementation plan is developed. "How I do it is the strategy. So, every strategy must have an implementation plan. So, the implementation plan would span the lifetime of the strategy" (DIM). According to the participant, the implementation plan usually includes a set of long-term goals set over the entire period of the strategy. The implementation plan is further broken down in bits, referred to as operational plans.

> "The strategy is normally 3 to 5 years, implementation plans are 3 to 5 years, each implementation plan would then have an operational plan so the operational plan is 1 year – what am I doing this year, so that is my operational plan. So, we work…and our vision is aligned to the national eHealth and mHealth strategy" (DIM).

It is evident from the response that there is a conscious effort on the part of the provincial health department to set up governance structures to take on the leadership necessary to foster the digital transformation of the public health sector in the Western Cape. The participant expressed confidence in terms of taking a definitive leadership role by saying that the Provincial Department of Health is “quite good in terms of the governance layers from an eHealth and mHealth perspective” (DIM). The participant went on to give a robust descriptive breakdown of the leadership roles within the governance structure and activities, which are illustrated in Figure 5.14 below.

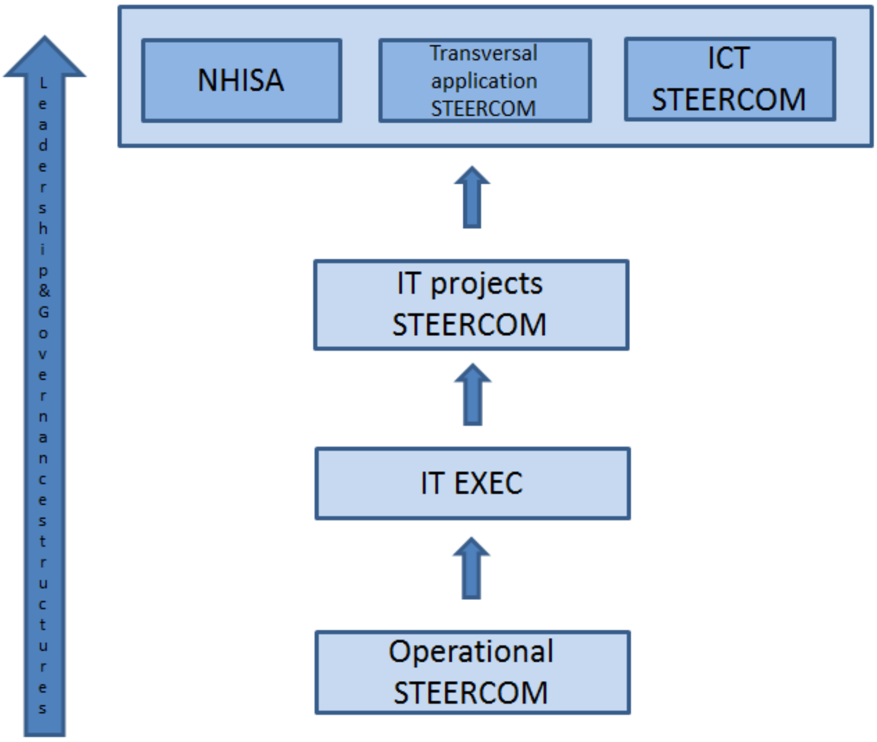


Figure 5.14: Leadership and governance layers established to realise the provincial IT vision

Figure 5.14 shows the layers of governance established by the Western Cape Department of Health. The finding shows that there is a process of approval at the initial stages of adopting HITs solutions in the public healthcare institutions of the Western Cape. Participant DIM responded that “if I want any initiative, I must take that to the IT exec that takes it to the IT projects STEERCOM for endorsement but the approval is given by the IT EXCO, so it’s a process”. The findings show that the Provincial Department of Health established an operational steering committee (STEERCOM) responsible for the management of the progress of the HITs selection process.

The operational STEERCOM layer consists of “the project managers together with our external partners that enable projects” (DIM). In essence, this layer of the governance structure works closely with the business analysis team to understand the user requirements to execute the implementation of IT projects. The next layer “above that is the IT EXEC. It’s basically my boss who manages that layer and we've got the rest of the stakeholders in there" (DIM).

> "All the projects…we basically have an operational STEERCOM…and we meet every second Monday to talk about progress…. We go through every project and we basically ask 3 simple questions: what have you done? What were the impediments and what are you planning to do? So those are 3 critical questions of focus on those in each of the projects to give you insights…" (DIM).

The layer above IT EXEC is called "the IT projects STEERCOM which is the HOD that manages that layer, we then feed into that. My boss and me would go there together with the CFO, the COO and the HOD" (DIM). The participant explained that the next layer is where meetings occur at the provincial level. The response suggests that the governance layers are responsible for coordinating stakeholder interactions, and consequently, actioning all the decisions reached.

> "We got external meetings as well, so we've got CeI – Centre of e-Innovation within the department of the premier responsible for everything from the wall outward, so broadband, network points, servers, routers…We have engagements with them because we feel that it's critical to the success of our IT vision" (DIM).

> "And then there's NHISA which is National Health Information Systems which is National, also there is an IT component there which we form part of. Then within government there is transversal application STEERCOM, there is ICT steering committee which is also external. So, every department is on that body and then there's the ePTM – provincial top management that would look at giving effect or signing off on certain initiatives or policies ... so that's it, we govern very well" (DIM).

The researcher asked about how the Healthcare 2030 vision influences policies created to guide the realisation of access to quality healthcare. The participant explained that:

> "… a policy in itself can be written sometimes outside of your system but you need to comply with it. Like the SITA, it's more legislation but from that legislation you'd write a policy, from that policy then you write some sort of guideline and from the guideline you write a SOP – standard operating procedure. People would then customise it to their own needs in a big organisation. So, in a CHC – community health centre, you basically have people breaking that SOP even further down to what they need from it as opposed to doing the entire thing whereas the hospital would even extend on it" (DIM).

The response indicates that the Provincial Department of Health and the public healthcare system follow guidelines to develop standard operating procedures. A standard operating procedure is a customisable guide to how different contexts of public healthcare institutions function to provide healthcare services and, by extension, the work activities of healthcare professionals. The decision to procure or develop HITs is influenced by complexity of work activities, the service needs of frontline individuals, cost implications and a need to improve inefficient work activities through digital transformation. In addition, it is clear that the Provincial Department of Health is committed to taking a leadership role in the execution of the national eHealth and mHealth strategies towards achieving the Healthcare 2030 vision.

The hierarchy of governance layers constituted to oversee IT projects is guided by national policies and guidelines to aggregate, identify and select relevant HIT solutions in tertiary healthcare. However, it seems that there might be a lack of communication between other relevant stakeholders that are involved in the implementation of HITs in the public hospitals of the Western Cape. According to MIM_H1, there are several independent information systems in Western Cape that are used for the purposes of information management. The participant was of the opinion that duplication of information systems could be avoided if all frontline stakeholders were engaged extensively during the selection process. MIM_H1 stated that having different information systems "causes problems because you have to use all those systems to get all your information whereas you could have used one or two".

It is clear that implementing multiple systems to draw reports complicates data reporting which, consequently, affects the accuracy of decision-making. MIM_H1 further stated that, "I am not aware if they still come out and ask people what their contribution is…I think they just have their own strategic plans and…not invite people working on the floor – what is their perception? Before they implement stuff, they must ask people their opinions and inputs but lately they implement stuff and try to make it then work". A lack of extensive engagement of frontline stakeholders during the selection of HITs may further add to the complexity of work activities, especially where data generated is essential to enable decision-making for the improvement of service delivery.

To summarise the thematic analysis of data collected from the semi-structured interviews in hospital **H1,** the summarised findings and emergent themes are presented in Table 5.3 below.

Table 5.3: Key findings from the semi-structured interviews in hospital H1

How can mHealth technologies be used to enable interaction moments within the work activities of healthcare professionals in tertiary healthcare settings?		
Objectives	**Summarised Findings**	**Emergent Themes**
To determine the current effects of implemented HITs on the outcomes of healthcare professionals' work activities	• The work activities of healthcare professionals are patient consultations, attending to remote referrals and determining treatment plans at points-of-care. • The nature of healthcare professionals' work activities requires them to move in between different locations • The mobility and routinised nature of clinical work-related activities requires healthcare professionals to be available, accessible and to have timely access to necessary resources that would empower the execution of their work activities.	Work activities of healthcare professionals
	• The health ICTs being used by healthcare professionals are: iSite picture archiving and communication system (PACS), enterprise content management (ECM), TrakCare, Nursing information management system (NIMS) and VULA mobile application • ECM system enables access to and retrieval of patient records electronically by doctors at the points-of-care • Nurses use NIMS to manage administrative aspects of patient care during nursing activities • PACS is used to book requests for clinical examinations and store medical images including x-rays and scans • The VULA mobile application is used to facilitate communication and remote consultations between healthcare professionals.	Purpose of implemented HITs
	• Implemented health ICTs enable healthcare professionals easy and quicker access to health-related information (clinical notes and patient records) stored electronically. • Management of patient referrals has improved in the sense that the process is simplified and the number of unnecessary referrals has been limited. • The VULA mobile application and PACS have improved how healthcare professionals communicate with each other. • VULA has reduced the costs and time implications associated with hospital visits.	Outcomes of HITs use for work activities

Objectives	Summarised Findings	Emergent Themes
To identify pain and gain points experienced by healthcare professionals at service interaction moments during their work activities at points-of-care	• Handwritten information could sometimes be illegible, time consuming and does not afford opportunity to make further enquiries. • The paper (or hardcopies) of patient records could easily be misplaced, damaged and are restricted from concurrent use where necessary. • There is a delay in the turnaround time it takes the hospital scan centre to convert handwritten clinical notes (paper) by scanning into the ECM system (digitised version). • Nurses accompany patients from one point-of-care to another without adequate means to access and update patients' records during movements.	Work activity challenges
	• PACS or ECM downtime impedes workflow in the sense that healthcare professionals are unable to perform tasks that depend on the use of electronic systems for completion • Implemented HITs embedded for intended purposes to aid the tasks of healthcare professionals can enable or inhibit execution of their work activities. • VULA mobile application interrupts healthcare professionals during their consultations with patients and results in an increased workload. • There is restricted user access to HITs in the nursing department due to under-resourced desktop computers	Challenges of HITs use
	• Healthcare professionals experience an extended time to complete their work activities • Healthcare professionals experience delays when attempting to access electronic records. • VULA mobile application is time consuming and might give patients a perceived negative impression about the professionalism of healthcare professionals	Effects of work activities and HITs use challenges
	• VULA mobile application enables accountability with regards to tracking referral sources, exchange of comprehensive feedback on consultations and electronic documentation. • VULA mobile application has eased the management of emergency and trauma referrals and influx of outpatients to hospital clinics.	Enhanced work activities

What are the characteristics of a desired touch point required to integrate mHealth technologies in the work activities of healthcare professionals?		
Objectives	**Summarised Findings**	**Emergent Themes**
To determine how mHealth technologies and human actors could be aligned at different service touch points	• Information is generated at every point-of-care. The complexity of work activities carried out by healthcare professionals determine what kind of tool is required, either health ICTs or paper. • Findings suggest that the mHealth technologies for instance, the VULA mobile application is suitable for referrals, communication, retrieval and the exchange of health-related information. • Nursing activities require time efficient technologies to support care administration provided to patient and report writing at different points-of-care.	Patient and information management in clinical settings
	• To redress the interruption of work activities at points-of-care, the VULA mobile application requires a form of push notification to healthcare professionals that are available and rather less busy than the ones busy in clinics or wards or theatres. • The kind of mHealth technologies needed to support work activities at points-of-care may include a voice command and recorder with speech recognition to capture verbal communication during patient consultation. • Other features could include, high resolution cameras, web-enabled, touch screen and instant messaging, to reduce the waiting time of retrieving information from ECM system • Implemented HITs are available on the mobile platform but in read-only formats	Functionality of mHealth ICTs
	• mHealth technologies enable remote and local communication between healthcare professionals regardless of location • The use of VULA mobile application assisted doctors to coordinate and provide collaborative care services.	Means of communication between healthcare professionals
	• Administrative workflow influences the availability aspects of information management during clinical work activities. • A wireless connection (Wi-Fi) infrastructure and adequate bandwidth are key components to support communication and exchange of information between technology devices.	Enabling conditions for mHealth supported work activities

Objectives	Summarised Findings	Emergent Themes
To understand the role of the Provincial Department of Health in stakeholder engagement during selection of HITs for tertiary healthcare services	• Selection of HITs is dependent on service needs of healthcare professionals and the complexity of their work activities. • The complexity of healthcare professionals' work activities determines whether HITs are procured from industry vendors or developed locally. • The findings indicate that a business analysis team engages healthcare professionals to identify frontline service needs.	Selection of HITs for the work activities
	• HITs are implemented at an enterprise level to enable data interoperability and aggregation from public healthcare institution to a central point • The enterprise implementation facilitates business intelligent process to inform decision-making at a provincial level.	Implementation of HITs for the work activities
	• There are leadership governance layers established by the provincial department, to align its IT vision to the national healthcare 2030 vision. • There is a framework used to engage frontline end users and select HITs but not to evaluate effectiveness of the systems post-implementation. • The structure within the governance layers manages all HIT projects in public healthcare institutions.	Leadership and governance of the provincial IT vision

5.6 Descriptive presentation of findings in hospital H2

The findings in this section are presented according to a thematic analysis of the interview responses from the healthcare professionals in hospital **H2**. There was an oversight on the part of the researcher in terms of the formulated open-ended questions. The open-ended questions were formulated according to the research objectives for contexts which were assumed to have implemented and actively using health ICTs. While explaining the purpose of the study, participants stated upfront that they mostly use their personal technology devices to support their work activities. The participants indicated the lack of implemented hospital information systems (HISs) to execute their clinical activities at points-of-care.

The researcher had to be pragmatic and switched to an unstructured interview approach to engage participants. The unstructured interview approach influenced how the transcripts of data from hospital **H2** were then thematically analysed. However, participants indicated that they are aware of the potential benefits attributed to the use of a HIS at points-of-care in healthcare services. At first, the researcher sought to understand the typical work activities of the healthcare professionals in hospital **H2** and the likely reasons for the lack of HIS implementation for clinical activities in hospital.

5.6.1 Details of work activities in hospital H2

The findings on the work activities in hospital **H2** are quite similar to hospital **H1.** The work activities of healthcare professionals in hospital **H2** are patient consultation, referrals, and a work-up plan (SC_H2, OrtC_H2 and SRNS_H2). This similarity can be attributed to the nature of the medical profession, where the role of healthcare practitioners is to deliver care services to the general public. When the researcher asked participants to describe their typical work activities in hospital **H2**, one of the participants mentioned that when patients come to the hospital, the healthcare professionals "listen to their complaint, we examine them and then we have a professional diagnosis based – in many cases based on the clinical – the history that I have taken from the patient; your physical examination. You will be able to have idea of, what this patient may be suffering from" (SRNS_H2). The respondent continued that "with the assessment, after the clinical interview and the examination we make an analysis for investigations. And the investigations for us in surgery many times may involve radiological which could be ultrasound, it could be x-ray, it could be a CT scan or a magnetic resonance imaging".

Likewise, OrtC_H2 explained that, "I attend to patients with orthopaedic related conditions, I treat trauma patients both outpatients and in ward (in patients), I'm also into surgical treatments. I lecture and teach medical students". The responses are similar to the responses from the participants in hospital **H1**. The work activities of doctors in hospital **H2** can be categorised as attending to outpatients in the clinic or from the causalities unit, academic meetings, ward rounds and performing surgical procedures in theatre.

The researcher asked nurses to describe their typical work activities in the hospital. One of the participants, ADNS_H2, explained that “as a nurse assigned to the radiology department, we receive patients that come from home for their radiological visitations. In most cases the patient will be booked and they will be given an appointment…” The participant continued to say that on the day of appointment when the patient arrives, “history is taken… to find out if there are histories of past medical diagnosis; the vital signs will be checked” (ADNS_H2). The examinations are carried out to determine whether a patient is qualified to undergo radiological investigation. Then, the nurse “files the case to the radiologist who gives…who file for this study to be carried on” and the patient “is told about the cost of the procedure or the preparation that is required” (ADNS_H2). Similarly, the orthopaedic nurse describes that patients arrive as outpatients, through the clinics or casualty, and are admitted to wards as inpatients. ONS_H2 explained that the administrative staff notify the nurses by sending “an attendant to come and inform…that we should be expecting a patient…and that they are getting him or her ready for admission”. Also, “if the patient will be coming through the casualty will have been called from the casualty through a phone, CUG [closed user group]” (ONS_H2).

On receiving patients after admission, the “patient is assessed from head to toe, the vital signs are taken, the level of pain is taken; and regularly, like half hourly the patient is monitored but the patients on the wards already they are stable. They are given the appropriate care” (ONS_H2). Nurses monitor the vital signs of the patient to stabilise their patients and, subsequently, administer the required care to the patients. “When patients are to do investigations you assist, you ensure the doctor collects enough specimen, maybe it’s blood, urine and the attendant sends the specimen to the lab and also you remind them on the collection of the results” (ONS_H2). ONS_H2 continued to describe that “…if patient is to go through x-ray, you call for an ambulance when the patient must have paid; you assist and the attendant to transfer the patient to x-ray and when procedure is done, the patient is brought back”.

The responses indicate that nursing activities can be categorised as the monitoring of patients, administering of care, communication with ambulance and clinical units and assisting doctors to facilitate clinical examination, as well as verbal explanation of results to patients.

The findings show that the tools used for clinical activities by doctors and nursed include paper, pens, and manual devices such as thermometers used to measure vital signs, and medical equipment for clinical procedures, such as medical imaging machines. With regards to the nursing activities, ONS_H2 explained that the nurses “then … record all these things on the paper, the nurses’ assessments and vital sign check”. The responses indicate that nurses are informed about patients’ admission by a messenger or by using a phone. The phone is known as a closed user group (CUG).

When asked to indicate the tools used by participants for their work activities, the findings showed that in addition to paper, there are other medical devices used at points-of-care. According to ADNS_H2, “at the booking stage we use paper and then when the forms are filled in by the medical team. Asides that we use things like sphygmomanometer; there’s stethoscope, the thermometer to do the monitoring of the vital signs; we also check for the pulse rate. Then, the x-ray is produced through the x-ray machines”. Similarly, ONS_H2 mentioned that tools used for nursing activities include “sphygmomanometer, thermometer, stethoscope and weighing scale”. When asked at which points during nursing activities a CUG is used, ONS_H2 indicated that “every time we want to communicate to other units, other departments, to the theatre, with other wards, with regards to a new patient, regarding work…”

Another participant mentioned that doctors make use of their phones to enable the exchange of images and texts during teleconsultations. Social media applications such as WhatsApp were cited as the tools used to support the work activities of healthcare professionals.

> “During call hours we make use of our mobile phones and some social and some apps, WhatsApp, Snapchat. Now this we use mostly to send images, radiological images and even some laboratory reports. So, a lot of times if a resident is reviewing a patient somewhere and is conversing over the phone, a lot of times I tell them to send images on my phone” (OrtC_H2).

The response is similar to responses on the use of the VULA mobile application received from doctors in hospital **H1**, i.e. to facilitate information exchange and to perform teleconsultation during referrals. The administrative and clinical work activities of healthcare professionals are divided into the doctors taking patient histories, making informed decisions and referrals of patients for clinical investigation. The nurses oversee the administration and monitoring of the patients from the time they see the doctor until the point at which they are admitted as inpatients, or discharged as outpatients. The work activities of healthcare professionals in hospital **H2** are mostly supported by manual medical devices such as a thermometer, a sphygmomanometer, paper and mobile phones. However, these tools are associated with challenges that inhibit the work activities of healthcare professionals to deliver care services in an already complex work environment.

5.6.2 Challenges experienced by healthcare professionals during work activities in hospital H2

Despite the efforts made by healthcare professionals in hospital **H2** to carry out their work activities in line with the mandate of their profession, there are challenges that inhibit the effective delivery of healthcare services. These challenges are infrastructural inadequacies; lack of adequate records and information management; and human-induced issues. Human-induced challenges have to do with individual beliefs, a lack of accountability and inconsistencies in the administrative process. According to SRNS_H2, challenges experienced by healthcare professionals are not always introduced by the use of technology.

> "It is basically human factors. Now the problem is in an ideal setting where we see a patient, make my diagnosis and I'll say I want to admit. Right from the time you make the decision I must operate the patient to the time that you actually free the patient; you'll be the one monitoring every step. Because if you don't push nothing is going to happen" (SRNS_H2).

The participant gave an example that "we needed blood for blood transfusion…the blood bank said sorry, we don't have blood for this patient. The only blood that matches that of this patient is proposed to be used for another patient" (SRNS_H2). This prompts a doctor "to go to the blood bank to tell them that this patient, if he doesn't have this surgery will likely die. That was unnecessary. It's not supposed to be my business to be worrying about how to get blood and all those things. The human factor in this case was the inability of this person to prioritise" (SRNS_H2), especially in the case of an emergency. The participant further explained that:

> "The human factor is not the blood bank problem; it is the societal problem. Number one is the average person who claims that my blood is not enough even when he or she has not been tested. Then, two some people know that before you donate blood you'll be screened for transmissible diseases and many of our people rather not know their statuses" (SRNS_H2).

The response indicates that administrative activities have an influence on clinical activities. The administrative issues explained above are human-induced and closely related to cultural beliefs and a lack of health awareness. This implies that in the context of hospital **H2**, there are external factors that influence the activities of the healthcare system. Therefore, it is argued that administrative activities that are independent of the healthcare professionals inhibit their work activities at points-of-care. For example, SRNS_H2 explained that on "clinic days you see many patients complaining. I was the first to come now nobody attended to me. And if you want to look into it, you realise that that patient's folder has actually not arrived. And the reason may be because the patient who came last, the folder is in the record library that is close to you…"

The administrative process of records management impacts on patients' appointments and the availability of doctors to be consulted during scheduled consultation times. This is similar to the case of hospital **H1**, where a backlog at the scan centre impacts on the turnaround time for the availability of digitised paper records during patients' follow-up visits. Additionally, among the challenges mentioned, is an inadequate information communication channel. SRNS_H2 mentioned that "more than 70% of our patients have been elsewhere before coming to a tertiary hospital". "Many a times, we see referral or consultation request that is not from a doctor or from professional colleagues that we do not actually know their professional standard" (SRNS_H2).

According to ONS_H2, government facilities are not functional. The participant said that "from my observation and experience over the years, it has been that the primary and secondary institutions have not been actually functioning to expectation". It can be inferred from this response that healthcare services are not consolidated and the referral process is not organised, especially because "the primary healthcare in Nigeria is basically not very functional" (ONS_H2).

Participants indicated that there is a lack of communication between healthcare professionals, which can be costly in terms of financial implications and misdiagnosis. Healthcare professionals mainly rely on their experience to counteract the delays in the provision of the information required to make decisions about a diagnosis and treatment plan. It is evident that the lack of adequate means of communication inhibits information exchange between healthcare professionals at points-of-care. However, participants mentioned that there is a CUG to facilitate communication from one ward to another.

> "If I'm in the main surgical ward for instance, I want to call the theatre I can pick up the phone and call the theatre. But let's assume that I'm in theatre, I want to speak to the surgical doctor; I cannot pick up the theatre phone and call the ward because that doctor may not be there at that point in time" (SRNS_H2).

The participants indicated that the limited availability of the CUG is not ideal for communication, or to reach another doctor, because of the mobility of healthcare professionals since they move around the hospital. Consequently, it can be inferred that adequate infrastructure is essential to support the use of health ICTs by healthcare professionals at points-of-care during the execution of their work activities.

Several scientific publications have described a lack of adequate infrastructure as one of the key challenges faced in the Nigerian healthcare system since the start of democracy in 1999; this seems not to have been sufficiently addressed. According to SRNS_H2, there is a dearth of infrastructure of hospital **H2** and the efforts of the hospital management in this regard “at the moment is zero as far as this hospital is concerned”.

> “In many hospitals in Nigeria, some of these imaging machines may actually not be functional in the hospital. For example, this place now, MRI, CT, is not functional so our patient will need to go out” (SRNS_H2).

The participants indicated that there are aspects of their work activities that may require patients to undergo special investigations. However, the hospital is not equipped for this. For instance, ONS_H2 mentioned that “when a patient is to come for a surgical procedure, the theatre people must have called; maybe the patients is to be there but the ambulance is busy attending to other patient”. The lack of sufficient ambulances causes a delay in the patient being safely transported from the ward to the theatre. Ultimately, this affects scheduled surgical operations and creates a backlog of the clinical activities of the healthcare professionals. In addition, with the manual medical devices available, such as thermometers, “at times, they malfunction, when you take a patient’s BP and consider that this thing is not properly functioning as it used to…then you go ahead to get another. These are the challenges and we don’t have enough of all these materials” (ONS_H2).

The response from the nurse participant indicates that there are limited available resources, such as ambulances and manual medical devices. In addition, the available manual medical devices do not function properly when used during nursing activities that require the taking of vital signs. It can be argued that there is an opportunity to incorporate a mHealth application into the nursing activities to enable collection and monitoring of patients’ vital signs. There are instances when patients need to be referred to another institution for special investigation. This creates a gap in information management and increases the time it takes for both doctor and patient to complete the service delivery process.

> “In many of these private scanning centres it is also often not easy getting a feedback from them in terms of report; this is because many of them are out for business…Many of them do not have the CTU radiologist on ground…or that this image has been done, the radiologist cancelled. For example, if our CTU machine is working especially MRI as well, the moment the images are required, the radiologist or radiology resident will see the images immediately and may be able to provide you a report” (SRNS_H2).

The participant further explained that “the images will be transmitted to the radiologist” who is resident somewhere else, “who will now look through and write their report so…there is hick-ups. Most time the images may just come to you the surgeon…and that’s what you’ll be working on until they will bring the written report which may come much after you are done or you want to do the images” (SRNS_H2). These challenges indicate that a lack of adequate infrastructure causes fragmentation of information; consequently healthcare professionals are left to either complete their decision-making without the available information or wait for an extended period of time until the information becomes available. The challenges indicated above have a detrimental effect on service delivery and, eventually, on the health outcomes of patients, as well the reputation of the institution.

> "So, had the right communication channels with them and I am able to see oh, it's not my case; send to this person. The patient wouldn't have wasted his own time to come on that day in order to be told to come back on a different day" (SRNS_H2).

> "Then if I have to wait for the report before I take action then it may jeopardise the patient care. But luckily for some or many of us, when you are requesting for images for example, you already have idea of what you are expecting to see. You are trying to confirm what you suspect… to be sure that there is no further complication" (SRNS_H2).

When asked whether there are any particular challenges with nursing work activities, one of the participants, ADNS _H2 stated that:

> "Most times while patients are on the couch or radiology table for the study the power goes off and that causes delay and at times repeating of fields. Most times we are unable to carry out procedures due to unavailability of adequate water supply. Asides that our machines break down often due to age or maintenance. Most times when they come the machines are malfunctioning. Other than that, personnel is another issue. We don't seem to have enough personnel around".

The response shows that erratic power supply, machine malfunction, inadequacy of water supply and lack of personnel inhibit the work activities of healthcare professionals. All these challenges result in an overburdened system, which impairs service delivery and consequent outcomes. Because of the lack of personnel "most times we are forced to work extra load to accommodate care that is rendered. So, most [of the] time we are made to work under heavy pressure" (ADNS _H2). The participant also mentioned that "most times when" patients arrive for their scheduled appointment, "the machines are malfunctioning; they may have to be re-booked and they go home". Clearly, this has time and cost efficiency implications for the patients, the healthcare professionals and the hospital.

Other challenges include the lack of accountability, work culture and the fear of imminent job loss. These challenges prevent the implementation and use of health ICTs to enable the work activities of healthcare professionals at points-of-care. For example, it was noticed that, when desktop computers were provided by the hospital, "people start using it for private Internet services" and where there is not Internet, "many people start using it for gamming at the expense of work" (SRNS_H2). Still on accountability, the participant further explained that:

> "Many of them [referring to health ICTs] are never seen through because the funding was never completed. And then when there is funding, some people still see it as per usual Nigerian setting where people see getting contracts from government to get money and not really to push through what you ask. But funding is a key factor" (SRNS_H2).

Similar to the selection of HITs in hospital **H1**, funding is mentioned as a factor enabling the adoption and use of health technology solutions to support healthcare service delivery. The findings indicate that funding and fear of job losses are perceived as likely reasons for the lack of implementation and use of technology to support healthcare service delivery. In this context, there is a correlation between the lack of funding and accountability.

> "Fear in the public sectors in Nigeria that automation will bring downsizing of workforce. But the truth remains that people are still going to be overseeing those automated process. And if we are really afraid of that, it means that the work that many of us are doing we are really not supposed to be doing it" (SRNS_H2).

It can be argued that the Nigerian government has given less than adequate attention to the cost of improving the status of healthcare service delivery since 1999. Additionally, there is a concern that digital transformation in the healthcare system may result in a spate of job losses. The cultural belief that the personnel in hospital **H2** might not be sufficiently disciplined to separate the use of ICTs and Internet services for official purposes from their use for self-pleasure, could serve as one of the many barriers to the implementation of HITs. The next section presents the effect of work-activity challenges experienced by the healthcare professionals during service delivery.

5.6.3 Effects of challenges on the work activities of healthcare professionals

The findings show that there is insufficient information required to make decisions at points-of-care, there is a lack of accountability and inadequacy in information management. The lack of adequate information, erratic power supply and the malfunction of tools often cause delays in the work activities of healthcare professionals.

> "Most times there won't be papers to make a document that such a patient was contacted at the point…so, when issues crop up such individual are likely to deny being informed verbally. And when they are not physically within reach, we might not be able to look at what they have to deliver information or messages that they are meant to receive" (ADNS_H2).

The findings imply that the resulting effects on work challenges have implications for both healthcare professionals and patients. According to ADNS_H2, the challenges experienced by nurses affect the quality of services rendered to patients. One of the doctors explained that they have to take the names written in the theatre book and scheduled for surgery to a typist for typing, after which it the list distributed to all the units that require this list, which takes between 24 to 48 hours to accomplish. This sometimes leads to errors and causes delays.

> "All the patients we have booked on the diary; the same book is on paper designed for all patient lists. We now transfer that single paper where I write the name or the patient number, diagnosis, surgical procedure, surgeon name. Thereafter, I take it to our typing office. They will type what you have written, in terms of patient list they will type it and then make many copies" (SC_H2).

A copy of the patient list is given to the consultant, "they take one copy to the theatre where the case will be done so that the nurses can see the cases that are coming on and get ready for the patient" (SC_H2). The blood bank receives a copy of the list to determine the amount of blood bags required. A copy of the list is delivered to the ward "where the patients are admitted so that the nurse on the ward will see and get patient ready for operation that morning". A copy of the list is taken to the section where hospital bills are administered "so that we know do they have insurance" (SC_H2).

The manual process of sharing paper-based information between the clinical units seems to be tedious and time consuming. As observed in the case of hospital **H1**, the administrative process also impacts on the preparation and execution of clinical work activities in hospital **H2**. Similarly, at the end of the surgeries the nursing staff call the wards to prepare receiving patients and send for a porter to assist with transportation back to the wards.

5.6.4 Potential opportunities to use mHealth technologies at points-of-care in hospital H2

A gap or need associated with a challenge creates an opportunity for a solution to be designed and implemented in the context of use. For example, the healthcare professionals at hospital **H2** indicated that health ICTs could be ideal to support work activities at points-of-care. When asked how a mobile technology would assist their work activities, one of the participants specified that "it's going to go a long way to assist in doing my work in a sense that you get right information promptly…for example, if I have a patient on admission and there's any complaint, the nurses are there in the ward 24-7…if it is something that they are not going to be able to handle, then they will bring it to the attention of the doctor" (SRNS_H2).

The response indicates that mobile devices would be useful to facilitate communication between healthcare professionals, particularly to locate a doctor during emergency cases. However, one of the participants mentioned the facilitating conditions and rules applied that are specific when implementing technologies in a cultural background where there is a tendency to abuse usage of the technologies. With regards to contextual conditions, the participant indicated that "any of that form of communication using the mobile phone, whether WhatsApp, emails are at the expense of individuals using it currently in Nigeria…then you have means of communications within the hospital setting so I think we need to embrace such but because many of these hospitals are government funded that's why it doesn't work" (SRNS_H2).

The findings suggest that mobile technologies are being used, and that they are most desirable to enable communication between doctors and nurses at points-of-care during patient consultations and follow-up visits. Participants explained that in a situation where patients are required to attend multiple clinics, or are transferred from one point to another, records management is cumbersome and that this results in long waiting times. If mobile technologies were implemented to facilitate communication at hospital **H2**, it would be desirable to have measures, such as wireless internet or data from mobile network operators, funded by the hospital management in liaison with the government.

> "I may have a patient who will see me as the neurosurgeon today for instance and also has maybe an endocrinology problem. The patient comes to my clinic and asks one folder first. So, I've seen him and he needs to leave my clinic which is not in the same vicinity with the endocrinology clinic. On arrival again at the endocrinology, the patient will have to wait for somebody to leave the endocrinology clinic to go to the neurosurgeon clinic to pick the folder. But if it is automated, as soon as I see and close my assessments…the next person just login and have access to the same information; even when I am gone it will be there" (SRNS_H2).

It is clear from the response that there is an opportunity to schedule appointments or visits and automate records management during clinic days at hospital **H2.** It was evident in hospital **H1** that digitised records facilitated quicker access to information during patient consultation and could reduce the overall time taken to deliver services to patients.

> "The ideal thing is that when we have a clinic, the patient ought to have booked. That's another area where technology comes back to. Many times, we tell a patient to go and book and when they book, many of them there's not a reminder for them. That will go a long way. Patient can forget for a little bit; or may not be able to come for some reasons" (SRNS_H2).

Healthcare service delivery is complex because of the interplay between both administrative and clinical activities. It is evident that technology enables the timely execution of work activities when appropriate for use in a particular context to cater for the needs of healthcare professionals and patients. The findings suggest that health ICTs are ideal the management of information used for patient consultations, to facilitate communication between healthcare professionals, especially during referrals and to manage appointment bookings.

Table 5.4 presents the summarised findings and the emergent themes from the participants interviewed in hospital **H2**.

Table 5.4: Key findings and themes from semi-structures interviews in hospital H2

How can mHealth technologies be used to enable interaction moments within the work activities of healthcare professionals in tertiary healthcare settings?		
Objectives	**Summarised Findings**	**Emergent Themes**
To determine the work activities of healthcare professionals	• The work activities of doctors in hospital **H2** are: patient consultation, referrals and a work-up plan. • Nursing activities include: monitoring of patients; administering of care, assisting doctors to facilitate clinical examination and verbal explanation of results to patients. • The tools used for clinical activities by doctors and nursed are paper, pen, manual medical devices and medical imaging machines. • There are no health ITs used by healthcare professionals to support their activities at points-of-care • Findings show that healthcare professionals use their personal mobile phones to facilitate communication and information exchange.	Details of work activities
To identify the work activity challenges experienced by healthcare professionals	• Administrative activities that are independent of healthcare professionals inhibit clinical activities. • Records management measures are not efficient. • There is a lack of adequate communication channels among healthcare professionals. • The primary healthcare system of the public healthcare sector is not functional and puts a massive strain on tertiary hospitals. • There is limited available medical manual devices and material resources in hospital **H2**. • The healthcare professionals indicated that the limited available manual medical devices do not always function adequately at points-of-care. • Other challenges that inhibit the introduction of technology at points-of-care include: a lack of accountability to track patient care; a work culture associated with lack of meaningful use of the Internet and technology and fear of job losses	Work activity challenges experienced by healthcare professionals
To describe the effects of work activities' challenges on healthcare service delivery	• Healthcare professionals are compelled to depend on their years of experience to make initial diagnosis where there is a dearth of information • The lack of adequate infrastructure such as erratic power supply causes fragmentation of information	Effects of work activities' challenges

	• Lack of available information extends the time taken to make informed decisions and the delivery of healthcare services • Lack of communication and immediate access to information always cause delays to collaboration and the completion of work activities at points-of-care. • The findings suggest that the lack of adequate information management may lead to the waiting times experienced by patients and healthcare professionals	
What are the characteristics of a desired touch point required to integrate mHealth technologies in the work activities of healthcare professionals?		
Objectives	**Summarised Findings**	**Emergent Themes**
To determine how mHealth technologies could be aligned at different service touch points	• Findings suggest that mHealth technologies can enable quicker access to health-related information during patient consultation. • The use of mobile devices for communication can assist to improve coordination of collaborative care. • Findings suggest the use of instant messaging applications to facilitate communication among healthcare professionals. • Implementation of health ICTs depends on the willingness and commitment of the government and its funding. • Wireless communication infrastructure is necessary for the implementation of mHealth technologies at points-of-care • mHealth technologies can be used by healthcare professionals to track scheduling of patients' visits.	Opportunities for to use mHealth technologies at points-of-care

5.7 Summarised interview findings of hospitals H1 and H2 contexts

While the aim of this study was not to do a comparative investigation between two contexts, but rather to understand the typical work activities of healthcare professionals and how mHealth technologies can be integrated within the clinical settings, the thematic analysis of data collected in hospitals **H1** and **H2** suggests that there are similarities and differences between the two contexts. Table 5.5 below illustrate the similarities and differences identified.

Table 5.5: Similarities and differences in the thematic findings from hospitals H1 and H2

Hospital Contexts	Hospital H1	Hospital H2
Similarities	• The work activities of healthcare professionals are similar. The doctors manage patient consultation, referrals and treatment or work up plan while Nurses mainly administer physical care to patients and write a detailed report on all procedures of nursing activities.	
	• Both healthcare professionals indicated that paper use may become cumbersome.	
	• The healthcare professionals are aware of the potential benefits for mobile phones to facilitate the access, exchange of health-related information and communication. • The healthcare professionals use their mobile phones to facilitate phone calls and, in some instances, real time instant messaging to exchange medical images and ask for advice.	
	• Healthcare professionals incur personal costs in form of airtime and bandwidth data costs when they use their mobile phones to facilitate phone calls and exchange of information. • Doctors indicated that the use of their mobile phones disrupt patient consultations at the clinics or in the wards	
	• Healthcare professionals suggested the necessity of wireless communication (Wi-Fi) infrastructure to be present to support the use of mHealth ICTs in the clinical settings of hospitals	
Differences	• The doctors use health information and communications technologies (ICTs) such as the enterprise content manager (ECM), picture archiving and communication system (PACS) and the VULA mobile application to enhance the tasks within their work activities.	• The doctors do not use health ICTs to support their work activities.
	• The nurses use nursing information management system (NIMS) to manage patient care administration.	• The nurses indicate the use of manual medical devices and a closed user group (in form of a mobile phone) to communicate.

Differences (continued)	• Clinical notes are digitised and stored in hospital information systems to enable the quicker retrieval of patient records.	• Clinical notes and patient records are fully paper-based.
	• Healthcare professionals indicate that the use of health ICTs has enhanced work activities. These include reduction in unnecessary referrals and quicker access to patient records and health-related information at points-of-care in the clinical settings of hospitals.	• Healthcare professionals indicated lack of adequate communication and information management to enable decision-making.
	• The provincial government is invested in the adoption of health ICTs by frontline healthcare professionals in public tertiary hospitals.	• The presence and willingness of the government to drive adoption of health ICTs is barely visible.
	• Doctors mentioned that the completion of work activities is extended in cases where health ICTs are faulty or offline.	• Healthcare professionals mentioned erratic power supply, non-functional public healthcare system and limited available manual devices are major challenges that inhibit their work activities.

The work activities of healthcare professionals in hospital **H1** and **H2** are similar. It is clear that in both hospital contexts, healthcare professionals use pen and paper to write their clinical notes. However, in hospital **H1** the clinical notes are digitised and stored in hospital information systems to enable the quicker retrieval of patient records during follow-up visits, which, ultimately, reduces waiting times and improves the work activities of healthcare professionals. The healthcare professionals in both hospital contexts are aware of the potential for mobile phones to facilitate the exchange of information and communication.

With regards to referrals, the healthcare professionals in both hospital **H1** and **H2** use a combination of paper and their personal mobile phones. The use of paper does not ensure accountability and information accuracy, whereas the use of mobile phones affords doctors the opportunity to exchange information and communicate with each other easily. The doctors in hospital **H1** use the VULA application and WhatsApp is used in both hospitals, **H1** and **H2**, as a means of managing referrals and bridging the communication gap that could inhibit the process of decision-making at points-of-care during healthcare service delivery.

The nurses in hospitals **H1** and **H2** mostly use paper to support patient administration and information management. Because of the need to accompany patients from one point-of-care to another, the use of paper becomes cumbersome and does not provide quicker access to, and support the retrieval of, information. In hospital **H2**, the nurses mentioned the use of CUG phones, provided by hospital management for each ward, to enable communication between healthcare professionals. However, the doctors and nurses in hospital **H2** stated that the CUG does not function as it should; thus, there is a communication gap.

The work activity challenges in hospitals **H1** and **H2** are specific to each context and are similar in some instances. For example, both hospitals **H1** and **H2** experience inadequacies of paper to seamlessly support information management and communication. In hospital **H1**, where there are implemented HISs, the systems are sometimes unreliable, which causes doctors revert to paper. The doctors stated that the Wi-Fi network signal in the hospital is poor, which delays information exchange. The healthcare professionals in hospital **H2** indicated that the public healthcare system of Nigeria is non-functional, referring to the primary, secondary and tertiary levels. There is a shortage of personnel and material resources; while the manual medical devices and the machines barely function. Erratic power supply was one of the most common challenges to the work activities of healthcare professionals in hospital **H2**. The findings related to the work activity challenges are interpreted in Chapter Seven.

The benefits of incorporating mHealth technologies into the work activities of the healthcare professionals in hospital **H1** and **H2** are evident in the fit-for-purpose of these technologies, but the usefulness of these technologies comes with its own set of drawbacks. Firstly, the doctors in hospitals **H1** and **H2** mentioned that they are responsible for the cost of airtime and data used to make phone calls and to facilitate the exchange of information. Secondly, access to mHealth applications via personal mobile phones can cause distractions and interrupt the work activities of healthcare professionals. Thus, it is necessary to give adequate consideration to the tasks and complexity of the work activities of healthcare professionals when provided with mHealth-enabling tools by the government and the hospital management in public healthcare systems.

5.8 Conclusion to Chapter Five

The research aim was to explore opportunities for integrating mHealth technologies into the work activities of healthcare professionals at points-of-care in selected tertiary healthcare institutions in Sub-Saharan Africa to support healthcare service delivery. Two sets of data were collected from the participants. The first set of data presented was acquired through semi-structured interviews with doctors and nurses from the selected tertiary hospitals, as well as from senior administrative staff members involved in selection and implementation of HIT.

The data sets were analysed qualitatively since the researcher adopted an interpretivist viewpoint to guide this research, where the knowledge of how technology can adequately enable work activities is dependent on the socially-constructed realities of healthcare professionals. The objectives of each research question were analysed inductively to identify the emergent themes. The researcher then organised the themes into a coherent and descriptive report that aided the easy identification of findings that address the research questions.

According to the emergent themes of the objective presented in section 5.5.1, findings indicate that the work activities of healthcare professionals are structured and consistent. Consequently, the nature of healthcare professionals’ work activities requires them to move between different locations, from the wards to the clinics and to the theatres in the hospital, and the tasks performed either produce information or use existing information. These information-intensive clinical activities require that healthcare professionals are reachable and accessible and, at the same time, that they have access to the necessary resources that empower them to deliver services. Therefore, this offers an opportunity to integrate mHealth technologies into the work activities executed by healthcare professionals to enable timely access to, and the retrieval and exchange of, information during patient consultations and referrals.

It is evident that there are ICT tools implemented to enable the actions of healthcare professionals in clinical activities. The implemented ICT tools facilitate access to patient information electronically and enable remote communication and consultation, both within and outside of the healthcare institutions. In contexts where mobile ICT tools exist, they are being used by healthcare professionals to exchange images and text, as well as to make phone calls. With regards to the outcome of using implemented ICT tools to execute clinical work activities, there is timely access to patient information, while communication and consultation between colleagues within and outside of the hospitals is made easier, especially during referrals.

With reference to the emergent themes of the objective presented in section 5.5.2, the findings show that implemented ICT tools provide healthcare professionals with real-time information, which includes text and images, irrespective of their location. In particular, the VULA application provides the details regarding referring doctors and enables healthcare professionals in the tertiary hospital to probe further during consultation, in the interests of precise decision-making. However, notifications from the VULA application repeatedly interrupt healthcare professionals during consultation with patients and, when electronic systems are down or offline inhibits the progress of work activities. A mixture of gain and pain points, particularly attributed to the VULA mobile application and desktop tools, suggests that the systems were designed without adequate consideration given to their impact on patient-doctor interactions at the points-of-care. Thus, there are contextual conditions indicated by participants that are responsible for the unintended consequences of the use, or non-use, of health ICTs by healthcare professionals during their work activities in the clinical settings of hospitals.

One of the major factors affecting the use of health ICTs is electricity power supply. Erratic power supply inhibits the work activities of healthcare professionals and defeats the motives for the implementation of HITs, such as HIS. It was evident from the findings that limited available resources and the lack of a system to take stock inhibits the quality of services provided by healthcare professionals at points-of-care.

The emergent themes of the objective presented in section 5.5.3 suggest that a mobile device which immediately digitises records could reduce the waiting period of the turnaround time associated with scanning patient records into the HIS. Mobile technologies, at this point, are more suited to record (capture) verbal communication, in addition to written clinical notes, during patient consultation and teleconsultation involving emergency cases. For example, the VULA application used to manage referrals is more suited if used by healthcare professionals to deal with emergency calls and teleconsultation cases in remote locations.

According to the emergent themes of the objective presented in section 5.5.4, the findings indicate that frontline users are engaged in understanding their service needs for the selection process of fit-for-purpose HIT solutions. Some factors that influence the choice of HITs are complexity of work activities, cost attributed to funding acquisition, addressing inefficient work activities via digital transformation, and government's willingness to equip the institutions. In one of the contexts, HITs are implemented at an enterprise level, which allows for data storage and access to be centralised. This is possible because of the use of a unique identity number, the patient master index. The use of this index enables interoperability of data relating to all the services rendered by the healthcare providers in the public healthcare system. This implementation model ensures accountability and assists with budgeting and allocation of the resources required by hospitals for service delivery.

In the context of hospital **H2**, the work activities are consistent with what is observed and reported in hospital **H1** but the use of health ICTs is minimal. Healthcare professionals in hospital **H2** said that they largely use paper, manual medical devices and their personal resources to execute their work activities. The main challenges indicated include a lack of infrastructure, ineffective communication and poorly maintained resources. The healthcare professionals in hospital **H2** indicated that they are aware of the likely benefits associated with digitising manual processes associated with the collection, storage and retrieval of information, and for communication between professionals or between clinical departments. Some of the pain points expressed by the participants were specific to each context, while there were certain similarities as well. In the next chapter, Chapter Six, the researcher presents the themes and findings obtained from the co-design activities used to engage participants in hospitals **H1** and **H2,** respectively.

CHAPTER SIX: PRESENTATION OF FINDINGS FROM THE PARTICIPATORY CO-DESIGN ACTIVITIES

6.1 Introduction to findings from the co-design activities

The outcome of the interviews as observed from the responses of the participants show the current situation *'as-is'* with respect to the work-related activities of healthcare professionals and how ICT tools are used as enablers in tertiary healthcare. Consequently, the findings from the *'as-is'* were further interrogated using a co-design activity to validate the *'as-is'* situation and to identify enabling factors to bring about a '*could-be'* situation. A co-design activity was used to complement semi-structured interviews to inquire about, and to visualise the activities of healthcare professionals at the beginning, during, and at the end of care services. By doing so, the researcher was able to compare and validate what healthcare professionals *said* against their *actions*, during the execution of their work activities.

The co-design activity involved a combination of open-ended questions and the use of pictorial probes to engage with healthcare professionals about their workflow, tools used and their individual (or group) experiences. The engagement with participants through the use of a co-design activity correlates with the **DISCOVER** and **DEFINE** phases of the service design DDM. The objectives of these phases are focused on the touch points and respective identified service interaction moments towards proposing concepts for supporting technology-enabled work activities in the **DEVELOP** phase of the DDM. This enabled the researcher to confirm or identify the pain and gain points from the interviews, as well as to identify any other discrepancies associated with the participants' previous responses.

The layout of data presentation in Chapter Six is as follows: an introduction in section 6.1; followed by a detailed description of how each step of the co-design activity was planned and actioned in section 6.2. Findings from the co-design activity undertaken with orthopaedic doctors in hospital **H1** are discussed under different themes in section 6.3. These themes are the current work activities of orthopaedics doctors, in section 6.3.1; the challenges experienced during these work activities, in section 6.3.2; and suggestions for technology-enabled work activities, in section 6.3.3. The findings from the co-design activities with nursing staff in hospital **H1** from the trauma wards, theatre and intensive care units (ICUs) are then discussed in section 6.4. In section 6.5, a combined description of the findings from the work activities of specialist doctors in hospital **H2**, their work activity challenges and suggestions of technology-enabled work activities are discussed in sub-sections 6.5.1 – 6.5.3. The findings from the co-design activities with nursing staff in hospital **H2** are presented in section 6.6. In section 6.7, a combined summary from hospitals **H1** and **H2** are highlighted, followed by a conclusion to Chapter Six in section 6.8.

6.2 Description of the co-design activity with participants

In a co-design activity, the researcher assumes the role of a facilitator or designer to incorporate their knowledge of the issues of investigation and the research design methods in order to foster participants' active participation in the process of data collection. The researcher encouraged autonomy among participants so as to describe their current workflow, from the first contact with patients at the different points-of-care. Through this process, the researcher was able to gain knowledge close to first-hand knowledge from the experiences of participants in practice, and towards contributing to the enhancement of existing healthcare service delivery. The motivation for using a co-design activity was to comply with, and manage, ethical concerns or any associated disruptions that might arise from directly observing the clinical workflow of healthcare professionals in real time. A co-design activity also provides an opportunity for the participants to reflect on their experience in a more relaxed setting. To facilitate the co-design activity, the researcher prepared materials needed and set up dates, as determined by the participants, subject to their availability.

At the beginning of the co-design activity, the researcher provided neatly cut-out graphic representations of doctors, nurses and the tools that they use, in order to portray healthcare work activities, as indicated in literature. Then, large pieces of paper, pencils, erasers and stickers were provided to the healthcare professionals as writing materials to be used for illustrating their workflow during healthcare service delivery. According to Debrah et al. (2017), the use of cut-out representations of actors and tools provides an opportunity for participants to visually express their actions and experiences to researchers.

The first task was for the participants to visually illustrate how they perform their work activities and the different tools used to execute the tasks within their work activities. Subsequently, the participants used the cut-outs to represent themselves, as actors, on a large piece of paper using the stickers, thereby giving practical descriptions of the actions undertaken in the course of service delivery at the points-of-care. The outcome of the first task was a visual illustration of the workflow or user journey maps of healthcare professionals from the first encounter with a patient until the patient is discharged, or otherwise.

For the second task, the researcher used visual illustrations to identify the touch points within the process of service delivery. Afterwards, the researcher probed using open-ended questions to find out whether there were any challenges experienced by healthcare professionals while using technology to support their work activities. The outcome of this task produced the challenges and the resulting effects attributed to the technology used by the healthcare professionals. The results of the second task were used to facilitate a discussion between the researcher and the participants on how the technologies could be best suited for their work activities. The outcome of the third task was to present the summarised characteristics of the expected features that a fit-for-purpose technology could have to enable work activities. This marked the end of the co-design activities. The findings from each service touch point, and their respective service interaction moments, are presented in sections 6.2 and 6.3.

6.3 Findings from the co-design activity with orthopaedic doctors in hospital H1

The co-design activity included the healthcare professionals (**Ort1_H1** and **Ort2_H1**) who participated in the initial semi-structured interviews in the orthopaedic department. This enabled the researcher to maintain a certain level of consistency of data source. The co-design activity was a joint session; however, only one healthcare professional, **Ort2_H1,** mostly engaged with the researcher as a way to prevent redundancy and replication of data, since their work activities are same. In qualitative studies, findings are influenced by the attributes of variables that infer the issues of investigation and the frequency of occurrence. Thus, saturation point is reached the moment where no new information is revealed, or when participants from the sample reveal the same information (Saunders et al., 2009).

6.3.1 Current work activities of orthopaedic doctors – *as-is*

The findings revealed three main service touch points within the care path of healthcare professionals in a clinical department who use medical imaging and reporting to make a diagnosis and to deliver service to patients. Service touch points are described as instances where a user comes into contact with a service (Clatworthy, 2011). In the context of this study, the service touch points were indicated as consultations, bookings, retrieval of medical imaging, and the development of a treatment plan. Consultation can either be done locally with patients or remotely with other healthcare professionals, via digital referrals received on the VULA application.

According to the participants, consultation with patients usually takes place in either the outpatient clinic of the orthopaedics department, in trauma units or in the wards, when healthcare professionals are on duty call. The participant stated that during the consultation at the outpatient clinic, they “talk to them” during consultation, referring to the patients. When asked which tools are used to assist during this period, the participants responded, “No electronics, paper”, implying that consultation with patients is done using verbal communication and handwritten clinical notes written on paper. In other words, the service interaction moments during local consultation are verbal communication with patients, performing necessary clinical examinations on the patient and documenting patients’ history and preliminary diagnosis by writing notes on a piece of paper.

Once the patient history is taken and the clinical examination is done, healthcare professionals then "book x-rays on a computer". The x-ray booking is requested digitally using the PACS. This implies another interaction moment, but a one-way moment, from human-to-computer. The request is received by the radiographer in the radiology department, pending the arrival of the referred patient, who is assisted by the nurse. The service interaction moments at this touch point are mainly human-to-computer and human-to-human moments, facilitated by a computer or human-to-computer-to-human activity. This means that the specialist doctor uses a desktop computer to send the details of the procedure required to the radiology department. The request is accepted and processed by the radiographer and the digital x-ray is sent back to the specialist doctor who initially made the request for further processing or decision-making. The participant confirmed that the interaction moment at the consultation touch point is enabled digitally because the "x-ray is electronic". At the end of the consultation, the participant pointed out that the paper record generated during verbal communication and clinical examination is used to prepare the treatment of, or management plan for, the patient. Subsequently, the clinical notes and patient information handwritten on paper are put into a folder and taken away from the doctors to be scanned into an electronic format when the patient is discharged.

> "This [paper] is taken out of our hands then hospital captures it electronically. So, if I saw you last week, I make paper notes…put it in a folder and patient goes to the nurse. The nurse read the files in the folders where the admins are; and if I see you this week and I can't remember what is your information, I go onto the computer, on the website, ECM, and I can draw up my notes from last week" (Ort2_H1).

The response shows that clinical notes, handwritten by healthcare professionals, are handed to the nurses to take further action, where necessary. The paper records are then captured electronically by the administrative staff, a clerk. The doctor indicated that they are able to access and retrieve their clinical notes about patients from the web-enabled ECM system.

In an attempt to identify the specific points at which a technology is necessary during the workflow of healthcare professionals, the participant responded that "in [the] clinic, it is in front of computer…in trauma, you move around" (Ort2_H1). The participant further explained that the type of "work responsibilities, the type of patient, and location" differentiates consultation at the clinic and a call taken in the trauma unit. During clinic consultations, the doctor examines a patient physically in a room and can access the hospital information system accordingly. Hence, a desktop computer is ideal, but when the doctor is required to move around, healthcare professionals would require mobile technology to enable their tasks.

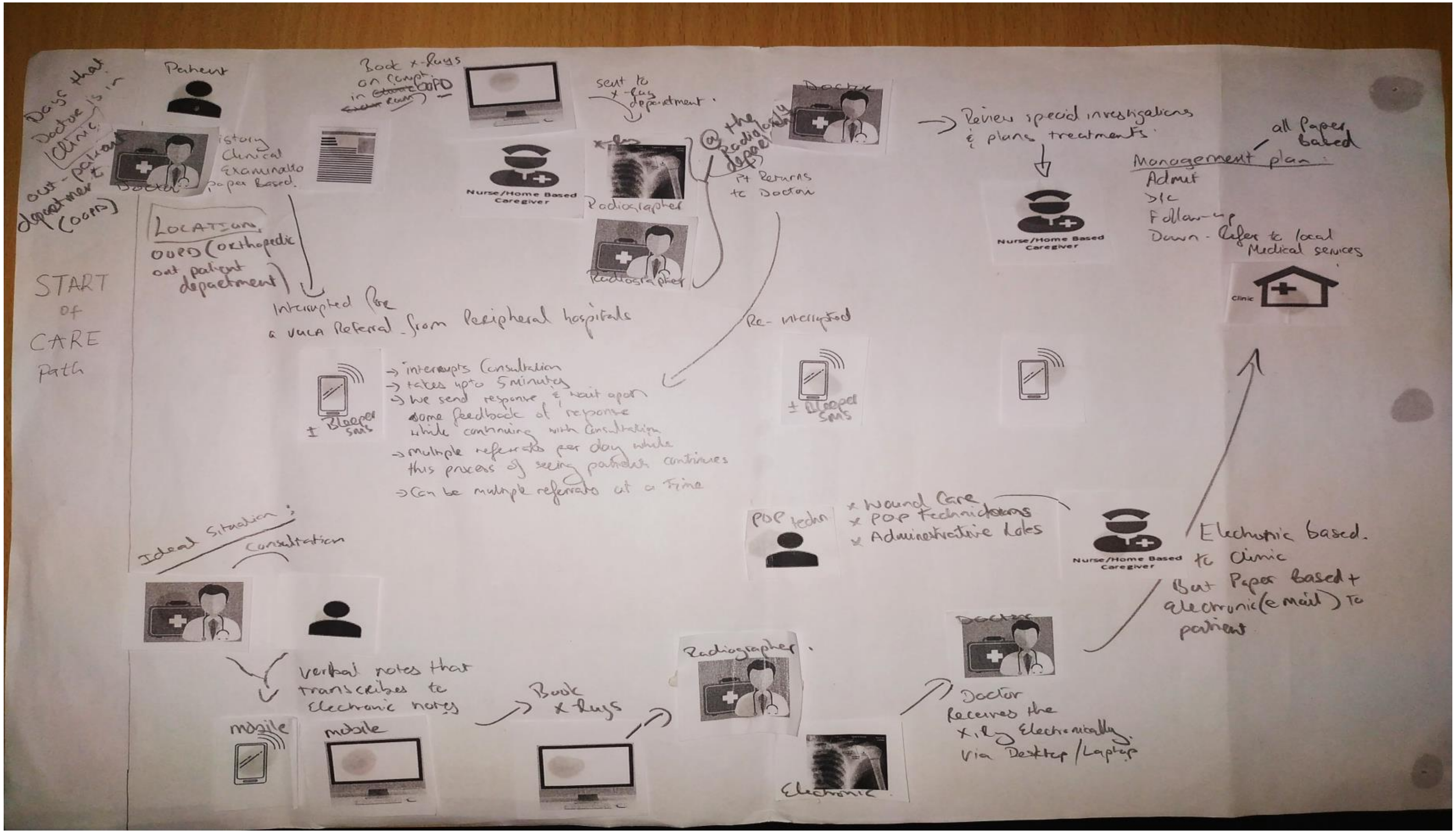


Figure 6.1: User journey map of healthcare professional in orthopaedics outpatient clinic

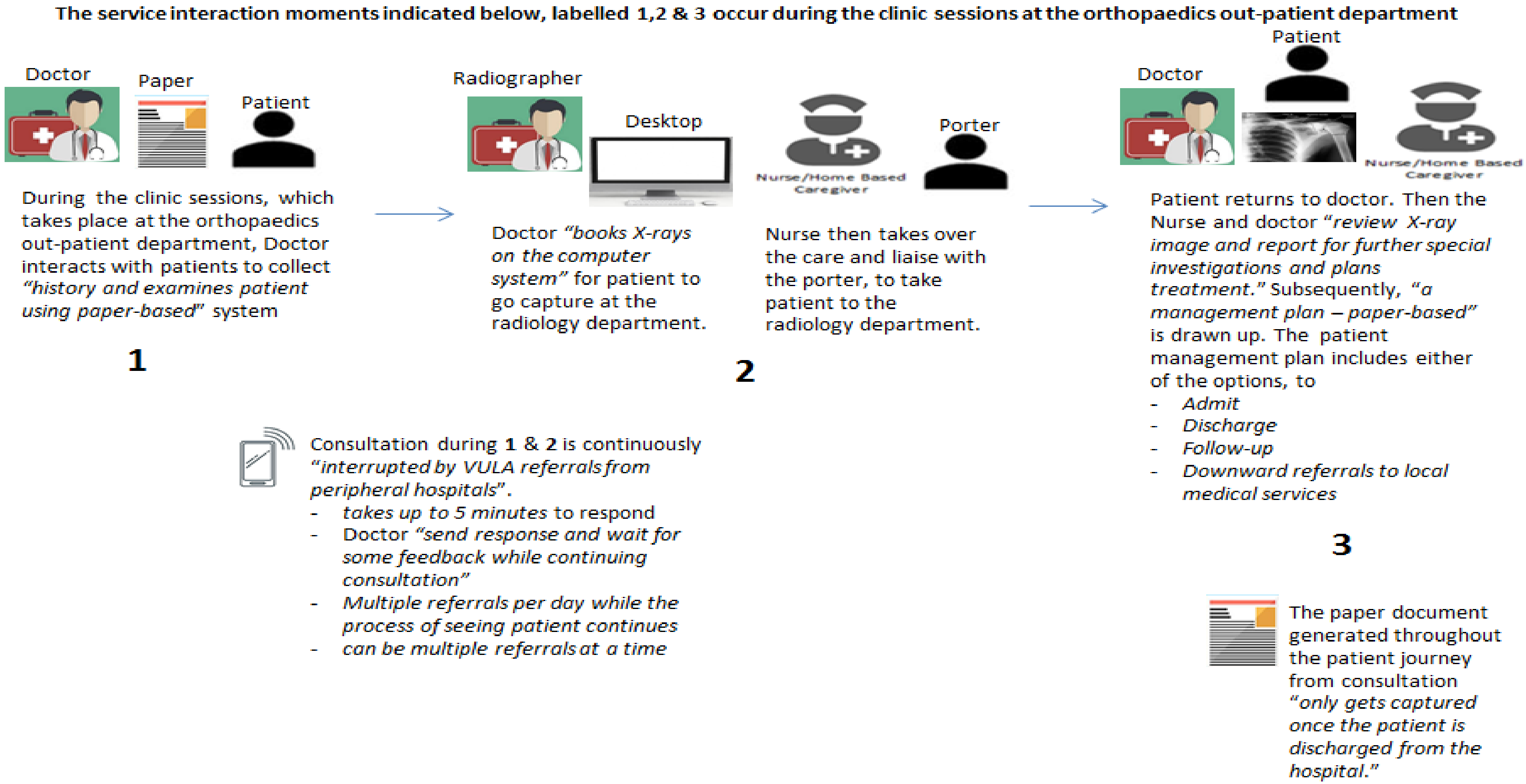


Figure 6.2: Digitised illustration of user (healthcare professionals') journey map in orthopaedics clinic

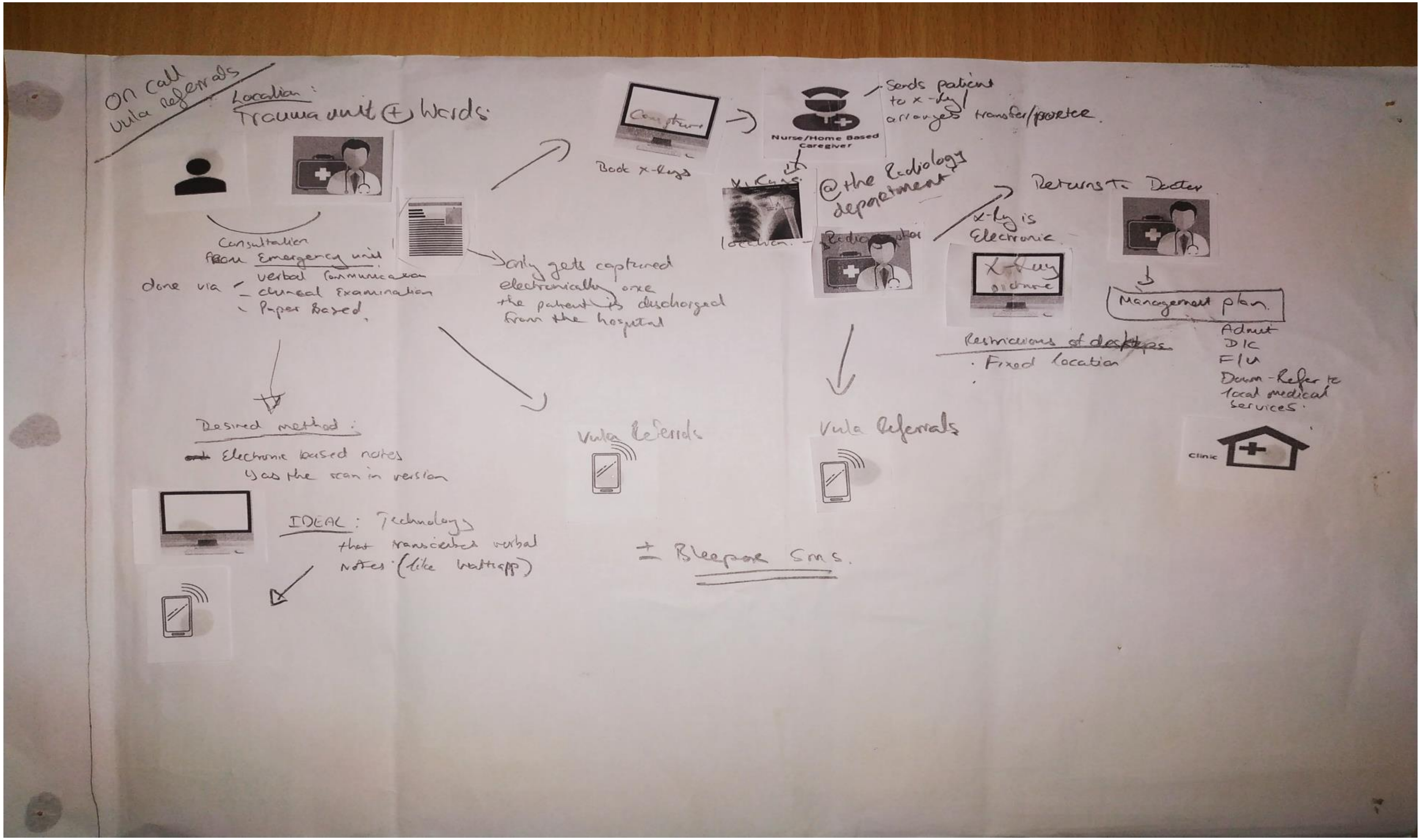


Figure 6.3: User journey map of healthcare professionals in trauma ward units

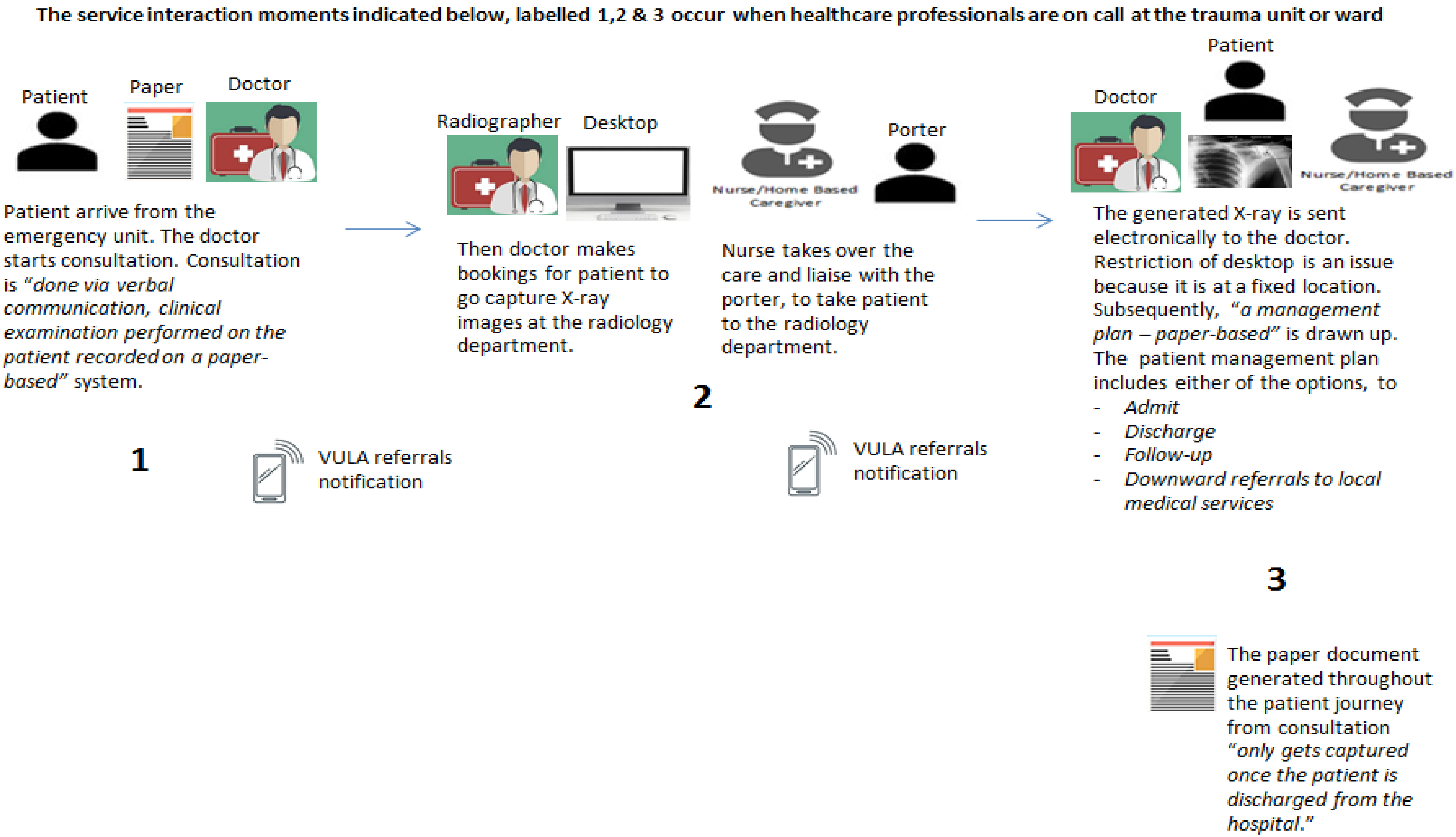


Figure 6.4: Digitised illustration of user (healthcare professionals') journey map at trauma ward units

Subsequently, the researcher asked the doctors to discuss the challenges associated with the touch points identified from the visual illustration of their current workflow. This enabled the researcher to further identify the interaction moments of tasks that could be challenging for healthcare professionals at points-of-care.

6.3.2 Challenges with the current work activities of orthopaedic doctors

On first contact with the patient, the first work activity when doctors engaged with patients is during consultation. In order to collect information in the form of histories, it was indicated that verbal communication and writing are the two prominent actions at this point. During the exercise, the doctor estimated that up to 40 patients are seen on a daily basis: “We strategically write patient stories…with my handwriting, I’d write two pages per patient” (Ort2_H1).

Participant (Ort2_H1) mentioned that producing handwritten notes could be exhausting, depending on the number of patients who are attended to on a daily basis. Furthermore, there is a restriction in the number of desktop computers in the trauma unit and wards. Therefore, the location and availability of desktop computers may influence how healthcare professionals make use of this technology. For example, the unavailability of desktop computers could compel a healthcare professional to revert to paper, as a work-around. Ort2_H1 indicated that “there are only three computers in the trauma unit and if someone is busy on the computer you can’t use it” (Ort2_H1). Nevertheless, the participant stated that while “attending to emergency patients, you can’t always interrupt management to answer a VULA referral” (Ort2_H1). The participant further mentioned that local consultations with patients in the orthopaedic outpatient clinic are often interrupted by several VULA application referrals from peripheral hospitals. The VULA application referrals are equivalent to remote consultations. The participant indicated that “it takes up to 5 minutes…we send the response and wait upon some feedback on the response while continuing with consultation” (Ort2_H1).

The service interaction moments during remote consultation include viewing a VULA referral, sending feedback to the referring doctor specialist, or getting someone to respond to the VULA referral request.

> “Let’s say you work from 8am to 4pm, that’s about 20/30 referrals. Depends on during the day of seeing patients… You’ll get about 30 between 8 o’clock and 4 o’clock when you hand over to the guy that’s on call after-hours. So, this process will happen about 30 times, in the process of seeing about 30 patients/ multiple referrals per day” (Ort2_H1).

The participant indicated that during the typical working hours of the day, they are required to attend to several VULA referrals, which could be both multiple and simultaneous. The responses show that this interruption prevents doctors from performing and completing their consultations with patients in time. This suggests that the VULA application was designed with little or no consideration given to how to prevent work interferences.

> "You can easily be interrupted for 10, 15 minutes where you're not seeing the patient in front of you because you're now replying to this, and you're getting another one that you have to now look at again and reply" (Ort2_H1).

The researcher asked the informant whether healthcare professionals had the option to transfer the VULA application referral notification to someone else, i.e. a less busy colleague within the clinic. The reason for asking this question was to establish whether there were measures in place that take into consideration the inability of healthcare professionals to respond to VULA application referrals during emergency cases involving face-to-face consultation with patients.

> "There's one person responsible for attending to VULA referrals during the day. He could maybe, say if he is in theatre for whatever reason…ask a buddy; can you just take the referrals for the next 2 hours while I'm in theatre… and then he hands over to the person that is on call for the day. So, let's say in a 24hrs cycle there would be two people. So that's essentially what happens when…in clinic" (Ort2_H1).

It is evident from the response that there are two healthcare professionals responsible for attending to VULA application referrals every 24 hours. The VULA application referral notifications sometimes become overwhelming when the healthcare professionals are exceptionally busy in the clinic or when they are attending to emergency cases in the trauma unit.

The participant indicated that during follow up visits, "there's a back log" and "it takes a month to six weeks probably" (Ort2_H1). It could be inferred from the responses that the electronic capturing of paper-based records creates a backlog in follow-up visits by patients and sometimes leads to the duplication of information. Evidently, the interaction moments or actions within the work-related activities of healthcare professionals either generate, or make use of generated information for decision-making, hence timely access to up-to-date and comprehensible information is essential. The challenge at the consultation touch point is the effect of backlogs in the ECM system and interruption of VULA referrals on points-of-care. Subsequently, the researcher sought to find out how challenges indicated at interaction moments during work activities at different touch points could be addressed.

6.3.3 Suggestions for ideal technology-enabled work activities – *could-be*

Based on the challenges identified in the *'as-is'* situation of the current work activities of healthcare professionals, the researcher asked the participants to suggest what would be an ideal situation, either based on their experiences or on their needs. The researcher asked about an ideal tool that could assist healthcare professionals to address the occurrences of backlogs associated with the capture of handwritten paper-based records electronically by the hospital. One participant suggested a device that transcribes verbal communication from audio to text would be ideal for localised consultation. To further describe the motivation of the response, the participant demonstrated to other colleagues how WhatsApp could be used to transcribe voice to text in real time. It is clear from the demonstrations that some healthcare professionals are conscious of technology features that are not designed specifically for their work-related activities but which could be immensely valuable to them.

> "Like you do on WhatsApp, instead of sitting there typing, you can just…have you used that on WhatsApp? Works incredibly well, just hold it in, talk, and let go. No, the one that transcribes/ Have you seen it? There's a little microphone? Where you press and then, it transcribes into the typing part… press that button, that microphone… Ok, talk in English, anything" (Ort2_H1).

The demonstration suggests that it could be ideal for healthcare professionals who have tested technology features available to them and to perceive them as being useful for certain work activities, to facilitate training for their colleagues. Additionally, there is a level of awareness displayed by this participant on how the innovative use of technology not designed for health-related purposes could assist healthcare professionals to perform tasks during their work activities. This is further discussed in Chapter Seven, where the researcher interprets instantiated interactions between humans and technology established from the participants' feedback.

The findings indicate that an ideal mHealth technology that could be used by the healthcare professionals during consultation with patients would require voice recognition and medical semantics. The use of such a technology during local consultation to capture patient data would eliminate the need to constantly write notes on paper, avoiding duplication and reducing the time (currently, approximately six weeks) it takes to scan the paper into an electronic system. In addition to the WhatsApp voice-to-text feature, participant Ort2_H1 explained that if "someone from a different speciality is looking for you, they phone the switchboard and then the switchboard beeps you on your cell phone…you get another number you must phone…on sms".

The response above indicates that healthcare professionals are well acquainted with the idea of using a mobile technology to facilitate communication and to locate their colleagues at anytime and anywhere in the hospital. In trauma, doctors move around, hence it might be ideal "that here the mobile device mostly fits in" (Ort2_H1). The doctor indicated that because of the movement between different locations, a mobile device would be ideal to access digitised paper records, to make audio notes in real time and to facilitate communication with other professionals during coordinated care service delivery.

Despite indications that the use of the VULA application has helped to reduce the frequency of unnecessary patient visits or referrals to a tertiary hospital, it definitely intrudes on the process of patient management in the trauma unit. An ideal functionality would see referrals being automatically transferred after a certain period of time with no response, depending on the severity of the remote consultation or referral. This would ensure minimal disruption of the specialist doctor busy with patient management at the different locations, which may include the clinic, theatre, the trauma unit or the wards.

In summary, the service interaction moments identified in the current work-related activities of healthcare professionals include verbal communication, performing clinical examinations and documentation of clinical notes by writing the notes on paper, as shown in Table 6.1. The outcome of these interaction moments often times influences (or renders ineffective) the work performance of healthcare professionals. In particular, it takes a long period of time to scan in paper notes into the ECM system, thereby creating a backlog and duplication of records. It is noteworthy that healthcare professionals are familiar with smartphone features on other applications that could assist them to improve the efficiency of performing the interaction moments of tasks when tailored specifically to work activities in clinical settings.

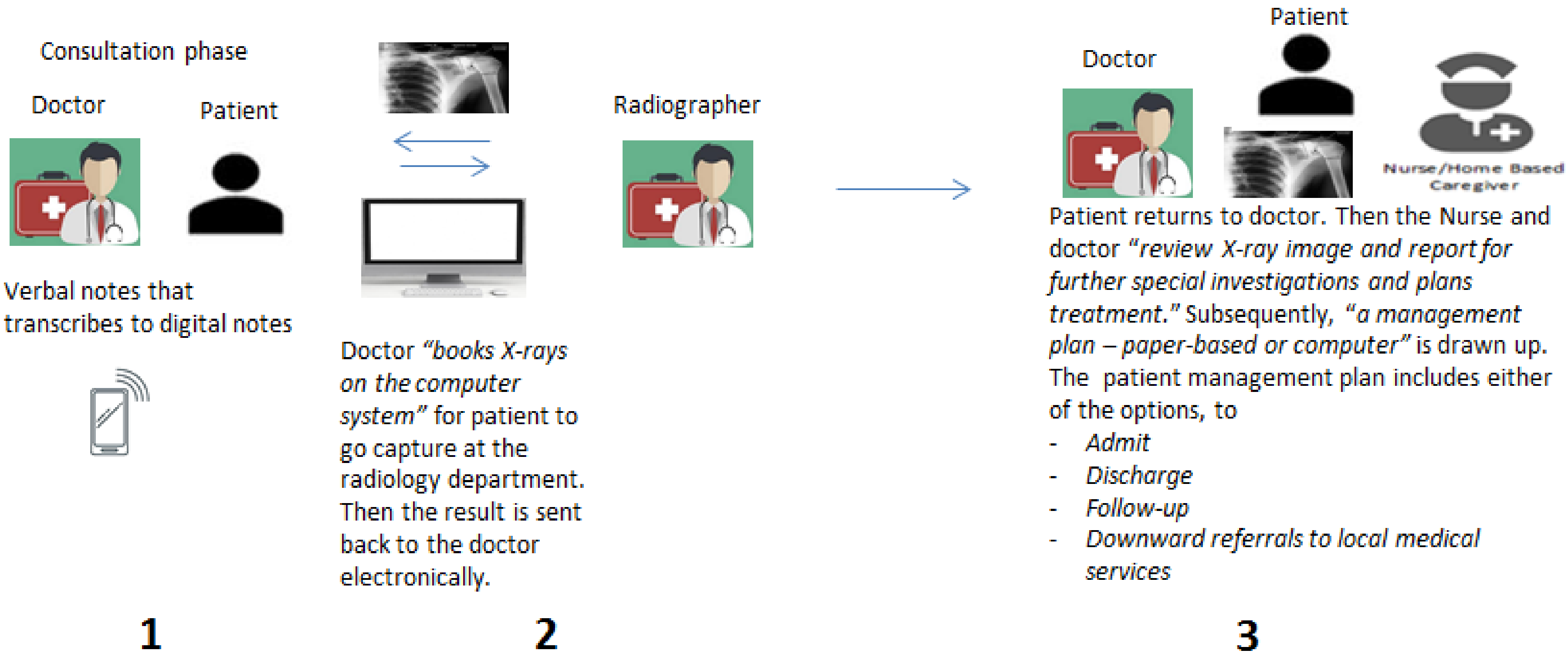


Figure 6.5: Digitised illustration of the prescribed scenario as informed by the healthcare professionals

6.4 Findings from the co-design activities with nursing managers in hospitals H1

In an effort to garner additional insights into how the nursing work activities complement that of doctors, the researcher engaged three participants who have in-depth experience and could provide comprehensive details of nursing activities in tertiary healthcare. The participants were nurses with over 20 years' of experience coordinating the activities carried out in the trauma theatre and intensive care units of hospital **H1**.

6.4.1 Current work activities of trauma nursing activities – *as-is*

The trauma nursing manager indicated that a clerk in the "admissions department…open the files" for patients being admitted into trauma. The nurse revealed that there are "three areas in trauma" unit (TrNM_H1). She continued that "we got a front room…this one is back from x-rays… and this is our referral area". At the front room, the patients are given "the new sticker that have a unique number, like a file number, so we use the same number if they come from a district hospital or a primary health care facility". The response shows that there is a patient management system in place across all the public institutions in the province, where every patient has a unique identification number.

Subsequently, the nurse attends to the admitted patient using a system that classifies patient visits and manages waiting times, based on the severity of care needed. The participant explained that "the triage system…like green patients can wait for so long then we explain to the patient you are green you can wait 6 hours before a doctor attend to you" (TrNM_H1). The participant continued to say that "red patients [are] our emergencies…those are the ones that need incubation right there". It can be inferred from the response that after patients are admitted, they are categorised using a triage system. The triage system prioritises the urgency of a particular case, provided by healthcare professionals based on the severity of the case. When asked if the triage report is paper based, the participant confirmed that "[a] nurse writes a report… and all the findings there… and will report to the doctor" (TrNM_H1). Then, the doctor is said to "write his management down there on the paper" and "he will book the x-rays, the scan…and examinations" on the PACS system. The participant also indicated that, while the nurse writes reports on a patient based on the triage system, the doctor uses both paper and a computer to make the requests necessary to support decision-making. This finding is similar to the information provided by the doctors during the semi-structured interviews and during the co-design activity. The details are discussed further in Chapter Seven.

After the doctors have concluded the examination of patients, the participant indicated that the nurse "give[s] medication, do observation [of] the vital signs; then…writes a report, patients seen by the doctor, all the examinations requested" (TrNM_H1). The nurse then informs the porter, via the “hospital’s landline phone” to “come and take patients into x-rays”. It is evident that the nursing administrative process is paper based, except for the phone calls made to the porters. The participant explained that the porters assist with physically exerting tasks, such as to “help with pushing the beds or wheelchairs taking the patient to the wards like ICU or theatre” (TrNM_H1). When a patient return from the radiology department, the nurse writes the report that the “patient is back from x-rays or had his scan”. When asked how the reports are written, the participant indicated that they are written on paper and “it’s in a file”; subsequently it is captured electronically on ECM “when the patient is discharged”.

The response suggests that the nurse captures a timeline of actions from patient admission into trauma until they are discharged in the form of reports, with the aid of paper. Nursing activities are focused on delivering patient care as well as on information management. In addition, the participant mentioned that security access to the ECM could be a concern, with claims that, “everyone has access to the ECM…confidentiality is a problem because anyone can now take your file number” and view patient information. While the likely effect of their security concerns were not mentioned nor addressed, there is a body of literature associated with the necessity to maintain confidentiality and privacy of patient information.

The participant mentioned that after the nurse receives a patient in the back-room area, “the doctor will see the x-rays…[and] look on the PACS” to make a diagnosis and a decision with regards to treatment. Depending on the severity of the injuries, “the doctor will discuss the patient with a referral doctor like the neurosurgeon or the orthopaedic surgeon” (TrNM_H1). The decision may require a discussion with “members of a multidisciplinary” team, including healthcare professionals or specialists who also “look at the x-rays on the PACS”. Subsequently, the referring doctor and the nurse phone the ward or theatre to inform these units of an incoming patient. The participant (TrNM_H1) said that they “phone the porters and then the porters will come” to transport the patients to the ward or theatre till the patient is discharged by the nurse.

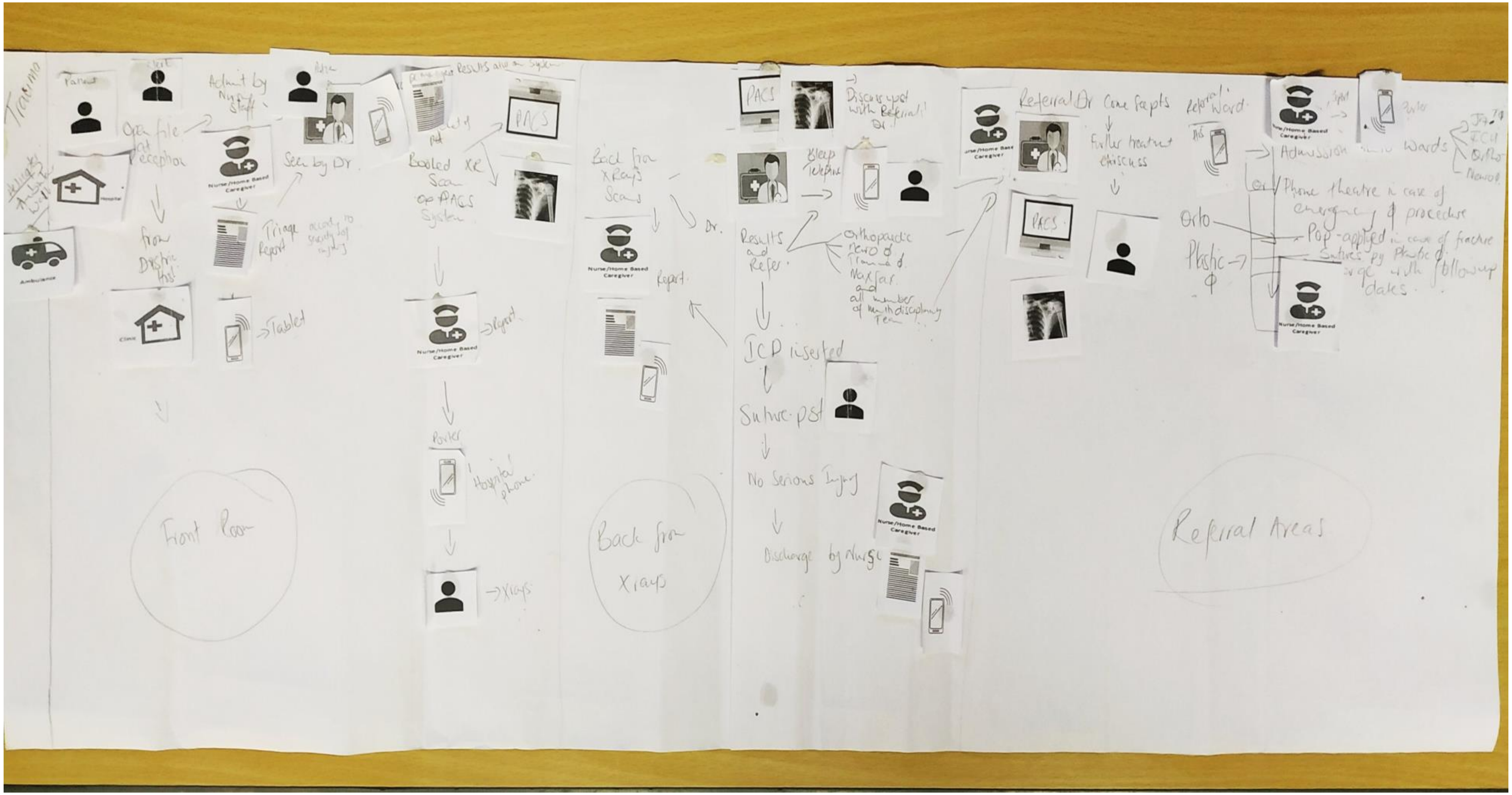


Figure 6.6: Nursing work activities journey map in trauma ward

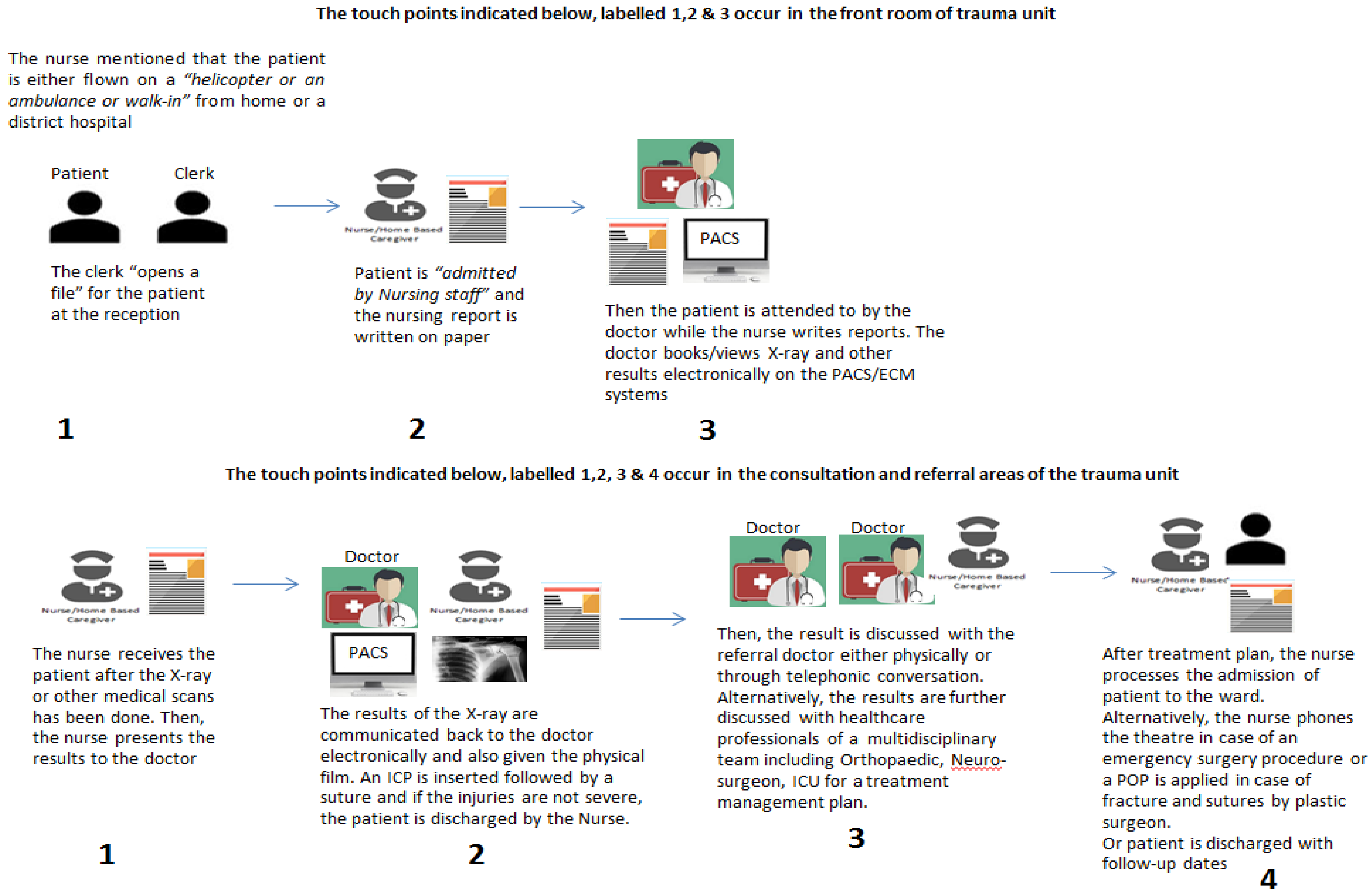


Figure 6.7: Digitised illustration of nursing work activities journey map in trauma wards

6.4.2 Towards improving technology-supported nursing activities in trauma wards of hospital H1

After having completed the description of the current nursing activities in the trauma ward *'as-is',* the researcher requested the participant to review the workflow and indicate the points at which a technology would be necessary to improve the effectiveness of the process. Participant TrNM_H1 indicated that technology should be implemented from the start of the process where a nurse begins to write reports on activities, demonstrating that "if you start here you must continue until here", namely, the end of the patient care path. TrNM_H1 continued by saying that "it can be like an iPad…it must be the same because it's the whole patient", showing preference for a handheld device to serve the purpose of continuous information capture. The participant further indicated that having such a device would reduce the need for paper: "It's a lot of paper. Who is 'their' here? If you draw blood its paper…if you give blood its paper…if you put on a drip, its paper". The choice of a technology device to capture nursing activity information and to facilitate report writing is informed by the need to continuously capture information at every point-of-care. Currently, report writing is done using pen and paper, and the report is eventually sent to the scanned centre of the hospital to be digitised when the patient is discharged. However, the use of paper becomes cumbersome over time and the notes generated are susceptible to loss and errors or omission of vital information during the multitasking involved in nursing activities.

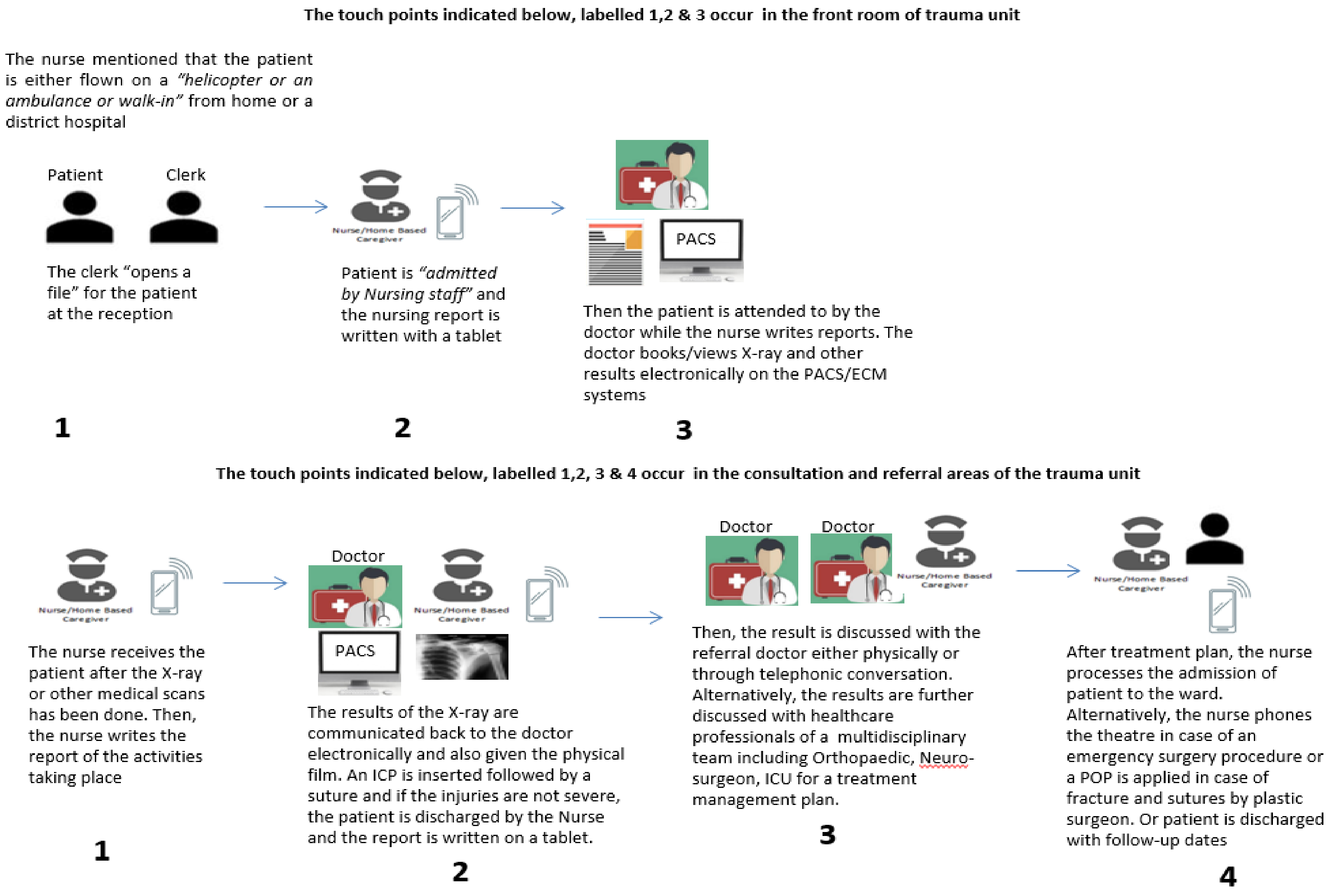


Figure 6.8: Digitised illustration of the prescribed nursing work activities journey map in trauma wards

6.4.3 Workflow of nursing activities in theatre

In the trauma ward, if the referral doctor makes a decision to admit the patient to the ward or theatre, the nurse in the theatre takes over from the trauma nurse. The following sets of excerpts are responses gathered from the nursing manager in theatre.

Participant TNM_H1 stated that patients arrive in the theatre “from other hospitals… emergency services…or wards”. To elaborate on the nursing activities in detail, the participant explained that “the patient is booked on the emergency list” by the doctor. The emergency list is described as “a book where they list the patients they are waiting for…in theatre, there’s a list with a lot of patient names”. Once the list is populated for the day, the doctor indicates that “the patient can come into theatre” for clinical procedures. It can be inferred from the response that the booking of patients for clinical procedures in the theatre in hospital H1 is paper based.

The nurse then makes a request for “the porters fetch the patient at the ward…to make sure they come to theatre” (TNM_H1). The porters are described as “the ones who collect the patients in the ward”. When the porter arrives with the patient, “the nurse receives the patient here at recovery for theatre now”. Before the procedure commences in theatre, “the doctors are using the PAC system”. The participant followed up with an instance of the type of information accessible on the PAC system, “the doctor now looks on the system…just in case it’s an orthopaedic patient, which side must be done” (TNM_H1). The PAC system assists doctors to access adequate patient information in order to make informed decisions on how to proceed with the scheduled clinical procedure. The participant continued that in the course of the clinical procedure, the nurse “writes down the complete recordings…writes it on the board and…writes it on the blue book” (TNM_H1). After the procedure is done, “the scrubs sister must fill in the register that is paper” and also “completes her record keeping like the register, specimen book, and the drug book”. The nurse summarised by saying that paper is used as the tool to assist the nursing process, “everything done here is paper”; however, “It’s only the PAC system…on the PAC system you get like the functions…like the information like…x-rays and blood results” (TNM_H1).

Similarly, as described by the nursing manager in the trauma unit, the responses demonstrate that a combination of a paper-based system (used by nurses) and an electronic system (used by doctors) enables the support and management of work activities. This hybrid system is discussed in Chapter Seven. The participant concluded that, after the clinical procedure is completed, “the theatre book is going to the data capture” where the information generated and recorded during the clinical procedure is put “on the system and that way they can count how many patients was done during the month or during the week” (TNM_H1).

From this response, it can be inferred that all information captured on paper is scanned into electronic systems. The participant views the electronic capture as a means to provide a sense of accountability and improve record management when conducting clinical procedures.

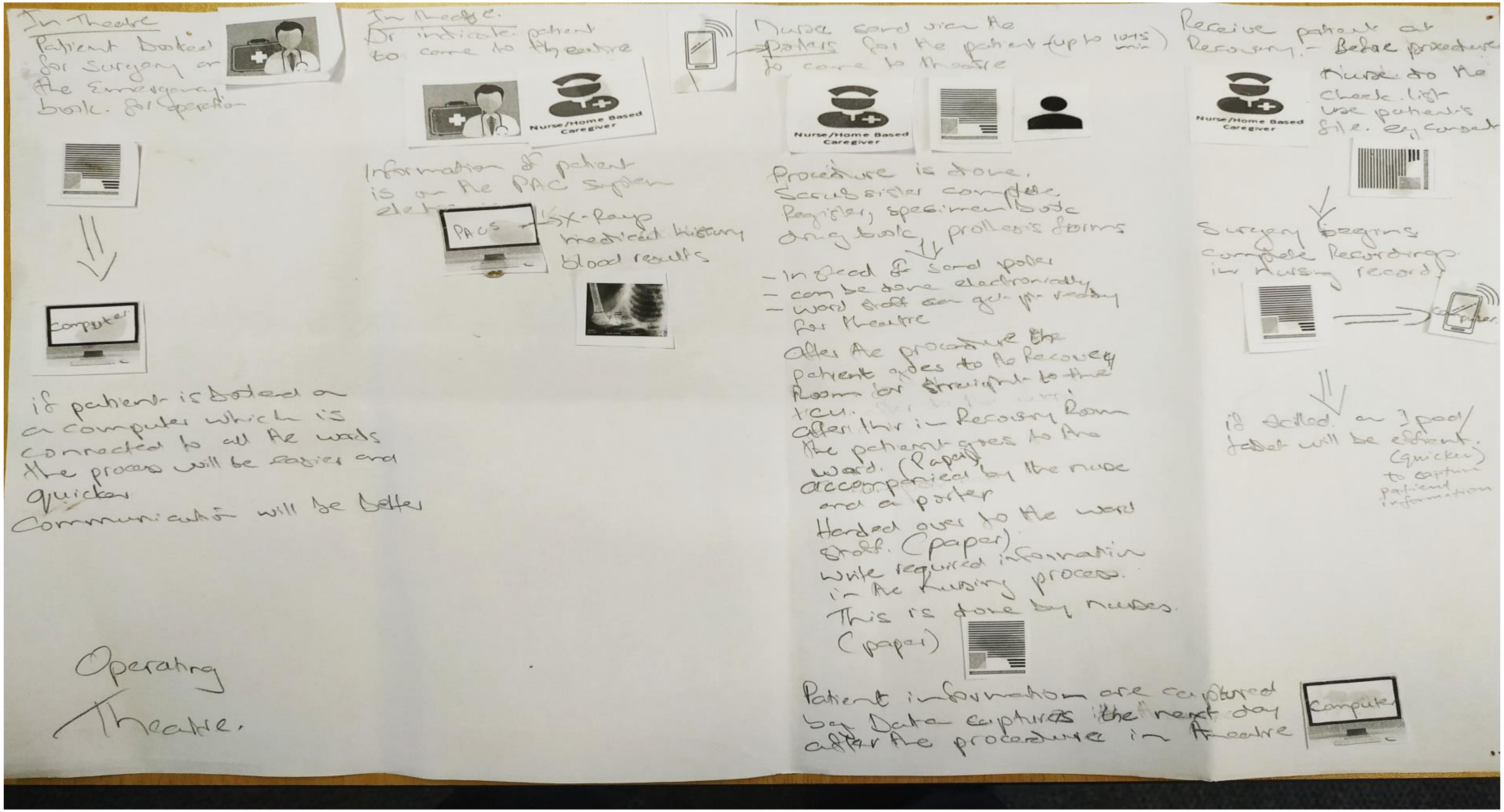


Figure 6.9: User journey map of nursing activities in theatre

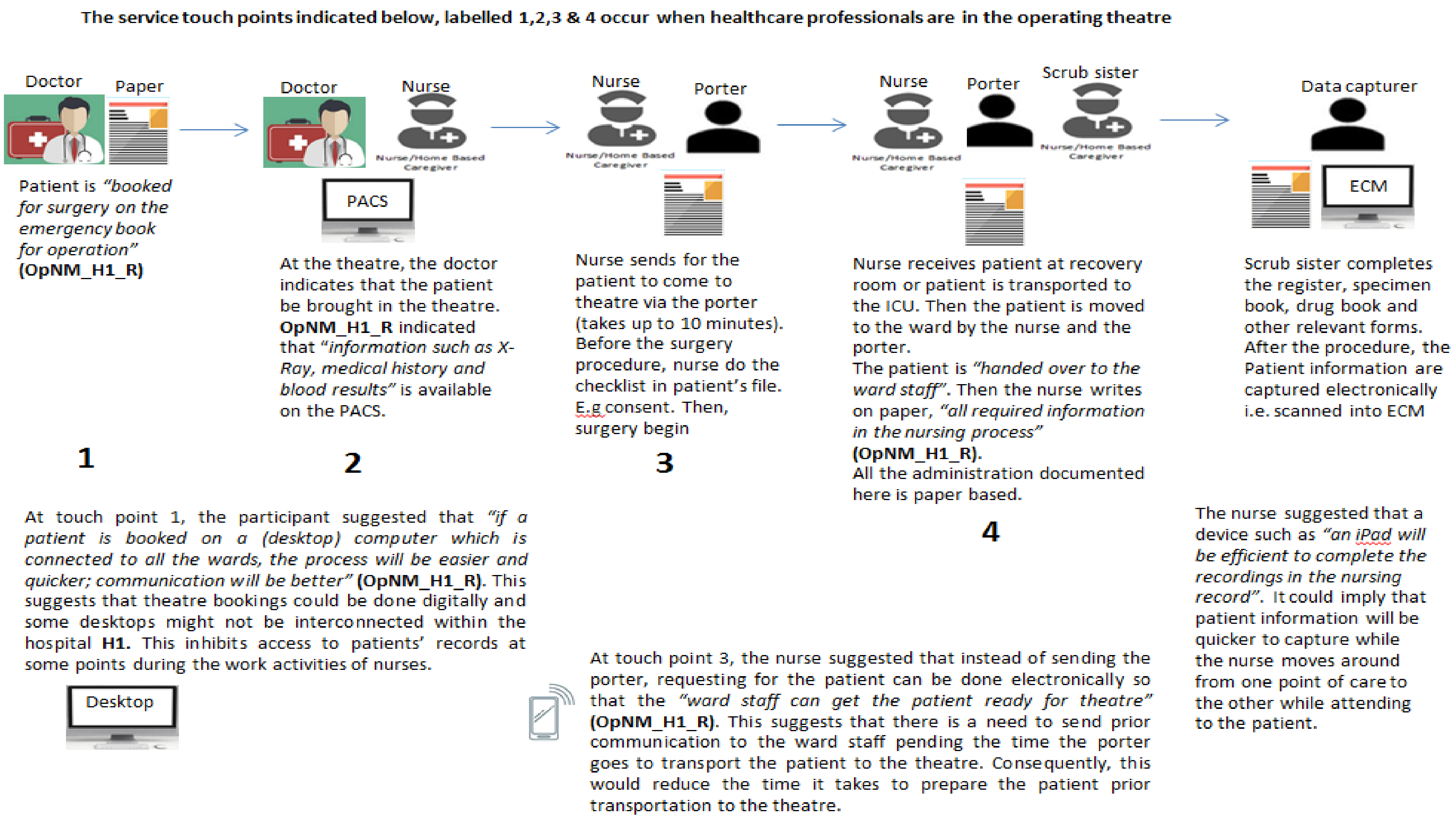


Figure 6.10: Digitised illustration of nursing work activities in the theatre unit

6.4.4 Suggestions for technology-enabled nursing activities in theatre

When asked at which points during the nursing process in theatre could an electronic system be used, participant TNM_H1 indicated that "we phone the ward…instead of writing out the form for the porter we can put it here on the system…and the ward staff can get [the] patient ready for theatre". In other words, making a call to the ward and filling in a form for the porter to take the patient to the ward in order to retrieve a patient for clinical procedures in the theatre is not time efficient. In addition to calling the ward, it could be faster to make an electronic request for patients to be prepared for pick up by the porter since this eliminates the need to complete a paper form, which also saves time.

The participant further suggested that, "If they had a tablet it would go faster. If the system is on there, then you can just press a button" (TNM_H1), referring to a portable electronic device on which booking requests can be made and the reports can be captured more quickly. For instance, "it will be efficient – it will be quicker instead of writing" because it "takes a lot of time, we have to report everything step by step". The participant suggested that "if a patient is booked on a computer which is connected to all wards the process will be easier and quicker" (TNM_H1). It is evident that nurses acknowledge the time-efficient and improved communication benefits of electronic systems and that work activities that involve movement of patients within the hospital can be facilitated by the networked computers that exist in all wards.

However, participant TNM_H1 commented that "sometimes you are just so comfortable with what you are doing", implying that the current work activities, *'as is'*, have "become a routine…as an old lady I cannot adjust to these things", in reference to the use of electronic systems. This prompted the researcher to ask the participant whether they had an interest in learning how to use technology to support their work. TNM_H1 responded, "yes man I do. But okay the new generation will do well". The response indicates that older nurses believe they are comfortable and satisfied with current nurse practices and may not necessarily be willing to embrace change. The use of technology by the older generation of nurses is discussed in detail in Chapter Seven.

6.4.5 Description of nursing work activities in the intensive care units (ICUs)

Once the clinical procedure performed on the patient is done, the doctor and nurse place calls the relevant wards or the ICUs (in cases where a patient requires a comprehensive monitoring), to inform them to prepare for the patient's arrival. The findings from this co-design activity show that there is a conscious effort to have a single, paper-based patient record. Nursing activities in the ICUs include administering physical care and report writing. The documentation of the reports is largely a paper-based activity. In addition to the reports about the nursing activities, the doctors write their own reports using a combination of paper and implemented systems to make a decision about, and plan treatment of, the patients. While the doctors use paper to write their clinical notes and to make referrals, implemented IS, such as PACS are used to make clinical requests and to access the results of these requests.

Participant ICUNM_H1 pointed out that patients are referred from “other hospital, or the emergency services or theatre or wards” as facilitated by “mostly the doctor”. The patient “already has a file…no one goes to theatre without a file”. When the patient arrives, the nurse in the ICUs takes “the vital signs then…put it on paper now we write reports”. The report written by the nurse consists of “the condition the patient was when he came in…so that is paperwork for us” (ICUNM_H1). The participant also mentioned that the “doctor also write their reports but on their own paper”. It can be inferred from the responses that the paper patient folder is largely used and patient administration is a continuous process. Healthcare professionals monitoring patients in the ICUs write separate reports, according to their independent observations, which are stored in the patient folder.

In addition to the use of paper to write reports, the doctor “request[s] this x-ray and scan” from the “scan department or the x-ray department”, depending on the diagnosis of patient made. Then, the “request is done via paper through the department or electronics”. In the ICUs, x-ray and scan bookings are requested electronically and “then the blood test and urine test…we do with paperwork” (ICUNM_H1). From the responses, it is evident that the information management aspects of work activities of healthcare professionals are supported by both paper and electronics. The results of tests received from the laboratories, as well as x-rays and scans booking requests from the radiology department, are retrieved by doctors “on the PACS system” to continue investigations during patient consultation.

During the decision-making phase, participant TrNM_H1 mentioned that while the doctor is “checking for the results of the x-rays” on PACS, the “nurse writes” their observation reports. This implies that the nursing process entails providing a physical care examination to the patient while, at the same time, making notes on the tasks being carried out and the outcome, as it is observed. Depending on the outcome of the patient’s results, the doctor “refers [the patient] to different departments”. The referral process is done telephonically “but he also has to write it on a piece of paper”. The participant added that nurses fetches the patient’s “medication…write down all the medication that was prescribed…and everything”, referring to all the tasks carried out. Then the patient is transferred to the ward. The participant concluded by saying, “and so the story goes everyday” indicating that the nursing activity described has become a routine (ICUNM_H1).

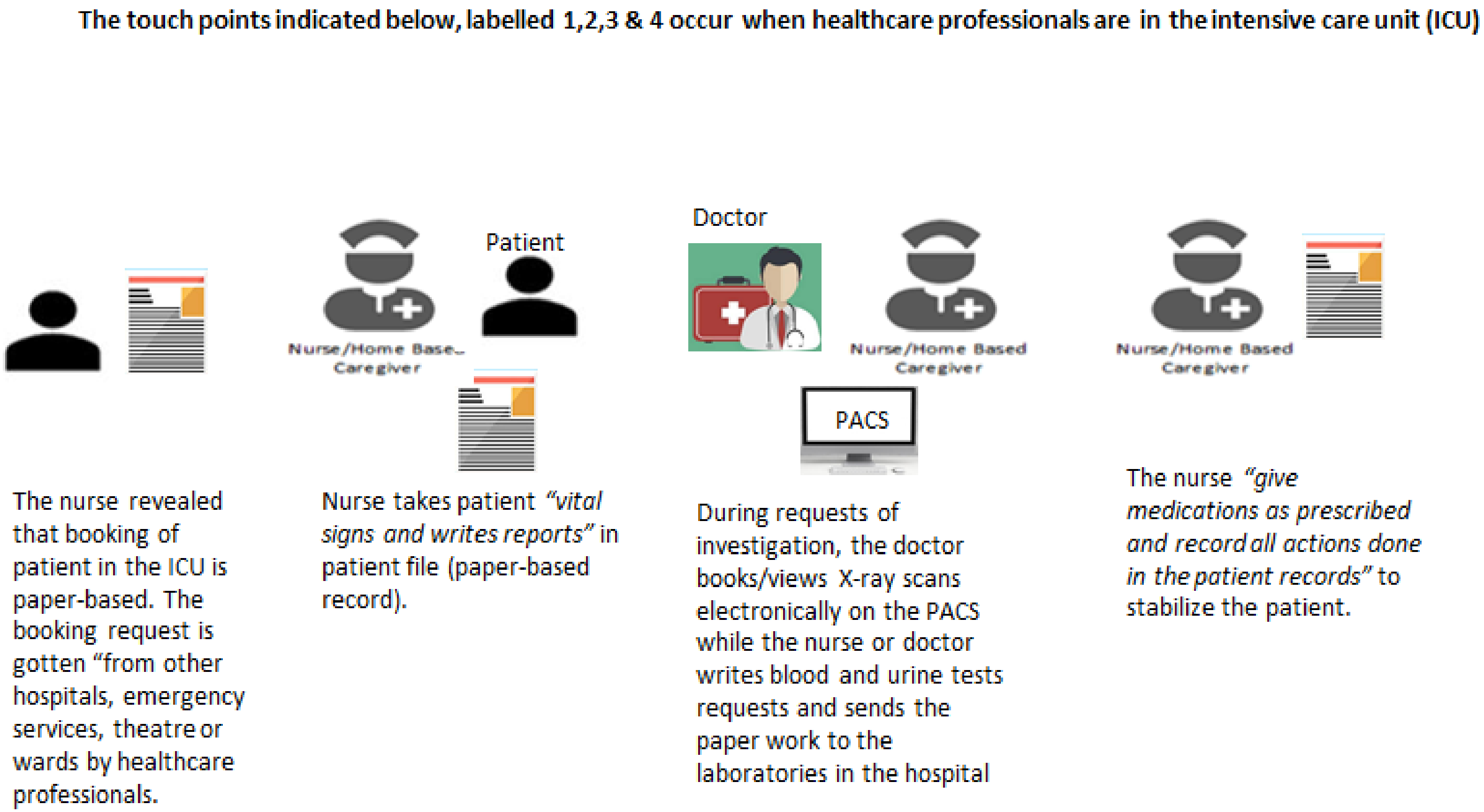


Figure 6.11: Digitised illustration of nursing work activities in the intensive care unit (ICU) wards

6.4.6 Towards improving nursing activities with mHealth technology in ICUs

When asked at which point during nursing activities could the support of a computer or mobile device be required, the participant ICUNM_H1 indicated that "the reporting can be on a mobile device" to reduce the amount of writing being done on paper. The researcher draws on the findings from both the interview and the co-design activities to discuss the touch points that could be technology-enabled in Chapter Seven.

The nursing staff indicated that report writing was a major part of their nursing activities and requires a great deal of paper. One of the tasks required in the nursing activity at points-of-care is to accompany patients to and from different the clinical departments for medical care. The shared sentiment among the nursing staff that participated in the interview and co-design activity is that the effect of the continuous use of paper can be addressed by introducing a mobile technology designed to facilitate report-writing on-the-move. In addition, it was inferred from the information provided by the participating healthcare professionals that the version of the EC) installed on desktop computers in hospital **H1** compels the utilisation of paper to record clinical notes. The paper record is eventually scanned electronically' hence, it can be argued that, during the clinical work activities of healthcare professionals in hospital settings, there are touch points where capabilities of an HIS, such as the ECM system, influences the execution of work activities. The interplay between the agency of human actors and machine capabilities to influence work activities are discussed in Chapter Seven.

Table 6.1 shows the analysis of the co-design activities describing the themes, touch points of work activities, the service interaction moments of tasks and the tools used by healthcare professionals.

Table 6.1: Analysis of co-design activities with healthcare professionals in hospital H1

Themes	Touch points of work activities in clinical settings of the hospital	Service interaction moments of the tasks performed	Tools
Illustration of current work activities	Consultation (and referrals) attending to patients	1. Verbal communication 2. Writing notes/patient history 3. Physical examination 4. Communication with healthcare professionals	Voice Pen & paper Smart mobile phone
	Booking request for clinical examinations	1. Access to patient record on a screen through a keyboard 2. Request of examination	Desktop computer
	Retrieval of examination results	1. Access to patient records 2. Retrieval of x-ray or laboratory results of patient examination	Desktop computer
	Development of treatment plan	1. Communication with other healthcare professionals	Face-to-face Smart mobile phone
	Patient care administration by Nurses	1. Track patient admission, transfer or discharge triage progress 2. Administer physical care 3. Report writing on patient status and detailed procedures 4. Communication with healthcare professionals and other hospital staff	Pen & paper Face-to-face
Challenges with current work activities	Consultation with patients	1. Writing of notes 2. Delayed access to digitised records	Pen & paper Desktop computer
	Referrals	1. Interruption of consultation by VULA application notifications 2. Uncontrolled notification	Smart mobile phone
	Booking examination requests and retrieval of results	1. Offline/slow/faulty/limited availability of computer	Desktop computer

Themes	Touch points of work activities in clinical settings of the hospital	Service interaction moments of the tasks performed	Tools
	Patient care administration by Nurses	1. Report writing and capturing of patient information gradually become cumbersome	Pen & paper
Inferences for ideal technology-enabled work activities	Remote and local consultation with patients	1. Recording to verbal communication 2. Transcription of consultation 3. Immediate access to patient record 4. Write/update function	Device with voice recorder and speech recognition features
	Patient care administration	1. Track patient admission, transfer or discharge triage progress 2. Report writing on patient status and detailed procedures 3. Access to patient records in electronic format 4. Communication with healthcare professionals and other hospital staff	Tablet or smart mobile phone with touchscreen and a preloaded database of nursing activities Access security
	Booking examination requests and retrieval of results	1. Access to patient records 2. Retrieval of x-ray or laboratory results of patient examination	Desktop computer (local access) and smart mobile phone (remote access)

6.5 Co-design activities with doctors in hospital H2

Similar to the data collection process in hospital **H1**, the researcher conducted a series of co-design sessions to engage the participants that were interviewed in hospital **H2**. This was done in order to compare the responses of the interviews with the actions of the interviewees. In some instances, the co-design activity took place on the same day as the interviews, while in other instances the activity took place on a different day, scheduled as advised by the healthcare professionals. The researcher sought to develop a visual illustration of the current work activities executed by doctors at points-of-care during service delivery. The resulting user journey maps assisted the researcher to identify the service interaction moments of the tasks performed by healthcare professionals at different points-of-care in the clinical settings of hospital **H2**.

6.5.1 Current work activities of doctors in hospital H2

The participants indicated that the entry points of patients are either at the clinic, from referrals, or at the accident and emergency (A&E) unit. The orthopaedic consultant, OrtC_H2, indicated that patients are usually seen (patient consultation) at the clinics where they are referred to, in order to undertake further clinical examinations based on available information and they are, subsequently, booked for clinical surgery or referred to other clinical units.

> “We can treat; we can do a work-up, depending. For example, a patient can come to the clinic acutely ill, we admit to the ward and stabilised, then we work-up” (OrtC_H2).

The participant explained that a ‘work-up’ is where a doctor *“*requests for tests to be done by patients…look at the results of the tests and take a decision whether the patient needs to continue as outpatient or the patient needs to be admitted to the ward”. The researcher observed that requests for tests and patient records are done in paper format. The observation that all documentation is paper based was confirmed by the doctor:

> “Paper documentation is like a submission of what we do in clinic including seeing patient’s exam. Every examination is documented and the findings are documented. These are the tools we use during examination; notes on the patient and some imaging that the patient comes with” (OrtC_H2).

The findings suggest that doctors verbally communicate with patients, and then write clinical notes and request forms for clinical examinations on paper. The fact that referrals between clinical units are paper based was confirmed by SRNS_H2:

> "So, for this, this comes in duplicate. So, when they issued the results, we retain this in the laboratory and issue this. So that's why this is here. But for the other one, its physically just one form. This is for request and this is for the results" (SRNS_H2).

It is clear that the paper forms have duplicate copies. This is done to make sure that laboratories or radiology clinical departments maintain some form of data accuracy and to ensure the reliability of records and the information contained in the patient folder. Therefore, it was established that paper was largely used for information management during patient consultation and for referrals. In addition, OrtC_H2 mentioned the use of an "electronic device and manual devices …during certain specialised procedures". The doctor indicated that there are work activities which involved coordinated care services with other healthcare professionals during follow up, or post initial treatment.

> "Most times after either surgery or medical there is always a follow up or rehabilitation. So, this will fall into post-treatment rehabilitation. Now for this post-treatment rehabilitation, this is usually done by the physiotherapist" (OrtC_H2).

> "For example, when someone is going to do an ultrasound and while doing the ultrasound, the radiologist may notice certain things and they may call us to take a biopsy. Like we want to take a small specimen but that can be done under the image guidance" (OrtC_H2).

The responses indicate that there are certain work activities that may require collaborative care services between different specialist doctors, including orthopaedic surgeons, radiologists and physiotherapists. It could be inferred from the responses that collaborative care requires a means of coordination and communication in order to organise the different specialists. When asked how the other healthcare professionals in the collaborative care process are contacted, the doctor indicated that this is done through "paper referrals and forms". Similarly, SRNS_H2 confirmed that the referral system is paper based most times; otherwise it could be verbally undertaken, based on mutual familiarity between healthcare professional colleagues.

> "Occasionally, you see a doctor that knows you so you say 'ah doctor I have a patient with this, I want to send him to your clinic'. So, the person will go without any paper referral. But 80% of the time it's a paper base referral" (SRNS_H2).

The responses from the doctors suggest that paper forms and verbal communication, which could either be made face-to-face or through phone calls, are mostly used to facilitate referrals. Another activity suggested by OrtC_H2 is the use of mobile devices to access academic journals to facilitate teaching. The participant mentioned that "these days we tend to use our mobile device in clinic, but really we should have a laptop… if you see patients most times, you have residents and students. You can check up journals' abstracts to compare and to show them some images and pictures" (OrtC_H2). This shows the need for doctors to have access to the Internet, either through a mobile network operator or through Wi-Fi. Further, the doctor explained that mobile devices are seldom used in wards to facilitate teaching of medical students "because they believe it tends to be a distraction" (OrtC_H2). Similarly, in hospital **H1**, some participants indicated self-consciousness as a likely factor that deters the use of mobile devices at points-of-care when attending to patients. These findings are further referenced and discussed in Chapter Seven.

According to SRNS_H2, there are patients who need collaborative care. This is similar to the response from OrtC_H2. Collaborative care includes the involvement of one or more healthcare professionals in delivering care or post-treatment to a patient. When asked how different clinical specialists communicate, the doctor indicated that communication is done either by a CUG phone call; personal telephone communication or by text messaging. Other clinical units prefer different means of communication, which includes the writing of paper-based clinical examination requests, depending on the specialists.

> "If its surgical specialties, in this case its physically phone, personal phone communication or text messages. However, for those in some other department, like medicine, internal medicine, they will prefer that you write paper-based consultation tests. For the ones in emergency, its usually phone call. If its ward, what we do is we prepare an operation list, which is paper based … and based on that, they will come see the patient" (SRNS_H2).

This supports the argument that the preference for tools (paper, mobile device, desktop computer or a combination of all three) is dependent on the complexity of tasks and on the points-of-care where the work activities are being executed, as indicated by participants in hospital **H1**. Healthcare professionals would use a tool (paper or technology) that is fit-for-purpose, depending on how the tool enables the execution and completion of service delivery.

At the end of the first phase of the co-design activity, a user journey map that visually illustrates the work activities of doctors was generated. The user journey map consisted of three service touch points, which are patient consultation, work-up and post-rehabilitation treatment. The tools most frequently used by the healthcare professionals for information management are paper-based request forms and record folders, where doctors write, call or walk to inform nurses of the next call of action with respect to their patients. Subsequently, the researcher inquired from the participant whether there were any challenges experienced during and after work activities, as well as how this affects the intended outcomes of care service delivery.

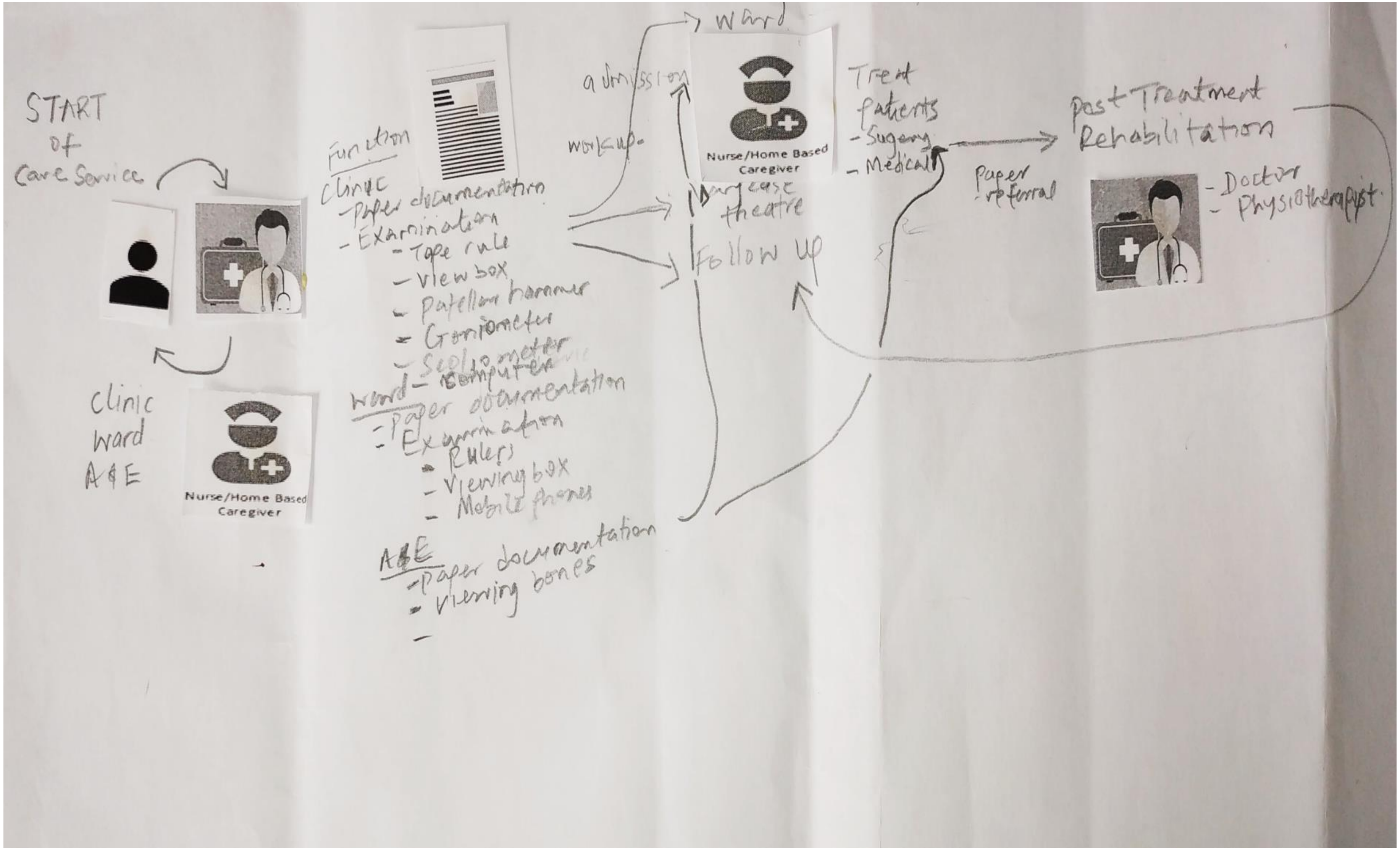


Figure 6.12: User journey map of doctor's (orthopaedic) work activities at different points-of-care

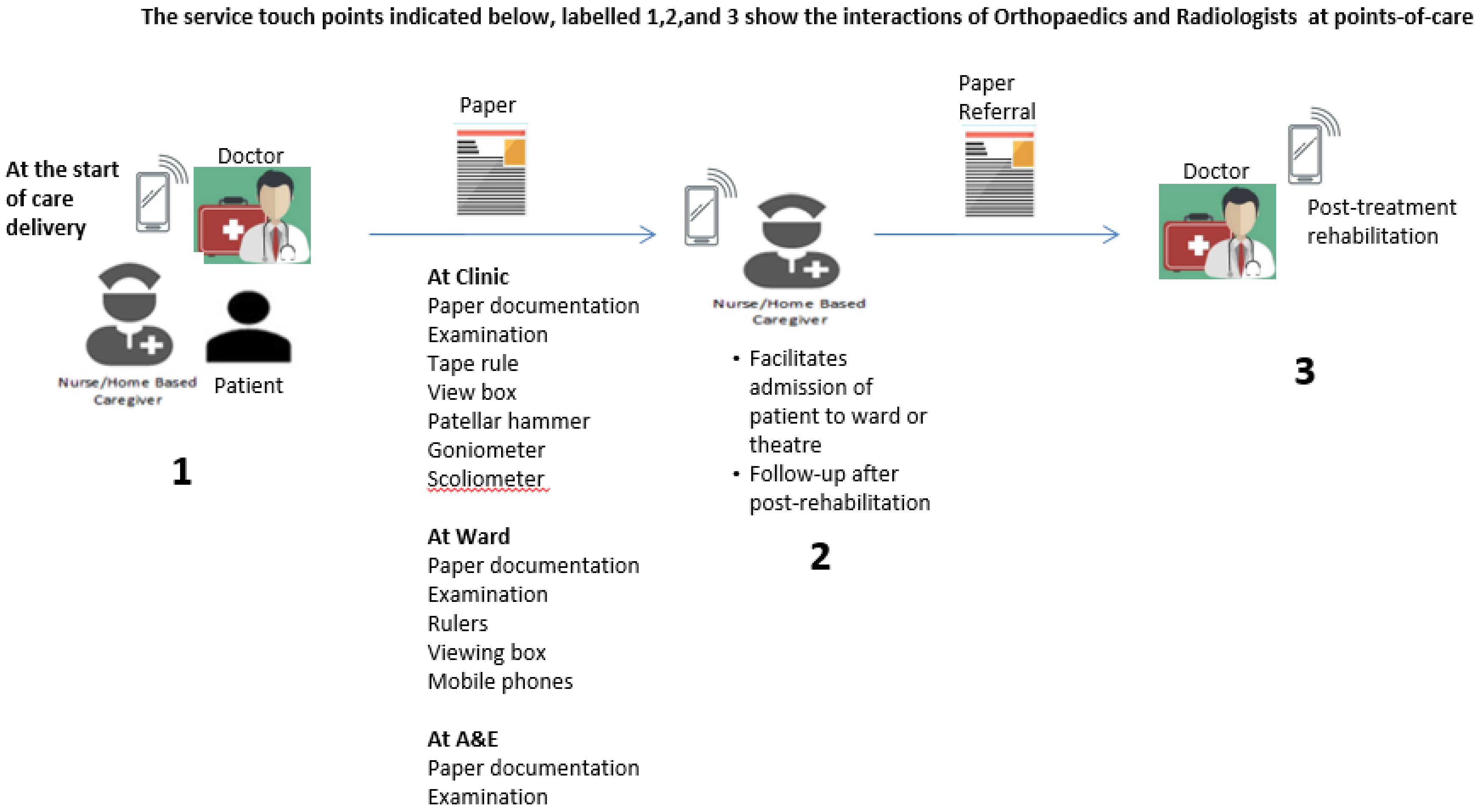


Figure 6.13: Digitised visual illustration of doctor's work activities journey map in hospital H2

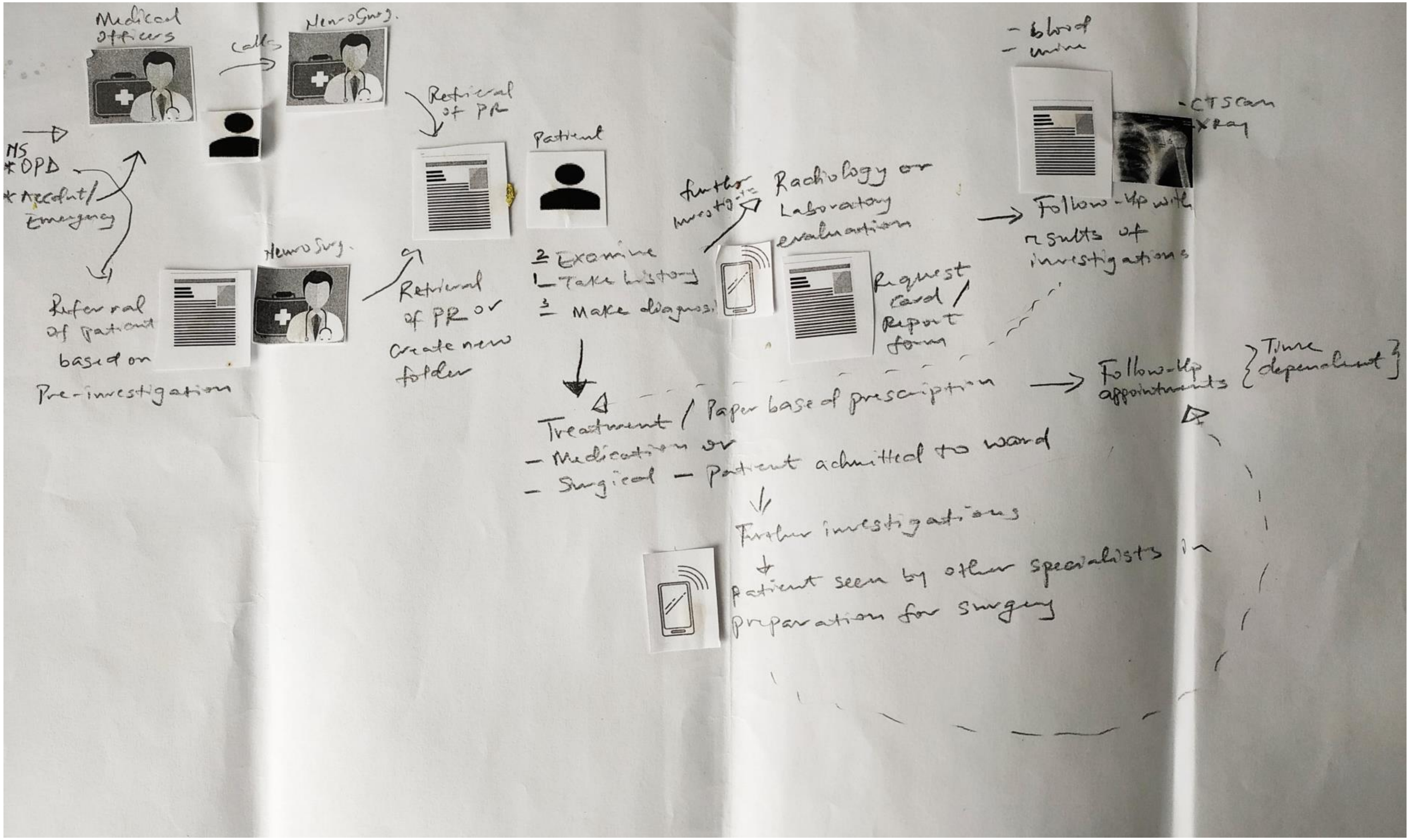


Figure 6.14: Visual illustration of doctor's (surgeon) journey map showing service touch points

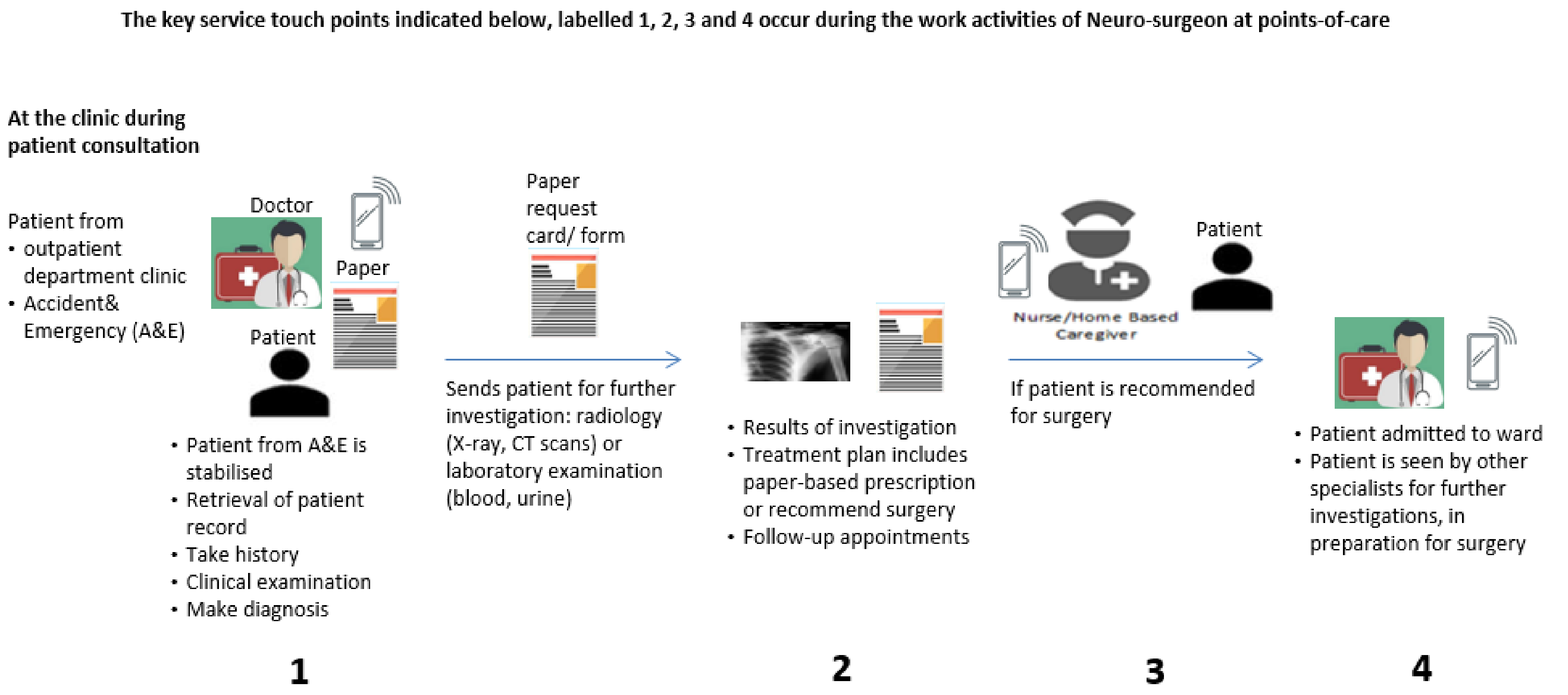


Figure 6.15: Digitised visual illustration of surgeon's work activities journey map in hospital H2

6.5.2 Challenges experienced by doctors during work activities in hospital H2

Given the complexity of the work activities in a tertiary hospital, including administrative and clinical processes and the inadequacies of tools being used to undertake these processes, the researcher established the major challenges experienced by the doctors in hospital **H2**. The findings show that there are challenges in respect to information management during patient administration and consultation. During consultation, one of the healthcare professionals mentioned a language barrier as a potential work challenge. SRNS_H2 gave the example that it is time consuming to write while attending to "a patient that does not speak English and speaks a local language that I do not understand". It is clear that a language barrier could be an inhibitor during the execution of work activities, thus prolonging the time it takes to perform the taking of a patient's history and using the accurate information to make an informed diagnosis.

With regards to patient administration, there is a communication gap between doctors and nurses when "moving a patient from the clinic to the ward" (OrtC_H2). The doctor expressed the frustration that there is a lack of adequate communication, such that "I'll need to walk down to the nurse at the reception, inform her and possibly hand the case file to her". It can be inferred from this response that the lack of communication between doctors and nurses places additional strain on the points-of-care activities, especially when the doctor has a queue of patients to attend to at the clinic. The nurse, in turn, walks to the wards to confirm the availability of bed spaces.

> "And also, the same goes for nurse-to-nurse interaction from the clinic to the ward. So, most time they have to walk down to find out if there are bed spaces in the ward and come back to the clinic" (OrtC_H2).

Similarly, SRNS_H2 mentioned that it takes a long time for patient information to be retrieved. The effect of the wait is experienced by both the doctor and the patient. The participant mentioned that the opening of a new file and the retrieval of existing patient records are not efficient, explaining, based on the architectural planning of the hospital buildings, that:

> "So, for a patient to come to clinic here, he has to go to phase two or somewhere in phase 4, to go and do that. Yes, so at this point you have more than two or three other clinics at the same day. So sometimes patient comes in delayed with an hour or more… it can be up to 3 hours sometimes. By the time the patient comes back to you, it'll be so late. That you have not seen other patients … waiting for one patient who is held up by the record department" (SRNS_H2).

The patient is required to go retrieve the records and bring them back to the clinic. Physical distance between the clinic and records management presents a work challenge to doctors during patient consultation. Consequently, it takes several hours for the patient to return to the clinic. The doctor may get tired of waiting and the patient might have lost the opportunity to get attended to on that particular clinic day. The participant revealed that a new record folder is created for patients and it could be inferred that there are instances where patient records are duplicated in the records management department of hospital **H2**.

During the co-design activity, the researcher noticed a pile of patient folders which the doctor mentioned are being used for other studies. The researcher then asked what happens when the patients require their folders for consultation with other healthcare professionals. SRNS_H2 explained that the records management are aware of the location of the folders.

> "There's a tracer card inside the folder at the record unit. So, when the folder is leaving that record, they remove the tracer card and keep it at the record. So that if anybody is…looking for this folder, in the place where the folder is going to be, a tracer card is going to be there" (SRNS_H2).

As a way of keeping track of the movement of records, there is a tracker card in every patient folder. This system helps to maintain some form of accountability between the records department, the clinics and wards where the patient folder is being used by healthcare professionals. But the participant further explained that the use of tracer cards is not effective.

> "Many times, you don't find many folders when you see patient. For example, amongst these folders were requested for 20 something, and only about 12 or 13 came. So that shows that a lot of them are misplaced somewhere or maybe didn't find them properly at the record…some of them claim that they are taken by one Doctor or another" (SRNS_H2).

In addition, the response indicated that the lack of timely communication leads to healthcare professionals performing additional tasks in an already overburdened healthcare system. Consequently, this causes delays in the time it takes to deliver care services at point-of-care and extends the patient waiting times and journeys. In addition to the communication gap, doctors stated that hospital **H2** has limited available resources in an already overwhelmed system. The doctor explained that "nurses always complain and say they don't have enough hands".

> "If I want to operate on a patient for 8 o'clock and I'm ready by 7/7:30, there is just one ambulance that serves the whole of the hospital at times ... some have broken down. So, it's very difficult, getting patients to theatre such that the Doctor at times has to use his own personal car to take patients…with the nurses…to theatre and that is not tenable anywhere … it shouldn't be" (SRNS_H2).

In hospital **H2**, there is a lack of sufficient human and material resources. As a result of the limited available resources in hospital **H2**, doctors have to execute their work activities at a personal cost, as indicated above and during the interview sessions. Similarly, the doctors (Ort2_H1 and Opht2_H1) in hospital **H1** use their mobile phones to support information acquisition and storage at points-of-care.

The researcher asked one of the participants whether they had any sentiments with respect to the use of their personal phones. The participant explained that this is relative, depending on individuals.

> "For example, I can bring out my phone and call any ward, anybody. It's not because I have so much. I don't feel. I just see it as part of my work. And if my call credit gets exhausted, I load it immediately. You understand? But people see it as a taboo to be using" (SRNS_H2).

The work challenges experienced by healthcare professionals and their effect are further discussed at a conceptual level using the ActAD model to discuss emergent findings from both the interviews and the co-design activities.

Another issue that affects the work activities of doctors is the location of, or distance between, the hospital buildings. OrtC_H2 expressed the opinion that there is "a major issue in terms of theatre location. It tends to make my work difficult…to monitor the progress of patient transfers, physically. Because then I have to walk down to theatre," It can be inferred from this response that the design or architecture of the buildings may have an impact on the work activities of healthcare professionals. The response suggests a lack of adequate architectural planning of the hospital buildings in relation to the clinical needs of healthcare professionals and patients. Thus, this presents an opportunity to integrate a device that can be used to communicate and monitor the status of the work activities that involve other healthcare professionals.

The work activity challenge of follow-up visits or post-treatment rehabilitation is the fact that medical personnel do not work in an organised manner during collaborative coordinated care. For instance, OrtC_H2 stated that:

> "There is this disjointed management of patients, where the Doctor comes and does his job and the nurse is not there; and the physiotherapist comes and see the patient. And everyone sees the patient disjointedly and there is no team approach to patient care" (OrtC_H2).

The response above further reflects the work activity challenges experienced as a result of the communication gap between healthcare professionals. A lack of communication can be attributed to a lack of tools to facilitate communication, or in some cases the means of communication is available but does not function properly. The impact of this means of communication and coordination in a work activity is discussed in Chapter Seven. In the third phase of the co-design activity, the researcher requested that participants to suggest ways in which technology could address the challenges faced at the identified service touch points.

6.5.3 Suggestions of technology-enabled work activities

Because of the challenge of information management, there are efforts to centralise the record systems. A doctor suggested that a desktop computer loaded with information management software would be an ideal technology to have at the hospital to address the lack of adequate communication during the transfer of patients to wards. To eliminate the unnecessary walk to instruct the nurse, OrtC_H2 suggested that "if there is a desktop that I can type…and it beeps on her own device there and then she gets to know the number of patients that are admitted". The findings propose that technology can be used to eliminate additional tasks, such as the walking done by patients and healthcare professionals, as well as ensure information accountability. Another participant indicated that:

> "Technology will help a lot. This can be eliminated (referring to request forms and assessment forms). For example, it would be easier if, by the time I see a patient here, I say go to radiology department for investigations, and he gets there; they are already aware of what I want. If before the patient gets there, they have seen the information that I've sent to them, my requests, and there is any ambiguity, before the patient get there it can actually be clarified. All these things…the patient that bears the brunt of the whole thing" (SRNS_H2).

To address the location constraints, communication and monitoring of the patients' progress in the course of service delivery, OrtC_H2 suggested that all healthcare professionals should be given a communication-enabling device. For example:

> "The CUG is not available to all the doctors, maybe just the chief reg. and only one CUG is available to the wards. It'd be different if everybody had a CUG because then you can always reach whoever" (OrtC_H2).

These responses suggested that the already available resources provided by the government and hospital management can be improved. In a case where all healthcare professionals possess a CUG mobile device, communication and monitoring of patient journeys could be improved. In terms of addressing the language barrier challenge and its resulting delay in time to make informed diagnosis, SRNS suggested a device or "something that can easily transcribe; not just record but at least convert voice to text".

To address lack of coordination during collaborative care, OrtC_H2 suggested the need for a means of coordination where "one can communicate with all other members of multi-disciplinary team to be on ground at a particular time and place, to see the patient and discuss". The doctor further explained that "a beeper" that displays "patient name, ward and time that there's a round on this patient by all units" would be ideal to notify the multidisciplinary team during post-treatment rehabilitation or follow-ups. SRNS_H2 explained that a technology solution would be ideal to book and update reminders to patients about scheduled appointments.

> "Many times, you discharge a patient that never gets to come back. The reason is that we print paper based and then we do not follow them up unless they follow us up. Unless they come to us, we do not make effort…" (SRNS_H2).

The doctor suggested that a booking appointment system would assist post-treatment plans where patients are scheduled for follow-up visits. When asked about the usefulness of the tracer card used to monitor the retrieval of patient folders, one of the participants mentioned that digitising patient records would address the associated ineffectiveness of tracer cards and lost or misplaced patent folders.

> "So, digitising it would really help a lot, then I will not have to be going on all around. That will help a lot to reduce unnecessary waiting time. Many times, we are at the clinic, we have to be waiting for folders to arrive before we start" (SRNS_H2).

According to SRNS_H2, the response was informed by an experience from the previous use of electronic systems to write reports and suggested treatment plans for patients.

> "I've had an opportunity to go somewhere and operate. And before I finished writing (and making a request), which was also electronic…and get into the intensive care unit where the patient was moved to the ward, what I requested that they do, they started doing it" (SRNS_H2).

Based on the experience of using electronic systems within a similar hospital environment, the doctor believed that technology could enhance the execution of work activities in clinical settings. The doctor expressed the opinion that digitising the records management system would help to simplify patient information retrieval. The doctor also mentioned that digitised information management holds the potential to reduce the current long waiting times. Similarly, SC_H2 mentioned that:

> "Like for example your patient notes, a desktop will be ideal to upload the patient notes so people will just be checking it, as it will be available to all the people involved in the treatment of the patient and to communicate operation notes or patient list".

Consequently, SRNS_H2 proposed that an ideal electronic system would require patients to have a unique number. The unique patient number could then be used to search for the patient's record. This suggestion is similar to what is already in existence in the context of hospital **H1**, where the patient master index links all information pertaining to a patient and hospital processes.

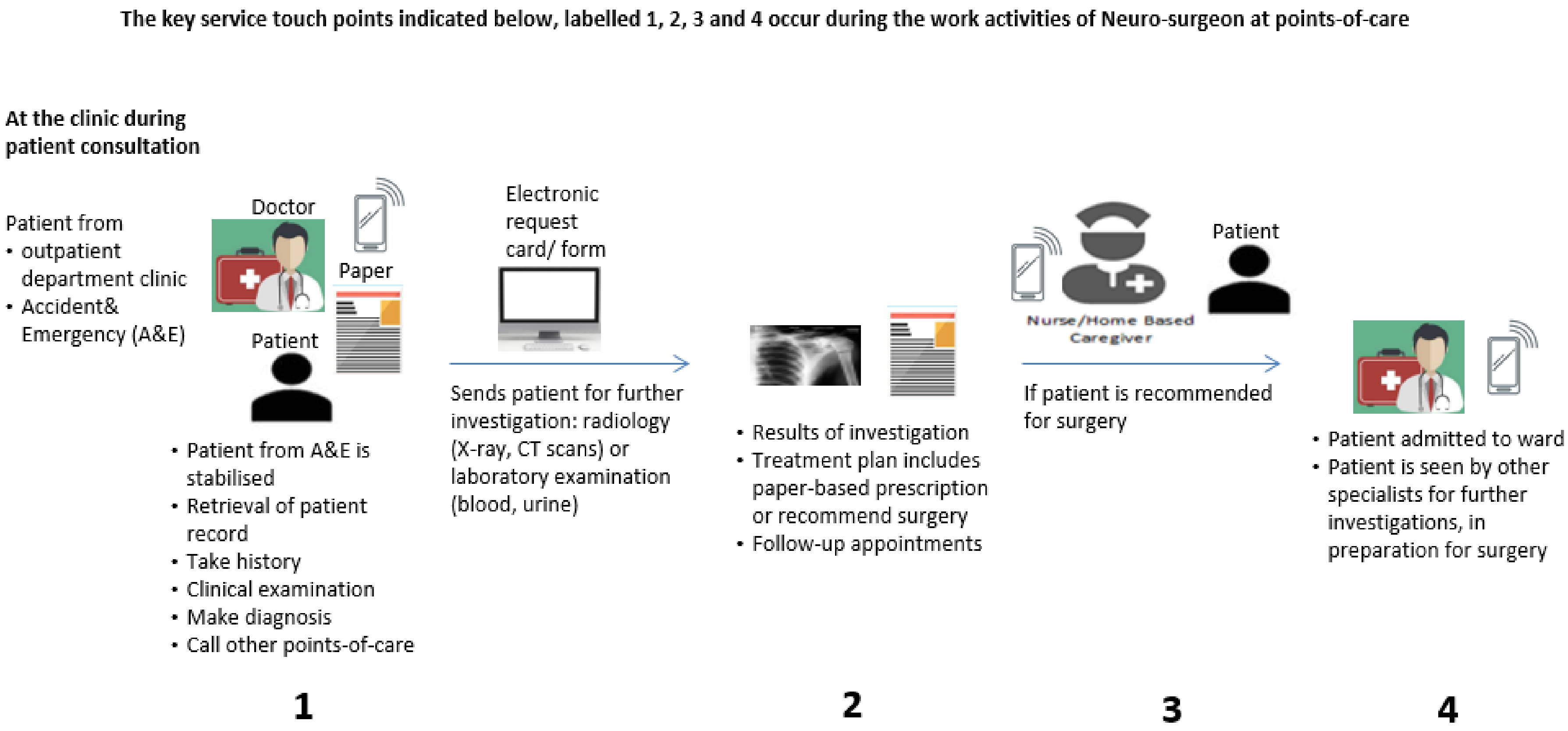


Figure 6.16: Digitisation of visual illustrations describing doctor' technology-enabled work activities

6.6 Co-design activities with nurses in hospital H2

This section presents the themes extracted from the co-design activity sessions held between the researcher and the interviewed nurses from orthopaedics and radiology departments of the hospital. The researcher sought to compare what the nurses *say* with what they *do* during the execution of nursing work activities at points-of-care. The themes were categorised into a description of current nursing activities, work activity challenges experienced by healthcare professionals and suggestions of touch points where mHealth technologies could be useful.

6.6.1 Descriptions of current nursing activities

In addition to the feedback from the interviews with nurse participants in hospital **H2**, the researcher facilitated co-design activities with them to identify the prospects for technology-enabled nursing activities. The co-design activity produced user journey maps that visually illustrate nursing work activities during the process of healthcare service delivery. The user journey maps provided additional opportunities for the researcher to probe the different service touch points of nursing activities.

After the user journey illustrations had been completed, the researcher asked the nurses to explain the process from the start of executing nursing activities to their completion. A participant showed that patients "come from home or they are referred from outside". The nursing participants confirmed that healthcare providers use paper for the documentation of readings from other manual medical devices to support their nursing activities at the clinics. For example, one of the nurses expressed that:

> "At the clinic the doctors and the nurses make use of paper to take the record of the patients and when they are through doctors have their instrument that they use to assess the patient. Nurses use a sphygmomanometer, they use weight scale … the thermometer and all that, then all the records are documented" (ONS_H2).

Additionally, at the point where a patient is discharged or admitted to the wards, participants indicated that "there are closed user groups (CUGs) around the wards" to facilitate communication between healthcare professionals. However, the CUGs are limited to one per ward and do not always function; to the extent that they are not repaired or replaced when damaged. Later, the researcher probed the nurse participants for descriptions of how the challenges experienced at the different touch points affected the execution of their work activities.

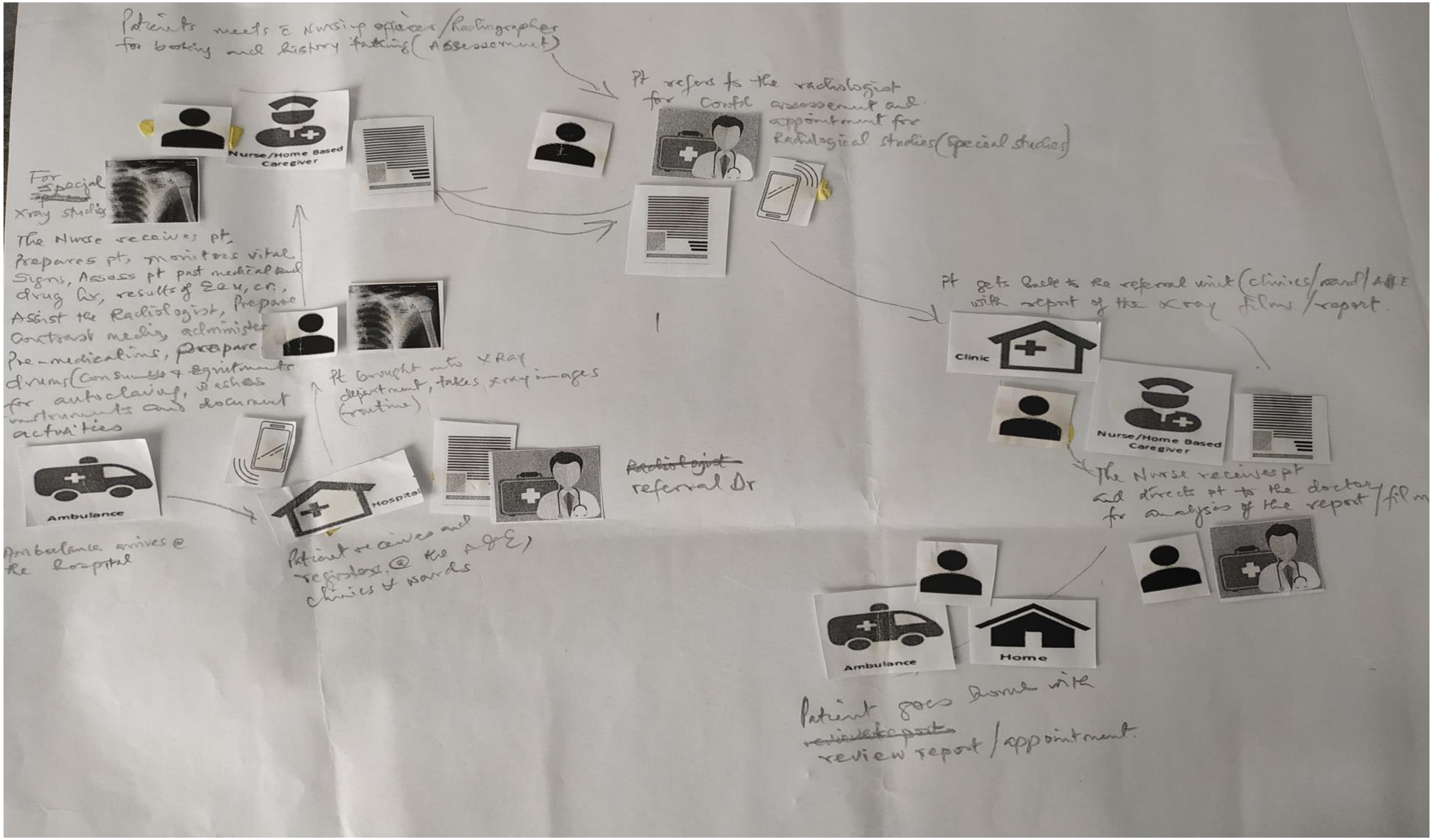


Figure 6.17: Visual illustration of user journey map showing nursing activities

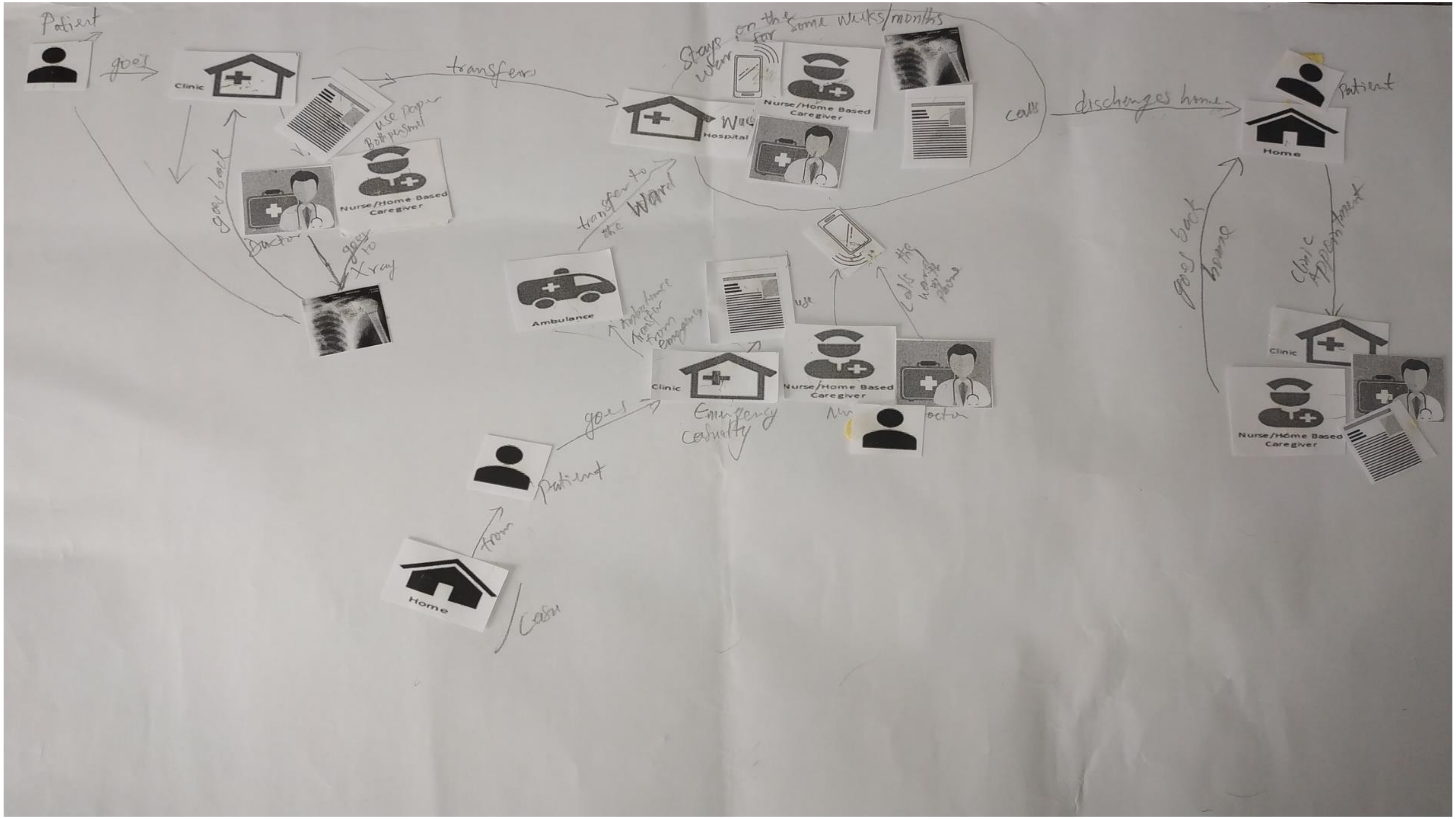


Figure 6.18: Visual illustrations of user journey map showing nursing activities

The key service touch points indicated below, labelled 1 and 2 & 3 occur during the nursing activities between different points-of-care

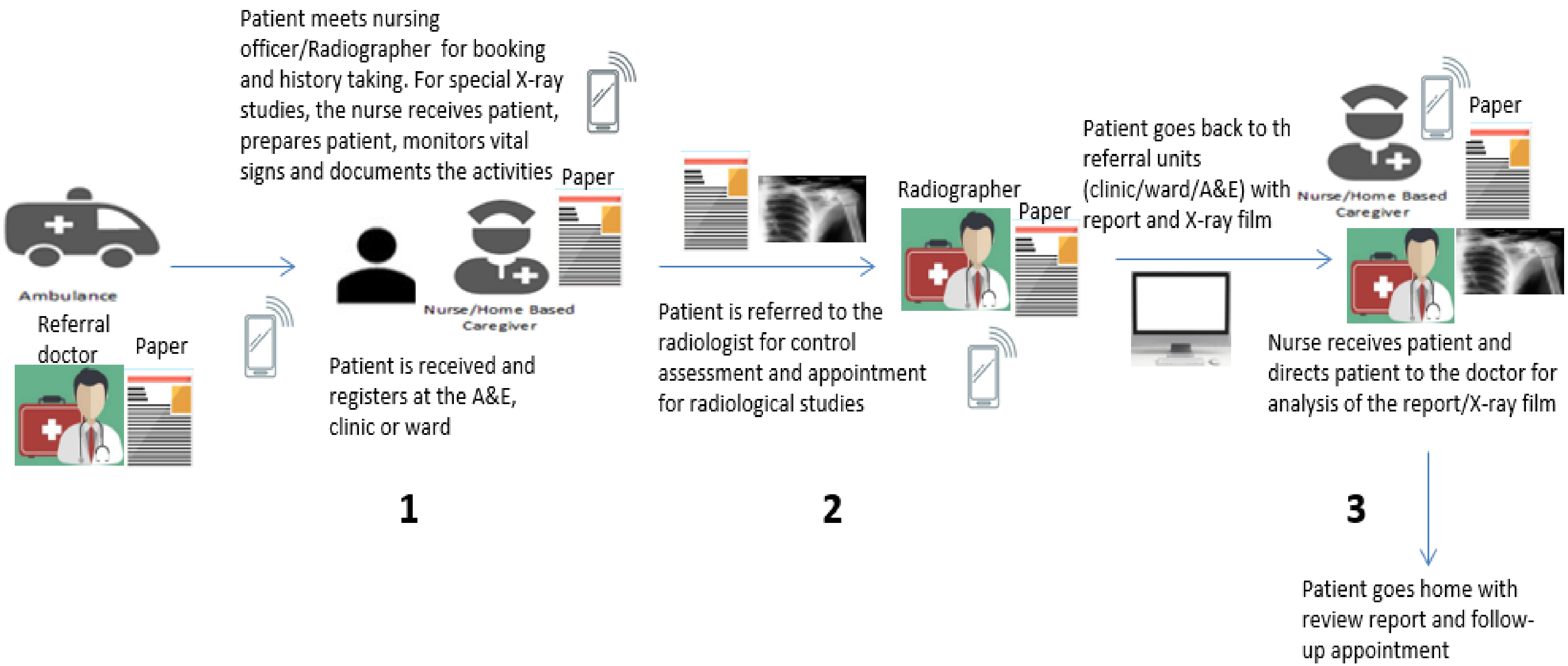


Figure 6.19: Digitised user journey map of nursing work activities

6.6.2 Challenges experienced at different service touch points within nursing work activities

The findings confirmed that the challenges at points-of-care include malfunctioning of the manual devices, limited resources, paucity of nursing personnel and erratic power supply. One of the participants mentioned that, at the point of emergency, there is the lack of adequate staff and limited resources are pronounced.

> "At the emergency there can be mass casualty…where a nurse is to attend to three patients as well as four at a time. So, you see like 30 patients being rushed to the casualty and then you have two nurses on ground…at the same place you might be looking for things to use, where to admit the patient" (ONS_H2).

With regards to limited available resources, the respondent indicated that "at times there might not be enough stationery…the sphygmomanometer might start to malfunction and you get disappointed". Additionally, when the doctor calls to inform the wards to prepare for the admission of patients, "there's no bed, there is nowhere to admit the patient in casualty" to the extent that patients are observed "some on the floor, some on the chair…" (ONS_H2).

The response indicates a non-functional system of keeping stock of the available resources nurses require in order to execute their work activities. The lack of a system to keep stock presents an opportunity to use some form of technology to manage the available resources, as well as to budget for and replace materials when it is necessary.

> "And when there's need for quick investigation, it's either they say at the x-ray, there are no materials, the power is off, the machine is down and then … the patient are being referred out, they go to other facilities" (ADNS_H2).

The causes and effects of these work challenges are discussed through the lens of the ActAD model in Chapter Seven. In the third phase of the co-design activity, the researcher sought suggestions on the potential for the use or non-use of technologies to enable the tasks in the nursing work activities at different touch points during service delivery.

6.6.3 Suggested touch points to use mHealth technologies at points-of-care

Based on the challenges experienced by nurses during their work activities, the researcher asked participants to suggest suitable technologies that could address the ensuing effects. To address the issue of limited available resources, a participant suggested that:

> "From the points of assessment - casualty around the ward, from the point of assessment we need a gadget that can take patients' parameter … and you see it so in all the stations" (ONS_H2).

The response suggested that the manual medical devices used by nurses to take vitals at the points of assessment could be replaced with a technology-based device, such that the recordings are instantly available. ONS_H2 further explained that “it will be better if it’s mobile,” since this would allow easier movement and should be “interconnected to all wards, clinics…” so that “at a click, it sends the information concerning the patient” to other nurses at the next points-of-care. This is essential in situations where nurses deal with both conscious and unconscious patients, and eliminates the need “to bring the case notes of the patient to the ward…since the documentation of the patient is sent before the arrival of the patient” (ONS_H2).

The other solutions are based on the roles of the hospital management and the government to provide sufficient material resources required in order to support the work activities of healthcare professionals during service delivery. Furthermore, to address limited available resources, the nurses expressed that a need for more ambulances to transport patients from one point to another around the hospital and the employment of more personnel. Table 6.2 shows the analysis of the co-design activities describing the themes, touch points of work activities, the service interaction moments of tasks and the tools used by healthcare professionals.

Table 6.2: Analysis of co-design activities with healthcare professionals in hospital H2

Themes	Touch points of work activities in clinical settings of the hospital	Service interaction moments identified from tasks performance	Tools
Illustration of current work activities	Consultation with patients	1. Verbal communication 2. Writing notes/patient history 3. Physical examination 4. Writing referrals forms	Voice Pen & paper
	Booking requests for clinical examination including medical imaging or laboratory tests	1. Fill request forms 2. Verbal requests 3. Face-to-face communication with healthcare professionals	Pen & paper Voice Mobile phone (closed user group)
	Receipt of clinical imaging	1. Collection of paper or hardcopy results	Paper
	Work-up plan/post-rehabilitation treatment	1. Fill request forms 2. Face-to-face communication with healthcare professionals 3. Post-treatment coordination of multidisciplinary care 4. Consultation of medical journals	Voice Pen & paper Mobile phones (closed user group)
	Patient care administration	1. Tracking of patient admissions, discharge and transfer 2. Administer physical care	Paper Mobile phone (closed user group)
Challenges with current work activities	Consultation with patients	1. Verbal communication can be problematic due to barriers of language and cultural understanding 2. Limited availability of communication device 3. Limited availability of manual medical device to administer physical care 4. Doctors and Nurses are compelled to walk in a bid to pass messages 5. Lack of efficient access to patient paper records	Voice Mobile phones (closed user group) Paper

Themes	Touch points of work activities in clinical settings of the hospital	Service interaction moments identified from tasks performance	Tools
Challenges with current work activities (continued)	Work-up plan/post-rehabilitation treatment	1. Doctors and Nurses are compelled to walk in a bid to pass messages 2. Inadequate coordination of collaborative care administration	
Inferences for ideal technology-enabled work activities	Consultation with patients	1. Access and update of patient records 2. Electronic communication with other healthcare professionals	Desktop computer Paper
	Booking requests for clinical examination including medical imaging or laboratory tests	1. Access to patient record on a screen through a keyboard 2. Request of examination 3. Retrieve results of examination	Desktop computer Paper
	Work-up plan/post-rehabilitation treatment	1. Digital communication and coordination of multidisciplinary care	Desktop computer (local access) and smart mobile phone (remote access)
	Patient care administration	1. Track patient admission, transfer or discharge and schedule follow-up visits 2. Administer physical care 3. Report writing on patient status and detailed procedures 4. Digital communication with healthcare professionals and other hospital staff	Device with voice recorder and speech recognition features Desktop computer Health-related smart mobile device

6.7 Co-design activity findings from hospitals H1 and H2

The similarities and differences identified from the analysis of the co-design activities obtained from engagement with healthcare professionals in hospitals **H1** and **H2** are presented in Table 6.3 below. One of the commonalities between these hospitals is the fact that patient consultation is facilitated using paper on which to write clinical notes resulting from verbal communication with patients and for referrals between clinical departments. Given the overburdened healthcare system, this work activity presents an opportunity for doctors in both contexts to use a form of mHealth technology to support clinical note-taking during patient consultation. Furthermore, the doctors in both contexts indicated that a desktop computer would be ideal during patient consultation since it would facilitate faster communication with other healthcare professionals at points-of-care in clinics. This would potentially reduce the waiting times associated with patient journeys during first time or on follow-up visits to tertiary hospitals.

Healthcare professionals in both hospitals **H1** and **H2** tend to lack adequate information at points-of-care. However, doctors in hospital **H1** use a mobile application (VULA) to bridge the communication and information exchange gaps that tend to inhibit remote referrals and consultations. It could be inferred from both contexts that the features required for ideal mHealth technologies would enable access and exchange of information between healthcare professionals in a way that does not cause distractions nor increase workloads.

It was evident in both contexts that electronic referrals are (or would be, in the case of **H2**) faster than the use of the traditional methods of using paper and a messenger. However, it is clear that paper and other devices are perceived as useful, depending on the tasks, work activity and location of the points-of-care during service delivery. Particularly in hospital **H2**, there is a reported lack of sufficient material resources, scarce nursing staff and the hospital's architectural planning as the major sources of the work challenges experienced by this hospital's healthcare professionals. These are some of contextual differences specific to hospital contexts between **H1** and **H2**.

The infrastructure contextual conditions affect how work activities are executed in both hospitals **H1** and **H2**. However, in both contexts, healthcare professionals can be hailed as problem solvers and solution providers beyond their medical practice. Hence, they are likely to come up with solutions that mostly come at a personal cost. This is evident in the use of personal resources to execute their work activities. Thus, it can be argued that in the Sub-Saharan contexts, healthcare professionals are best suited to advocate for the type of tools that would enable them to perform tasks within their work activities at points-of-care.

Table 6.3: Similarities and differences between the co-design activities from hospitals H1 and H2

Common co-design themes		Hospital H1	Hospital H2
SIMILARITIES	• Work activities	• The work activities of healthcare professionals are similar in both contexts. The doctors manage patient consultation, referrals and treatment or work up plan while nurses mainly administer care to patients and write a detailed report on all procedures of nursing activities.	
	• Access to information	• There are instances of lack of adequate information at points-of-care	
	• Paper-based communication	• The service interaction moments of patient consultations involve the use of face-to-face verbal communication, pen and paper to take clinical notes • Both healthcare professionals indicated that paper use may become cumbersome. • Paper forms and porters (messengers) are used to facilitate inter-departmental referrals • Nurses use paper for documentation of patient status and procedures taken to administer physical care	
	• ICT/Mobile communication	• Doctors express the use of desktop computers as appropriate to facilitate access to patient records and to book clinical examination requests ad retrieve results • Mobile phones are mostly used to facilitate communication through instant messaging and calls during work activities • The healthcare professionals are aware of the potential benefits for mobile phones to facilitate the exchange of health-related information and communication. • The healthcare professionals use their mobile phones to facilitate phone calls and, in some instances, real time instant messaging to exchange medical images and ask for advice.	
	• Affect/personal cost/impact	• Doctors performed tasks at some personal costs • Healthcare professionals incur personal costs in form of airtime and bandwidth data costs when they use their mobile phones to facilitate phone calls and exchange of information. • Doctors indicated that the use of their mobile phones disrupt patient consultations at the clinics or in the wards	
	• Suggestions for ideal mHealth technology enabled work activities	• Healthcare professionals suggested the use of smart mobile devices with features that can capture verbal communication and transcribe voice to text electronically • Healthcare professionals suggested the necessity of Wi-Fi infrastructure to be present to support the use of mHealth ICTs in the clinical settings of hospitals	

Common co-design themes		Hospital H1	Hospital H2
DIFFERENCES	• Facilitation of referrals	• Intra-hospital referrals are facilitated using a smart mobile phone app	• Intra-hospital referrals are paper based and through verbal communication (sometimes using mobile phones)
	• Storage of information	• Clinical notes are digitised and stored in hospital information systems to enable the quicker retrieval of patient records	• Clinical notes and patient records are fully paper.
	• Booking requests and retrieval of results	• At hospital clinics, booking examination requests and retrieval of results is computer based	• At hospital clinics, booking examination requests and retrieval of results is paper based and verbal
	• Use of ICTs/ mobile technology	• Healthcare professionals indicated the use of instant messaging features such as WhatsApp to coordinate collaborative care • The doctors use health ICTs to enhance the tasks within their work activities. • Healthcare professionals indicate that the use of health ICTs has enhanced work activities. These include reduction in unnecessary referrals and quicker access to patient records and health-related information at points-of-care in the clinical settings of hospitals. • The provincial government is invested in the adoption of health ICTs by frontline healthcare professionals in public tertiary hospitals.	• There is a suboptimal leveraging of smart mobile phones to coordinate collaborative care amongst multidisciplinary specialists • The doctors do not use health ICTs to support their work activities. • Healthcare professionals indicated lack of adequate communication and information management to enable decision-making. • The presence and willingness of the government to drive adoption of health ICTs is barely visible.
	• Admission, transfer and discharge systems	• Nurses use a triage system to manage admission, transfer and discharge of patients.	• There is no system used to manage admission, transfer or discharge of patients.
	• Patient care administration	• The nurses use NIMS to manage patient care administration.	• The nurses indicate the use of manual medical devices and a closed user group (in form of a mobile phone) to communicate.
	• Challenges	• Doctors mentioned that the completion of work activities is extended in cases where health ICTs are faulty or offline.	• Healthcare professionals mentioned erratic power supply, non-functional public healthcare system and limited available manual devices are major challenges that inhibit their work activities.

6.8 Conclusion to Chapter Six

Analysing the set of healthcare activities enabled the researcher to understand how healthcare professionals deliver services and, consequently, the nature of intended outcomes. The rationale for using a co-design activity was to comply with, and manage, ethical concerns or any disruptions associated with any attempt to understand the healthcare settings through direct observation of the workflow of healthcare professionals in real time. The co-design activity generated an abstraction of user (healthcare professionals) journey maps. The user journey maps highlighted the interaction moments of tasks performed to achieve the intended goals during the execution of the clinical work activities currently (*'as-is'*) enabled by HITs. This technique assisted the researcher to identify enabling factors and technology features towards a proposed *'could-be'* situation.

Evidence from the co-design activity shows that the current work activities of healthcare professionals in tertiary hospitals are best supported by a combination of both paper-based and ICT tools. The doctors use a combination of paper to write clinical notes and technology systems such as PACS, which is used to request clinical examinations bookings, and ECM, to access electronic patient information. Nurse work activities, which include report writing and administering physical care to patients, are largely paper based. Some of these findings validate the feedback in the form of responses obtained from the interview data.

A general conclusion, drawn from the co-design activities, is that, within the work activities of healthcare professionals in tertiary hospitals, there are some touch points where technology performativity influences human agency and *vice versa*. For example, the ECM version installed in hospital **H1** compels healthcare professionals to utilise paper to record information, which is then eventually scanned electronically. This procedure results in a backlog of patient information that is unavailable electronically when required. Alternatively, some healthcare professionals have found innovated ways to always have the latest version of clinical notes available to them, when needed, rather than relying on the institutionalised process of scanning paper records.

Based on the challenges experienced by healthcare professionals while performing their work activities, suggestions were made by participants and inferences were drawn by the researcher regarding integration of mHealth technologies into the current work activities. In the next chapter, Chapter Seven, the researcher offers an interpretive discussion of research findings by applying the ActAD model to identify the conceptual knowledge about the technology-enabled work activities executed by healthcare professionals at points-of-care during service delivery.

CHAPTER SEVEN: DISCUSSION OF FINDINGS

7.1 Introduction to the discussion of research findings

The primary motive for any development efforts that include the introduction of information and communications technology innovation is to improve productivity (Mishra et al., 2013). Thus, improvement of productivity is associated with digital transformation in the form of automating manual processes to boost the efficiency and effectiveness of work performances (Meskó et al., 2017). In healthcare settings, the outcome of healthcare professionals' work activities is influenced by their ability to make timely and informed decisions that ensure quality of service delivery and, ultimately, improved patient wellbeing. Ideally, this should be in line with every healthcare institution's overall objectives and goals. However, when adopted and designed without adequate considerations to the work activities of healthcare professionals, HITs are eventually discarded or used in unintended ways. In this chapter, the researcher applies the interpretivist principles of Klein and Myers (1999) to critique the findings of this study by applying the elements of the ActAD model (Mursu et al., 2007) in order to offer explanations towards addressing the research aim.

To address the research questions of this study, the structure of this chapter is introduced in section 7.1 and a description of the combined emergent themes from the thematic analysis in chapters Five and Six is provided in section 7.2. The role of actors within healthcare service delivery as an activity system is discussed in section 7.3. The motives of work activities are discussed in section 7.4, followed by details on the IT vision and strategy of the Provincial Department of Health in section 7.5. The transformation process of the role of actors and how the purpose of activities is aided by the means of action during healthcare service delivery is explained in section 7.6. The outcomes of the transformation process at points-of-care are discussed in section 7.7. The researcher addresses the research questions in section 7.8 and the conclusions drawn are summarised in section 7.9. Figure 7.1 shows the interactions between the conceptualised elements within the work activities of healthcare professionals during service delivery. These elements are used to discuss the findings that relate to how healthcare professionals use tools to enable interaction moments during their work activities, and how this influences the anticipated outcomes. Subsequently, a conceptual framework is proposed as illustrated in Figure 8.1.

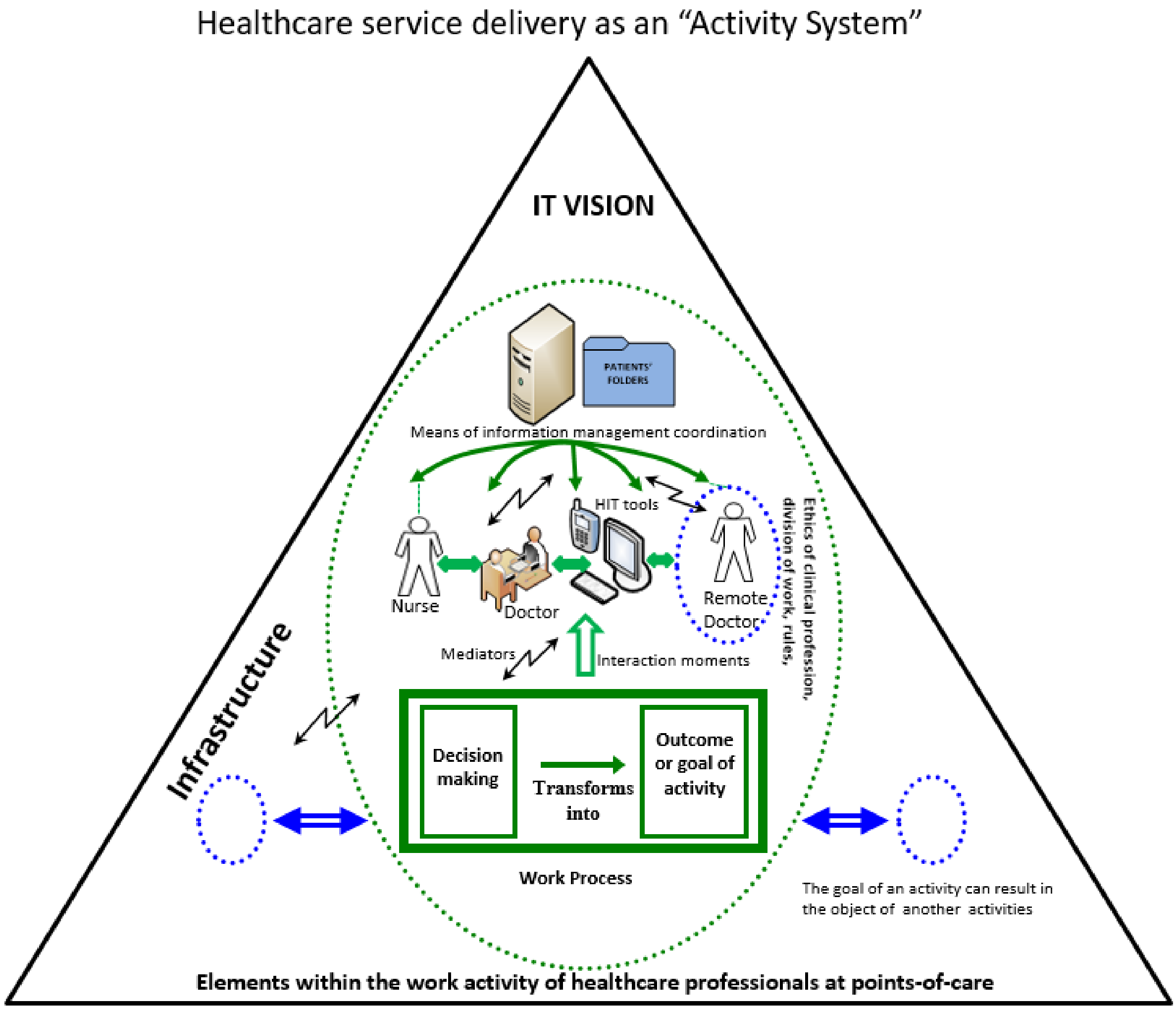


Figure 7.1: An ActAD illustration of healthcare service delivery as an activity system

7.2 Common themes identified from data analysis

In this section, the researcher highlights the emergent themes identified across the thematic analysis of interviews and co-design sessions involving the engaged participants. The themes are i) contextual factors, ii) work activity challenges, and iii) health ICTs and mHealth technologies.

7.2.1 Contextual factors relevant to emergent findings

An individual's actions are usually informed by the influence of their context or environmental factors (Mursu et al., 2007). According to O'Connor and O'Donoghue (2015), contextual factors condition the environment to either inhibit or enable the performance of a task and the execution of activities. The contextual factors that condition opportunities to integrate mHealth technologies into the work activities of healthcare professionals at points-of-care are technical, human-induced or infrastructural. These factors manifest in the contexts of the two hospitals with peculiarities that influenced responses from the findings inferred from the thematic analysis, documented in chapters Five and Six.

In terms of infrastructure, participants Ort3_H1 and Ort5_H1 placed particular emphasis on the need for a fast and reliable Internet connection. One of the participants mentioned that "faster Internet or connection. Up to date computers that can handle the new technology" are the facilitating conditions necessary to support the use of health ICTs at points-of-care. The researcher inferred from the responses that there is limited Internet connectivity in the hospital settings in relation to requirements needed for the execution of work activities and that legacy or older computing systems are in use. Erratic Internet connectivity would inhibit timely access, retrieval and exchange of patient records from networked computing devices and mHealth technologies at points-of-care. Internet infrastructure contributes to the timely application of features, such as instant messaging services and access to medical journals, by healthcare professionals during the work activities (Fischer et al., 2019).

Since the field study considered tertiary hospitals, respondents implied that the number of patients attended to during consultations and referrals is sometimes overwhelming, particularly when coupled with multitasking at points-of-care. The researcher associated this with a dearth of sufficient skilled personnel to facilitate and administer care. This has been a recurring challenge to the healthcare systems in Sub-Saharan Africa. As a result, healthcare professionals make use of ICTs that should ideally be infused into their daily routine to enable the execution of their work activities during delivery of healthcare services. Moreover, the presence of organisation and infrastructure factors play a mediating role in setting the stage for adequate facilitating conditions for the use of health ICTs and mHealth technologies by healthcare professionals. As discussed in section 7.5, the involvement of government health bodies and tertiary hospital management in the process of adopting health ICTs is essential to address the work activity challenges indicated by the respondents in the contexts of both hospitals.

7.2.2 Work activity and associated challenges

Work activity challenges were identified as a common theme extracted from the analysis of the interviews and co-design session conducted with healthcare professionals in the two tertiary hospitals. Some of the challenges were similar between the contexts, while others were specific to each hospital. The researcher attributes the work-activity challenges identified to the outcomes of tensions between contextual factors and the expectation reality gap experienced by healthcare professionals, which inhibits the execution and completion of tasks in the process of healthcare service delivery. The work activity challenges identified were mostly as a result of the inadequate facilitating conditions that occur because of the use of personal devices for work and because of infrastructure limitations. The feedback received from the participants suggests that, in one of the hospitals, the influence of contextual factors is more prominent than in the other, to the extent that healthcare professionals are obliged to improvise in their personal capacity to execute their work activities. It is argued that the lack of willingness on government's part to engage healthcare professionals and to invest in the implementation of health ICTs to enhance work activities might poorly reflect on the quality of healthcare service delivery, job satisfaction and even on patient outcomes in the public healthcare sector. Therefore, the influence of contextual factors in the creation of an enabling environment for healthcare professionals to perform their tasks may also influence how tools such as health ICTs are used to support service delivery.

7.2.3 Health ICTs and mHealth technologies

In addition to work activities, health ICTs, which include mHealth technologies, are central to the themes identified across the data analysis documented in chapters Five and Six. The inadequacies resulting from a lack of enabling conditions for healthcare professionals to execute their work activities leaves a gap that inhibits job performance and even the quality of service delivered in hospital settings. The findings suggest that the occurrence of inadequacies provided an opportunity to introduce, integrate and infuse technology into the work activities of health professionals as a tool to address the complexities these activities in a more efficient manner at points-of-care. These tools act as an extension to, but not necessarily as a replacement of, the work activities usually performed manually in the hospital environment by healthcare professionals.

According to the healthcare professionals in both tertiary hospitals, desktop computers and smart mobile devices which are interconnected because of Internet access are perceived as the essential tools to support patient care and information administration. The health ICTs in these contexts are used to facilitate storage, access and retrieval of health-related information, as well as to enable communication, particularly to support decision-making at points-of-care locally in the hospital or remotely. A breakdown of the work activities executed with the use of health ICTs is further discussed in section 7.4, using the ActAD model. Due to the potential and realised benefits attributed to health ICTs in instances where they have been implemented, governments and individual donors continue to invest financially, through collaboration with industry vendors, to develop healthcare digital systems. With the digital systems infused into the work activity of healthcare professionals, along with suitable facilitating conditions, there is a higher prospect of improving the quality of healthcare service delivery in the hospital settings.

7.3 Actors within the activity system of healthcare service delivery

In this study, actors are defined as healthcare professionals who are the frontline end users of the implemented HITs, as well as other personnel, such as information managers responsible for the choice of HITs implemented at tertiary hospitals. Emphasis in this discussion is placed on healthcare professionals who use enabling tools to deliver healthcare service to patients. In the ActAD model, the role of the actor is mediated by means of an action performed to execute the motive of activity. Hence, the findings suggest that actors have different use behaviours and attitudes that enable or inhibit how technology is used to support work activities at points-of-care during service delivery, particularly in a tertiary hospital setting.

Healthcare professionals experience contextual factors that frustrate adequate delivery of services, particularly in public healthcare institutions. These contextual factors include an overburdened healthcare system, backlogs in patient visitations, longer waiting times, and sometimes, a lack of access to the necessary health-related information because of an inefficient records management system (Scheffler et al., 2015). Over time, these factors influence the lived experiences and job performances of healthcare professionals in alignment to how healthcare services should be appropriately delivered. Consequently, an urgent need to overhaul the healthcare service delivery system is inevitable. The attributes that influence the human agency with regards to challenges experienced during work activities and how machines, such as health ICTs, can be beneficial are discussed in section 7.6.

The research objective was to understand how mHealth technologies could enable the service interaction moments which occur during work activities by regarding the human and technology components as nodes of a socio-technical interaction at points-of-care. In this study, the researcher engaged with healthcare professionals in selected tertiary hospitals in South Africa and Nigeria. The researcher learnt that some HITs and mHealth technologies are being used by healthcare professionals in hospital **H1** during the performance of their work activities at points-of-care, while there were no implemented HITs used to support the clinical work activities of healthcare professionals at points-of-care during service delivery in hospital **H2**. The findings in both contexts show that healthcare professionals experienced similar issues during the execution of their work activities and are aware that the use of ICTs could be a potential solution driver to enhance the quality of service delivery. In a similar study carried out by Abyaomi et al. (2017) in selected teaching hospitals in Nigeria and South Africa, performance expectancy and effort expectancy were found to influenced the usage of HITs. In addition, the authors stated that an enabling environment is vital for the acceptance of HITs by medical doctors and could ultimately enable the effective use of technologies during service delivery. In this study, the findings show that healthcare professionals perceived health ICTs as (or could be) beneficial to enable the tasks of their work activities and do not require much effort, particularly in hospital **H1**.

A study was conducted by Banderker and van Belle (2006) on the factors that influence the adoption of mobile technologies by doctors in public hospitals of the Western Cape. These authors reported that tech-savvy healthcare professionals were instinctively inclined to use the mobile technologies that were applicable and beneficial to their work activities. While the study did not describe the effectiveness of mobile technologies on outcomes of work activities, the authors recommended an action-research approach in order to understand user perceptions. The researcher discusses the perceptions, thoughts and lived experiences of healthcare professionals as actors in clinical work activities in the service delivery activity system.

Banderker and van Belle (2006) described the causal factors that influenced the intention of doctors to use mobile technologies during work activities. These factors were: perceived usefulness; technology capabilities and suitability for tasks; the effect of using the device in service delivery; and managerial support from government. Kim et al. (2016) indicated that hedonic motivations influence the behavioural intention of technology users to execute their work activities. For example, some participants in this study utilise technologies that they perceive would enable them to satisfactorily execute their tasks effectively and efficiently at points-of-care. One of the participants recounted that:

> So just to have the PACS on any computer, you would have the x-rays available and then of course you could do your planning and everything as well. And you could draw your lines or do your templating on the PACS itself. It has definitely helped in that regard. You can't lose the x-rays" (Ort1_H1).

The response indicates a feeling of satisfaction attributed to how HITs, such as the PACS, simplify access to the x-rays of patients and to carry out other clinical tasks during the decision-making process. This relates to claims by Ladan et al. (2019) that healthcare professionals are motivated to use eHealth technology solutions because they enable completion of their tasks. It can be inferred from the findings that the implemented HITs improve the efficiencies of performing tasks to enhance decision making-process at points-of-care. For example, the ECM facilitates quicker access to previous clinical notes written on paper which have been scanned as electronic copies. Ideally, the electronic copy of patient information should be made available and accessible on digital platforms, thus reducing the time it would take to collect and access paper folders. The researcher argues that perceived usability and suitability of PACS and ECM by the participants align with the conclusions drawn from the systematic literature review on factors that influence mHealth adoption by healthcare professionals (Gagnon et al., 2016).

Additional factors that influence the likely use of mobile devices by doctors are patients' perceptions and legal action (Banderker & Van Belle, 2006). These two factors were mentioned in this study. For instance, Ort4_H1 said that the VULA app "keeps a database of future reference and medico-legal issues can be referenced". This is because, "there is a record of the conversation and the advice given" (Opht2_H1) during consultation. Other participants also explained that there are situations where the institution is required to draft a report containing necessary information about unnatural incidents that are being treated in the hospital for court cases (TrNM_H1). According to DNM_H1, loss of information affects the integrity of information content in medico-legal reports:

> "Many a times when you need some medico-legal reports and that specific report is lost; it means that you got to write in retrospective a report of which you could have just stored it on a device".

It can be inferred from the response that paper records are susceptible to loss. The loss of a paper record may affect the information content which the institution provides in situations that require the involvement of law enforcement entities, such as the police or courts. However, the participant mentioned that the use of electronic devices to capture and store information would likely prevent unnecessary loss and inaccuracy of information when needed.

Ideally, the resultant experience of using HITs is largely dependent on their usability to support the particular tasks or interaction moments within a work activity. In this study, usability was conceptualised as the extent to which implemented HITs are effectively utilised by healthcare professionals to execute tasks within their work activities to deliver care services to patients at points-of-care. The points-of-care could either be the clinic, the wards or the theatre. This means that the HIT system used by healthcare professionals should be suitable, easy to use and useful to enable interaction moments at point-of-care in a satisfactory way to obtain the intended outcomes. For instance, healthcare professionals perceived the VULA application as useful to facilitate communication with their colleagues remotely and its positive effect on the referral process.

> "It has a very positive effect on service delivery. With ECM it is easy to access patients' information from any computer at any time. VULA app makes it very easy for a healthcare worker in the periphery to get in contact with the doctor on call, to refer patients and to get valuable feedback on management of patients" (Opht2_H1).

The participant indicated that the VULA application and the ECM system have a positive effect on the process based on how they enable interaction moments, such as access, communication and exchange of information at points-of-care during work activities. This indicates that there is a correlation between the perceived usefulness and ease of use and the satisfaction derived from the use of HITs to enable work activities.

"So, we would get pictures and a history then we could give information to the person that is referring on what he could do and so we've lessened the amount of unnecessary referrals to this hospital" (Ort1_H1).

Base on the response above, the researcher asked what the participant thought about the use of personal devices to perform tasks, especially when dealing with sensitive information relating to a patient. Participant Ort1_H1 explained that:

> "That probably depends on the opinion of each person using it because it has made referrals easier because you'd know what you're dealing with and there is a setting on the VULA itself where you can decide how much resolution you want on a picture. So, you can choose if you want to use minimum amount of data or a lot of data. But it all adds up if you are on a 24-hour call taking VULA referrals, it would use up your data…but if there's a way to not use one's own data it'd be beneficial because it is work related".

In the response the participant mentioned the benefits attributed to the use of the VULA application to manage referrals. In this case, it is clear that the VULA application is perceived as useful for attending to referrals because it provides the necessary information required by healthcare professionals to make informed decisions during consultations. The responses show that healthcare professionals use their personal resources, such as mobile phones and data, to facilitate the exchange of sensitive information relating to a patient health. However, this participant stated that the impact of using personal devices to take referrals is dependent on each individual and that data use can be minimised by adjusting picture resolutions. In the context of this study, South Africa, mobile data are regarded as expensive in comparison to other countries with similar socioeconomic status. Similarly, Opht2_H1 confirmed that the VULA application used data and that it is somewhat obligatory to have the app on their phones:

> "We don't get an allowance or anything extra for that (data)… I believe they felt obliged because the person that designed the app was - worked here so I think that's why we will always have it" (Opht2_H1).

In this study it is clear that healthcare professionals experience challenges when trying to execute their work activities in a timely manner, on top of the overburdened condition of the public tertiary healthcare system. To address these challenges, health technology solutions were implemented to facilitate tasks in a timely way. In this way, healthcare professionals found implemented HITs useful because of the associated benefits that accrued when executing their work activities more efficiently. The confidence that technology would enable the execution of tasks influences the trust of healthcare professionals in implemented HITs and *vice versa*. For instance, participants stated that they revert to the use of paper-based systems when implemented HITs are slow or offline. This inhibits their ability to carry out work activities to the extent that attending to patients late because of a lack of timely access to information can lead to complications, especially in emergency cases.

The implemented HITs, such as the VULA application and ECM systems, sometimes increase the workload of healthcare professionals. The invasiveness of mHealth technologies have been reported to be a barrier to the execution of their duties (O'Connor & O'Reilly, 2018). This increase in workload is evident from the dissatisfaction resulting from their need to multitask while attending to several patients in an already overburdened tertiary healthcare setting that caters to several clients daily. This dissatisfaction can be attributed to the self-awareness of healthcare professionals and their perceived ability (or inability) to carry out their work activities adequately at points-of-care in alignment with organisational objectives.

Consequently, there is a resolve to adapt to the situation by making use of other means of action, such as paper or a technology unrelated to health, because of its usefulness in activities unrelated to the medical profession. For example, participants stated that they preferred a technology that can transcribe verbal communication during consultation with patients. During the co-design activity, Ort2_H1 mentioned the occasional use of WhatsApp, instead of typing or writing notes.

> "There's a little microphone…where you press and then, it transcribes into the typing part. That, press that button, that microphone. Ok, talk in English, anything. 'I will be there soon'. Boom. See" (Ort2_H1).

It is clear that healthcare professionals may use other ICTs in the form of social networking applications like WhatsApp, which are not necessarily designed for health-related work activities. In this instance, a doctor perceived the usability of a WhatsApp feature suitable to enable the interaction moments of recording clinical notes during patient consultation. Consultations with patients are usually undertaken verbally and doctors have to write clinical notes during or after the session. In a sensitive context, such as the clinical setting, it is crucial for doctors to pay full attention when engaging with patients to avoid omission of valuable information that could be vital for decision-making. Multitasking at points-of-care without adequate support means that healthcare professionals are susceptible to making errors that might be detrimental to a patient's wellbeing and which could impair service delivery. The researcher terms these events as the unintended consequences caused by a lack of alignment between the human actor and the capabilities of ICTs to effectively execute work activities. More instances of the unintended consequences are reflected in the interplay between human and machine agency, as discussed later in section 7.5.3.

This study reiterates the assumptions of the literature that the perceived usefulness and ease of use attributed to HITs correlate with trust emergent from the use of, and satisfaction with, the technology, determined by the outcome of use by healthcare professionals. The resulting satisfaction derived from technology-enabled interaction moments at service touch points determines the perceived improvement of healthcare services delivered in line with the objectives of tertiary healthcare institutions. Hence, the effectiveness of mHealth technologies is evident where the needs associated with the complexity of the object of work activities are addressed, with minimal or no disruption during service delivery.

7.4 Motives of activities within healthcare service delivery

According to the ActAD model, the activity system can be described as a collection of work activities that are executed by different stakeholders to achieve a shared goal (Korpela et al., 2000). Each work activity is characterised by a specific purpose(s). The purpose or motivation for performing a work activity is influenced by the object of activity (Mursu et al., 2007). For instance, an object of activity in the healthcare system could be information management. The motive of managing information is to enable healthcare professionals at the points-of-care make an informed decision on the health and wellbeing of patients. Another object of activity within the healthcare system is the wellbeing of patients. The motive of consulting with a patient transforms the medical history collected from patients into prescribing a treatment plan to enhance their wellbeing. The motive and object of a work activity are intertwined and are transformed into outcomes successively. The outcome of a previous activity then becomes the object of the next activity (Korpela et al., 2000). In this way, the sequence of work activities, including administrative and clinical activities, form the service delivery activity system.

In this study, the goal of the work activities performed by different healthcare professionals within tertiary healthcare is to deliver a service, i.e. the outcome of an activity. The service could be improved or impaired, depending on the influence of elements, as illustrated in Figure 7.1. When delivering services, newly generated or retrieved information at every point-of-care is used and the type of information usually has an impact (positive or negative) on the purpose of use (Debrah et al., 2017). The information becomes the shared object of the action upon which an individual or collective actor executes the motive of the activity.

The key element requested from, or provided to, patients by the administrative or clinical staff in hospitals is information. The types of information generated or retrieved at different points-of-care include patient demographics, clinical notes on the likely symptoms of ailment, booking requests for clinical images and pathological tests, as well as results. The information is either used to keep track of the patient administration or to make decisions on the treatment plan. Consequently, patient information can also be referred to as the shared object of networking. It is, therefore, essential for healthcare professionals to manage the trail of events to ensure data or information accuracy in order to support decision-making at points-of-care.

Information is captured and can be exchanged using tools otherwise known as the means of action in the ActAD model (Korpela et al., 2004). Tools are conceptualised as artefacts that enable actors to perform actions or interaction moments within work activities effectively, i.e. easier and quicker (Kaptelinin & Nardi, 2018). HITs or health ICTs can be the means of an action by an individual upon the object (doctor studying electronic records to make a diagnosis during patient consultation); as a means of coordination and collaboration between the actors of a joint activity (doctors and nurses studying the record of a shared patient at different times); and as a means of networking between activities within a network of activities (referral from outpatient clinic to inpatient ward). In this study, the tools used by healthcare professionals are the PACS and the EHRs in the form of the ECM. Other HITs include electronic medical equipment, WhatsApp and the VULA application. Some tools are used manually, while others are desktop computer- and/or smartphone-enabled and owned by the healthcare professionals.

In tertiary healthcare (*activity system*), healthcare professionals (*actors*) use tools (*means of action*), such as paper or HITs, to capture or access (*action*) information (*object of action*). However, the information could be interpreted as either a *shared object of networking* or *shared object of action,* depending on how it serves the collective activity within the system. The captured information enables healthcare professionals to make an informed decision (*work activity*) on the state of wellbeing (*object of activity*) of their clients in order to improved health conditions (*outcome of the activity*). Therefore, healthcare service delivery is not an isolated event but requires the collective effort of the different actors involved.

In retrospect, the data collection techniques of semi-structured interviews and co-design activities enabled the researcher to identify and establish the key service touch points where healthcare professionals could use mobile devices. The findings show that the VULA application, iSite, PACS and ECM systems are mostly used during the administration of, and consultations with, patients. These HITs enable interaction moments during tasks which include information collection, and the access and retrieval of information to support decision-making by doctors.

According to the findings documented in sections 5.5.1 and 6.3, the work activities indicated by healthcare professionals are patient administration and reporting by nurses, consultation by doctors and management of remote referrals at the outpatient clinic and trauma ward. The findings align with the systematic review undertaken Bassi et al. (2018) which found that patient consultations, remote communication and diagnosis and facilitation of follow-up visits are the primary activities of healthcare professionals at points-of-care. In attempts to facilitate these activities in a timely and effective manner, health ICTs, including mHealth technologies, are implemented to support healthcare professionals. The outcome of these activities is the development of a treatment plan, which marks the end of the work activities at the points-of-care.

7.4.1 Consultation and communication as work activities

The administration of patients by healthcare professionals can be divided into consultation with patients and communication with colleagues. During patient consultation, there are multiple tasks performed by healthcare professionals. The actions performed include verbal communication, the use of a pen to write clinical notes on paper and the use of HISs. The verbal communication is undertaken to enable information acquisition to assist the doctor to understand the patients' complaints while a pen is used to write down clinical notes on paper. To make the captured handwritten notes easily accessible and always available, the hospital has a dedicated scan centre where data capturers scan all the paper copies into an electronic system after the patient is discharged or transferred.

ECM and PACS are the HISs mainly used by doctors in the South African context. The ECM system facilitates access to the clinical notes history stored in a digitised format, while PACS is used to book requests for, and access results of, clinical examination. The digitised information is retrieved from the ECM by healthcare professionals by a desktop whenever there is a follow-up visit by patients. The scanned information enables information to be available at all times in an electronic format, thereby simplifying access this information and mitigating against the consequences associated with paper damage or loss, as indicated by healthcare professionals in hospitals **H1** and **H2**.

The benefits attributed to the use of ECM is consistent with the global drive initiated by the promulgation of the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 for promoting use of EHRs to facilitate easier access to information and to simplify other related clinical tasks efficiently (Ratwani et al., 2019). In this study, findings show that healthcare professionals experience delays when attempting to access electronic copies of scanned handwritten clinical notes during patient consultations. The delay is attributed to the time taken for paper folders, sent to the hospital scan centre, to be scanned and made available in an electronic format. This is referred to as turnaround time (Tokosi, 2017).

Given the nature of healthcare professionals' work activities, it is imperative that information should be readily available and easily accessible to enable decision-making at points-of-care

(Miah et al., 2017). However, implemented HITs might be used in unintended ways or used partially to enable the interaction moments at a specific snapshot in time, and not to the full functionality potential of their original design, because of contradictions, as indicated in Figure 7.1. These contradictions are mediators in the form of either elements or events that deter the original intended use of tools by actors (Wiser et al., 2019). The prominent effects of contradictions on the use of health ICTs by healthcare professionals during work activities are the delays.

The causal factors of delays in work activities are referred to as inhibiting mediators (Mlitwa & Belle, 2010). These include technical inadequacies attributed to usability, capabilities and fit-for-purpose of health ICTs; contextual conditions such as characteristics of public hospitals; human-induced issues, such as resistance; and the lack of adequate skills to use health ICTs. The healthcare systems in majority of the Sub-Saharan Africa countries is characterised by overburdened public hospitals; a shortage of skilled personnel; a lack of infrastructural and material resources; and even a burden of diseases (Yaya et al., 2020). In this study, the presence of, and interplay between, these factors are responsible for the unintended consequences experienced associated with the execution of work activities.

According to Tokosi (2017) there is a correlation between satisfaction derived by healthcare professionals and the performance impact of health ICTs during work activities at points-of-care. Similarly, the doctors in this study revealed that, during follow-up patient consultations, the ECM does not facilitate quicker access to patient information when needed. Doctors stated that it often takes six to eight weeks before paper records become available on the ECM. It could be argued that the current health ICTs implemented in hospital **H1** do not take into considerations the unintended consequences of the application and appropriateness of the systems for work activities during the process of service delivery at points-of-care.

Even though health ICTs are implemented to redress the inefficiencies in executing work activities to improve service delivery, healthcare professionals perceive that some of these ICTs further add to the already strained workload and the need to multitask at points-of-care. Therefore, a prominent factor in the execution of work activities in a hospital setting is time. According to O'Connor et al. (2013), time criticality influences how healthcare professionals perceive the usefulness of mHealth technologies during their work activities. They are saddled with the responsibility of attending to several patients daily and, when implemented, systems waste time and inhibit the interaction moments of work activities, which has an unfavourable effect on job performance, quality of service and overall satisfaction (Micheal et al., 2019).

The findings indicate that healthcare professionals seem to experience the effect of a lack of resources such as insufficient desktop computers or mobile devices at points-of-care. This finding aligns with claims made by Mlitwa (2011) that the type of tasks, appropriateness of HITs to enable the tasks, context of use and rules influences how healthcare professionals actually make use of ICTs at points-of-care during healthcare service delivery. In other words, technology-enabled service interaction moments are dependent on how the tasks are to be performed, the location/situation of the user and the facilitating conditions that support the use of HITs.

According to Chen and Hsiao (2012), quality of information and system quality are significant determinants to user satisfaction. The findings in this study indicate that the work activities of healthcare professionals are largely dependent on information. When accuracy of the information is in dispute, this affects how healthcare professionals perceive the usefulness of implemented HITs and, ultimately, their satisfaction. Manda and Herstad (2015) suggest that the utilisation of mobile technology solutions during work activities requires an adjustment to the existing paper- and desktop-enabled practices.

In essence, paper has it strengths in terms of the surface area and flexibility, which mobile phones and desktop screens do not offer. With regards to desktop computers, the work activities of healthcare professionals require access to computers in order to view medical images electronically, on a larger screen than mobile devices provide, especially in a hospital setting. However, mobile technologies provide opportunities to bypass challenges associated with paper and desktop computers in terms of retrieval and exchange of information, as well as challenges associated with communication when away from a desktop or on the move in a hospital setting.

Other technology tools used by healthcare professionals to enable interaction moments at the points-of-care are the PAC system, used to enable communication and clinical examination bookings, such as laboratory and radiology tests. The VULA mobile application seems to be particularly suited to electronic referrals in two clinical departments in hospital **H1**. “It allows direct communication with referring practitioners and keeps a record of all interaction” (Ort5_H1).

Patient information stored in an electronic system would facilitate quicker access to records needed to enable decision-making at points-of-care, to assist to resolve the long waiting periods for consultation in tertiary healthcare and, ultimately, the duration of service delivery. However, in hospital **H2**, the doctors indicated that every history, diagnosis, prescription and treatment plan recommended is documented in the patient folder. This enables doctors to monitor the progress of treatment plan for patients on the subsequent follow-up visits.

Table 7.1: Description of elements in consultation activity

Element of work activity at point-of-care	Description in this study
Actor(s)	• Specialist doctors that interact with patients at points-of-care • Nurses administer continuous physical care
Tools ✓Means of action ✓Means of collaboration and coordination	• Paper to write in hospitals **H1** and **H2** • ECM to access patient records in hospital **H1** • PACS to book clinical examination requests and get results in hospital **H1** • CUG phones to communicate amongst professionals in hospital **H2**. • Smartphones to communicate in hospitals **H1** and **H2**
Object of work activity ✓Shared means of network	• Shared patient records (paper or electronic format)
Community	• Clinical settings of tertiary hospitals
Division of Labour	• The roles of doctors and Nurses during work activities are complementary in hospitals H1 and H2
Outcome of work activity	• Information acquisition to make informed decisions to improve patients' ill health

For HITs and mHealth technologies to enable the interaction moments of tasks performed during work activities, an enabling environment and consideration to the information needs of healthcare professionals would redress a perceived any lack of timely application and inappropriateness. In turn, this increases the effective use of HITs and mHealth technologies at points-of-care, which, ultimately, has a positive impact healthcare professionals' satisfaction. The healthcare professionals stated that the mHealth technology (VULA application) is perceived to be useful for the management of referrals.

7.4.2 Referral management as a work activity

There are situations within a work activity where the actors work as a collective group, informed by a shared object of action. In this study, patient information is referred to as the shared object of action since it is required by different healthcare professionals to enable the motive for activity. In a case where different actors perform actions on a shared object, it is necessary to have the means to coordinate and facilitate communication towards achieving the goal of the work activity. In this study, the two major means of coordination were found in the form of an electronic database and paper folders. For example, the referral of patients is similar to a collective network of activities where a patient is referred up through the system for tertiary healthcare. While, in the tertiary healthcare institution, the patient is seen by a specialist doctor in order to receive more comprehensive attention. This means that the patient history and other related information is needed by the specialist doctor at the point-of-care. Here, the motive of activity is remote consultation, which also known as teleconsultation, between healthcare professionals from different institutions. Particularly in hospital **H1**, the means of action is the VULA mobile application.

The findings indicate that VULA mobile application is used as a means of facilitating communication between healthcare professionals. The application enables teleconsultation, where doctors exchange information, including patient medical history and clinical images, to assist decision-making process. This incorporates the actions of individual healthcare professionals into a collective activity. In this case, patients who have been referred for tertiary healthcare are attended to remotely, thereby saving time and eliminating a need for additional face-to-face contact.

> "Specifically, from a referral point of view, the fact that you can actually see an x-ray which is a big part of our discipline; you can make a much better decision or better-informed decision and also can relieve the burden to us and maybe our referring institution. In some cases, you can make a decision where you maybe in the past couldn't because you don't have a visual representation of an x-ray for example. So, I do think it made a big difference for the better in terms of quality of care for patients" (Ort2_H1).

An added advantage of the use of electronic communication is that records of information exchanged are stored for future reference. The outcomes/benefits attributed to the VULA application concerning communication and consultations in tertiary healthcare settings are a simplified referral process, comprehensive feedback on patient management and a limit to unnecessary patient referrals. Thus, the researcher argues that, while the VULA application is used as a means of action, it could also be used for information management coordination. Hence, a healthcare professional with access to mHealth technology is empowered to access electronic databases or to communicate with their colleagues, who can access paper folders to retrieve reports and facilitate the exchange of medical images.

It is noteworthy to mention that the HITs used by healthcare professionals to perform tasks within their work activities do not function independently of their context. There are facilitating conditions that support the operation of these means of action. For example, the ECM and PAC systems require a database to store patient information. The VULA application requires data and a strong network signal that is dependent on an external mobile operator or a Wi-Fi Internet service provider (ISP) with an adequate bandwidth. The findings in this study align with claims made by Kabanda and Rother (2019) that the hospital settings require sufficient Wi-Fi coverage to enable the use of mobile applications at points-of-care.

According to Cresswell et al. (2013), infrastructure plays a vital role since it creates and serves as an enabling environment for HITs, including mHealth technologies, within tertiary healthcare. Examples of infrastructure include constant power supply, back-up power supply and sufficient bandwidth. Establishing an adequate enabling environment would guarantee the ease of use of HITs by healthcare professionals. Other necessary infrastructure includes a wired local area network (LAN) that makes use of cables to connect point-to-point devices directly or through a wall patch. For example, the desktop computers or smart phone through which the ECM and PAC systems are accessed needs to be part of a wired or wireless network to enable communication and information exchange within the hospital, or remotely from other healthcare institutions. In addition, there are challenges in the utilisation of implemented HITs to execute work activities at points-of-care or remotely.

Table 7.2: Description of elements in referrals management as a work activity

Element of work activity at point-of-care	Description in this study
Actor(s)	• Specialist doctors that interact with patients to manage remote consultations
Tools ✓Means of action ✓Means of collaboration and coordination	• Paper to write in hospitals **H1** and **H2** • CUG phones to facilitate communication amongst professionals in hospital **H2**. • Smartphones (VULA application, WhatsApp) in hospitals **H1** and **H2**
Object of activity ✓Shared means of network	• Patient records (paper or electronic format) • Patients' ill health
Community	• Online digital space
Division of Labour	• Doctors communicate remotely to request or offer medical advice in hospital **H1**
Outcome of work activity	• Information acquisition to make informed decisions to improve patients' ill health

In hospital **H2**, doctors indicated that paper forms and patient cards were used to facilitate referrals within clinical departments in the hospital. The patients who are attended to, have hospital cards. The doctor uses the patient card as a means to request bookings for the examining to be done by the laboratory or radiology departments. The patient has to physically submit the cards because they are required to pay for the service before proceeding to booking points. Depending on the physical state of the patient, the relatives may be tasked with the responsibility to take the cards to the referral points where investigations are booked. On the doctors' end, an assessment form (paper) is used to document the types of investigations to be done and the cost implications of these investigations, respectively. In this way, the hospital is able to keep the records of investigations performed and the cost implications, while doctors are able to monitor the compliance of patients to the medication adherence in the treatment plan.

In support of the argument by O'Connor et al. (2013) that mHealth technologies enabled the continuous movement of staff to accomplish their tasks anywhere within the hospital, findings from this study also indicate that mobile technologies can reduce mobility. A study by Manda and Herstad (2015) revealed that the use of mobile technologies in healthcare enables remote communication of data, while addressing the need for physical transportation and the related cost implications thereof. Hence, the use of paper and the incorporation of mHealth technologies to facilitate information management would improve time- and cost-efficiencies during patient referrals between the clinical departments in hospital settings. This enhances the tasks performance of healthcare professionals at points-of-care (O'Connor et al., 2020). As a result, healthcare professionals are able to easily coordinate treatment plans for their patients in a timely manner, irrespective of location constraints.

7.4.3 Treatment plan as a work activity

The treatment plan is the outcome of the work activities that include patient administration and technology-enabled (including mHealth applications) management of referrals. Therefore, the diagnosis and decisions made by healthcare professionals are informed by the individual's knowledge and experience, as well as the data accrued from clinical examinations (Reina, 2019). At this touch point, an individual or a group of healthcare professionals decides to admit, discharge or schedule a follow-up visit, or to refer the patients to peripheral medical services for coordinated continuity of care. In this study, continuity of care is characterised by post-treatment plans, which could include follow-ups on treatment progress, monitoring of medication adherence, scheduling appointments and rehabilitation. Bates (2015) indicated that most EHRs do not provide a platform where multidisciplinary teams can develop and update the treatment plan of patients. The lack of adequate care coordination was evident in the findings of this investigation and presents an opportunity for the integration of mHealth ICTs into the work activities executed by healthcare professionals. According to Martin et al. (2019), mHealth ICTs can transform collaborative work activities in hospitals.

A study by O'Connor and O'Reilly (2018) examined the infusion of mHealth technology into the work activities of healthcare professionals in a hospital setting. The authors found that the infusion of mHealth technologies facilitates inclusive engagement of all stakeholders in order to improve health outcomes during continuity of care. The findings of this study indicate that when mHealth technologies are infused into the work activities of healthcare professionals, they can improve efficiencies in records management, communication and patient monitoring. This aligns with the care coordination framework suggested by Bates (2015) that ICTs could be used to identify collaborators, for communication, to aid collaboration and for monitoring.

Table 7.3: Description of elements in development of treatment plan as a work activity

Element of work activity at points-of-care	Description in this study
Actor(s)	• Specialist doctors • Nurses
Tools ✓Means of action ✓Means of collaboration and coordination	• Paper to write in hospitals **H1** and **H2** • ECM to access patient records in hospital **H1** • PACS to book clinical examination requests and get results in hospital **H1** • Smartphones to communicate in hospitals **H1** and **H2**
Object of work activity ✓Shared means of network	• Shared patient records (paper or electronic format)
Community	• Clinical settings of tertiary hospitals
Division of Labour	• The roles of doctors and Nurses during work activities are complementary in clinical settings
Outcome of work activity	• Improved service delivery associated with outcomes associated with patients' health status

While there are no particular rules that guide how implemented HITs should be used by the healthcare professionals during their work activities, the ethics and best practices of the profession require that patient information be kept confidential at all times. The division of labour between healthcare professionals is evident in the complementary nature of nursing activities and that of specialist doctors at points-of-care. With the aid of mHealth applications, doctors can facilitate the exchange of information remotely, and consult with each other. These findings reinforce the notion that there is a correlation between perceived usefulness and technology fit, particularly because there are instances where a technology is useful but partially fits work activities at the points-of-care. Nonetheless, it is clear that the means of action used in the tertiary healthcare a South African context is used to enhance the quality of work activity and to improve the service delivery as well as health care outcomes. These outcomes are in partial fulfilment of the national vision of Healthcare 2030 and the Provincial Department of Health's IT vision for the healthcare system of the Western Cape.

7.5 IT vision and strategies for HITs in tertiary healthcare

In this section, the researcher discusses the findings of the role of Western Cape's Provincial Department of Health in the selection and implementation strategy of HITs to enable the work activities of healthcare professionals at points-of-care. The information manager in the Provincial Department of Health indicated that frontline end users are usually engaged by a business analysis team during the selection of the selected HITs in tertiary healthcare institutions. The business analysis team is tasked to identify the service needs of healthcare professionals when they execute work activities at the points-of-care. This allows the Department of Health to understand the context and to, subsequently, make a decision to either procure or develop health technology solutions. This aligns with the findings of Chen and Hsiao (2012) that there is a correlation between the competency of a project team that is knowledgeable in relevant methods to understand the complexity of the work activities of healthcare professionals and the successful selection of HITs. Understanding the tasks of healthcare professionals assists the project team to identify the needs of different departments of a hospital. The authors confirmed the importance of a competent project team to the successful development and implementation of HITs in a hospital environment.

Similarly, Cresswell et al. (2013) recommended that the decision to select an appropriate system should be guided by organisational purposes and clinical practice. The goal of healthcare service provision by institutions is to provide care services to manage the wellbeing of individuals. The aim is to prevent epidemics of communicable and non-communicable diseases leading to untimely and avoidable deaths. Consequently, ICTs and HITs are viewed as a means to drive efficiencies, and to improve productivity of hospital staff members and the outcome of service delivery.

Hence, the Provincial Department of Health gives adequate consideration to the tasks of hospital staff members, particularly healthcare professionals who are the principal users of HITs to enable decision-making. The decision to either procure or develop HITs depends on the complexity of work activities of healthcare professionals in practice. It is evident that the tasks performed by doctors and nurses at points-of-care may require different levels of automation or, in some cases, no automation. Based on the outcome of user engagement by the business analysis team, the Provincial Department of Health decides to procure or develop technology solutions from industry vendors or from local software developers, respectively. The findings by Hwabamungu et al. (2018) indicated that the peculiarities of a public hospital setting should influence the implementation of IT strategies, and leadership is an important part of understanding the interactions between different stakeholders.

To manage and sustain the Provincial Department of Health’s IT vision, governance layers have been set up to administer leadership roles in the strategy and implementation plans of HITs in the tertiary healthcare institutions.

> “To a large extent I think that we are quite advanced in terms of where we want to go. We’ve got a good framework that we working towards to achieve our objectives. We are quite good in terms of the governance layer from the eHealth and mHealth perspective. So, we’ve got various layers within the organisation right up (DIM).

The response implies that the organisational structures put in place to provide necessary governance have been effective in achieving the IT vision of the province and are aligned with the national eHealth and mHealth strategies of the National Department of Health. This is in support of a study conducted by Hwabamungu et al. (2018) to investigate stakeholder relationships and their influence on implementing an information system strategy in the public hospitals of South Africa. The authors implied that continuous interaction between different stakeholders within the strategy yield results over time, otherwise they disengage when they perceive they are not adequately involved in determining the strategy of the IT vision.

The Provincial Department of Health is governed by standards and guidelines to complete the process of procuring HITs solutions from industry vendors in healthcare. This is corroborated by the strategic initiatives reported by Hwabamungu et al. (2018), namely, that there are established budget allocation models adopted by each of the provincial governments in South Africa. However, the authors claimed that there are concerns about the appropriateness of the funding approach. Cresswell et al. (2013) stated that the procurement of a system that enables a degree of customisation to meet the service needs of frontline end users requires a practical balance between functionality and affordability. Cost has always been indicated as a major deterrent to the adoption of new technologies, despite its capabilities and how well a system fits the purpose of use (Labrique et al., 2018).

In addition to the service needs, complexity of work activities and funding, findings indicate that the need to digitise manual process enables or inhibits the choice of selected HITs. The contextual factors of tertiary healthcare settings influenced the need to integrate technologies that enable the work activities of healthcare professionals during service delivery. For instance, there are the preferences of healthcare professionals about which tool is most suitable for work activities. Hence, it becomes important for the business analysis team to have a thorough understanding of the service needs of healthcare professionals. One of the doctors stated that they preferred to use paper while working in the tertiary healthcare clinic, while they preferred to use technology to attend to referrals from outside the hospital. The reasons for the preference were attributed to the potential failure of systems on which the work activities of healthcare professionals are dependent.

Findings indicate that HITs in tertiary healthcare are implemented at an enterprise level. In essence, the data generated at each healthcare institution in the province is aggregated at a central point. The aggregated data are subjected to a BI process. The BI process generates reports. These reports enable the Department of Health to make decisions on resource allocation and other funding obligations that are informed by the BI process.

In context of hospital **H2**, healthcare professionals attribute an absence of hospital information systems to a lack of willingness by the hospital's management to motivate for improvements to infrastructure and the employment of skilled personnel. Hence, a lack of adequate resources contributes to the work activity challenges experienced in terms of a lack of communication, an information gap, and non-accountability. These issues are addressed at a personal cost to healthcare professionals. Therefore, efforts by the relevant health governing authorities to improve the current status of the public healthcare system in Nigeria are a point of reference that require extensive investigation if service delivery quality by healthcare professionals is to be enhanced.

The engagement of frontline healthcare professionals is necessary to avoid loss of return on investment, to mitigate resistance to the need for incorporating actual enabling technology to the workflow and to moderate the time it would take for healthcare professional to learn the new system use. For the IT vision of the Western Cape Province to be realised, the strategic and operational plans established by the province's Department of Health need to take into account the transformation process of the interactions between healthcare professionals and HITs at points-of-care. The next section discusses the human and machine factors that influence the transformation of the object of activity into the goal of activity, in the healthcare system.

7.6 Transformation process of healthcare professionals' work activities

In this section, the researcher discusses the interaction between actors, object of activity, means of action and the shared object of activity/networking. In this study, the participants represent the actors, as earlier discussed in chapter 7.2. Healthcare professionals have a mandate, which is to deliver care services to patients. Hence, the object of activity is usually the purpose for which healthcare professionals perform tasks towards an intended goal in the process of service delivery. The use of HITs by healthcare professionals is to simplify execution of their work activities and to enhance productivity. However, the findings show that there are contextual conditions that mediate how an object of activity is carried out by actors and during the use of tools or a means of action.

As described earlier, these mediators inhibit the timely execution of work activities to the extent that it takes healthcare professionals an extended period of time to perform their tasks in an already overburdened tertiary healthcare system. For instance, findings on the effect of challenges on work activities suggest that the use of paper causes delays during administration of patients by nurses, and during doctor's consultation with patients. Participants mentioned that the delays could be attributed to the time it takes to write clinical notes, depending on their initial diagnosis, while verbally communicating with patients. Nurses also indicated that report writing is a major part of nursing work activities and this becomes cumbersome during the course of the day, with instances of paper loss and illegible handwriting.

Another cause of delay at the point-of-care was attributed to the obligation to respond to VULA referrals sent from other healthcare professionals. Doctors mentioned that they had to multitask in order to attend to their colleagues in remote locations. This interrupts their work and so it takes longer to complete consultations with patients, to the extent that doctors have a mixed perception on the VULA application, based on the benefits and challenges associated with using the application. As observed from the trends, work activities that are heavily dependent on the information stored in, or accessible via, the implemented HITs are mostly affected in the event that the systems are unreliable. For example, during consultation the doctors complained that sometimes it takes time to access electronic copies of previous clinical notes. This situation is attributed to the backlog of paper notes that have to be scanned by the data capturers in the hospital scan centre. It is evident that, in addition to inadequacies of implemented health ICTs, administrative work processes influence how healthcare professionals perform aspects of their work activities.

The implemented HITs were perceived to have both positive and negative influences on the execution of work activities. The positive influence of HIT usage is attributed to the doctors' perceived usefulness of the HIT, hedonic motivations, trust and ease of use of the HIT during healthcare service delivery. Conversely, the capabilities attributed to implemented HITs have drawn negative reactions from healthcare professionals, to the extent that they revert to paper-based support or resolve to use alternative approaches to execute their work activities at points-of-care during work activities. Rose and Jones (2005) provide a perspective on the conflicting influence between how human actors use machines and the impact of machines on work activities of human actors, which is referred to as the "double dance of agency". From an interpretivist viewpoint, the researcher argues that agency is informed by human attributes to the extent that machine agency can be attributed to the inadequacies attributed to human inefficiencies when performing tasks.

In sections 7.5.1 – 7.5.3, the researcher discussed human agency, machine agency and how the interplay between the concepts ultimately influences the intended outcome or goal of work activities, namely, healthcare service delivery. The difference between human agency and machine agency is distinguished by the characteristic definitions of agency defined by Giddens (1984) and Bandura (1999).

7.6.1 Human agency

Agency is defined by Giddens (1984) as the "capability to make a difference", while in social cognitive theory "agency refers to acts done intentionally" (Bandura, 1999). At face value, these definitions extend to human actors and machine objects; however, the degree of agency is typically shaped by historical actions and lived experiences of humans in a social context (Rose & Jones, 2005). For instance, human agency is characterised by self-awareness and intentionality (Pickering et al., 2017). These attributes provide human actors with autonomy and the choice to make conscious decisions, which influence how they perform tasks and the outcome of their activities. The resultant effects of choices shape their lived experience and perceptions about the continued use or non-use of health ICT for their work activities at points-of-care during healthcare service delivery.

One of the resultant effects of the lived experiences and perceptions of healthcare professionals is evident in the trust displayed for a particular technology when it enables them to perform tasks in their own preferable manner. Healthcare professionals are likely to have a relative level of confidence in the capabilities of a technology to facilitate complex tasks or tasks that are perceived as time consuming. Conversely, in instances where implemented health ICTs do not satisfactorily facilitate the tasks of healthcare professionals, and consequently result in the inhibition of work activities, there is a possibility for trust to dwindle with time.

The implications of the dynamics between the lived experiences and expectations of the healthcare professionals and the capabilities of health ICTs are further discussed in section 7.5.3. For example, some of the participants described the ECM system as a database for patient records that has improved access to information at points-of-care because of the availability of information, and easier and faster access to electronic data. However, participants expressed their frustrations at the turnover time it takes to scan and digitise paper records in the hospital scan centre. In addition to the capabilities of the ECM system, the amount of paper to be scanned and the human-induced factors of the administrative process can contribute to the total turnaround time. Nevertheless, a participant indicated that there is an alternative to bypass the frustrations of the turnaround time.

> "I have an app on my phone where I take a photo of each patient's last notes when I've seen him. In this way I always have the latest notes of a patient on my phone and don't waste time waiting for notes to be found" (Opht2_H1).

The response indicated that healthcare professionals are able to devise optimal ways in which to use health ICTs in a manner that best integrates the ICTs into their work activities at points-of-care. Conversely, when systems inadequately meet the preferences of the intended end users to achieve an anticipated outcome, ultimately motivates them to adopt alternate means or to discard the implemented HITs (Cresswell et al., 2013). Healthcare professionals are aware of the discomfort experienced with some of the implemented health ICTs and, therefore, make a conscious decision to adapt to the situation. The decision to adapt portrays intentionality and is influenced by personal experiences, intrinsic motivations and a reflective decision on how best to make use of health ICTs to achieve pre-set goals.

In addition, a typical instance of adapting to an unfavourable circumstance is through workarounds. For example, the turnaround time of digitising paper records to be stored electronically in the ECM delays the retrieval of past records. When healthcare professionals perceive that implemented HITs inhibit aspects of their daily work activities, they tend to adopt alternate means to achieve their goal. Workarounds could be viewed as a temporary solution to the lack of appropriateness of particular HITs to the timely execution of healthcare professionals' work activities; although there is a chance that, after a certain period of time, workarounds could become a permanent solution to address incessant challenges experienced by healthcare professionals. In the next section, the researcher considers how facilitating conditions may influence the suitability of implemented HITs for work activities of healthcare professionals at points-of-care.

In this study, healthcare professionals use implemented health ICTs to feel empowered and complement their abilities to execute the object of activity. Consequently, health ICTs enable the interaction moments of tasks, while influencing the perception of healthcare professionals, to achieve an improved healthcare service. According to Ort5_H1, "there is an expectation to remain professional even though one is interacting through a device". The codes of conduct of the medical practice influence the way healthcare professionals interact when communicating with colleagues and when sharing patient information, as well as when responding to medical questions.

The influence of technology in a social context occurs through its appropriation by humans (Orlikowski, 2005). Ideally, health ICTs are machines that are expected to deliver the results anticipated by their designer, as guided by user requirements and purpose or action for which they are intended (Rose et al., 2005). Hence, when there is a change in the context of use in work activities, this is not automatically reflected, except when a software update is initiated by the developers on request, or the device is physically modified. Ultimately, ICTs are only as useful to perform tasks in a particular capacity, based on the input instruction by the human agency. However, it is evident that the effect of the machine produces an anticipated result, thus exhibiting its capacity to make a difference, i.e. machine agency (Pickering et al., 2017).

7.6.2 Machine agency (Technology performativity)

The motivation to integrate machines into almost all aspects of today's social world is typically to enhance human tasks and interactions, such as access to, and exchange of, information to aid decision-making, as well as enhancing human capabilities to improve productivity (Følstad et al., 2017). In the context of this study, the HITs are technology artefacts in a human-machine network, referred to as machines. According to Engen and Følstad (2017), machine agency is attributed to the impact or effect caused by a machine when utilised to execute work activities, thereby influencing how human actors perform tasks. This description is used to discuss the effect of implemented health ICTs in the case of hospital **H1**. The form and function of a specific technology is emergent from historical and social conditions, and purpose for which it is designed. It is designed to either sustain or transform the objectives of an organisation. Thus, technology can be said to exhibit agency (Engen et al., 2016). This begs to question about attributing agency to machines, particularly if a technology is an inscription of the designer's understanding of the needs of the intended users, to meet their own interests. Orlikowski (2005) refers to the agency attributed to technology as material performativity.

According to Rose and Jones (2005), machine agency is attributed to a machine's capabilities to either enable or inhibit the anticipated outcome of human agency under a particular set of contextual conditions. Therefore, a machine augments the performance efforts of humans during the execution of work activities. In this study, healthcare professionals use HITs, such as ECM and PACS, which are perceived as useful, to address inadequacies associated of paper-based/manual systems. Perceived usefulness and benefits influence the routine use of HITs (Gagnon et al., 2016). The VULA application enables healthcare professional to exchange necessary information in situations where distance and location are major factors affecting attending to referral cases.

> "When referring a patient with the VULA application the referring doctor must give a lot of important information about the patient to us that include a photo of the eye and then we can have a conversation with them to get a better idea of the problem. This way of referring is much more comprehensive that a telephonic referral and we can get a better idea of the problem" (Opht2_H1).

The capabilities of the mobile device enable healthcare professionals to communicate and exchange patient information remotely. These capabilities include a camera to take images, and a screen with on-screen or physical keyboard to support chat applications. This suggests the use of a quality camera and long battery life, given the frequency of use when attending to VULA referrals. These features support the requirements of smartphone use in a clinical setting, as recommended by Park et al. (2015). The authors suggest that the potential use of smartphones and built-in sensors might reduce the workload of healthcare professionals.

Other participants highlighted the dependency of healthcare professionals on implemented HITs. Ort4_H1 stated that most of their work activities, which include consultation, booking examination requests, communication and referrals, are reliant on PACS and VULA app.

> "It's often difficult to determine if a patient can be seen as an outpatient or do they need urgent referral, and using the VULA app with clinical pictures helps with this decision making" (Ort4_H1).

The response reflects the challenges of referral management. Healthcare professionals are already working in an overburdened environment, where the lack of timely application and inappropriateness of tools have a negative influence on work activities. This prompted the need to improve the urgency of referral work activities. The VULA application enables healthcare professionals to simplify the referral process. There is a similarity with the findings of Ladan et al. (2019), where task-focused HITs aided healthcare professionals to execute their clinical tasks. It is evident that the suitability of health ICTs improves the efficiency of the work activities of healthcare professionals at points-of-care, which serves as a motivation for routine use.

Conversely, the resistance or adaptation of actors to an implemented technology often arises in scenarios where technology does not adequately serve the intended purposes of human activities. For example, a participant mentioned that:

> "With regards to the PAC system, the negative part to that is not all computers always work… I think that's the biggest challenge, is when electronics don't work. Then it's a massive irritation, So, if we can't see x-rays and you've got a clinic full with 40 patients; it's actually a nightmare" (Ort2_H1).

Healthcare professionals express frustration with particular HITs if their usefulness is not evident or when they do not adequately serve their purpose. This resistance often leads to health ICTs being discarded or users finding alternate means to perform tasks in order to get the anticipated results (Barrett, 2018). The capabilities of a system influence how healthcare professionals experience the discomfort or suitability of health ICT because of the awareness and skills of the user. These attributes distinguish human agency from machine agency. A participant stated that:

> "The ECM database has a waiting period of more or less 2 months before it is scanned in, so if I see a patient within a month or two, the last notes will not yet be on the ECM. It is possible to request the notes then, but it wastes time as it takes a few hours to be found / scanned in" (Opht2_H1).

The ECM is a database that houses scanned paper records. Once healthcare professionals are done with consultations, to the point that a patient is being discharged, all the paper generated is transferred to the scan department. In the scan department, there is a backlog of work that prevents the instant availability of digitised paper records. This process causes delays during the follow-up visits of clients to the extent that healthcare professionals are compelled to improvise means to access patient information in a timely manner. The backlog can be associated with the number of clients and the workload in tertiary level of public healthcare institutions, relative to the data capturers. However, the way ECM is designed gives less than adequate consideration to the context of use and the work activities that use the system to access electronic health records.

Some of the risks associated with inappropriate infrastructure include reduction in speed of the system, regular loss of network connection and the inevitable loss of data, as well as damage to the system (Cresswell et al., 2013). Consequently, users might eventually get frustrated and may develop negative attitudes towards use HITs. This results in systems being underutilised or, eventually, discarded. For example, it was mentioned that the VULA application interrupts healthcare professionals during consultation at points-of-care. Therefore, healthcare professionals believe that their work activities take longer to be complete because of attending to patients physically while at the same time, responding to VULA referral notifications.

> "During the day it actually interferes and slows you down massively … because you have a lot of patients that you need to see that's in the encore room, you need to answer the phone, the phone at ER, you need to answer your bleeps and then you also get VULA referrals" (Opht1_H1).

The response reflects the negative aspects of how machine agency influences the overall work activities during service delivery. While the VULA mobile application has simplified the referral process between healthcare institutions, and facilitates easier communication between the professionals, the unintended consequences are that using this application interrupts and slows down work activities. Compatibility of mHealth technologies to tasks was identified by Gagnon et al. (2016) as one of the factors that are perceived to enable or inhibit the workflow of healthcare professionals. According to Yahya (2019), time constraints and the perceived reactions of patients to the use of mHealth ICTs by doctors could inhibit optimal use of mHealth ICTs.

Going by the need to address the lack of timely application and inappropriateness of HITs to the work activities of healthcare professionals during service delivery, the VULA mobile application is inadequately tailored to support tertiary healthcare. Lessons learnt from the past study of Cresswell et al. (2013) indicate that such health solutions may be eventually discarded. It is barely enough to design mobile applications for specific purpose without considering how they fit into a work activity. Therefore, it is evident that the elements of the work activity system play a complementary role in the eventual success or failure of HITs.

During the co-design activity, a doctor mentioned that they use WhatsApp as a tool to record information. The tool enables the doctor to give adequate attention to patients while engaging in verbal communication during consultation. Wallis et al. (2017) stated that healthcare professionals tend to communicate easily through WhatsApp messenger by sharing patient information, including pictures, to seek advice and get a third professional opinion. The authors indicated that the use of WhatsApp has potential risks to the patient confidentiality because there are no built-in security measures and consent is a requirement for the exchange of patient information. Kabanda and Rother (2019) argue that ownership of mobile devices, such as smartphones, by healthcare professionals presents a real opportunity to develop mHealth applications to support the decision-making process at points-of-care.

At face value, it seems the WhatsApp voice-to-text feature could be an ideal tool to assist healthcare professionals to capture patient history digitally, especially because it is readily available on smartphones. However, there are limitations to the use of the WhatsApp voice-to-text feature that makes the application inadequate to enable interaction moments during the patient consultations. One of the limitations is that the WhatsApp voice-to-text feature only transcribes verbal communication in English coherently. This puts a patient that speaks an indigenous language at a disadvantage. In addition, there is no timestamp distinction between the voices of the doctor and a patient and this would result in a cluttered clinical history note. WhatsApp usage by healthcare professionals during clinical work activities has been widely cited as a convenient and useful tool to facilitate information access, information retrieval and communication (Martin et al., 2019). Therefore, a voice-to-text and speech recognition application would ensure that the software distinguishes between voices and during transcription from audio to text when used in the clinical context of healthcare service delivery.

While the participants do not expand on the causes of system downtime and how long it takes to get back online, the resulting effect indicates the influence of the machine agency or material performativity on human agency. Yet, to continue performing work activities, the healthcare professionals revert to the paper system. This further indicates that the perceived inadequacy (or unintended consequences) of a technology such as ECM system prompts the consciousness of healthcare professionals to address (adapt or discard) the resulting setback caused by the machine.

Human and machine have been considered as equivalent by Latour (2005) because each actor possesses some characteristics of power or influence over the other. According to Giddens (1984), power involves the selective manipulation of resources used to organise or control the output, of human interactions during work activities. For example, a machine satisfies the interests or expectations of humans during work activities and, without the effect of a machine, the inefficiencies experienced by humans remain constant. In this study, the researcher support claims by Rose and Jones (2005) that human agency is not comparable to machine agency. However, both are essential considerations in understanding the design process and use of information systems to support healthcare service delivery.

To give additional context to the transformation process in work activities, the interplay between human agency and machine agency is discussed in the next section 7.5.3.

7.6.3 Interplay between human agency and machine agency

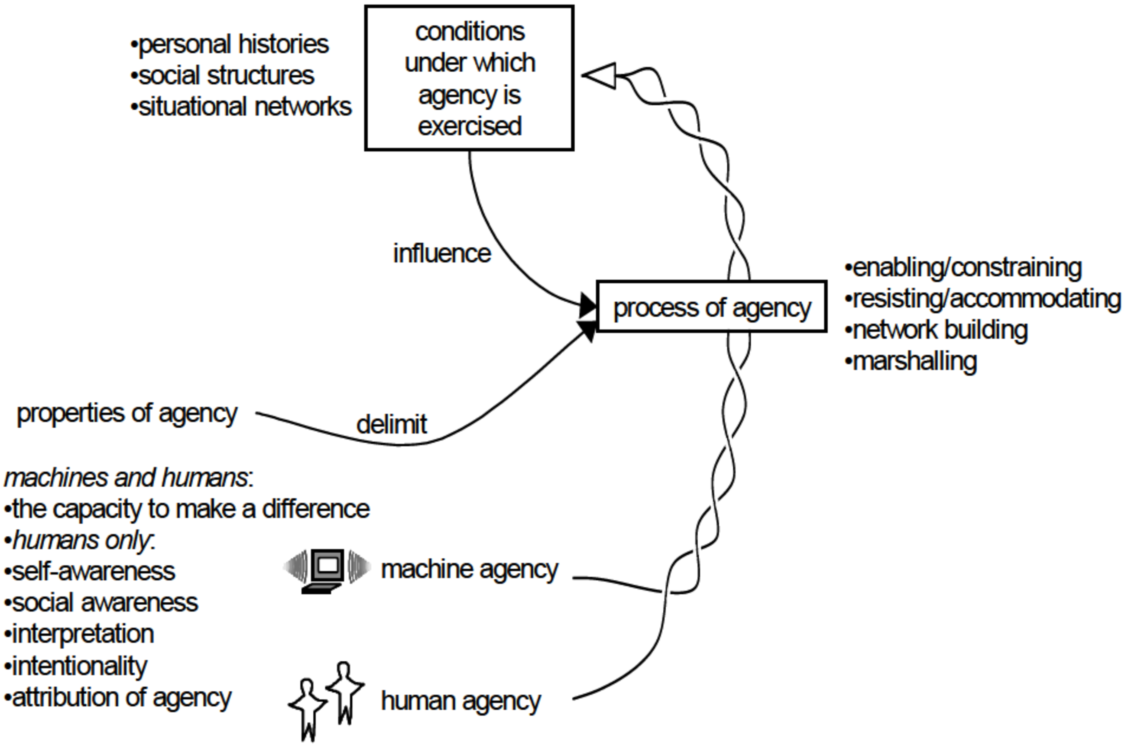


Figure 7.2: The Double Dance of Agency model (Rose & Jones, 2005)

Unlike human actors, machines do not have the degree of agency to act independently (Rose & Jones, 2005). The ability of the human actor to act independently, compared to a machine, in a situation is differentiated by intentionality. Ideally, a machine, as a means of action, translates the input instructions configured by actors to enable a defined object of activity. This determines its performativity. As a result, these instructions are transformed into an expected output. In contrast, human actors have the ability or self-awareness to perceive the suitability and the comfort emergent from using machines or otherwise.

In the contrary cases of perceived discomfort, humans adapt and act beyond the available input during their work activities. Adaptation is influenced by the human actor's choice, intentions, suitability, usability and acceptance of a machine. For instance, a machine does not possess the capabilities to exhibit the awareness to express forethought, to self-reflect and to adjust as a reaction to the unintended consequences in an established context (Engen et al., 2016). Thus, workarounds reflect the influence of human agency over machine agency or material performativity in the eventuality that a technology is unavailable or associated with usability challenges during the execution of work activities.

Nevertheless, there are machines built as *autonomous artificial agents*, such as artificial intelligence (AI) machines. AI machines are developed using complex algorithms, such as machine learning, to provide a relative degree of autonomy (Zafari & Koeszegi, 2018). In the case of AI systems, the machine is aware, and can interpret and continuously adapt to a change in the conditions of a human environment, and adjust its output accordingly. The claims of machine agency argued by Latour (2017) in a socio-technical interaction can be justified within the context of AI systems, for example, recommender systems used to determine consumer preferences.

The degree of autonomy associated to agency in machines is influenced by the conditions of human agency in a human-machine network (Pickering et al., 2017). These conditions may be defined as instances or circumstances that make a certain course of action more favourable than other alternatives (Rose & Jones, 2005). The root constructs of conditions include personal histories, social structure and situational networks. These root constructs influence the circumstances of the process of human and machine agency. For example, human agency is informed by lived experiences and expectations which are enabled or restricted by the elements of socially constructed structures, such as cultures, rules, strategies and resources (Odendaal, 2011). However, human actors have the choice to act either in acceptance of. or resistance to, the constructs of these conditions (Wimelius, 2011). In reference to the use of implemented health ICTs, participant Opht2_H1 indicated that “it definitely speeds up all activities, making access to patients’ records, information, lab results and radiology much easier than before”.

Another participant Ort2_H1 said that:

> “From a referral point of view, the fact that you can actually see an x-ray which is a big part of our discipline; you can make better informed decision and also can relieve the burden to us and maybe our referring institution. In some cases, you can make a decision where you maybe in the past couldn’t because you don’t have a visual representation of an x-ray for example. So, I do think it made a big difference …” (Ort2_H1).

Similarly, Ort1_H1 revealed that:

> "I remember when I worked here before PACS and the VULA, we had the hardcopy x-rays. And they would get lost or misplaced somewhere or you would want to discuss a case here and then the x-rays would be in the ward. So just to have PACS on any computer, you would have x-rays available …" (Ort1_H1).

In the responses, the participants indicated their experiences of the evident impact health ICTs have on the task performance during work activities. Indicators such as "…definitely speeds up …", "… much easier than before …", "… it made a big difference …" and the availability of electronic information at hand to aid decisions, suggests a positive impact and the effectiveness of implemented health ICTs. It is evident in the context of this study that healthcare professionals make use of implemented health ICTs based on the presumption and experiences of their suitability and their capabilities to improve task performance in a timely manner, regardless of location. The impact is often as a measure of the past experiences by healthcare professionals while performing tasks, and a desire to improve efficiencies of work activities. Consequently, the properties of human and machine agency have a major influence on the outcomes of work activities.

> "The biggest challenge with the VULA app is to be able to find time during patient consultations to also answer on referral doctor's questions…when disrupted; it takes longer to complete a consultation …" (Opht2_H1).

The response indicates a conflict of interest between the use of health ICTs and the nature of the work activities. Based on the self-awareness of healthcare professionals, they experience some discomfort when the implemented health ICTs interrupt and delay the completion of work activities. Another participant expressed the opinion that VULA interferes massively in the work activities because they deal with a large number of patients and the referrals received are not necessarily emergency cases. According to Adeleke et al. (2014), time constraint is a major inhibiting factor to the use of health ICTs by healthcare professionals at points-of-care.

> "During the day it actually interferes and it slows you down massively. Definitely because you have a lot of patients that you need to see that's in the encore room, you need to answer the phone, the phone at ER, you need to answer your bleeps and then you also get VULA referrals. And some of them - I would say half of them aren't emergencies and those people want an answer now because they've got a patient sitting in front of them but I've got 50 patients sitting outside and now I need to answer about something elective and they push you for it. And sometimes I let them wait because I need to deal with emergencies there and then that's in front of me but it's actually – nice" (Opht1_H1).

Despite the perceived suitability of the VULA application to manage referrals, as reported by healthcare professionals, there are unintended consequences in the form of interference and consequent delays in the timely completion of work activities. In addition, Ort5_H1 and Opht2_H1 expressed their concerns about attending to VULA application referrals while in consultation with patients. “I feel that it seems unprofessional to constantly be looking at your phone screen whilst consulting patients” (Ort5_H1).

The benefits attributed to the use of the VULA mobile application are perceived in the reduction of the number of unnecessary referrals from peripheral hospitals to tertiary healthcare institutions and the facilitation of remote consultation and communication between healthcare professionals. However, it is evident from the response that the design functionalities of VULA have an influence on how healthcare professionals execute other work activities. A participant expressed their projection of how they perceive their patients would interpret their constant interaction with the mobile device. According to Yahya (2019), healthcare professionals are concerned that the use of mHealth ICTs might be misconstrued by their patients during consultations at points-of-care.

Thus, the researcher argues that self-awareness is a key mediator that influences how healthcare professionals perceived the suitability or discomfort attributed to attending to VULA application referrals during consultation with patients. However, this finding is in contrast to the study by Kabanda and Rother (2019), where the authors found that participants were comfortable using their mobile devices during consultations. The inconsistency of results within the same research context further clarifies the notion that the interplay between human actor and machine agency is experienced differently and is not generalisable across clinical settings, especially because of the effects of choice and self-awareness.

Additionally, the increased workload of attending to multiple referrals during patient consultation could be attributed to how the VULA application was designed, i.e. without adequate consideration given to the impact of this application on patient-doctor interaction at the points-of-care. For example, one of the participants stated that “most people are quite negative about it because it gets abused” (Opht1_H1). The response indicated that the use of the VULA application evokes negative feelings because there is little to no restriction on the extent of use by referring doctors “but no one really complains”. It is evident that, after a period of time, the healthcare professionals eventually get used to a system that is fit-for-purpose in the course of their work activities. This aligns with the findings of a longitudinal study carried out by Vaghefi and Tulu (2019) on continued use of mHealth applications. Consequently, healthcare professionals pay less attention to the few challenges and, ultimately, make a choice to either adapt and be satisfied, or be dissatisfied and eventually discard implemented health ICTs.

> "Doctors will ask you elective questions at night because they've got access ... you are answering them 24 hours they think that is all that we do; sit with the app to answer their questions but it is not" (Opht_H1).

The current manner in which health ICTs are used by healthcare professionals to enable the service interaction moments of tasks at points-of-care is influenced by the capabilities of the tools available to enhance productivity of work activities. However, it is clear that there are instances where the health ICT tools inhibit execution of work activities performed by healthcare professionals. Such instances defeat the efforts to address the lack of timely application and inappropriateness of implemented HITs for work activities. Therefore, the benefits of integrating Health ICTs, particularly mHealth technologies, into the work activities of healthcare professionals may be partially realised in tertiary (public) hospital settings.

7.6.4 Extent of the interplay between human agency and technology performativity

Based on the continued use of implemented health ICTs in the clinical settings of hospital **H1**, despite challenges experienced by healthcare professionals, the researcher concluded that the extent of the interplay between human agency and machine agency rages from intermediate to advanced. At the intermediate interplay level, healthcare professionals use health ICTs to enable the tasks of their work activities based on the capabilities of their features at initial interaction. The lived experience of the initial interaction results in a perception. The ensuing perception is either attributed to suitability of the technology or the discomfort experienced by healthcare professionals during work activities. Subsequently, the implemented health ICTs can be fit-for-purpose but not particularly useful as a result of the contextual conditions of use. As a result, doctors are likely to discard the implemented health ICTs and adopt an alternative technology that is not specifically designed for health-related tasks or revert to paper.

At the advanced interplay level, healthcare professionals are eventually able to adapt, despite the contextual conditions of use. In this study, healthcare professionals in hospital **H1** tend to become more familiar with using health ICTs largely because of their many benefits, in contrast to the challenges experienced, during and after work activities. Hence, it can be inferred that, at the advanced interplay level, healthcare professionals are able to negotiate and become either satisfied or dissatisfied from the continued use of health ICTs. At both levels of interplay, the lived experiences and benefit analysis of healthcare professionals, as influenced by the capabilities of health ICTs to enable the tasks within their work activities, determines acceptance or non-acceptance.

The researcher acknowledges that both humans and machines are capable of making a difference in human-machine interactions. However, the types of health ICTs identified and used in the context of study do not act intentionally. The technology is designed by humans as part of a solution influenced by historical events of adverse lived experiences, perceived expectations, desired outcomes and the need for humans to exhibit some level of power. Hence, the researcher proposes that, in healthcare, agency is ascribed mainly to the human in a human-machine interaction and technology is viewed as an enabling tool to facilitate the actions of humans or during the interaction moments of tasks.

The study established that the outcome of work activities within an activity system is largely dependent on how the attributes of human actors, necessary to perform the object of an activity, are interleaved with perceived capabilities of the means of action. In other words, the interplay between healthcare professionals and health ICTs performativity is informed by human intentionality, self-awareness, the code of medical practice and system capabilities after the technology is implemented. According to Vaghefi and Tulu (2019), when there is a perceived fit between user and system attributes, to the extent that the goals of an activity are achieved, users would continue to use a technology beyond the initial interactions. The complementary fusion and interplay transforms work activities at points-of-care to ultimately impair or improve service delivery in tertiary healthcare, i.e. the goal of the work activities.

7.7 Outcomes of transformation – Improved healthcare service delivery

The quality of tertiary healthcare service delivered by doctors and nurses is the desired goal and the anticipated outcome of the decision-making process (Sekgweleo & Nemutanzhela, 2018). This claim is aligned to the mandate given to public healthcare institutions, particularly in Sub-Saharan Africa, because of the impact of the prevalent burden of diseases and the recurrent challenges within the healthcare system (Ladan et al., 2019). A few examples of the challenges include infrastructural deficiencies, long waiting times, limited accessibility to healthcare and other human-induced factors. As the number of individuals that require the services of the public health sector increases, so the work activities of healthcare professionals require necessary the support and facilitating conditions to perform actions more effectively and efficiently through the use of relevant tools. Therefore, efforts are being made to adopt suitable ICTs as a means to address some of the challenges faced, and empower healthcare professionals to carry out their work activities in a timely manner, conveniently (Bervell & Al-Samarraie, 2019).

In this study, findings suggest that, when healthcare professionals perceive HITs as useful and convenient, and they are satisfied with the outcomes of their use, this improves the overall service delivery process. For instance, participants stated that the use of HIT systems has had a positive effect on service delivery.

> It has a very positive effect on service delivery… It definitely speeds up all activities making access to patients' records, information, lab results and radiology much easier than before (Opht2_H1).

It is evident from the response that the influence of implemented HITs enables quicker and easier access to records and the information needed by healthcare professionals for decision-making purposes at points-of-care. This implies that, prior to the implementation of health ICTs, the activities within the service delivery process were not time efficient, which could have adverse effects on the way service used to be provided in tertiary healthcare institutions.

One of the work activities that has been evidently influenced by implemented health ICTs in tertiary healthcare is the referral system. Participants reported that the VULA application has helped to reduce the number of patients that require tertiary healthcare by preventing unnecessary referrals. The VULA application facilitates the exchange of "a lot of important information about the patient to us that includes a photo of the eye and then we can have a conversation". The implications are that electronic referrals are preferred because this aids the exchange of information and real time communication, which is required to make informed decisions about diagnosis and treatment plans. At the same time, records of information exchange serve as evidences in the case of any possible legal disputes between the hospital and their clients.

> This way of referring is much more comprehensive that a telephonic referral and we can get a better idea of the problem. The amount of patients accepted by us is much less now as many unnecessary referrals can be prevented. Medico-legally there is a record of the conversation we had and of the advice given (Opht2_H1).

A systematic review of the literature published in South Africa between 2011 and 2016 was conducted by Ojo (2018) to evaluate the evidence of the effect that mHealth technology interventions have on health outcomes. The author suggested that mHealth technologies are mostly implemented in form of SMSs on mobile phones targeted towards the adherence of patients to treatment. However, there is limited evidence of the impact of mHealth technologies on healthcare service delivery. The author indicated that past studies mostly focused on the use of mHealth to manage the health outcomes of patients, with barely any attention given to the healthcare practitioners and the delivery process.

While this might be the case from the patient's perspective, there are indications that mHealth technologies improve the execution of the work activities of healthcare professionals. In the context of this study, the researcher found that healthcare professionals make use of mHealth applications at points-of-care during healthcare service delivery. For instance, the VULA application enables the referral of patients electronically, and facilitates real-time consultation, which assists healthcare professionals to make informed decisions. Thus, electronic facilitation of referrals has simplified the process. Additionally, one of the participants (Opht2_H1) stated that they use a mobile application to keep an updated version of their clinical notes when attending to patients on follow-up visits. Having the application eliminates the time it takes to get access to the electronic copy stored in the ECM. This means that the effect of mHealth technologies is evident in the facilitation of remote consultation and in the instant, or time efficient, access to digital records needed by healthcare professionals during service delivery.

7.8 Addressing the research questions

The aim of the research was to explore opportunities to integrate mHealth technologies into the work activities of healthcare professionals at points-of-care, to enable the service interaction moments performed by the healthcare professionals. To achieve this aim, the researcher sought to understand the interactions between human actors and technology objects to produce a desired outcome. In other words, the researcher investigated the tasks executed by healthcare professionals, and the usability and functionalities of HITs during work activities at points-of-care in tertiary healthcare settings.

To understand the work activities of healthcare professionals, the researcher adopted an interpretivist viewpoint to make sense of the underlying participants' interpretations attributed to the use of technology at points-of-care. The researcher drew on the experiences and expectation narratives as they emerged from the responses of healthcare professionals. The service design DDM provided the researcher with a human-centric approach used to obtain a holistic understanding of the work activities form the frontline end users point of view. The four phases of the DDM were influential in the approach adopted by the researcher as a guide to understand how the human and technology components interact during work activities within healthcare services. The DDM guided the use of multiple qualitative techniques, including the interviews and co-design activities used to collect data from participants about the different touch points of healthcare service delivery path.

During the semi-structured interviews, the open-ended questions assisted the researcher to probe how healthcare professionals execute their work activities at points-of-care during service delivery. This technique also afforded information managers an opportunity to discuss the efforts made by the Provincial Department of Health in the choice of implemented HITs and the constant effort to improve data management across the public healthcare system. The open-ended questions helped the researcher to understand the work activities executed by doctors and nurse in tertiary healthcare, particularly activities associated with medical images and reporting. It was established that the healthcare professionals in hospital **H1** use both traditional paper-based and health ICTs to support their work activities, while healthcare professionals in hospital **H2** largely use paper and, in some cases, compact discs read-only memory (CD-ROM) to store images.

A second technique, a co-design activity involving both the researcher and healthcare professionals, was carried out to illustrate the current work flow, the challenges experienced and how technology can address these challenges. Several user journey maps were generated to illustrate the workflow of both doctors and nurses, from the first contact with patients until a treatment plan is formulated. This technique was used to evaluate the similarities and differences between what healthcare professionals say they do and what they actually do. Subsequently, the interaction moments of tasks which are enabled, or could be enabled, by technology were identified, as suggested by doctors and nurses, as well as inferences drawn from their responses by the researcher.

7.8.1 The effects of implemented health ICTs on the outcomes of work activities at different touch points

The researcher wanted to understand how the use of implemented health ICTs during work activities of healthcare professional influences the outcomes of care service delivery. Based on the accounts of most healthcare professionals, the use of implemented health ICTs for work-related activities has mostly yielded positive outcomes at an organisational and individual level. The key objective of a healthcare institution is to deliver care services towards improving the quality of the population’s health, when required. The use of technology by healthcare professionals has improved the outcome of work activities. For example, ECM and PACS facilitate access to, and retrieval of, electronic patient records because these records are always available electronically. The use of the VULA mobile application for referrals has simplified the referral process and reduced the number of unnecessary referrals attended to at a tertiary healthcare level. In addition, the implemented health ICTs have enabled a level of accountability and information accuracy needed to make informed decisions.

Despite the benefits attributed to the perceived usefulness and ease of use of implemented health ICTs, there are unintended consequences attached to this implementation experienced by healthcare professionals during their work activities at points-of-care. The unintended consequences are as a result of the mediators that inhibit the interplay between human actor and machine agency. These interactions affect the overall objective of the healthcare institution to provide quality services. Hence, it is evident that contextual factors mediate how a technology is used and the expected result.

7.8.2 Pain and gain points experienced by healthcare professionals

The pain and gain points experienced by healthcare professionals, as experienced during their work challenges, and during the use of health ICTs at points-of-care, were identified. The pain points inferred from the findings are mostly experienced during patient consultation in the outpatient department clinics. Doctors expressed the frustration that, during patient consultations, the VULA application interrupts their work activities multiple times. This causes a delay in the time it takes to complete a consultation. Furthermore, there is a tendency for the VULA application to be abused by colleagues during and off-peak of working hours, to the extent that some doctors are not feel comfortable with attending to VULA application referrals while attending to patients at points-of-care during the process of healthcare service delivery.

Work activities are inhibited when electronic systems are offline and down. Even though this was reported not to occur often, when it does occur, it may completely halt the decision-making process and extend the time taken by healthcare professionals to see patients. The gain point is that implemented health ICTs simplify processes and enable the execution of work activities faster, to a point where healthcare professionals are mostly satisfied with their usage, despite the challenges reported. The study shows that there is an intermediate level of interplay between human actor and machine agency, where the human is able to perceive the discomfort or suitability of the machine to execute work activities at initial stages of interaction. Consequently, when the benefits of the system outweigh the unpleasant experiences, humans adapt and tend to focus on the satisfaction derived from the machine.

7.8.3 Conditions for the incorporation of mHealth technologies at service touch points

In this study, the use of mHealth technologies is mostly aligned to patient consultation and management of referrals in the wards where there are limited desktop computers. This alignment is tailored to the interaction moments of tasks that could be improved, where healthcare professionals experience difficulties to access digitised paper records at points-of-care. During verbal communication and the writing of clinical notes, doctors can use their smartphones to record the conversation in order to get a more comprehensive history from patients. In the wards, where desktop computers are limited and fixed, smartphones can be used to access electronic systems to perform read and write operations on digitised copies of patient records. This ensures that data are integrated across all electronic platforms. An adequate wireless connection to facilitate information exchange and access to the Internet via mobile devices would suffice. In addition, doctors may use their smartphones to access the HIS to keep track of patients' schedules so that they are aware of impending follow-up visits and can organise their work activities on a daily, weekly or monthly basis, accordingly.

The use of mHealth technologies in clinical settings is more efficient where location may be an inhibiting factor to the work activities and tasks that require minimal to no distractions, for example, during academic meetings and to facilitate communication. Communication is an essential part of healthcare professionals' work activities. The nature of the work activities tends to require both doctors and nurse to be mobile and to move between different locations. The use of a handheld device that facilitates timely access to information and healthcare professionals irrespective of location is required in a hospital clinical setting. In addition, nurses are saddled with the responsibility of patient administration, including of admission, discharge and transfer. Since the amount of paper increases, depending on the extent of the patient's journey, a mobile device is ideal to support the report writing and other information management tasks when nurse move from one point-of-care to the other.

Once an adequate needs analysis has been carried out, and the opportunities to integrate mHealth technologies is established, the development phase should take into account the available resources, such as infrastructure and technical know-how (Cresswell et al., 2013). The implemented mHealth technologies should be sustainable in order to provide support to the work activities of healthcare professionals, depending on the type of healthcare services being provided. Therefore, the environment in which mobile devices and health software applications would function, policies that guide the development, interoperability and integration of mHealth technologies into existing systems, should be considered (Lodhia et al., 2016).

7.8.4 The role of relevant health bodies in the selection of HITs

The Provincial Department of Health engages with healthcare professionals as frontline users of technology through a business analysis team, using a user experience framework. Based on the service needs of healthcare professionals, the complexity of clinical work activities, the costs and a need for digital transformation; HITs solutions are procured or developed in-house. Consequently, procurement of HITs is guided by standards and policies which are supposedly adhered to by the Provincial Department of Health. However, what is not clear is the extent to which the selected HITs in tertiary healthcare are evaluated post-implementation, because of the unintended consequences of using implemented health ICTs, as experienced by healthcare professionals at points-of-care during service delivery. Thus, it could be argued that there are inconsistencies in the accounts provided by the healthcare professionals and the representative of the Provincial Department of Health. The engagement of the frontline end users of technology in tertiary healthcare seems to be inadequate.

For example, the provincial department of the Western Cape has implemented its HITs at an enterprise level, where data are aggregated at a central point. This enables the business intelligence team to analyse and make sense of the data to facilitate resource allocation and to plan accordingly. The implementation of HITs at an enterprise level influences the use of a PMI. The PMI enables the interoperability of hospital data across the public healthcare institutions of the province.

There are layers of governance structures that manage how the provincial health department approaches the realisation of the national Healthcare 2030. The province has an IT vision divided into strategic plans. The strategic plans are subdivided into implementation plans that are made up of different operational plans. These plans are driven by a committee responsible to manage the implementation projects of HITs in the public sector of the province.

However, implemented systems are not entirely suited to the purpose of the work activities. The researcher argues that there is a strong correlation between fit-for-purpose and the usefulness of a technology under specific conditions. In the case of ECM system, despite making records available electronically, the system sometimes causes delays in the retrieval of patient-related information at points-of-care.

7.9 Conclusion to Chapter Seven

This chapter provided explanations of the research findings with regards to the alignment of healthcare professionals, health ICTs (including mHealth technology), and the execution of technology-enabled tasks during healthcare service delivery. These explanations were facilitated using the ActAD model as an analytical lens and the principles of conducting interpretive research, to understand the underlying conceptual meanings of the research findings.

It is evident that the transformation of the object or motive of activity is mostly dependent on the interplay between the attributes that influence human agency, the characteristics of the technology and complexity of the overall work activity at points-of-care. The consequences of the human-machine interaction mediate the behaviour of humans and influence their future actions. Consequently, the transformation of the object of an activity as mediated by the interplay between human agency and technology performativity influences the anticipated outcome of the work activity system.

The selection and use of HITs by healthcare professionals in tertiary healthcare is largely influenced by the suitability, value-added and satisfaction of using health ICTs for their work activities. This is evident by how much easier and faster doctors are able to access patient information and communicate remotely with their colleagues. The reduction in unnecessary referrals is evidence of the success of one such health ICT, the VULA application. The VULA application facilitates consultation and communication between healthcare professionals in real time, where they are able to discuss the treatment plan of patients remotely across healthcare institutions. Overall, it is desirable to consider how the use of implemented HITs influences tasks within work activities and the satisfaction of healthcare professionals with the intended outcome when designing health ICT solutions.

The pain and gain points experienced by healthcare professionals while using implemented health ICTs to support their work activities is associated with the effects of the benefits and the challenges related to how work activities are executed and their outcomes. In line with the ActAD model, contradictions result in unintended consequences experienced by healthcare professionals during the use of the means of action. For example, during nursing activities, the use of paper at different points-of-care becomes cumbersome because of the number of patients cared for. Doctors also experience this since they have to write a great deal. Another challenge in the tertiary healthcare context is the lack of sufficient resources, such as desktop computers, in the hospital. This is attributed to the funding allocated by the government to run public healthcare institutions. One of the pain points experienced by the healthcare professionals is system downtime. This is because a larger part of decision-making is dependent on access to information, hence, when the HIT systems are down; there is an evident interference in their work activities and, in most cases, they revert to paper for support. This definitely supports the argument that a hybrid system, which includes a complement of both paper and ICT, is most suitable to execute work activities in healthcare services.

The alignment of mHealth technologies with healthcare professionals at service touch points is guided by the identified challenges and unintended consequences of work activities. The findings suggest that, when health ICTs are easy to use and do not disrupt or delay the execution of tasks at points-of-care, healthcare professionals perceive their usefulness positively and the systems are put to effective use. The use of mHealth technologies is most relevant to work activities that involve information access and exchange of information, as indicated in the referral process of patients between healthcare professionals. The findings suggest that instances where healthcare professionals are on the move, then mobile access might be ideal to facilitate read and write operations.

There is a sense that the Provincial Department of Health understands the importance of its role in the selection of HITs to support healthcare professionals during service delivery in tertiary healthcare. The needs of healthcare professionals are determined by a designated business analysis team that engages with the frontline end users who deliver healthcare services. Hence, the complexity of the work activities and a consensus by the relevant stakeholders influence decisions to procure or develop health technology solutions for tertiary healthcare. The findings have established that the engagement of frontline end users to reach a consensus should be a continuous process beyond the initial stages of adopting a suitable system. There is an evident display of leadership, as indicated by the layers of governance structure constituted to manage and implement the operational plans of strategies to accomplish the provincial IT vision.

In the next chapter, Chapter Eight, the researcher offers recommendations, based on the shortcomings of the research findings, to address the research questions, as well as a conclusion to the thesis.

CHAPTER EIGHT: RECOMMENDATIONS AND CONCLUSION

8.1 Introduction to recommendations and conclusion of the thesis

The emergence of mobile health technologies originated from a need to provide support for healthcare professionals, workers and patients to deliver and receive services efficiently at anytime and anywhere. However, just like with other HITs, it is important to acquire a thorough understanding of development and implementation issues that may hinder the success of mHealth technology solutions in use. According to Yu et al. (2006), the healthcare service activities that could be aided by mHealth technologies mostly include communication, home-based healthcare services and emergency care.

This chapter is introduced in section 8.1 to give a context to the use of HITs for healthcare services, followed by the extent to which the research questions were addressed, in section 8.2. This is followed by clarifying the credibility of the research process in section 8.3; the research contributions were split into practical, theoretical and methodological as indicated in sections 8.4, 8.5 and 8.6, respectively. Limitations of the study are described in section 8.7. In section 8.8, the researcher offers recommendations that should be considered during the design phase of mHealth technologies for use by healthcare professionals, especially in tertiary healthcare and other similar contexts. The conclusion of the thesis is presented in section 8.9, along with highlights, the researcher’s reflection on the study and considerations for future research.

8.2 Research aim addressed

The researcher identified prospective opportunities where mHealth technologies could be integrated into the work activities of healthcare professionals at points-of-care. The findings show that the doctors in hospital **H1** receive referrals via the VULA application on their smart mobile phone during consultation with patients in the outpatient clinics and when on-call at trauma wards. The VULA application enables communication between healthcare professionals and the exchange of patient information to inform decision-making remotely. The VULA application is flawed in the sense that it does not take into account the unintended consequences that are associated with its use at different touch points and its effect on the work activities of healthcare professionals. Hence, the use of the voice or speech recognition feature on mobile devices during patient consultation could aid the adequate collection of patient history and reduce multitasking by doctors.

During the engagement with nursing managers from ICU, trauma and theatre units, they revealed that the nature of nursing activities requires continuous report writing during patient care and administration. The main challenge is that paper is easily lost, nurses move around and the amount of paper increases, depending on the patient journey. Hence, there is a need to have a mobile device that facilitates report writing and information management as the nurses move between the ICUs, the wards and the theatre room.

The doctors at hospital **H1** are able to access past clinical notes and patient records on the PACS and the ECM. They revealed that desktop computers are ideal and support their work activities in the outpatient clinics, as they are able to access and view x-ray results and laboratory test results on PACS. The doctors indicated that they have mobile access to the ECM system but the format of the document does not afford them the opportunity to edit the information, especially when they are preparing treatment plans.

To develop a treatment plan, particularly for continuity of care, mHealth technologies offer a platform to ensure the identification of specialist doctors and nurses (collaborators) that need to work together, facilitating communication and monitoring. As a result, the information generated can be consolidated and integrated into a central hospital information system, such as the ECM and PAC systems.

8.2.1 mHealth technologies as an enabling tool for interaction moments

Research Question 1 guided the researcher to understand how mHealth technologies can be used to enable interaction moments by healthcare professionals at points-of-care in tertiary healthcare settings. Time efficiency and usability are key concepts that are strongly emergent to address this question. It was evident from the findings that a combination of paper and HISs are used to support patient consultation, in addition to a mHealth application for referral management in tertiary healthcare. The HIS and mHealth application facilitate quicker access to, and retrieval of, patient information that is initially recorded on paper. Due to the inadequacies of the paper records, the mHealth technology enables teleconsultation, and facilitates information exchange and communication remotely with other healthcare workers from peripheral healthcare institutions.

Healthcare professionals experience challenges when executing their work activities. These challenges are as a result of a lack of timeliness or delays experienced by the inappropriateness of enabling tools. To enhance timeliness and appropriateness of implemented health ICTs for work activities at points-of-care, there are functionalities that could be incorporated into the tools already being used by healthcare professionals. The ownership of a smartphone affords healthcare professionals an opportunity to use voice-recognition and transcription applications. A voice-recognition and transcription application assists doctors with capture every detail of the clinical notes while taking patient history and reducing the workload associated with writing multiple times on paper. In this way, information is swiftly available in an electronic format and the waiting time attributed to the turnaround time to get paper to the scan centre and onto the electronic systems could be reduced immensely.

In terms of appropriateness for work, studies show that some healthcare professionals are accustomed to writing; this offers an opportunity to integrate technologies having storage capabilities into their writing pen in order to enable audio recording while healthcare professionals write. In this way, healthcare professionals would spend less time undertaking training and learning about an entirely new technology. This study has shown that healthcare professionals perceive a technology as useful when it is fit-for-purpose and easy to use during their work activities. The interaction between healthcare professionals' attributes and the features that enable the capabilities of a technology at points-of-care is further captured in Figure 8.1.

8.2.2 Desired touch points to integrate mHealth technologies at points-of-care

Research Question 2 guided the researcher to determine the characteristics of a desired touch point required to integrate mHealth technologies at points-of-care. A mHealth technology that is used by healthcare professionals requires hands-free functions, such that there is less contact with the device, thereby allowing healthcare professionals to concentrate on patients during consultation. In a case where there is contact, it is minimal. The integration of mHealth technologies into nursing activities is based on report writing at every point-of-care. It is arguably expected that a mHealth technology supports the administration required by nursing activities from first encounter with patient until end of care service. Nurses are tasked with continuous report writing and facilitation of patient movement from one point-of-care to the next. The features of a mHealth-technology-enabled nursing activity may include a device that facilitates access to patient records to update patient information, use of a touchscreen to type or swipe in different directions, and a dropdown menu list. Given the number of patients served in tertiary healthcare institutions, specific features are required of a mHealth technology to simplify report writing and communication between clinical units during healthcare service delivery.

The doctors expressed frustrations with the need to find time during patient consultation to attend to mHealth technology notifications. While mHealth technologies are best suited to facilitate communication and information exchange during referrals, such usage may result in unintended consequences that cause an additional workload for healthcare professionals. Thus, there is an evident interplay between healthcare professionals' attributes and capabilities of health ICTs at points-of-care. There is no known framework within the Sub-Saharan African healthcare context used to design and evaluate mHealth technologies specific to the work activities of healthcare professionals, especially in public hospitals. This investigation presented an opportunity to consider how mHealth technologies could be designed based on the work activities and the context of use when considering healthcare professionals in tertiary hospitals.

Given the extent to which the research aim was addressed in this section, the process of investigation and the shortcomings influenced the richness of the data as well as biases of interpretation associated to the researcher's philosophical viewpoint. The credibility of the research process and its effect on the investigation are discussed in the next section (8.3) below.

8.3 Credibility of the research process

The qualitative data collected during this investigation assisted the researcher with extending his knowledge of the research phenomenon particularly in the contexts of the investigation. For instance, during the data collection process, the researcher observed that the younger healthcare professionals are technologically inclined and constantly thinking of innovative ways to execute their work activities. This is influenced by their experiences and exposure to possibilities of how their professional colleagues in high income countries are enabled by technology to deliver quality healthcare services.

When conducting this type of research, which is qualitative in nature, the findings are not generalisable by virtue of the interpretivist perspective; they and are open to multiple interpretations. Although the findings in this research are subjective and represent a snapshot in time, as when interviews and co-design activities were conducted, the researcher analysed the data by operationalising the variables. The variables were determined by their attributes, in essence, words or phrases that imply the objectives of this study. This process assisted the researcher with capturing more or less every possible meaning or perspective inferable from the responses of the participants in this study. Consequently, the findings of this study can be expected in similar settings as the contexts of study and the recommendations can be applied accordingly.

While the ActAD model was selected as theoretical lens through which to analyse the research findings, the researcher made sure to analyse the qualitative data transcripts inductively. This ensured that the researcher was not restricted by the elements of the model and that there was room for other unrelated themes to emerge as the data analysis process unfolded. In the sections 8.4 – 8.6, the researcher highlights the practical, theoretical and methodological contributions of the study.

8.4 Practical contributions

The research goal was to contribute to the research disciplines that underpinned this study, illustrated in Figure 1.1. Other contributions are tailored to the application of elements in the ActAD model in order to understand mHealth studies, the adopted methodology, and the practical contribution. The findings from this study confirm that ICT and healthcare professionals are required to work across a transdisciplinary team in the design and development phases of health ICT. According to Katurura and Cilliers (2018), the inclusion of healthcare professionals as the principal end users of HITs holds the potential to save time and costs involved in facilitating training at the pilot and post-implementation stages. Design considerations drawn from the co-design findings may positively influence the in-use experiences of mHealth ICTs by healthcare professionals in a context where physical touch and distancing are localised.

Additionally, the implications of the research findings provide pertinent considerations when deciding to develop or purchase HITs and mHealth technologies in line with the South African national eHealth (2012) and mHealth (2015) strategy documents. For instance, the Western Cape Department of Health can draw on the recommendations for how the choice of mHealth ICTs should consider the complexity of work activities of healthcare professionals in tertiary healthcare. The Nigerian federal Ministry of Health may benefit from how the IT vision, strategies and policies that guide the Western Cape Department of Health in South Africa have steered the selection and implementation of health-related ICTs in public hospitals.

8.5 Theoretical contributions

Drawing from a combination of service-design concepts, the elements of the ActAD model developed by Korpela et al. (2004), and the DDA model proposed by Rose and Jones (2005), the researcher argues that the transformation process of the object of activity into the goal of activity is mediated by the interplay between attributes that stimulate human (actor) agency and the capabilities that influence technology performativity; hence, the transition from Figure 3.4 to Figure 8.1 where the researcher further expands on the socio-technical interactions that occur at the touch points of healthcare professionals' technology-enabled work activity towards enhancing service delivery. Thus, the nature of the research problem confirms that a service is the product of related activities and justifies combining activity thinking to analyse the transformation process of the objects of activity in the healthcare context of Sub-Saharan Africa.

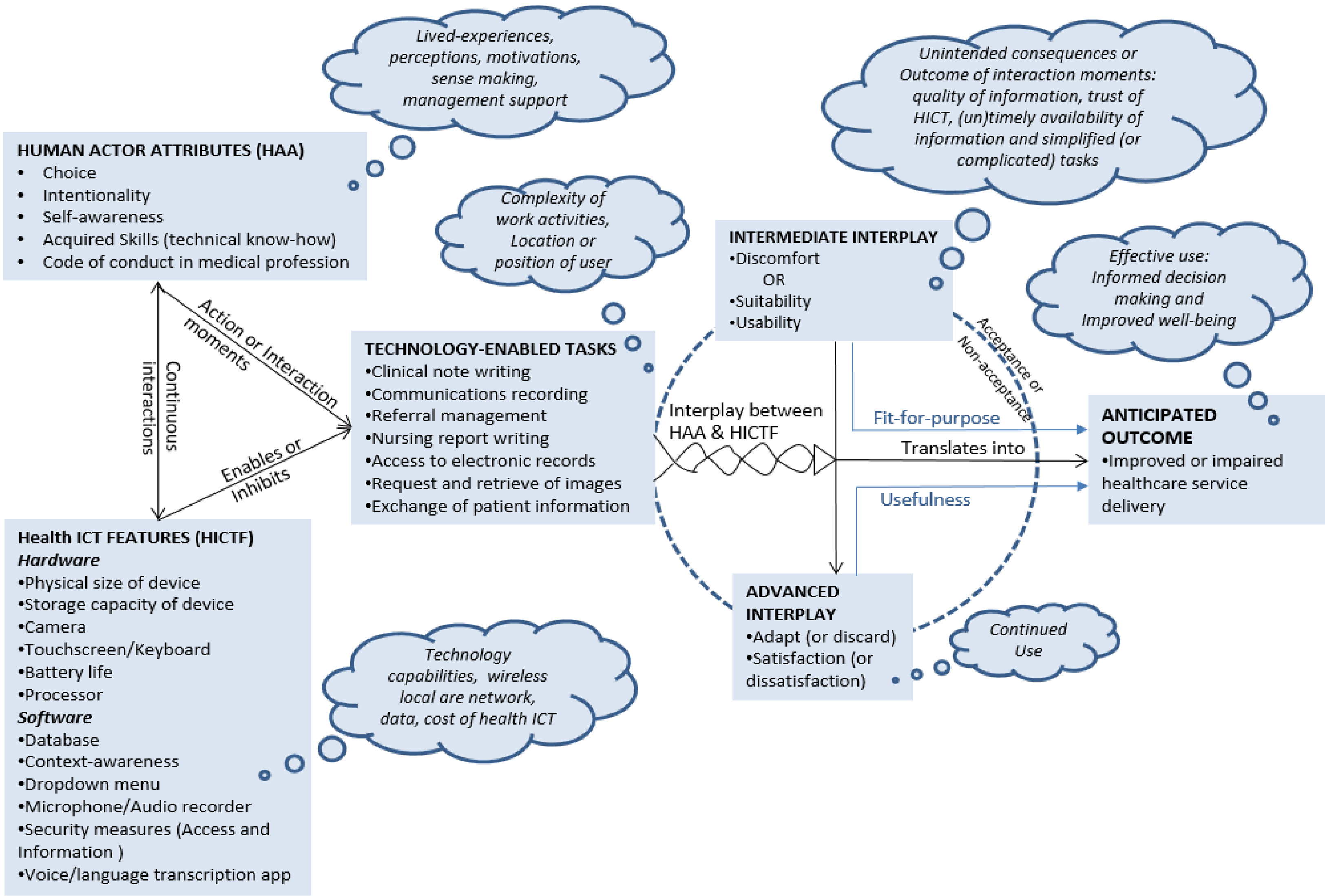


Figure 8.1: Conceptual framework on the interplay between healthcare professionals and health ICTs during work activities at points-of-care in tertiary healthcare settings of selected Sub-Saharan Africa context

Figure 8.1 is a visual summary of the theoretical contribution of this study to the body of knowledge with respect to the design and effective use of health ICTs to transform work activities of healthcare professionals during service delivery in Sub-Saharan African contexts. The main relational concepts of work activities within tertiary healthcare services are human actor attributes, health ICT features, technology-enabled tasks, intermediate and advanced interplay as experienced by human actors and, ultimately, the anticipated outcome.

The elements indicated in the clouds of Figure 8.1 are mediators that are emergent from, or determinant of, the mains relational concepts involved in transforming the motive of activity to the desired outcome of work activities. The choice, self-awareness, skills and intentionality attributes of healthcare professionals to adapt to a situation (favourable or unfavourable) influence how HITs are perceived on the basis of the extent to which its design capabilities enhance or inhibit work-related tasks at points-of-care. Thus, it is argued that the resulting task benefits or unintended consequences experienced by healthcare professionals while using HITs for their work activities, determine the resulting suitability of the application and the resulting job satisfaction; otherwise, the implemented health ICTs would be partially utilised, or even discarded, when healthcare professionals are not satisfied with the values attributed to its usage.

The concepts drawn from ANT, AT, TAM and TTF contributed to understanding how the factors that influence healthcare professionals' attitudes affect the use of health ICTs during execution of technology-enabled activities in a work activity system. The study established that the transformation success of a work activity is not independent of the combination of the object of activity, the attributes of a social actor, influence of the contextual conditioning, contradictions, and technology fit. The product of the synergy of the aforementioned elements may ultimately determine the favourable or unfavourable quality of service delivery.

The effective use of health ICTs to enable informed decisions and, ultimately, patient wellbeing leads to an improved delivery of healthcare service delivery. The theoretical contribution made by this research can be relevant to an evaluation of the effectiveness of mHealth intervention projects and could scale up their use by frontline users in tertiary hospitals. This contribution mainly addresses the knowledge gap of the context in this study as indicated by Ojo (2018:6), who states that:

> Evidently, it also seems researchers are more interested in health outcomes, at the expense of health care delivery processes, going by the fact that the studies reviewed focused only on patients, and none focused on health care practitioners.

The next section presents details of how the choice of methods and techniques influenced the research findings that support the pre-set research objectives. These techniques enabled the researcher to triangulate the collected data and the findings with the existing literature.

8.6 Methodological contribution

The methodological contribution of this study was evident in the use of multiple techniques to collect data and its resulting outcome in the descriptive analysis of the research findings discussed in chapters Five and Six. The research strategy adopted was service design, which enabled the researcher to consider the interactions that take place within the work activities during the service delivery process. The use of DDM afforded the researcher the opportunity to use a combination of techniques at each phase. In the **DISCOVER** phase, the researcher was able to articulate the research problem from the literature and from engagements with participants. In the **DEFINE** phase, a combination of semi-structured interviews and co-design activities were used to engage participants within their work environment.

The advantage of using a semi-structured interview technique enabled the researcher to interrogate and be pragmatic while engaging with participants on the phenomenon of research. However, this technique of inquiry does not guarantee the reliability of the collected data on the basis that participants might tend to disclose what they think the researcher wants to hear. The consequences could be counterproductive to the validity of the research findings and defeat the purpose of gaining understanding of the issues under investigation. Thus, an additional technique of inquiry was used to support and then validate the information acquired from interviews. In order to complement the reliability of the interviews, a co-design activity was used to engage participants in a second round of data collection. This technique was facilitated by the researcher, while the participants were given the autonomy to drive the session based on their lived experiences.

Open-ended questions were used to facilitate the interactions with participants during both semi-structured interviews and co-design activity. The outcome of applying the techniques guided the **DEFINE** phase of the service design DDM. In this phase, a visual user journey map that shows the current work activities of healthcare professionals, tasks and respective interaction moments, resources used and challenges they experience was constructed.

It was evident during the co-design activity that participants were comfortable with the idea of actively using things to generate something tangible that they could relate to, as opposed to only interviews. The researcher particularly provided cut-out representations of doctors, nurses, patients and tools used for the work activities in tertiary healthcare, as opposed to participants writing on sticky notes and categorising results in a thematic layout. The use of visual representative of human and objects in the co-design activity allowed healthcare professionals to express the interactions that occur in their daily work activities at points-of-care in the process of service delivery.

The combination of these two data collection techniques offered a unique opportunity for the researcher to capture the experiences of what healthcare professionals say they do and how they actually perform the tasks during their work activities. Healthcare professionals claimed that the co-design activity was interestingly engaging and afforded an opportunity for them to understand their daily workflow from a new insightful viewpoint and the areas that could be improved. Applying semi-structured interviews and co-design activities in this study offers a novel way of engaging healthcare professionals in research investigations that align with activity-driven and goal-oriented services.

8.7 Limitations of the study

While scholarly investigations are tailored to the discovery of new knowledge to support or refute known claims or assumptions, the research process is often times associated with unintended limitations. In this study, the limitations were evident in the qualitative nature of the research design, the process of engaging with participants, and the presumptions that influenced the framing of interview questions, as subsequently explained.

The data collected was cross-sectional; hence the findings are not entirely generalisable to the work activities of healthcare professionals in all tertiary healthcare settings. This is because of the subjective and contextualised nature of the study. Despite applying conceptualisation and operationalisation of words and phrases to understand the variables of the research questions, these operations do not completely guarantee the reliability of the data collected from participants. With respect to the research strategy, only three phases of the DDM were considered relevant to this study. The final phase, which is the **DEPLOY** phase, ideally requires the development of a finished product to be implemented and tested at the research sites. Since this investigation was not government-funded research, it was difficult to complete all the phases of the model where products are developed and handed to healthcare professionals of public hospitals. This is as a result of the ethical concerns associated with interference in the work activities of healthcare professionals while carrying out their work activities.

There were difficulties and delays in setting up interviews with healthcare professionals in tertiary healthcare institutions. Despite the researcher’s first contact with the gatekeepers to inform them of the purpose of the study and requesting access to healthcare professionals, it remained challenging to get willing participants. This was essentially ascribed to the busy schedules of healthcare professionals in a public hospital setting. Hence, this restricted the data collection process to a few clinical departments that provide tertiary healthcare. The complexity of the work activities of healthcare professionals and administrative staff in hospitals were not given particular consideration during the data collection process, mainly because the clinical work activities were the focus of the research aim. The data indicated that administrative activities had an influence on clinical work activities. This presents a vital opportunity for future research on ways to engage with a skilled participant population, such as in the healthcare sector of lower- and upper-middle income countries.

The researcher is referred to as the instrument of enquiry in a qualitative research. Thus, the researcher designed interview questions based on his understanding of literature and the assumption that the healthcare professionals use some form of health information and communications technologies to enable their work activities. In the South African context, healthcare professionals used implemented health ICTs, including some form of mHealth technologies, while in the Nigerian context there were no HITs used. In order to accommodate this, the researcher was pragmatic and adjusted the semi-structured interviews to include unstructured open-ended questions during the data collection.

8.8 Recommendations for mHealth technology-enabled touch points

In line with the aim of this study, the researcher identified interaction moments within the touch points where healthcare professionals could use mHealth technologies tailored to their work activities at points-of-care during service delivery in tertiary healthcare settings. Based on the research findings from both hospitals **H1** and **H2**, these recommendations were made to meet the goals of the objectives that ultimately guided the research process.

8.8.1 Towards the improvement of the effect of implemented technologies on the outcomes of work activities

The evidence from this study indicates the need for the organised use of a hybrid system that includes both paper and electronic systems. The use of an organised hybrid system would cater to the preference of healthcare professionals to use paper, desktop computers or mobile technologies, which depends on the complexity of the tasks at points-of-care. Data synchronisation between these three tools will contribute to data accuracy and the seamless delivery of healthcare services in the clinical settings of public hospitals.

It is imperative for the hospital management to collaborate with healthcare professionals and the relevant bodies of health to include an evaluation plan in the IT vision to assess implemented HITs. This will help the relevant stakeholders to address the readiness to integrate advanced technology to support healthcare services.

Thus, the operational plans of IT implementation strategies established by relevant bodies of health in Nigeria and South Africa need to consider how the positive and negative lived-experience of healthcare professionals influence the outcomes of service delivery.

8.8.2 Addressing the identified pain and gain points experienced by healthcare professionals

The version of the ECM system only caters for scanned copies of paper records to be digitised and available electronically for healthcare professionals to retrieve during the follow-up visits. As patient records increase, it becomes cumbersome to easily search and find relevant information, especially in a situation where there has been a string of, and change in healthcare professionals attending to patients in public healthcare settings.

The current version of the ECM should be upgraded to accommodate digital versions of clinical notes and examinations. The digital version easily facilitates read and write operations on the records when accessible on desktop computers and mobile platforms. This ensures that doctors are able to edit lists on the ECM systems and have full control when updating the necessary information required for treatment plans, when necessary.

Infrastructure plays a key role in the use of health ICTs during work activities. Because of the time-sensitive nature of healthcare services and the associated cost implications, adequate system backups should be put in place to cater for the rare instances of system downtime, particularly to avoid inhibition of work activities during load shedding periods. In addition, there is a need to deploy an adequate Internet infrastructure to eliminate the use of personal mobile data by healthcare professionals. This offers an opportunity for the government and the hospital management to collaborate with willing Internet service providers (ISPs) to provide wireless infrastructure in hospital environments. This ensures that healthcare professionals are able to progress with their work activities at points-of-care and gain access to information required to make informed decisions in a timely manner. Healthcare professionals that utilise electronic referrals perceived this as more effective than paper-based referrals; hence, hospital management and the Western Cape Department of Health should consider adopting the VULA application model in the clinical settings of public hospitals. This could be essential towards the alignment of mHealth technologies to the activities of healthcare at points-of-care during healthcare service delivery.

8.8.3 Ensuring the alignment of mHealth technologies and healthcare professionals at service touch points

The ideal mHealth technologies for healthcare professionals in an overburdened tertiary healthcare setting could be in the form of a pen or smartphone used by doctors during patient consultation. This would ensure the use of devices that they are already comfortable with and would eliminate the introduction of an entirely new device into their work activities. In this way, training would be minimised and information management during patient consultation would be improved.

Time efficiency and usability of mHealth technologies are essential factors to the integration of technologies into clinical settings. A suitable mHealth technology to facilitate patient consultation requires speech recognition, medical semantics (context sensitive or aware) and a transcription application. These features would ensure a mHealth software application timestamp and distinguish between engaged voices during transcription from audio to text. The design of mHealth technologies requires mechanisms that would reduce the amount of use time by healthcare professionals at points-of-care. This would contribute to the uptake and increased use of mHealth technologies to enable specific tasks at points-of-care.

It is evident that there is disconnect between data generated by electronic systems and by the mHealth application. mHealth technologies designed for clinical settings should be interoperable and integrate with other hospital information systems. In this way, data stored in a mHealth device could be easily transmitted to the hospital information system databases.

The VULA mobile application update needs a mechanism that allows for multiple healthcare professionals to have access in order to attend to, and treat the notifications, provided that they are less busy and are available to undertake a teleconsultation. This would reduce the interruption of healthcare professionals when they are busy with patients during consultations in tertiary healthcare at the points-of-care. In clinical settings, mHealth technologies should preferably be designed with audio-enabled medical references at points-of-care to enable healthcare professionals' access to updated knowledge to enhance decision-making and ergonomics.

Feasibility studies should be conducted in the Nigerian context to consider the development of health software applications locally, given the growing technology industry in the country. A particular focus is needed to explore the possibilities of designing systems that can operate offline, especially when there are power cuts or network downtime. By doing this, the collection, access, retrieval and exchange of patient information will not be inhibited.

In the Nigerian context, there are options to consider alternate power generation, particularly for the healthcare sector, and health ICTS can be designed to cache information during faults, using asynchronous inter-process communication models. Furthermore, affordable bandwidth and engagement of all stakeholders need to be addressed. This would serve as notable efforts in the adoption of a balance between paper and technology to support the work activities of healthcare professionals during service delivery. In addition, the Nigerian

Ministry of Health could identify initiatives, particularly from the Western Cape Provincial Department of Health, and adopt them in their role in the selection and implementation of HITs for public hospitals.

8.8.4 Actionable roles of the Provincial Department of Health in the selection of technology solutions to support tertiary healthcare services

The Provincial Department of Health needs to carry out an evaluation of implemented systems to identify any unintended consequences that might inhibit the process of service delivery in tertiary healthcare; otherwise, the IT vision and efforts to improve public service delivery, particularly in the healthcare sector, will be delayed. This study and similar literature have established that there are instances where healthcare professionals have demonstrated an interest in software development, based on their problem-solving nature and experiences during service delivery. There is a need to empower healthcare professionals to champion eHealth and mHealth projects, particularly across Sub-Saharan Africa. In this way, frontline end users will be involved in all phases of health ICT implementation projects.

The national and provincial departments of health need to formulate guidelines or standards, based on the findings of literature in the context of this study, to develop and evaluate the effectiveness of mHealth technologies for the work activities of healthcare professionals in public hospital settings. Furthermore, the Provincial Department of Health should develop policies to manage the design and implementation of mHealth technologies to support the work activities of healthcare professionals. This would largely address the challenge of professional isolation of healthcare workers in urban and resource-constrained areas.

Table 8.1 outlines the key summaries of the recommendations, as informed by the research objectives and the relevant stakeholders that could benefit by taking necessary actions.

Practical lessons should be taken from how the VULA application and similar mHealth initiatives, such as the MomConnect messaging service, currently work. It is important when designing a mobile application for localised use within a hospital setting, to consider whether the application is suitable for the use context without causing an intrusion or delays at points-of-care.

Table 8.1: Recommendations informed by research findings

Objectives	Recommendations	Relevant Stakeholders
To determine the current effects of implemented HITs on the outcomes of healthcare professionals' work activities	There is a need for an organised use of a hybrid system that includes paper and electronic systems at points-of-care	Hospital management Healthcare professionals
To identify pain and gain points experienced by healthcare professionals the service interaction moments during their work activities at points-of-care	Upgrade the current version of the ECM to accommodate *write* and *update* operations when accessible on both desktop and mobile platforms.	Healthcare professionals Provincial Department of Health: Business analysis team User Experience and interaction designers
To determine how mHealth technologies and human actors could be aligned at different service touch points	An ideal mHealth technology in the form of a digital pen or smartphone would be adequate for use by healthcare professionals during patient consultation. The design of mHealth technologies should consider mechanisms that would reduce the amount of use time by healthcare professionals at points-of-care. Usability of mHealth technologies is key to its integration into clinical settings. mHealth technologies designed for clinical settings should be interoperable with other hospital information systems. The VULA application update needs a mechanism that allows multiple healthcare professionals access to a notification provided that they are less busy. In clinical settings, mHealth technologies should be designed preferably with audio-enabled medical references at points-of-care.	Healthcare professionals Provincial Department of Health: Business analysis team Software developers User experience and interaction designers HITs implementers
The objective is to understand the role of the Provincial Department of Health in stakeholder engagement during selection of HITs for tertiary healthcare services	The Department of Health should carry out evaluation of implemented systems to identify any unintended consequences that might inhibit the process of service delivery in tertiary healthcare.	Provincial Department of Health: decision-makers, policy makers, HITs implementers

Objectives	Recommendations	Relevant Stakeholders
	There is a need to empower healthcare professionals to champion eHealth and mHealth projects nationally and provincially The Provincial Department of Health should consider formulating guidelines or standards from the findings of this study and similar studies to develop There is a need for the Provincial Department of Health to develop policies in order to manage the integration and implementation of mHealth technologies into the activities of healthcare professionals in the public healthcare system	

8.9 Conclusion to the thesis

In hospital settings, appropriateness of health ICTs and their timeliness for the work activities of healthcare professionals is largely dependent on the capabilities of the technology to satisfactorily assist an individual in the completion of tasks amidst contextual factors. The unique contribution of this study is the breakdown of the different levels of interplay that occur when healthcare professionals execute technology-enabled work activities at points-of-care and how it could influence the quality of service delivery outcomes. Additionally, the research strategy offers a novel way of investigating opportunities to gain insights into how mHealth ICTs should be designed to cater for specific healthcare contexts.

Based on the lack of evidence on the effectiveness of mHealth technology-enabled work activities, as claimed by Ojo (2018), the researcher explored the opportunities to integrate mHealth technologies at points-of-care in selected tertiary hospitals. Hence, the research findings contribute knowledge on developing suitable mHealth technologies within similar hospital settings that were considered in this study. Consequently, the aim of the research informed the approach adopted to guide the process of addressing the research problem articulated in section 1.3.

8.9.1 Personal reflections on the study

Table 8.2 shows a timeline of research activities engaged in the period of four years leading to the final submission of this thesis.

Table 8.2: Timeline of research activities

<table>
<tr><th rowspan="2">Project Activity</th><th rowspan="2">Year</th><th colspan="12">Months</th></tr>
<tr><th>January</th><th>February</th><th>March</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>September</th><th>October</th><th>November</th><th>December</th></tr>
<tr><td rowspan="2">Reading and development a proposal</td><td rowspan="2">2017</td><td colspan="6">Developed proposal</td><td colspan="4">Proposal presentation</td><td colspan="2"></td></tr>
<tr><td colspan="12">Review of Literature – Chapter Two</td></tr>
<tr><td rowspan="2">Methodology: Data collection</td><td rowspan="2">2018</td><td colspan="12">Data Collection</td></tr>
<tr><td colspan="12">Literature and writing up of chapters Two, Three and Four</td></tr>
<tr><td rowspan="3">Writing up Findings</td><td rowspan="3">2019</td><td colspan="12">Data Analysis</td></tr>
<tr><td colspan="5">Presentation of working paper at Conf-IRM 2019 in Auckland, New Zealand</td><td colspan="7">Submission of journal and conference articles</td></tr>
<tr><td colspan="12">Revision of all eight chapters and submission of thesis first draft</td></tr>
<tr><td colspan="14">Submission of final thesis (2020)</td></tr>
</table>

The most difficult part of the research journey was learning to be patient with the delays caused by processes out of the researcher’s control, such as ethics approval and obtaining responses from participants. The abrupt delays caused adjustments to be made to the pre-set timelines. The researcher had to deal with unresponsive potential participants and discouragement from healthcare professionals within one of the contexts about the feasibility of this study. However, the main supervisor was instrumental in assisting the researcher to make positive inferences and move past these disappointments. Lessons learnt by the researcher were used to further negotiate with different stakeholders at different points of the journey.

The journey started when the researcher registered to pursue a self-funded PhD degree in Informatics in the Faculty of Informatics and Design at the Cape Peninsula University of Technology (CPUT) in January 2017. During this period, the researcher undertook part-time lecturing in the Department of Information Technology. By October 2017, the researcher developed and submitted his proposal for review. The review feedback was positive, which enabled the researcher to present the proposal to the research committee of the Faculty of Informatics and Design. The presentation panel gave constructive comments, which helped to improve the proposal and the study was approved. Proposal approval enabled the researcher to qualify, and subsequently apply, for assistance from the University Research Fund (URF) to assist in the field work. A positive proposal presentation and URF grant marked the end of the 2017 academic year.

In January 2018, the researcher registered for the academic year as a prerequisite to apply for an ethics clearance certificate from CPUT’s Faculty of Health and Wellness research ethics board, to proceed with the process of data collection. Ethical approval was granted to the researcher in April 2018. On approval, the ethics certificate had to be sent to the Western Cape Provincial Department of Health, through their website application process, to obtain permission immediately. At the same time, a copy of the ethics certificate was sent through email to the chief medical administrative staff of the tertiary institution in South West Nigeria, which served as the second research context of this study. The permission from the Western Cape Department of Health and the tertiary hospital in South West Nigeria was communicated to the researcher in June 2018. While waiting, the researcher continued to explore the literature and write up certain chapters of the thesis. The granting of permission allowed the researcher to gain access to, and approach, the three tertiary hospitals in the Western Cape. Of the three tertiary healthcare institutions, only two responded at first. The researcher had to physically visit the two hospitals several times to set up appointments. Subsequently, only one of the tertiary hospitals granted the researcher permission to engage with its healthcare professionals and information manager. Engagement with the healthcare professionals in the Western Cape took place between September 2018 and November

2018. The trip to Nigeria happened in November 2018 and the data collection at the tertiary hospital in that country began immediately and continued until January 2019. It took several visits to the hospital, similar to the experience in the South African context, to set up meetings with healthcare professionals. This is understandable, given the busy schedule of healthcare professionals in public hospitals. Nonetheless, the outcome of 2018 academic year was the continuous writing, while waiting for the eventual ethics approval and the start of data collection process.

The researcher had to report for work duties at CPUT, sort out school fees, registration and other expenses in January 2019 at the start of the academic year. Data transcription commenced in February of 2019 and lasted until April of 2019. The data analysis commenced in May 2019, during which time the researcher attended and presented during a conference at the Auckland University of Technology in New Zealand. The data analysis continued until December 2019, while the research report was being drafted. By the end of January 2020, the researcher organised the research report to produce the first draft of this thesis and sent articles to scientific journals for potential publication. The research process afforded the researcher an opportunity to further develop an interest in the IS field, while, at the same time, preparing and learning how to approach, as well as negotiate, difficult situations that may inhibit the research progress in future.

8.9.2 Considerations for future research

The potential benefits associated with the use of mHealth technologies to support universal health care services in Africa have been confirmed in scholarly literature but with limited evidence of their effectiveness to support healthcare service delivery in the hospitals. Additional studies are required to address the development of mHealth applications and the evaluation of their integration into existing healthcare technologies at points-of-care to enable work activities.

Further studies should consider conducting extensive usability tests applicable to the work environment of healthcare professionals in the healthcare sector of Sub-Saharan Africa. There is a need to examine the readiness of government-funded hospitals to adopt artificial intelligent systems to manage large volumes of data and the standardisation of information exchanged across different hospital information systems to make informed decisions.

The use of service design as a strategy to investigate the different use cases of mHealth technologies in healthcare service delivery in Sub-Saharan Africa is uncharted territory that needs sufficient exploration. Subsequently, the researcher advocates for this study to be replicated on a larger scale in similar Sub-Saharan African countries that are making efforts to adopt HIT solutions to improve healthcare service delivery towards achieving the sustainable development goals.

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APPENDICES

This section consists of a chain of evidence of additional references generated during the different stages of the study.

Appendix A: CPUT ethics clearance approval

Appendix B: Approval for data collection from hospital **H1**

Appendix C: Approval for data collection from hospital **H2**

Appendix D: Information sheet handed to participants

Appendix E: Consent form (for all participants)

Appendix F: Interview questions (Healthcare professionals and Senior Hospital Administrators)

Appendix G: Visual probes for co-design activity

Appendix H: Frequency of Codes, Categories and Themes

Appendix A: CPUT ethics approval clearance

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HW-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

19 April 2018
REC Approval Reference No:
CPUT/HW-REC 2018/H4

Dear Mr Ogundaini Oluwamayowa

Re: APPLICATION TO THE HW-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC on 15 March 2018 to Mr Oluwamayowa ethical clearance. This approval is for research activities related to research for Mr Oluwamayowa at the Cape Peninsula University of Technology – Information and Design Faculty)

TITLE: **Integration of mHealth within socio-technical relationship networks to facilitate service interaction moments at public hospitals**

Supervisor: Prof Retha de la Harpe

Comment:

Approval will not extend beyond 20 April 2019. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the HWS-REC in December of that particular year, for the HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Mr. Navindhra Naidoo
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

Appendix B: Approval for data collection from hospital H1

Western Cape Government
Health

REFERENCE:
Research Projects
ENQUIRIES: **Dr**

TELEPHONE:**021 938 5752**

Ethics Reference: **CPUT/HW-REC 2018/H4**

TITLE: Integration of mHealth within socio-technical relationship networks to facilitate service interaction moments at public hospitals.

Dear Mr Ogundaini Oluwamayowa

PERMISSION TO CONDUCT YOUR RESEARCH AT HOSPITAL.

1. In accordance with the Provincial Research Policy and Hospital Notice No 40/2009, permission is hereby granted for you to conduct the above-mentioned research here at Hospital.

2. Researchers, in accessing Provincial health facilities, are expressing consent to provide the Department with an electronic copy of the final feedback within six months of completion of research. This can be submitted to the Provincial Research Co-Ordinator (Health.Research@westerncape.gov.za).

DR
MANAGER: MEDICAL SERVICES

DR
CHIEF EXECUTIVE OFFICER
Date: 22 June 2018

Administration Building, Parow, 7500 Private Bag X3, . 7505
tel: +27 21 938- fax: +27 21 938-4890 www.capegateway.go.v.za

Ethics Reference: CPUT/HW-REC 2018/H4

TITLE: Integration of mHealth within socio-technical relationship networks to facilitate service interaction moments at public hospitals

BY ____

An authorized representative of Hospital

NAME Dr ____

TITLE CEO ____

DATE 22 June 2018 ____________________

Appendix C: Approval for data collection from hospital H2

Director of Administration: O. Bola Alejo (Miss) B.A. (French), MPA, PG Cert. Health Planning & Mgt. ArtSAN, mhm (UK)

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0903 0000 839 Servicom

Our Ref:......CMAC.53/Vol. XIII/472

Date:..5th June, 2018.

Mr. Ogundaini Oluwamayowa (Student Number: 214282422)
Cape Peninsula University of Technology,
South Africa.

Re: Letter of Request for Data Collection

I hereby convey the Chief Medical Director's approval to you to carry out your research on the integration of mobile Health (mHealth) technologies in tertiary public hospitals in sub-Saharan Africa.

It was noted that you have obtained ethical approval from your institution's Faculty Research and Ethics Committee.

By this, you are permitted to conduct interviews with healthcare professionals across different clinical departments, allied health workers and senior hospital administrative staff in the University Teaching Hospital

As indicated in your request letter to the Chief Medical Director, you would be expected to commence your data collection as from November 2018 up until February 2019, according to the availability of prospective participants.

I wish you all the best.

Dr. J.B.E. Elusiyan,
Director of Clinical Services & Training and
Ag. Chairman, Medical Advisory Committee.
For: Chief Medical Director.
CHAIRMAN
MEDICAL ADVISORY COMMITTEE

Cape Peninsula University of Technology

Appendix D: Information sheet handed to participants

INFORMATION SHEET FOR PARTICIPANTS

Dear Participant,

You have been invited for this study because of your:

A) Position and profession in this hospital

B) Experience on the area being studied, i.e. use of health related information technologies as part of your routine to perform daily clinical work activities.

It is entirely **voluntary** for you to take part in the study and you have the right to withdraw any time and to take out your individual responses without any implications of penalty or consequence. I truly appreciate your time and effort. Please read more information about the study below. I will gladly answer any concern you may have about the study.

Thank you very much!

With sincere gratitude,

PhD Student: OGUNDAINI, Oluwamayowa
Department of Information Technology
CPUT, Cape Town Campus
Email: mayowa.ogundaini@gmail.com or ogundainio@cput.ac.za
Cell phone number: 073 598 9341

Supervisor details: Associate Professor Retha de la Harpe
Acting Head Department of Research, Innovation & Partnerships
CPUT, Cape Town Campus
Email: DeLaHarpeR@cput.ac.za

Title of the study
Integration of mHealth technology-enabled service touch points at selected cases of tertiary healthcare in sub-Saharan Africa

Aim and objectives of the study
The aim of the research is to explore the opportunities of integrating mHealth technologies to support the work activities of healthcare professionals during service delivery in clinical settings of public hospitals. The research objective is to identify the pain points as experienced by healthcare professionals that could be serviced by mHealth during the provision of healthcare services. The study intends to contribute towards enhancing the

processes of healthcare services provision in the public hospitals of lower-middle-income countries (LMICs) particularly in sub-Saharan Africa.

Procedures of the study

It is entirely voluntary for you to take part in the study. During the study, the researcher will interview you each individual healthcare professionals in order to acquire information and identify the possibilities for integrating a form of mobile technologies that is designed for their work activities.

With your permission, the interviews will be recorded and transcribed (from voice to text using a computer afterwards). The purpose of the recording is to reduce disruptions during the interview and to capture all the essence of the discussion. Photographs will not be taken and video recordings will not be made. You will be able to receive a paper copy of your transcribed interview if you want to. The transcript file would be kept, at all times in a password protected folder that is secured on the university premises.

The study is not centred on neither interested in patient data but interested in exploring opportunities for easier access and communication between healthcare professionals through the use design of a “fit-for-purpose” mobile technology.

Participating in the research does not and would not pose any physical or psychological stress to the participants according to the researcher’s knowledge.

Conflicts of interest

There is no conflict of interest, as the researcher is self-funded and a part-time contract lecturer at CPUT, Cape Town campus. Therefore, there are no other interests tied to the research such external organisations – NGOs, NPOs, nor the Government. The results of the study, however, will be made available locally and globally. The researcher has received permission from all the appropriate authorities in the Western Cape to do the study at your hospital. Participating in the research does not bring about any personal benefits to you either, although the results of the study may benefit the organisation. Participation to the study is not paid.

The expected duration

Each interview (or focus group) session will take approximately 45–60 minutes depending on the availability of the informed participants. Each question is optional and you may leave at any time without giving a reason. The researcher would be subjected to the availability of the participants throughout the process of data collection due to their busy schedule.

Debriefing

You are welcomed to ask questions before, during or after the interviews or at any other time during the study via any of the contacts provided above as convenient.

Publication and presentation of findings

The researcher aims to share the knowledge that the research will produce. This means that in addition to the final thesis output, they will, publish the findings in scientific publications including Journal articles, book chapter(s) in international and/or local scientific communities. There might also be opportunities to give presentations at events and/or seminars related to the field of research ONLY.

Confidentiality, anonymity, and a chance to check what you have said

Every effort will be made to protect your confidentiality. Your name or the name of the hospital will NOT be revealed in any case, however, the name of the area (Cape Town) may be revealed. Sometimes the researcher may want to highlight an issue with a quote. The responses will be reported anonymously or under pseudonym concerning your profession (for example **MD_H1_R3**, **Nurse_H1_R1**, **Administrator_H2_R2**). Similarly, we wish you not to mention anybody (colleagues or patients, etc.) by name. Such replies will be also anonymised in any given case. Finally, if your profession is such that it may reveal your identity (for example Senior Official from Western Cape Department of Health) you may request an option where I send you the quote I wish to use by email and you will approve or disapprove it.

Unlikely event of discovering illegal activities

If you make illegal activities known, these will be reported to appropriate authorities.

Cape Peninsula
University of Technology

Appendix E: Consent form (for all participants)

LEAD RESEARCHER: OGUNDAINI OLUWAMAYOWA

Title of the PhD study

Integration of mHealth technology-enabled service touch points at selected cases of tertiary healthcare in sub-Saharan Africa

Procedures of the study

It is entirely **voluntary** for you to take part in the study. During the study, the researcher will interview and perform a joint co-design session with you in order to acquire information with respect to the topic of research. With your permission, the interviews will be recorded and transcribed (from voice to text afterwards). You will be able to receive a paper copy of your transcribed interview if you want to. The transcript file would be kept, at all times in a password protected folder that is secured on the university premises. ***The study is not interested in patient data but in opportunities to address the need for easier management, exchange and communication of information between healthcare professionals through the use of a mobile health technology.*** Participating in the research does not and would not pose any physical or psychological stress to the participants according to the researcher's knowledge.

Publication plan

The researcher aims to share the knowledge that the research will produce. This means that in addition to the final Thesis output, the findings would be published in scientific publications including Journal articles in international and/or local scientific communities. There might also be opportunities to give presentations at events and/or seminars related to the field of research only. Every effort will be made to protect your confidentiality. Your name or the name of the hospital will NOT be revealed in any case. The responses will be reported anonymously or under pseudonyms of your profession (for example **MD_H1_R3**, **Nurse_H1_R1**, **Administrator_H2_R2**). Similarly, we wish you not to mention anybody (colleagues or patients, etc.) by name. Such replies will be also anonymised in any given case. Finally, if your profession is such that it may reveal your identity (for example Senior Official from Western Cape Department of Health) you may request an option where I send you the quote I wish to use by email and you will approve or disapprove it.

DECLARATION:

- I am 18 years or older and am competent to provide consent.
- I have read, or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.
- I agree that my data are used for scientific purposes and I have no objection that my data are published in scientific publications in a way described above.
- I understand that if I make illicit (illegal) activities known, these will be reported to appropriate authorities.

- I understand that I may stop electronic recordings at any time, and that I may at any time, even subsequent to my participation have such recordings destroyed (except in situations such as above).
- I understand that, subject to the constraints above, no recordings will be replayed in any public forum or made available to any audience other than the research team which includes (investigator and the supervisor).
- I consent to my interview being audio-recorded
- I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights. I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.
- I understand that my participation is anonymous in a way described before and that no personal details such as my name me will be reported.
- I understand that signed consent forms and original audio recordings will be retained by the researcher according to CPUT's research data storage policy.
- I understand that I am free to contact any of the people involved in the research to seek further clarification and information.
- If the research involves viewing materials via a computer monitor I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.
- I have received a copy of this agreement.

PLEASE COMPLETE	**YES**	**NO**
• I wish to have a copy of my interview	☐	☐

Where will the copy be sent?

____

____

____

PARTICIPANT'S NAME: ____

PARTICIPANT'S SIGNATURE: ___________________________________

DATE: ____

Statement of investigator's responsibility: I have explained briefly but detailed the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and hence has freely given informed consent.

Cape Peninsula University of Technology

Appendix F: Interview questions

Thank you for making time out of your busy schedule to attend to me.

My name is Ogundaini Oluwamayowa. I am a registered PhD student at the Faculty of Informatics and Design, Cape Peninsula University of Technology, Cape Town Campus. I'd like to have a discussion with you, in an attempt to understand the use of ICTs for your work processes but particularly the opportunities to integrate mobile technologies to redress work constraints.

With your permission, I would like to request that I record our session so that I do not cause any forms of distraction while trying to capture the essence of our meeting today. Also, I'd like you to peruse the informed consent form and sign that you understand the terms and conditions and, can be applied at any time during and after the interview.

Interview Questions

1. a. To begin with, could you introduce yourself by stating your names, department, your position and years of experience in the healthcare sector?

   b. Can please describe your organisation or the department you work in?

- **How can mHealth technologies be used to facilitate service interaction moments within a socio-technical relationship network to optimize healthcare information services?**

  - *How does the use of existing implemented technologies for work processes affect the outcomes of healthcare information service delivery?*

2. Could you describe your work activities on a typical day in the hospital?

3. Are there ICT tools used to support healthcare related activities in the hospital? If yes, can you please describe these technology tools?

   If No, which activities would you like to be supported by ICT tools, and why?

4. How often do you use these ICT tools to support your work activities?

5. Does the use of these ICT tools affect the outcome of services provided to your clients or patients?

6. And what is your opinion on the ICT support provided by the hospital management?

   What are the pain/gain points of healthcare professionals at the service interaction moments during service delivery processes?

7. How do you feel using these ICT tools for your work activities compared to when you use paper or manual systems?

8. a. Are there any challenges in the course of using any of these ICT tools to carry out your work activities?

   b. At which specific point/time during your work activities do you encounter these challenges?

   c. How do these challenges affect the outcome of your work activities?

9. How do you deal with any other challenges that inhibit your work activities?

10. **In what aspects** would you suggest that the existing ICT tools can be improved to fit your work activities?

11. a. Are there any particular rules or procedures you are required to adhere to when using these ICT tools for your work activities?

    b. **If Yes,** how do these policies influence your use of ICT tools? **If No,** what kind of policies would you prescribe as a healthcare professional?

    How can the use of mHealth be incorporated at the different service interaction moments to improve the outcomes of healthcare information service delivery?

12. a. Do you have any mobile ICT tools you make use for your work activities?

    b. **If Yes**, why were these mobile ICT tools implemented in the hospital?

    c. At which points during your work activities do you feel it is necessary to have mobile ICT tools?

13. What kind of functions would you expect a mobile ICT tools to have in order to support your work activities?

14. How do these missing functions affect your abilities to perform your work activities at the moment?

15. In relation to your work activities, can you describe the ideal mobile ICT tools that would be most appropriate for your work activities?

16. What are the resources you feel are necessary in order to use mobile ICTs for your work processes?

- **What are the characteristics of a desired socio-technical relationship network required to incorporate mHealth technologies for healthcare service delivery?**

Using stakeholder mapping as a method, how can opportunities to integrate mHealth to optimise touch points be identified?

17. Can you mention the roles of personnel that your work activities require you to interact with?

18. When carrying out your work activities, how do you currently interact with these personnel?

19. How do ICT tools play a role in your interaction with other personnel during your work activities?

20. How do you think mobile ICT tools can support interaction with the other personnel during your work activities?

21. How would you prefer to interact with your colleagues?

22. Do your colleagues influence your use of ICT tools?

Conclusion

Thank you for your time and attention, I have exhausted the questions which signifies that we have concluded our discussion. Whilst the discussion was very informative,

a. Do you have further additions that might have been skipped due to oversight?

b. Do you have any questions for me?

c. Do you think it is necessary for me to have this discussion with someone else you feel might be in a position to give more insights on my research title?

Appendix G: Visual probes for co-design activity

Doctor / Specialist

Nurse

Patient

X-ray Film

Paper (records)

Computer

Mobile device

Ambulance

Appendix H: Frequency of Codes, Categories and Themes

How does the use of existing implemented technologies to support work activities affect the outcomes of healthcare service delivery process?

DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
morning handover meeting X3	administrative duties and planning	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
prepare theatre list for call or extra trauma lists X2	administrative duties and planning	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
academic meetings (and presentations) X3	academic engagements	ADMINISTRATIVE DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
operate the patients	perform clinical procedure on patients	CLINICAL DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
trauma theatre X6	perform clinical procedure on patients	CLINICAL DUTIES	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
ophthalmology clinic X2	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
Orthopaedic clinic X5	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
consulting patients in the outpatient clinic and theatre	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
we see outpatients	consultation with outpatients in clinic	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
ward rounds X8	consultation with inpatients in the ward	PATIENT CONSULTATION	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
trauma referral screening/Accepting X3	VULA enables patient referral from other hospitals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
taking referrals from outside of the hospital	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
Accept VULA requests	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
our referrals come in via VULA	reception of referrals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
Referring patients to other colleagues X5	VULA enables patient referral from other hospitals	REMOTE REFERRALS	WORK ACTIVITY OF HEALTHCARE PROFESSIONALS
It is the official referral route for our department	VULA enables patient referral from other hospitals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
Decide whether or not you need to see the patient	VULA enables patient referral from other hospitals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
ask advice	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
Advice on treatment plan	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
Advice on first-aid treatment before referral	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
Ask the doctor questions X2	VULA enables consultation between healthcare professionals	REMOTE CONSULTATION	PURPOSE OF IMPLEMENTED HITs
send picture X3	information exchange	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
Send-X-rays	information exchange	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
Communicating with referring colleagues	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
Contact with doctor on call	communication	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
allows direct communication with referring practitioners	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
the app streamlines our communication with outside centers	VULA facilitates remote communication between healthcare professionals	FACILITATE COMMUNICATION	PURPOSE OF IMPLEMENTED HITs
Teach the doctor	learning and development tool for healthcare professionals	TEACHING TOOL	PURPOSE OF IMPLEMENTED HITs
Access to X-rays	PACS enables access to patients' medical image records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs
Access to all laboratory examinations in public hospitals X2	IS/IT enables access to patient laboratory records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs
Short history	digitised records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs
Scanned documents	digitised records	FACILITATE ACCESS TO PATIENT INFORMATION	PURPOSE OF IMPLEMENTED HITs
Store X-rays	PACS enables storage of patients' medical image records	FACILITATE INFORMATION STORAGE	PURPOSE OF IMPLEMENTED HITs
keeps a record of all interaction	storage of information	FACILITATE INFORMATION STORAGE	PURPOSE OF IMPLEMENTED HITs
Database of radiology	storage of patients' information	FACILITATE INFORMATION STORAGE	PURPOSE OF IMPLEMENTED HITs
Store all patient information	storage of patients' information	FACILITATE INFORMATION STORAGE	PURPOSE OF IMPLEMENTED HITs
Store theatre list	storage of patient information	FACILITATE INFORMATION STORAGE	PURPOSE OF IMPLEMENTED HITs
Requesting special investigations on patients	booking request	FACILITATE BOOKING REQUESTS	PURPOSE OF IMPLEMENTED HITs
Book X-rays on a computer system	booking request	FACILITATE BOOKING REQUESTS	PURPOSE OF IMPLEMENTED HITs
Book waiting list	booking request	FACILITATE BOOKING REQUESTS	PURPOSE OF IMPLEMENTED HITs
Admission	HITs is used to support nursing administrative duties	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs
Register patients	HITs is used to support nursing administrative duties	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs
Transfer patients	HITs is used to support nursing administrative duties	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs
Discharged	HITs is used to support nursing administrative duties	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs

Digitisation of records	HITs is used to facilitate digitisation of patient records in hospital H1	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs
Take patients off system if discharged or die	HITs is used to keep track of patient treatment in hospital H1	FACILITATE PATIENT ADMINISTRATION	PURPOSE OF IMPLEMENTED HITs
Order food	HITs is used to support nursing administrative duties in hospital H1	RESOURCE MANAGEMENT	PURPOSE OF IMPLEMENTED HITs
Order stock	HITs is used to support nursing administrative duties in hospital H1	RESOURCE MANAGEMENT	PURPOSE OF IMPLEMENTED HITs
Chat application	chat tool	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Take photos	app functionality - snap pictures	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Name of patient	type of patient information	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Visual acuity	VULA functionality	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Do planning	PACS functionality	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Draw your lines	PACS functionality	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Do your templating	PACS functionality	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
bleep from a switchboard and then you'd have to phone switch	Bleeper facilitates communication	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
Write referral	VULA app functionality	INTERACTION MOMENTS	PURPOSE OF IMPLEMENTED HITs
See what you're dealing with	VULA enables consultation between healthcare professionals	HITs FUNCTION	PURPOSE OF IMPLEMENTED HITs
use VULA app X8	health ICT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
Most of our work is reliant on PACS	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
ECM system X3	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
TRACKCARE	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
ISITE X2	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
PACS X3	ICT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
Any computer	medium of access that enables the use of HITs	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
Have PACS on any computer	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
CLINICOM	health HIT used	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
Bleeper	medium of access to healthcare professionals	NAME OF HEALTH ICT/HIT	PURPOSE OF IMPLEMENTED HITs
Get valuable feedback on management of patients	improved consultation between healthcare professionals	IMPROVED TREATMENT PLAN	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Amount of patients accepted is much less X2	reduced number of patients	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
A lower number of patients to be seen at both outpatient clinics and As trauma referrals	reduced number of patients	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Lessen the burden of trauma in emergency and Orthopaedic department	reduced number of patients	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Achieved to limit unnecessary referrals	reduced number of patients	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
referring is much more comprehensive	VULA has improved patient referral from other hospitals	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Simplified the referral process	VULA has improved patient referral from other hospitals	IMPROVED REFERRAL PROCESS	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Speeds follow-up with patient	quicker execution of work activities	IMPROVED PATIENT CONSULTATION	OUTCOME OF HITs USE FOR WORK ACTIVITIES
speed up all activities	quicker execution of work activities	IMPROVED PATIENT CONSULTATION	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Don't waste time waiting	time efficient	IMPROVED PATIENT CONSULTATION	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Saves time than having to take phone calls	time efficient	IMPROVED PATIENT CONSULTATION	OUTCOME OF HITs USE FOR WORK ACTIVITIES
X-rays available	PACS enabled the availability of patients' medical image records	ADEQUACY OF HITs	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Helped to have it always available	PACS enabled the availability of patients' medical image records	ADEQUACY OF HITs	OUTCOME OF HITs USE FOR WORK ACTIVITIES
Can't lose the X-rays	PACS has improved the storage of electronic X-rays	ADEQUACY OF HITs	OUTCOME OF HITs USE FOR WORK ACTIVITIES

What are the pain and gain points experienced by healthcare professionals while using implemented technologies?

DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
when there is a problem with technology	faults with HITs	pain point HITs UNRELIABILITY	CHALLENGES OF HITs USE
does not work properly	faults with HITs	pain point HITs UNRELIABILITY	CHALLENGES OF HITs USE
Poor picture quality	poor picture quality	pain point HITs UNRELIABILITY	CHALLENGES OF HITs USE

technology not always reliable	trust issues with HITs	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
back-up systems clumsy	clumsy back-up system	pain point	HITs UNRELIABILITY	CHALLENGES OF HITs USE
PACS iSite upgrade is slow	PACS is slow	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
iSite PACS is slow	PACS is slow	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
rare occurrences of ECM downtime	ECM system downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
when the ECM is down	ECM system downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
when PACS is offline	PACS downtime	pain point	SYSTEM DOWNTIME/SLOWNESS	CHALLENGES OF HITs USE
waiting period to scan paper into ECM	waiting periods for scanned patient information into ECM system	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
there is a waiting period for notes to be scanned in	waiting periods for scanned patient information into ECM system	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
Time-consuming process to get clinical notes scanned impromptu	time-consuming process	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
it takes so much time to type	time-consuming process	pain point	LONG WAITING PERIODS	CHALLENGES OF HITs USE
VULA referrals interferes	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
Need to answer requests/questions	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
time to look at and address the ICTs questions or demands	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
you need to explain yourself a lot	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
Find time during consultations	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
Consultation disrupted by VULA referrals	interruption during patient consultation	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
Lots of multi-tasking	Multi-tasking	pain point	INTERRUPTION OF WORK ACTIVITIES	CHALLENGES OF HITs USE
it wastes time	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
it causes issues and delays	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
slows down massively	delay of work activities	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
can't go on with your work	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
You can't book a patient for any surgery	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
halts work progress	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
then you have to see the patient again	inhibition of work activity progress	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
need to revert to paper based	revert to paper-based	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
falling back onto the paper system	revert to paper-based	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
the VULA app, we can discard that	discard IT app	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
Increase in consultation time with patient	increased consultation time	pain point	UNINTENDED CONSEQUENCES	EFFECTS OF CHALLENGES
See lots of patients	healthcare professionals attend to lots of patients	pain point	PATIENT POPULATION SIZE	WORK ACTIVITY CHALLENGES
Reception of referral 12 hours after written	time-consuming process	pain point	TIME INEFFICIENT PROCESS	WORK ACTIVITY CHALLENGES
wait for referral to be taken to a department	time-consuming process	pain point	TIME INEFFICIENT PROCESS	WORK ACTIVITY CHALLENGES
Illegible handwritings	illegible patient information	pain point	INADEQUACY OF PAPER_BASED RESOURCES	WORK ACTIVITY CHALLENGES
Lost or misplaced	loss of paper records	pain point	INADEQUACY OF PAPER_BASED RESOURCES	WORK ACTIVITY CHALLENGES
documentation gets lost	loss of paper records	pain point	INADEQUACY OF PAPER_BASED RESOURCES	WORK ACTIVITY CHALLENGES
Unavailability of hardcopy X-rays anywhere and any time	Unavailability a single X-ray hardcopies at multiple places	pain point	INADEQUACY OF PAPER_BASED RESOURCES	WORK ACTIVITY CHALLENGES
Single individual with access to a computer	single access to HITs	pain point	INSUFFICIENT MATERIAL RESOURCES	WORK ACTIVITY CHALLENGES
more beneficial for the patient, definitely not for the workload	Increased workload	pain point	EFFECT OF WORK ACTIVITIES CHALLENGES	EFFECTS OF CHALLENGES
Late trauma referrals have significant complications	effect of late referrals	pain point	EFFECT OF WORK ACTIVITIES CHALLENGES	EFFECTS OF CHALLENGES
Reception in the hospital can often delay messages	network signal delays	pain point	EFFECT OF WORK ACTIVITIES CHALLENGES	EFFECTS OF CHALLENGES
Reception in hospital is unfortunately a provider issue	network signal delays	pain point	EFFECT OF WORK ACTIVITIES CHALLENGES	EFFECTS OF CHALLENGES
most people are quite negative about it	perception of healthcare professional	pain point	SELF CONSCIOUSNESS OF HEALTHCARE PROFESSIONALS	EFFECTS OF CHALLENGES
Feels unprofessional to attend to VULA referrals during consultation	perception of healthcare professional	pain point	SELF CONSCIOUSNESS OF HEALTHCARE PROFESSIONALS	EFFECTS OF CHALLENGES
it seems unprofessional to constantly be looking at your phone screen	perception of healthcare professional	pain point	SELF CONSCIOUSNESS OF HEALTHCARE PROFESSIONALS	EFFECTS OF CHALLENGES
using WhatsApp to see the images, do improve the quality	quality of information	gain point	IMPROVED COMMUNICATION AND CONSULTATION	ENHANCED WORK ACTIVITY
Interaction is improved	Improved communication between healthcare professionals	gain point	IMPROVED COMMUNICATION AND CONSULTATION	ENHANCED WORK ACTIVITY
get valuable feedback on management of patients	improved consultation outcome between healthcare professionals	gain point	IMPROVED COMMUNICATION AND CONSULTATION	ENHANCED WORK ACTIVITY
if you need to give feedback or medical referral	improved consultation outcome between healthcare professionals	gain point	IMPROVED COMMUNICATION AND CONSULTATION	ENHANCED WORK ACTIVITY
Easy access to patient information from any computer at any time	Ease of access	gain point	IMPROVED ACCESS TO PATIENT INFORMATION	ENHANCED WORK ACTIVITY
Quick access	facilitate quick access	gain point	IMPROVED ACCESS TO PATIENT INFORMATION	ENHANCED WORK ACTIVITY
Immediate access	facilitate quick access	gain point	IMPROVED ACCESS TO PATIENT INFORMATION	ENHANCED WORK ACTIVITY
Carry on you	Portability of communication device	gain point	IMPROVED ACCESS TO PATIENT INFORMATION	ENHANCED WORK ACTIVITY
VULA makes it easier to make clinical decisions without seeing patients	enables decision-making	gain point	FIT FOR PURPOSE	ENHANCED WORK ACTIVITY
Using the VULA app with clinical pictures helps with this decisions making	enables decision-making	gain point	FIT FOR PURPOSE	ENHANCED WORK ACTIVITY
help with decision making and follow up plans	enables decision-making	gain point	FIT FOR PURPOSE	ENHANCED WORK ACTIVITY
I prefer paper based for note taking	paper-based system note taking	gain point	FIT FOR PURPOSE	ENHANCED WORK ACTIVITY
IT based for outside referrals	electronic patient referrals	gain point	FIT FOR PURPOSE	ENHANCED WORK ACTIVITY

helped us significantly with accountability	information acquisition	gain point	ACCOUNTABILITY	ENHANCED WORK ACTIVITY
way of tracking patient	trace referral information	gain point	ACCOUNTABILITY	ENHANCED WORK ACTIVITY
it is obviously traceable	trace referral information	gain point	ACCOUNTABILITY	ENHANCED WORK ACTIVITY

How could the use of mHealth technologies be incorporated at the different service touchpoints?

DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
for emergency cases during the day	emergency use	USE CASE	PATIENT AND INFORMATION MANAGEMENT
Nurses accompany patients around	movement of nurses	USE CASE	PATIENT AND INFORMATION MANAGEMENT
putting a specific hour to do it	reduce time spent to operate health ICT	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
you need something that doesn't go long routes	reduce time spent to operate health ICT	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
have someone dedicated person	dedicate personnel to attend to VULA referrals	TIME CONSIDERATIONS	PATIENT AND INFORMATION MANAGEMENT
Enter patient information	record patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
write continuous report	record patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
register patient details	record patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
access to radiology done remotely	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
notes scanned into ECM system	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
Access to electronic systems	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
quick access to information of a specific patient	facilitate access to patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
nurse can have access to enter whatever goes wrong with the patient	facilitate access to and entry of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
helps with quality and service improvement	VULA facilitates record keeping and feedback	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
have patient information readily	readily available patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
database of future reference and medico legal issues can be referenced	storage of patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
latest notes of a patient on phone	availability of updated patient information	INFORMATION MANAGEMENT	PATIENT AND INFORMATION MANAGEMENT
Click of a button	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
dropdown option	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
Ability to edit theatre and waiting lists	feature of mobile ICT	FUNCTIONALITY of MOBILE ICT	FUNCTIONALITY OF MHEALTH ICTs
I have an app that takes photo of patient's last notes	feature of mobile ICT	TECHNOLOGY CAPABILITY	FUNCTIONALITY OF MHEALTH ICTs
touchscreen is just a quicker way of doing some things	feature of mobile ICT	TECHNOLOGY CAPABILITY	FUNCTIONALITY OF MHEALTH ICTs
Computers that can handle new technology	processing capabilities	TECHNOLOGY CAPABILITY	FUNCTIONALITY OF MHEALTH ICTs
work group on WhatsApp to communicate about meetings	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
Place request notes to be scanned	means to speed up information availability	COMMUNICATION	MEANS OF COMMUNICATION
use phone to contact someone	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
phone calls X 4	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
WhatsApp X 3	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
To give advice	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
Wait for referral to be taken to specific department	facilitation of referral between departments	COMMUNICATION	MEANS OF COMMUNICATION
interaction with less experienced colleagues	facilitation of communication amongst healthcare professionals	COMMUNICATION	MEANS OF COMMUNICATION
Colleagues outside of the hospital	remote communication	COMMUNICATION	USER LOCATION OF HITs
Reception area	location where HITs is used to support work activity	COMMUNICATION	USER LOCATION OF HITs
Not always near computer	mobility	MOBILITY	USER LOCATION OF HITs
Patients get transferred from the entry point	manage transfer of patient	MOBILITY	USER LOCATION OF HITs
Healthcare worker in the periphery	remote communication	MOBILITY	USER LOCATION OF HITs
Mobile data or Wi-Fi access	Wi-Fi access	INTERNET CONNECTIVITY	ENABLING CONDITIONS FOR WORK ACTIVITIES
provide Wi-Fi that can ensure attention to referrals without the delay	Wi-Fi access	INTERNET CONNECTIVITY	ENABLING CONDITIONS FOR WORK ACTIVITIES
reliable internet connection	availability of adequate network signal	INTERNET CONNECTIVITY	ENABLING CONDITIONS FOR WORK ACTIVITIES
Faster internet	faster internet	INTERNET CONNECTIVITY	ENABLING CONDITIONS FOR WORK ACTIVITIES

How do the technology selection decisions made by the Provincial Department of Health influence the work activities of healthcare professionals in tertiary healthcare?

DESCRIPTIVE CODES	CATEGORIES	sub-THEMES	THEMES
Responsible for IT, knowledge and records management	personnel roles and responsibilities	PERSONNEL PROFILE	

Responsible for all implementation of applications at hospital levels	personnel roles and responsibilities	PERSONNEL PROFILE	
Engage with different service cadres	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
We engage mostly people on the frontline of the services	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Engage clinician	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Review the engagement	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Extract story points	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Story points become specification or application	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Service heads inform the engagement of business analysts	engagement of frontline users	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
What staff require to manage workload	establish the need for HITs	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Provide care services to more patients	establish the need for HITs	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Use of UXD framework	user engagement framework	STAKEHOLDER ENGAGEMENT	HITs SELECTION PROCESS
Implement according to needs of service	service needs consideration	SELECTION OF HITs	HITs SELECTION PROCESS
Procure software solution in existence	procurement of HITs	SELECTION OF HITs	HITs SELECTION PROCESS
IT solutions are procured	procurement of HITs	SELECTION OF HITs	HITs SELECTION PROCESS
procured patient administration system	procurement of HITs	SELECTION OF HITs	HITs SELECTION PROCESS
develop solution in-house	development of HITs	SELECTION OF HITs	HITs SELECTION PROCESS
Determine to develop or procure IT system	development/procurement of HITs	SELECTION OF HITs	HITs SELECTION PROCESS
complexity of billing at hospital level	complexity of work activity	SELECTION OF HITs	HITs SELECTION PROCESS
Simple to develop primary healthcare health information technology	complexity of work activity	SELECTION OF HITs	HITs SELECTION PROCESS
Unable to develop radiology HITs	complexity of work activity	SELECTION OF HITs	HITs SELECTION PROCESS
Unable to develop pharmacy HITs	complexity of work activity	SELECTION OF HITs	HITs SELECTION PROCESS
Procurement is based on specifications that meet service needs	service needs consideration	SELECTION OF HITs	HITs SELECTION PROCESS
IT systems needed to be put in place	service needs consideration	SELECTION OF HITs	HITs SELECTION PROCESS
Moving towards patient interaction	service needs consideration	SELECTION OF HITs	HITs SELECTION PROCESS
Request for patient needs	service needs consideration	SELECTION OF HITs	HITs SELECTION PROCESS
Need to digitise manual systems	factor that influence choice of HITs selection	SELECTION OF HITs	HITs SELECTION PROCESS
Funding issue	factor that influence choice of HITs selection	SELECTION OF HITs	HITs SELECTION PROCESS
Quality of IT to be procured	factor that influence choice of HITs selection	SELECTION OF HITs	HITs SELECTION PROCESS
loopholes exploitation	factor that influence choice of HITs selection	SELECTION OF HITs	HITs SELECTION PROCESS
Document admission, discharge or transfer (ADT)	documentation of process	PURPOSE OF HITs SELECTION	HITs SELECTION PROCESS
Document reason for visit at primary healthcare level	documentation of process	PURPOSE OF HITs SELECTION	HITs SELECTION PROCESS
Application of BI process – extract, transfer, load	processing of patient big data	PURPOSE OF HITs SELECTION	HITs SELECTION PROCESS
Create report	processing of patient big data	PURPOSE OF HITs SELECTION	HITs SELECTION PROCESS
Guided by SITA act	HITs selection governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
Provincial accounting officer system	HITs selection governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
adoption is governed by standards	HITs selection governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
The act governs procurement of software in SA	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
Provides procurement process of any IT	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
PFMA governs procurements of government bodies in SA	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
AOS provides supply-chain rules and regulations and other related matters to procurement	HITs procurement process governed by standards	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
Government regulation on management of public funds	regulation on management of public funds	ROLES OF REGULATIONS/STANDARDS IN HITs SELECTION	HITs SELECTION PROCESS
We are quite advanced	advancement in HITs implementation	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
Significant advancement towards achieving vision and strategy	significant advancement to achieving HITs vision	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
Quite good in governance	good governance to realise HITs vision	PERCEPTION OF HITs SELECTION	HITs SELECTION PROCESS
Applications are implemented at an enterprise level	enterprise level implementation of IS	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Business analysis team	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Don't want to digitise inefficient processes	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Understand work processes as a business analyst	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Get specifications	business analysis of healthcare service delivery process	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Data are stored in a central portal	storage of patient big data	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Pushed to a data warehouse	storage of patient big data	IMPLEMENTATION OF HITs	HITs IMPLEMENTATION
Identifier assigned to every patient	patient identifier on HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
PMI links to all other implemented HITs	patient identifier on HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
PMI used to interoperate data	patient identifier on HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
Cost centre code assigned to different specialities	use of cost centre code	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
Investigate funding associated with care	use of cost centre code	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
Integrates system FBU	integrated HITs	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
Manage services better	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION

See how much resources is allocated	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
Bench mark against other hospitals	purpose of HITs integration	INTEROPERABILITY IN HITs	HITs IMPLEMENTATION
There is an IT vision	vision of HITs	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Strategy accomplished the vision	HITs selection strategy	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
eHealth and mHealth strategies are aligned to the National healthcare 2030 thinking	HITs selection strategy	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Strategy has an implementation plan	HITs strategy implementation plan	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Implementation plan is subdivided into operational plans	HITs implementation operational plan	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Various layers within the organisation	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
There is an operational layer STEERCOM	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
IT exec layer	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Centre of e-Innovation (CEI) responsible for enabling hardware solutions	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
NHISA	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
ICT steering committee (STEERCOM)	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
EPTM	layer of governance to realise HITs vision	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Meet every fortnight to discuss progress	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Deliberate on the progress of projects	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Process of approving HIT projects	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Acts that govern security issues	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Familiarity with relevant acts	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Have own data policies	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Grant access to data	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Have non-disclosure agreement	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Sign non-disclosure agreement to access data	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Proper channels to access data	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Investigate all existing mHealth initiatives	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Aggregating existing mHealth initiative	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Evaluate existing mHealth initiatives	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Avoid duplication of mHealth initiative	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION
Meetings to action a process	role of governance layer	GOVERNANCE OF HITs VISION	LEADERSHIP AND GOVERNANCE OF IT VISION