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TITLE OF THESIS/DISSERTATION

The level of alignment between the use of implemented Health Information Technologies (HITs) and the clinical work activities of nurses in the public hospitals of Cape Town

by

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ABSTRACT

In the healthcare field, technological innovations have been introduced which are referred to as digital health technologies (DHTs). As digital technologies continue to impact the nursing profession on a global scale, nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare sphere.

When considering the lived experiences of using DHTs in practice, the perspectives of nurses have received insufficient attention. Consequently, there is limited information on the experiences of nurses regarding the use of DHTs in healthcare in sub-Saharan Africa (including South Africa) to guide future use thereof, particularly in view of the current influx of ICT into the region.

It is evident that there is a misalignment between the implemented DHTs and the work practices/clinical work practices of nurses as they experience DHTs in the practice (Lammintakanen et al., 2010; While & Dewsbury, 2011; Middleton et al., 2013; Karuri et al., 2013; Limbu, Kongsuwan & Yodchai, 2019; Zaslavsky, Chu & Renn, 2022). This misalignment indicates that there is a substantial gap in engagement between decision-makers and the nursing workforce to the extent that the perceived benefits of the implemented DHTs are not fully realized.

The research questions for this study are: 1) How do nurses experience their work practices influenced by DHTs? This question is based on the lived experience of the nurse who uses DHT in the nursing care process when providing care to patients in a particular situation. 2) Why is there a misalignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice? This question is based on the lived experience of nurses in terms of their involvement in the development and support processes versus the use of DHTs.

The researcher adopted an interpretive stance, and a qualitative phenomenological approach was the most appropriate research method to explore the lived experiences of experienced nurses who are presently using DHTs in practice. In-depth interviews and observation were used to collect data. A thematic analysis was used to organize the data acquired from the participants and the Normalization Process Theory (NPT) served as a theoretical lens to interpret the findings of this study. Purposive sampling was used to identify participants, who included nurses, nurse managers, an operations manager and a member of the clinical engineering department.

The findings of this study indicate the following: While the NPT provides a conceptual framework that explain the processes by which new health technologies and other complex interventions can

be routinely embedded or operationalised into everyday work, and subsequently sustained in practice, the NPT constructs only focus on the implementation of new health technologies, and not on the design and development thereof. Further findings include the fact that DHTs have been fully incorporated/embedded into their daily work activities as patient care is optimised. This is evident from the positive perceptions of nurses to the extent that they cannot do their work without DHTs. This is substantiated by their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill. Further findings indicate that nurses' input is not sought before the introduction of new technologies, they are merely informed via the nurse managers (whose input is also not sought) that the implementation of new technologies is underway. The findings clearly show that nurses' work practices were not considered when DHTs were developed, and as such, training needs do not seem to be a priority, before and after implementation. Although nurses are not involved in the development of DHTs, they nevertheless use these DHTs and are happy with it and the support structures that are available to them.

This study's knowledge contribution is using the theories, lived experience, interpretive phenomenology, and the NPT, as theoretical lenses to guide the data collection and analysis based on the in-situ lived experience of nurses in public hospitals. It contributes the knowledge of using the results of both the interpretive phenomenology analysis and normalized process analysis to gain deeper insights into the lived experiences of nurses using digital health technologies in practice from their introduction to the level of enabling routine work. Although there is existing knowledge about the design-reality gap of health technologies, the contribution is that it has not yet been studied from a lived experience perspective.

This study contributed on a practical level to determine the best practices in the involvement of the nursing workforce in the implementation processes of ICTs in the healthcare field. On a methodological level, the researcher demonstrated the use of theoretical lenses to analyse the data representing the nurses' in-situ lived experiences as informed by the different fields of the study.

Keywords: Nurse, Digital Technologies (DT), Digital Health Technologies (DHT), Nurse Care Process (NCP), Nursing Practice (NP), Lived experience, Situated practice, and Context of care.

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DEDICATION

Dedicated to the memory of my beloved daughter, Nabilah Mohsam. You remain forever in my heart.

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ABBREVIATIONS/ACRONYMS

ABBREVIATION	FULL TERM
CDSS	Clinical Decision Support System
DSS	Decision Support System
eHEALTH	Electronic Health
EHR	Electronic Health Record
EMR	Electronic Medical Record
HECTIS	Hospital Emergency Center Tracking Information System
HIS	Hospital Information System
ICTs	Information and Communication Technologies
mHEALTH	Mobile Health
NIMS	Nursing Information Management System
NPT	Normalisation Process Theory
PACS	Picture Archiving and Communication System
SA	South Africa
SSA	Sub-Saharan Africa
UHC	Universal Health Coverage
WHO	World Health Organisation

KEY TERMINOLOGIES

Nurse: A licenced professional who provides patient-centric services including teaching, planning care, administering medications, performing treatments, and delegating tasks in a variety of healthcare settings (Eley et al., 2009; Cohen, Coleman & Kangethe, 2015).

Digital Health: The general use of information and communications technologies (ICT) for health and is inclusive of both mHealth and eHealth (WHO, 2016:viii). Digital health technologies refer to a a wide range of technologies that include personal wearable devices, internal devices, and also include sensors that are used in people, homes, cars and communities.

Digital Technologies: Digital technologies comprise a wide range of technologies, such as communication support, decision support, electronic health records (EHR)/electronic medical records (EMR), hospital (or care institution) information systems (HIS), specific software applications/apps, telecare, process planning/data exchange and target-specific interfaces, include personal wearable devices, internal devices, and also include sensors that are used in people, homes, cars and communities, Personal Digital Assistant (PDAs) . (Kowatsch *et al.* 2019).

Digital Health Interventions: Refers to the different ways in which digital and mobile technologies are being used as a means to support health system needs (WHO, 2018).

Nurse Care Process (NCP): Refers to systematic and dynamic way to deliver nursing care, operating through five interrelated steps or phases, namely, assessment, diagnosis, planning, implementation and evaluation (Pokorski *et al.*(2009:303).

Nursing Practice (NP): A caring-based practice, which applies processes of diagnosis and treatment to human experiences and illness. As nursing practices are care-based and executed by nursing processes, it is a problem-solving process. Pope *et al.*(1995)

Lived experience: Lived experience refers to "…the meaningful ways in which things are experienced, made sense of, and enacted in everyday life" (Berglund, 2004).

Situated practice: Nursing is caring situated in space, place, and time (Jarrin ,2012:4). In other words, caring is dependent upon where you are (meaning the time, space and culture, and also the level of development of the individual)

CHAPTER 1: RESEARCH ORIENTATION

1.1 Introduction

In the healthcare field, technology innovations have been introduced which are referred to as digital health technologies (DHTs). Over the last three decades, the use of DHTs, especially for data collection, processing and management is developing, having impacted the healthcare environment since the early 1980s. Several information and communication technology (ICT) systems are used in healthcare organisations to serve physicians and other healthcare professionals in their daily work with patient treatment services. These systems describe a broad range of applications, from the widely used computerised physician order entry (CPOE) systems to modern speech recognition technologies and mobile applications, diagnostic and imaging, clinician decision support and electronic prescribing technologies, a variety of patient monitoring systems using sensor network technology, and electronic health records (EHR) (Kuo, Liu & Ma, 2013; Ahlan & Ahmad, 2014; Cohen, Coleman & Abrahams, 2015; Huter, Krick, Domhoff, Seibert, Wolf-Ostermann & Rothgang, 2020; Tsegaye & Flowerday, 2021).

Digital health, or the use of digital technologies for health, has become a prominent field of practice when it comes to employing routine and innovative forms of information and communications technology (ICT) to address health needs. Rooted in e-Health, the term *digital health* is defined as “the use of information and communications technology in support of health and health-related fields” (WHO 2019: iv). *Mobile health* (mHealth), a subset of eHealth, is defined as “the use of mobile wireless technologies for health” (WHO, 2019:iv). More recently, the term *digital health* was introduced as “a broad umbrella term encompassing eHealth (which includes mHealth), as well as emerging areas, such as the use of advanced computing sciences in ‘big data’, genomics and artificial intelligence” (WHO, 2019:iv).

The World Health Assembly Resolution on Digital Health unanimously approved by WHO Member States in May 2018 demonstrated a collective recognition of the value of digital technologies to contribute to advancing universal health coverage (UHC) and other health aims of the Sustainable Development Goals (SDGs) (WHO, 2019).

Digital technologies provide concrete opportunities to tackle health system challenges, and thereby offer the potential to enhance the coverage and quality of health practices and services.

Digital health interventions may be used, for example, to facilitate targeted communications to individuals to generate demand and broaden contact coverage. Digital health interventions may also be targeted to health workers to give them more immediate access to clinical protocols through, for example, decision-support mechanisms or telemedicine consultations with other health workers.

The term *digital health interventions* (DHIs) refers to the different ways in which digital and mobile technologies are being used as a means to support health system needs (WHO, 2018). Digital health interventions may also be geared towards health workers to provide them with more immediate access to clinical protocols, for example, by means of decision-support mechanisms or telemedicine consultations with other health workers. Therefore, given the variety of ways in which digital technologies can be used to support the needs of health systems, these technologies continue to evolve as a result of their intrinsically dynamic nature of the field (WHO: 2019).

Whilst digital health has the potential to help address problems such as distance and access, it nonetheless still faces many underlying challenges faced by health system interventions in general. These include poor management, lack of training, limitations in terms of infrastructure, and poor access to equipment and supplies. As such, it is imperative for these considerations to be addressed in addition to the explicit implementation requirements introduced by digital health (WHO, 2019).

Multiple studies have shown that implemented DHTs are important and the general consensus within and across the scientific research space is that they have the potential to improve patient safety, quality of care and reduce the cost of healthcare (Hillestad, Bigelow, Bower, Gisori Meili, Scoville & Taylor, 2005; Rao, Desrosches, Donelan, Campbell, Miralles & Jha, 2011; Piscotty, Kalisch & Gracey-Thomas, 2015; Krick *et al.*, 2019; Booth, Strudwick, McBride, O'Connor & López, 2021).

Whilst the benefits of DHTs have been empirically proven, usability problems, often encountered with usage, can be frustrating to both healthcare professionals and patients compared to other industries. In addition, the healthcare industry is confirmed to lag behind in realising the potentials of adopting a technology (Cresswell & Sheikh, 2013; Cresswell, 2014). A number of challenges seem to recurrently hamper the effective use of DHTs, especially in the context of this study –

Cape Town, South Africa. The implementation and use of DHTs have particularly been below par given that an e-Health strategy has been developed since 2012.

The end-users, especially healthcare professionals, are the eventual champions of DHTs adoption processes, since technology is irrelevant without end-users (Rippen, Pan, Russell, Byrne & Swift, 2013). By champions, it means they are the ultimate deciding influence to a successful (or failed) implementation process (Mammen & Weeks, 2014; Martikainen, Kaipiob & Lääveri, 2020). Adoption in this regard refers to the processes leading up to the acceptance and implementation to incorporate DHT applications into everyday practice (Cresswell & Sheikh, 2013). However, the focus of this investigation is '*Use*' especially by the nurses. A successful adoption of DHTs is particularly important for nurses because they are the largest single discipline within the public healthcare setting, and their acceptance of DHTs is essential to the success of any healthcare initiative (Kelley, Brandon & Docherty, 2011; Mutala, 2015; Matakainen *et al.,* 2020).

1.2 Background to problem statement

As the proliferation of ICTs has taken over healthcare organisations globally, information sharing and retrieval have become easier, with greater reliance on computers. Nurses, therefore, are not exempted and easy and quick access to information is crucial for effective nursing today (Ericksen, 2009; Cornell & Herrin-Griffith, 2010; Asah, 2013). An important aspect of nursing and the nursing process is the management of patient information since the timeous exchange of relevant information of a patient is essential to ensure quality of care. Critical patient information is conveyed in a variety of forms, for example through the electronic health record, healthcare decision support systems, referral co-ordination, prescription and medication management, laboratory and diagnosis management. As proficiency in the use of DHTs is thus essential in today's nursing care, the advantages of using DHTs in the nursing profession are limitless. It is therefore essential for nurses to improve their competencies (Eley, Fallon, Soar, Buikstra & Hegney, 2008; While & Drewsbury, 2011). Nurses must continuously utilise technology as a means to access and manage records, and to provide care via electronic means such as e-medicine and telehealth platforms. These digital technologies provide a significant opportunity to improve, enhance and transform healthcare (Brown, Pope, Bosco, Mason & Morgan, 2020). However, to take advantage of these opportunities, nurses need to be competent; in other words,

they need to possess the requisite knowledge, skills and resources to make use of technology and integrate it into their daily working activities.

Therefore, owing to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work processes. Hence, nurses' acceptance of DHTs and their lived experiences play a significant role in the public healthcare institutions. However, scientific research that adequately explores lived experiences of nurses using DHTs is limited, especially in the context of this investigation – Cape Town, South Africa.

The involvement of healthcare stakeholders in the planning design and implementation of digital systems is imperative; however, this is not always done. Bernstein, McCreless and Coté, in their study on the five constraints of information technology adoption in healthcare, cite the importance of involvement of end-users in the adoption of new IT. The authors opine that development and evaluation of new technology often take place from an organisational perspective. In other words, instead of focusing on individual users' needs and preferences, the focus is on how organisational processes and activities are supported by technology. Whilst the organisation may initiate and fund the implementation of an IT project, it is the end-user who will eventually use the technology in the performance of his or her job (Bernstein *et al*., 2007).

Similarly, Kent, Redley, Wickramasinhe, Nguyen, Taylor, Moghimi and Botti (2015) state that technology which is capable of supporting nursing practice and nursing workflow could greatly improve care delivery and patient safety and outcomes. However, the authors caution that, for this to succeed, early contribution and buy-in from nurse end-users is required. This emphasises the importance of the involvement of nurses as end-users in the implementation and evaluation of new IT services and applications. More recently, Matakainen *et al.* (2020) emphasise the importance of involving end-users in the development of digital health technologies. This view is supported by Seibert, Domhoff, Huter, Krick, Rothgang and Wolf-Ostermann (2020) and Mather, Cummings and Gale (2019) who stress the importance of involvement of healthcare stakeholders in the planning, design and implementation of digital systems. Failure to involve them will culminate in healthcare workers not being fully satisfied with the technologies after implementation, because their needs have not been met (WHO, 2019). Bass and Heeks (2011) refer to the design-reality gap model which is based on the premise that there are specific assumptions and requirements built into the design of any organizational change, and as such,

the expectations that emanate therefrom may either match or mismatch the reality after implementation, resulting in a gap between design and reality.

Digital technologies continue to impact the nursing profession on a global scale, and as a result, nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare sphere. Booth *et al.* (2021) highlight a number of benefits to nursing practice as a result of digital technologies: 1) telehealth programmes which enable nurses to perform daily monitoring, coaching, and triage of patients with several chronic diseases have helped reduce emergency department admissions; 2) mobile devices such as smartphones and health applications make it possible for nurses to offer remote advice on pain management to adolescent patients with cancer and supplement aspects of nursing education by providing innovative pedagogical solutions for content delivery and remote learning opportunities.

Against this backdrop, Eley *et al.* stress the importance of policy makers, administrators and managers working together with nurses to ensure that access to technologies which support good practice, as well as the work activities of nurses, is not compromised by practices that do not take into consideration the needs of nurses and their patients (Eley *et al.*, 2009). Moreover, a lack of inclusion of nurses not only negatively impacts the quality of care that patients receive, but also the overall efficiency of the healthcare system (Ludwick & Douchette, 2009; Boonstra & Broekhuis, 2010; Mather *et al.* 2019). Therefore, failure to include nurses in the design and development of new technologies will not only negatively impact the quality of care that patients receive, but it also impact on the morale of nurses.

A study conducted by Yusif, Hafeez-Baig and Soar (2020) offers valuable insight into improving circumstances under which health information technology is adopted. In an effort to promote change management and stakeholder engagement, and to avoid the design-reality gap, these guidelines, when effectually carried out, could be very useful in avoiding losses on large investments, effort, time, delay and more importantly, dissatisfaction among stakeholders. Some of these guidelines include the following: 1) Stakeholders Involvement in Selecting e-Health Systems/Technologies Promote Change; 2) The Need for Evidence of Past Successes with Instituting HIT-Related Initiatives; 3) Top Management Support and Availability of Change Leaders Promote Change Management; 4) Identification of Internal/External Champions to Promote the Implementation of HIT Systems; 5) Availability of System Implementation Plan with Clear Anticipated Changes; 6) Technology, System Implementation and Quality Assurance; 7)

Lacking Skilled Health Informaticians Impede System Implementation Success (Yusif *et al.,* 2020).

Given the above statements, it would seem that the Western Cape Department of Health (DoH) and implementers have given little to no consideration, either before or even after the implementation processes, to adequately seek input from the potential end-users of DHTs.

1.3 Problem statement

When considering the lived experiences of using DHTs in practice, the perspectives of nurses have received insufficient attention (Eley *et al.,* 2009; Wright, Yogeswaran & Govere, 2012; Gartrell, Storr, Trinkoff, Wilson & Gurses, 2015; Colligan, Potts, Finn & Sinkin, 2015; De Leeuw, Woltjer & Kool, 2020; Frechette, Bitzas, Aubry, Kilpatrick & Lavoie-Tremblay, 2020; Upadhyay & Hu, 2022). Consequently, there is limited information on the experiences of nurses regarding the use of DHTs in healthcare in Sub-Saharan Africa (including South Africa) to guide future use thereof, particularly in view of the current influx of ICT into the region (Akanbi, Ocheke, Agaba, Daniyam, Agaba, Okeke & Ukoli, 2014; Manyati & Mutsau, 2021). With little or no information with regards to acceptability and usability of DHTs from nurses (the dominant group of end-users in a clinical setting), research is needed to begin to fill this gap in knowledge.

It is evident that there is a misalignment between the implemented DHTs and the work practices/clinical work practices of nurses as they experience DHTs in practice (Lammintakanen *et al.*, 2010; While & Dewsbury, 2011; Middleton *et al.*, 2013; Karuri *et al.*, 2013; Limbu, Kongsuwan & Yodchai, 2019; Zaslavsky, Chu & Renn, 2022). This misalignment indicates a substantial gap in engagement between decision-makers and the nursing workforce to the extent that the perceived benefits of the implemented DHTs are not fully realised. The intention to improve processes are rarely met, particularly since nurses are the largest single workforce in the health sector (Mcbride, Delaney & Tietze, 2012; Cline & Luiz, 2013; Maher *et al.,* 2019). Nicollini aptly notes that, during the design process of technology, designers devise a scenario in terms of how a system is to be used. This scenario is then inscribed into the system, and as a result, the system is built, based on this scenario, which includes programmes of actions for the users as well as roles to be played by the users and the system. The designers, therefore, assume explicitly as well as implicitly, which competencies are required by the end-users. However, the patterns of use that were inscribed into the system by the designers only come to life in when the technology is used daily by its intended users. This may result in the technology interacting in complex ways with the existing work practices of end-users, often having a negative impact thereon. This

indicates a misalignment between the intended use of technology and existing practices (Nicollini, 2005). To combat this, Brown *et al.* (2020), when examining the factors influencing nurses' capacity and skills to use digital technology at work, have recommended the involvement of nursing staff in the process of developing technology and prioritising continuous education for nurses in an effort to increase their proficiency. Furthermore, the authors stress that involving senior nurses in the development of new technology, coupled with orientation of staff will go a long way towards capacity building and the successful implementation of digital technology in nursing care, which could enhance the nurses' user experiences.

In general, two opposite implementation approaches can be distinguished: (1) top-down and (2) bottom-up strategies (Haycock-Stuart & Kean, 2013). The common practices within a top-down approach is for policies to be set at government level, with the government setting the priorities and nurses being the users (Richte, Mill, Muller, Kahwa, Etowa, Dawkins & Hepburn, 2013; Shariff, 2014). In contrast, bottom-up approach advocates a more participatory approach, with a key factor in these processes being the incorporation of user participation (Ruxwana, Herselman, Pottas & Ouma, 2010). Whilst it is acknowledged that systems implementation is a top-down approach, this study is aims to only focus on the use of DHTs by nurses, and not on how it came into existence. The study is, therefore, delineated to exclude the top-down approach. In the ensuing section, the research aim, research questions and sub-questions will be presented.

1.4 Research orientation

The fields that inform this study are considered next. The focus is on the development and use of digital health technologies and therefore the study draws from the related field of information communication technologies (ICT). The domain for the study is in healthcare and specifically, nurses care practices in hospitals and therefore the inclusion of Health Sciences. The focus is on the lived experiences of nurses using digital health technologies in their nursing practices in real-life situations. The field of social and behavioural sciences provides the theoretical lenses used in this study to investigate the behaviour in the form of lived experiences of the nurses in practice. The intersection between the fields of health sciences and ICT refers specifically to ICT in healthcare as digital health technologies (DHT). The intersection between health, social and behavioural sciences refers to the practices of routine work in the domain of healthcare, i.e., nursing practices (NP). The intersection between social and behavioural sciences and ICT refers to the implementation and use of ICT in practice to establish how humans make sense of their enabling abilities as part of their work. The intersection between all three fields of study represents

the focus of this study, i.e., the lived experiences of nurses taking care of patients using digital health technologies in a healthcare setting, namely a hospital in this case.

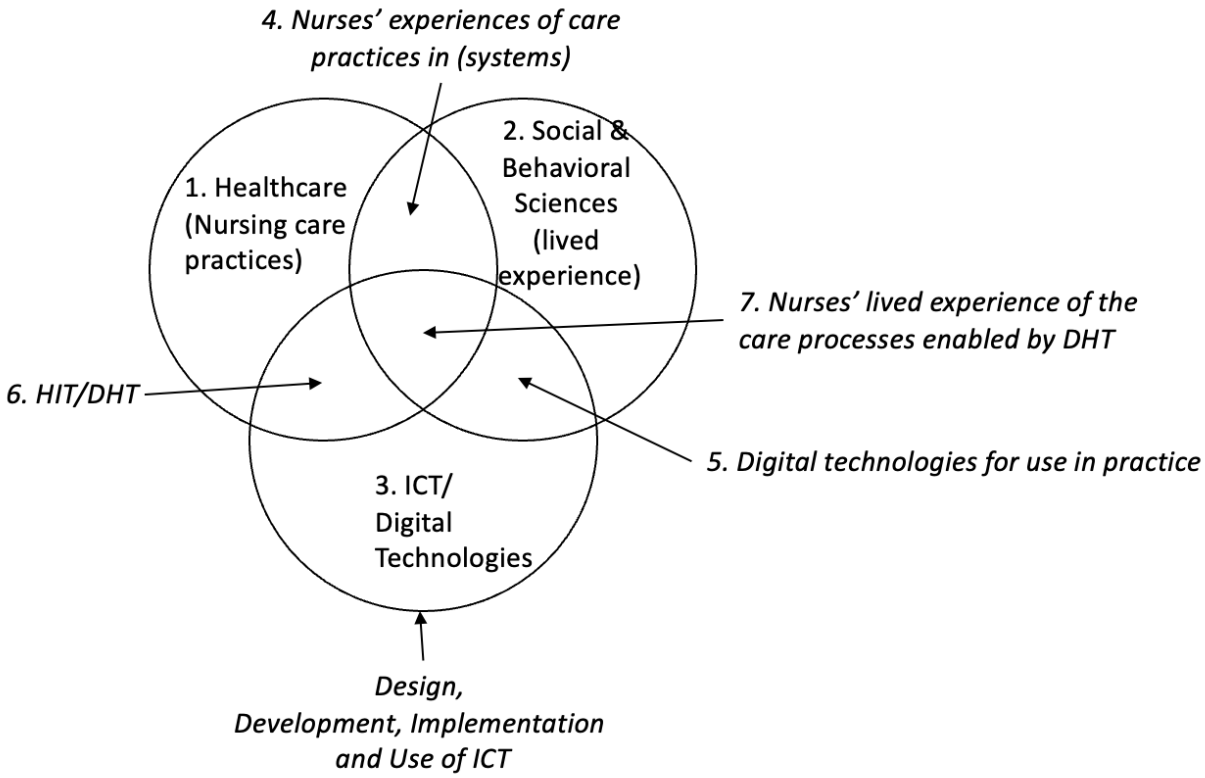


Figure 1: Research orientation

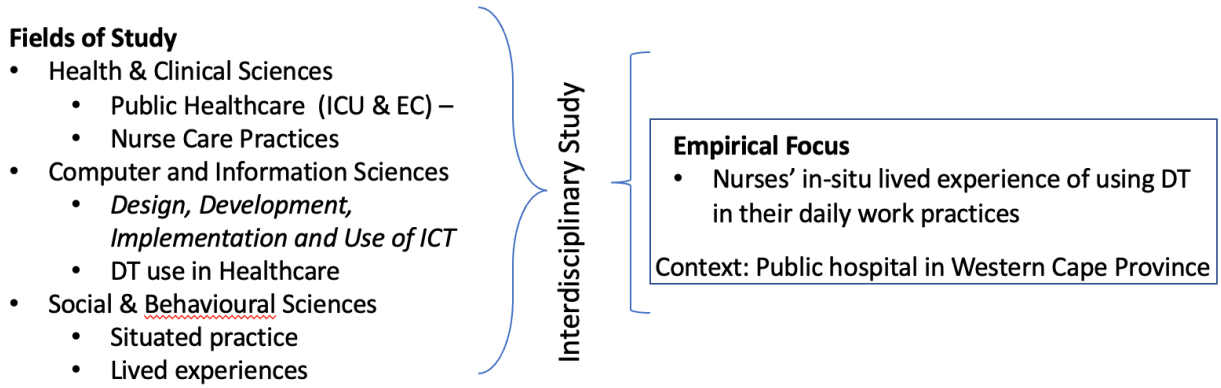


Figure 2: Fields that inform the study

The keywords that are used to review the related literature are as follows: nurse, digital technologies (DT), digital health technologies (DHT), nurse care process (NCP), nursing practice (NP), lived experience, situated practice and context of care.

Next, the research questions that will address the identified research gap of the research problem orientated to the applicable fields are discussed.

1.5 Research questions

1.5.1 Research question 1 (RQ 1)

How do nurses experience their work practices influenced by DHTs? This question is based on the lived experience of the nurse who uses DHTs in the nursing care process when providing care to patients in a particular situation.

1.5.1.1 Sub-research question 1.1 (SRQ 1.1)

How are DHTs incorporated into nurses' work activities?

1.5.1.2 Sub-research question 1.2 (SRQ 1.2)

For what purposes are DHTs used by nurses?

1.5.1.3 Sub-research question 1.3 (SRQ 1.3)

What are the perceptions and experiences of nurses in the use of DHTs?

1.5.2 Research question 2 (RQ 2)

Why is there a misalignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice? This question is based on the lived experience of nurses in terms of their involvement in the development and support processes versus the use of DHTs.

1.5.2.1 Sub-research question 2.1 (SRQ 2.1)

What was the level of involvement of nurses in the design, development and implementation process of DHTs?

1.5.2.2 Sub-research question 2.2 (SRQ 2.2)

How were nurses' work practices, as part of their lived experiences, considered during the design and implementation of DHTs?

1.5.2.3 Sub-research question 2.3 (SRQ 2.3)

What are the dynamic elements of the DHT-integrated work practices of nurses that contribute to the design-reality gap between implemented DHTs and the nurses' lived experience of using DHTs?

1.6 Aim of study

The aim of this qualitative study was to understand, analyse and assess nurses' lived experiences of using DHTs as part of their work practices to better guide DHT design and implementation and offer additional insights to the body of scientific knowledge to optimise the use of DHTs in public healthcare institutions in South Africa. The anticipated outcome will be the best practices in involvement of the nursing workforce in the implementation processes of DHTs.

1.7 Objectives of study

The objectives of the research were the following:

- To ascertain how nurses make sense of the work practices as DHTs influence their daily work activities; and
- To analyse and examine the misalignment between the intended use of DHTs and the lived experiences of nurses.

1.8 Research methodology

The aim of this qualitative study was to understand, analyse and assess the nurses' lived experience of using DHTs as part of their work practices to better guide DHT design and implementation and offer additional insights to the body of scientific knowledge to optimise the use of DHTs in public healthcare institutions in South Africa.

Since this study was of a qualitative nature that largely depended on the subjective views, opinions and even sometimes, the culture of individuals (social actors) associated with the phenomenon of study, an interpretivist stance was adopted. This research project thus adopted a qualitative approach since the researcher studied human action from the perspective of the social actors (nurses and administrators) in their natural setting (hospital). As this research study is qualitative in nature, interpretative phenomenology was an ideal methodology to use, particularly since the study focused on how individuals make sense of DHTs used as part of their

daily work activities. An interpretive study of nurses as end-users of DHTs has yielded important information about barriers, frustrations, needs and preferences of nursing staff. Interpretive research with qualitative interviews was considered the most appropriate starting point, as it has provided access to the nurses' subjective perceptions of DHTs. The data gained from the study was also useful in determining nurse users' specific needs and their preferences for modifications to the DHTs being used.

The researcher chose the normalisation process theory (NPT) as an analytical lens to analyse data gathered through the semi-structured interviews. The NPT has played a significant role in this qualitative research project as it has assisted in the research design, sampling and data collection. Furthermore, it has helped to inform, guide and structure the research focus and questions. Each construct was used to answer the main research questions and interpret the subsequent findings of this study.

For this study, the major data collection method associated with an interpretive phenomenological study was in-depth interviews and observation. As a result, the study used in-depth interviews and observation to engage the selected participants and to collect data. Through the interviews, the researcher was able to obtain a large volume of subjective data, which was then interpreted to gather in-depth information as understood and interpreted from the participants' points of view. In addition to interviews, observations supplemented primary gathered from interviews.

Since the data collection method for this study was qualitative in nature, the researcher made use of non-probability sampling, via purposeful sampling, to identify and select end-users who actively use DHTs as part of their daily work activities. This technique assisted the researcher in identifying a sample size that would provide in-depth information which are aligned to the research objectives of this study.

The target population for this study consisted of nurses, nurse managers/operations manager, as well as a representative of the Chemical Engineering Department who were involved in the design and implementation process of DHTs and participated in this study.

Two hospitals (one tertiary hospital and one district hospital) in the Western Cape were for the selection of participants and data collection. A total of 28 participants (14 from Hospital A, and 8 from Hospital B) were purposefully selected and interviewed until saturation was reached.

As this study was interpretive and qualitative in nature, pattern matching and explanation building were identified to be the most suitable methods of analysing the vast amount of data that was

collected through the in-depth interviews with nurses, nurse managers and other stakeholders at the public hospitals. In addition, the researcher used the NPT to organise data according to the constructs of the theory. In doing to, researcher also allowed for more themes to emerge that may not be covered by the NPT, which could provide important insights. For the purpose of this study, thematic analysis was used to organise the data acquired from the participants. The unit of analysis is the nurses' lived experience of using DHTs as part of their work practices. The unit of observation is the use of technology, or in other words, how nurses make sense of their interaction with DHTs as part of their work practices.

1.9 Ethics

Ethical issues were considered throughout the course of this research project. Ethical clearance was obtained from the CPUT Faculty of Health and Wellness Ethics Committee, as well as from the CPUT Faculty of Informatics and Design Ethics Committee. Thereafter, permissions were obtained from the Western Cape Department of Health to conduct the research within the selected tertiary and district hospitals. Participants' views were respected and participants were given an option not to respond if they so choose. All personal data of participants gathered during the research, as well as their responses, were treated as confidential. Anonymity of the participants was ensured as data was anonymised when coded. Information gathered was protected and was only available to the researcher. It was made clear to participants that they were under no obligation to participate and may choose to withdraw from the study or refuse to answer any questions at any time, without suffering any consequences. On withdrawal, any data that had been gathered would be destroyed.

1.10 Delineation

This study is limited to only tertiary public hospitals as well as district hospitals in the Western Cape Province. While the results of this study may be typical for hospitals in a similar geographic area, they may not be indicative of the practical challenges experienced in other public hospitals with a different type of governance in other parts of South Africa. The demographics and cultural backgrounds, as well of the extent to which digital health technologies have been implemented may vary in other locations. Also, the study investigated the use of and how implemented DHTs can be embedded in the existing routine clinical practices of nurses and not the process of adoption of the systems per se.

1.11 Main findings

An important finding is that, whilst the NPT provides a conceptual framework that explain the processes whereby new health technologies and other complex interventions can be routinely embedded or operationalised into every day work, and subsequently sustained in practice, the NPT constructs only focus on the implementation of new health technologies, and not on the design and development thereof. The NPT does therefore not make provision for the design and development of complex interventions.

The theme, decision-making, when mapped to the constructs of the NPT, could only be linked to the construct, Collective Action. This construct served to ascertain whether DHTs promote or impede the work of nurses, whether it is compatible with work practices and the impact thereof on the division of labour. In particular, it relates to the sub-construct of skill set workability, which refers to the degree in which the technology fits into existing work practices, skill sets and the nurses perceived work role. However, the construct does not explicitly focus on the decision-making aspect of a nurse's job.

The theme, DHT use, could be mapped to all four NPT constructs. This is significant because key findings from the data confirm consensus amongst the participants regarding the benefits of using DHTs as part of nurses' daily work activities.

A notable finding is that two themes, namely DHT Development and Support and training, could only be mapped to one theoretical theme. This would indicate a clear gap with the DHT development and support where the nurses were not involved in the development that resulted in access and use issues where the implemented DHT is not well-aligned to the design and development. As a result, nurses end up with technologies that are not aligned to their work practices, and they are not afforded an opportunity or avenue to appraise these technologies or provide input on how it can be enhanced once these technologies are implemented.

1.12 Conclusion

In Chapter 1, the researcher introduced the healthcare context in which the study was performed and the background to the research problem. As digital technologies continue to permeate the nursing profession on a global scale, nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare sphere. However, the perceived misalignment between the implemented DHTs and the work practices/clinical work practices of nurses as they experience DHTs in practice is problematic and points to a substantial

gap in engagement between decision-makers and the nursing workforce to the extent that the perceived benefits of the implemented DHTs are not fully realised.

The overall objective of this study was to ascertain how nurses make sense of the work practices as DHTs influence their daily work activities and to analyse and examine the misalignment between the intended use of DHTs and the lived experiences of nurses.

The researcher adopted an interpretive stance to answer the research questions. Chapter 2 provides an in-depth review of scientific literature on the concepts relevant to addressing the research problem within the context of this study.

1.13 Contribution

Despite the numerous benefits associated with the use of information and communication technologies (ICTs) and the potential to improve patient care and safety, there are recurring use challenges. This study contributed on a practical level to determine the best practices in the involvement of the nursing workforce in the implementation processes of ICTs in the healthcare field. Also, it added further insights on how to approach health information technology (DHTs) implementation and its use by the nurse workforce which is the largest unit in a healthcare organisation. This may have a positive influence on the frequency of DHTs use in public hospitals in the country. On a methodological level, the researcher demonstrated the use of theoretical lenses to analyse the data representing the nurses in-situ lived experiences as informed by the different fields of the study.

1.14 Summary

In this chapter, the researcher outlined the healthcare context in which this study was conducted and the background to the research problem. As digital technologies continue to proliferate the healthcare sector, nurses are using these as part of the work practices.

As the single largest workforce in healthcare, nurses play an important role in improving the quality of care. The proliferation of ICTs has resulted in greater reliance on digital technologies in the healthcare sector and as a result, it is imperative for nurses to be proficient in the use of DHTs as part of their daily work activities.

Although the literature stress the importance of involving nurses in the design and development process of new technologies, it is evident that this is not the case and raises concern.

Consequently, nurses end up with poorly designed technologies that do not meet their expectations.

The lived experiences of nurses using DHTs appear to be understudied; there is limited information on the experiences of nurses regarding the use of DHTs in healthcare in sub-Saharan Africa. This study, therefore, aims to understand, analyse and assess the nurses' lived experiences of using DHTs as part of their work practices.

In Chapter 2, 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.

1.14.1 Chapter layout

The structure of this chapter is as follows:

Chapter 1: This chapter introduces the study, and the researcher briefly explains the background to the research problem and the rationale for conducting 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. Thereafter, the delineation and intended contributions of the study, the outline of the thesis and a conclusion are presented.

Chapter 2: This chapter presents a systematic review of the literature, and provides an overview healthcare in the global, sub-Saharan and South African context, with particular reference to the Western Cape, where the study is conducted. The chapter further focuses on the role of nursing in healthcare, with sub-sections that describe the nursing process, nursing practice, nursing in hospitals and nurses and technology. The chapter concludes with an overview of digital technologies and how these technologies support healthcare, with sub-sections describing the different types of digital technologies, their uses and pertinent issues, DHT use and factors impacting the design, development and implementation of DHTs.

Chapter 3: In this chapter, the researcher presents her philosophical stance which 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. The theoretical lens through which data are analysed, namely the normalisation process theory, is discussed in this chapter. The chapter further elaborates on data collection, data analysis, data management and ethical considerations for this study. The chapter concludes with the delineation of the study and researcher's contribution to the study.

Chapter 4: In this chapter, the practical part of the research is presented in terms of how the research was conducted in practice. It outlines the background to the case, where the research was conducted, the duration and the parties involved in the process. The researcher describes how she collected the data and how data were recorded, transcribed and stored. In this chapter, the researcher also describes how data were analysed, as well as the coding and analysis process.

Chapter 5: In this chapter, the researcher introduces the discussion on the findings and presents a summary of the results of the NPT analysis as well as the thematic analysis. Furthermore, the researcher demonstrates how the results are mapped to the conceptual framework.

Chapter 6: In this concluding chapter, the researcher presents an overview of the research conducted. The research questions are revisited. The chapter concludes with recommendations based on the research findings, and also includes contributions to, and reflections on, the research process.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to the literature review

This dissertation's underlying goal was to capture nurses' lived experience as they experience digital health technologies (DHTs) in practice. Chapter 1 provided a general overview of emerging information technologies and the challenges this holds for nurses as the largest group of in-hospital healthcare providers.

In this literature review chapter, the researcher focuses on the concepts of healthcare services, the digital health technologies (DHTs) utilised in the provision of healthcare, and the nurses' experiences as they use these technologies as part of their daily work activities.

This chapter provides an expanded overview of emerging DHTs, how they impact nurses' daily work activities as well as current findings surrounding technology and nursing. There are a few scientific studies on the perceptions and post-implementation use of DHTs by nurses (DeVoe *et al.*, 2009; Juliet & Sudha, 2013; Govranos & Newton, 2014; Holden *et al.,* 2016; Molina-Mula & Gallo-Estrada, 2020). Whilst these studies have provided scientific information on the phenomenon of study, qualitative research pertaining to nurses' lived experiences with DHTs appears understudied. The more important questions pertaining to the use challenges they face during and post-implementation, and how they adapt to the transition from paper/manual-based systems to electronic systems need to be qualitatively captured and analysed, especially in the context of this study. In essence, further research needs to be conducted to verify how DHTs can be utilised optimally to assist nurses to optimise their work practices, hence this current study.

The World Health Assembly Resolution on Digital Health unanimously approved by WHO Member States in May 2018 demonstrated a collective recognition of the value of digital technologies to contribute to advancing universal health coverage (UHC) and other health aims of the Sustainable Development Goals (SDGs) (WHO, 2019).

The term *digital health intervention* (DHI) refers to the different ways in which digital and mobile technologies are being used as a means to support health system needs (WHO, 2018). Digital health interventions may also be geared towards health workers to provide them with more immediate access to clinical protocols, for example, by means of decision-support mechanisms or telemedicine consultations with other health workers. Therefore, given the variety of ways in which digital technologies can be used to support the needs of health systems, these technologies continue to evolve as a result of their intrinsically dynamic nature in the field (WHO, 2019).

Whilst digital health has the potential to help address problems such as distance and access, it nonetheless still faces many underlying challenges faced by health system interventions in general. This would include poor management, lack of training, limitations in terms of infrastructure, and poor access to equipment and supplies. As such, it is imperative for these considerations to be addressed in addition to the explicit implementation requirements introduced by digital health (WHO, 2019).

The aim of this qualitative study was to understand, analyse and assess the nurses' lived experience of using DHTs as part of their work practices as experienced by nurses, nurse managers and operations manager at a tertiary and district hospital in the Western Cape. This chapter is structured as follows: The introduction and a discussion on the literature review process are covered in section 2.1, followed by a discussion on healthcare in context, focusing on the status of healthcare globally, sub-Saharan Africa, South Africa, and lastly healthcare in the Western Cape Province, which is the focus of this study. Section 2.3 will focus on nursing, and will include a discussion on the nursing process, nursing practice, nursing in hospitals and nurses and technology. Sections 2.4 and 2.5 focuses on digital technologies, whilst section 2.6 introduces the proposed conceptual framework. The chapter will be concluded with section 2.6.

Juntunen and Lehenkari (2021) posit that the literature review forms the foundation for all academic research. The authors characterise the systematic literature review process as having a particular categorisation of actions to be concluded to reach the goal. According to Juntunen and Lehenkari, a narrative literature review process is iterative, not structured, and consists of multiple layers culminating in several written outcomes.

A literature review involves preliminary searching, reading, and a continuous evaluation of the relevant background of an investigation in an effort to advance knowledge (Webster & Watson, 2002). Once the research area and research topic were identified for this study, a comprehensive search of the literature was conducted to find existing studies related to the researcher's topic. When searching the literature, it is important to note that articles found in scholarly journals form the fundamental basis of the literature review. These journals can be found via online databases using specific terms and keywords as they pertains to the study. A number of searches were thus conducted on the various online journal databases subscribed to by the researcher‘s institution of learning. These include online databases, such as EBSCO Publishing, ProQuest, Web of Science, Springer, Elserivier and Google Scholar. Key words such as "digital health technology", "nurses' perceptions in using DHTs", "healthcare in sub-Saharan Africa", "healthcare in South

Africa" were used to query electronic databases. Access to peer-reviewed publications provided the researcher with the opportunity to read and obtain insights into the research area.

According to Webster and Watson (2002), the use of other scholarly publications and conference papers they may also be vital in a literature review to describe what is known about the topic. As a result, during the search process, whilst the researcher primarily made use of electronic and online sources throughout the course of this study, a few printed books related to research methodology and information systems were also used.

2.2 Healthcare in context

As good health is imperative for prosperity and essential for the overall well-being and development of a nation and therefore, it cannot be denied that the health of a population is any nation's greatest asset. However, there are numerous factors that can impact an individual's ability to access healthcare globally, including economic, social and geographical barriers. It is thus important to ensure equitable access to healthcare with the aim of reducing health inequalities and improving the population's health (Orzechowski *et al.,* 2020).

Existing literature suggests a substantial gap in healthcare between Africa and the rest of the world. Global healthcare research suggests that current healthcare systems in first-world countries have highly skilled medical professionals and better technology which provides the potential for extraordinary improvements to the healthcare systems (Hejduková & Kureková, 2016). Furthermore, existing literature indicates that sub-Saharan Africa is known to have substantially weak healthcare systems, the extent of which is largely unknown (Awoke *et al.,* 2017); Mills (2014), in his review of healthcare systems in low and middle-income countries, has highlighted the weaknesses of healthcare systems in these countries. These weaknesses can be attributed to various factors, most notably a shortage of suitably qualified staff, particularly at the primary care level, low salaries, lack of equipment and infrastructure, including poor accessibility of health services, weak and overly centralised systems for planning and management, bureaucracy (e.g., civil service rules and remuneration, centralised management systems), governance and overall policy framework (e.g., corruption, weak government, weak rule of law and enforceability of contracts, political instability and insecurity), fragmented governance and management structures for global health, and doctors and nurses emigrating to high-income countries. The ensuing section will focus on the status of healthcare on a global scale.

2.2.1 Healthcare globally {the role of context in healthcare, advanced vs African vs SA – private/public; levels}

It is generally acknowledged that foreign debt is an important source of government revenue for developed as well as developing (middle to low-income) countries such as the United Kingdom and the United States. However, in contrast with developing (middle to lower-income) countries, which are less stable, developed countries such as the US and the UK are better equipped to raise larger amounts via domestic debt. Furthermore, other factors such as inflation rates, underdeveloped infrastructure, and insufficient capital are factors that impact developing countries' abilities to raise revenue through domestic debt. Also, compared to developed countries, with foreign debt borrowing in developing countries, investors are more willing to offer shorter-term debt, resulting in foreign debt becoming repayable in a shorter time frame than for developing countries. This demonstrates how foreign debt can contribute to the underdevelopment of health sectors in these countries. Therefore, foreign debt is necessary for developing countries to finance their development expenditure, because, through the building of hospitals and other critical infrastructure, the government can create job opportunities for hospital staff. However, it is important to note that the servicing of foreign debt reduces the money that is available to finance public services (Yiega, 2022). On a global scale, access to healthcare is highly dependent on income distribution. As a result, compared to middle-income countries, developed countries tend to have better access to healthcare (Otu, 2018).

Research indicates that studies conducted in North America and Europe prioritise the importance of primary healthcare to achieve health policy goals (Reibling *et al.,* 2019). The standard of healthcare in the respective continents is strong and is easily accessible to the population. Some European countries' standard of healthcare stands out as being superior, such as Germany, Ireland, France, and Austria, for having the best quality healthcare (Reibling *et al.,* 2019).

Across developed nations, healthcare is funded by both private and public spending where public health is financed by the government while private health is financed by individuals in the form of health insurance (Hejduková & Kureková, 2016). In European nations such as France, Germany, Belgium, and the Netherlands, the main source of funding for healthcare comes from the government (Hejduková & Kureková, 2016). In contrast with low to middle-income countries such as South Africa and sub-Saharan nations, the aforementioned European nations' governments have allocated sufficient resources to take the financial burden of healthcare off of its population whilst providing equal and high-quality healthcare services to all.

Some low to middle-income nations are on the verge of implementing nation-wide government-funded healthcare. In the process of this implementation, numerous factors were considered such as availability, accessibility, acceptability, as well as quality of care (Wenang *et al.,* 2021) as such nations have citizens who live in both urban and rural areas, and those residing in the latter can be hard to reach and there could be resistance to healthcare. The leading and most ambitious developing nation in this respect is Indonesia which seeks to provide government-funded healthcare to its population of 225 million which would subsequently become the largest healthcare system in the world (Wenang *et al.,* 2021). This is a feat and ambition is something that South Africa seems to severely lack, especially considering that Indonesian population is significantly larger than South Africa's. The disparities in healthcare in South Africa can be mitigated by following Indonesia's example of prioritising healthcare and alleviating the financial burden of healthcare from its citizens as well as allocating funds to improve the equipment in hospitals and clinics to provide a higher standard of healthcare. A discussion the introduction of National Health Insurance for South Africa is briefly discussed in section 2.2.3. The section below will focus on healthcare in sub-Saharan Africa, with specific reference to Ghana, Tanzania, Kenya and Nigeria.

2.2.2 Healthcare in sub-Saharan Africa

Sub-Saharan Africa has become an emerging field of digital health innovation aimed at strengthening medical care, in the sphere of patient management as well as disease surveillance and prevention. As a region where the disease is seen to be the biggest burden in the world, is plagued by a severe shortage of health workers, the use of digital health solutions and interventions is gaining momentum (Holst *et al.,* 2020).

Despite this fact, the health of people in sub-Saharan Africa is a major global concern. Compared to other regions of the world, sub-Saharan Africa has the lowest ratings for well-being and the lowest satisfaction pertaining to healthcare (Deaton & Tortora, 2015). With growing populations and the emergence of infectious diseases such as Ebola and Covid-19, healthcare facilities in sub-Saharan African countries are under severe pressure. Furthermore, the uneven distribution of healthcare accessibility, coupled with the limited availability of public health financial resources and other fiscal constraints, increases the need for improved planning for the next generation of healthcare facilities (Falchetta *et al.,* 2022). The prevalence of corruption and mismanagement of available funds and the impact of foreign debt, plays a substantial role in limiting access to resources needed to fund government services, such as healthcare (Yiega, 2022).

In addition, on a global scale, women suffer healthcare inequalities which ultimately leads to mortality in all spheres of life. Research indicates that women of a lower socio-economic status are at highest risk, in every age group and in every part of the globe. Notably, women with low levels of education, women members of minority groups and migrant women are most likely to present for medical care late, or present with long-standing undiagnosed medical conditions and likely suffer complications of treatment. As a result, these issues should be urgently addressed in all countries around the world (Myatra *et al.,* 2021; Tessema *et al.,* 2022).

A recent survey-based analysis conducted by Wehrmeister *et al.*(2020) conclude that inequality in wealth distribution within the country remains one of the strongest barriers to coverage of healthcare in SSA countries. However, notwithstanding the presence of conflict, economic hardship, or political instability, there is evidence that most countries in sub-Saharan Africa have succeeded in reducing wealth-related inequalities in the coverage of essential health services. Notably, healthcare accessibility is a necessary condition for enabling access to healthcare services. A review of the literature on the location of healthcare services has established a significant relationship between proximity to healthcare facilities and health outcomes (Falchetta *et al.,* 2020). This finding is supported by Kelly *et al.* (2016) who confirmed the association between differences in travel time/distance to healthcare services and patients' health outcomes.

Falchetta *et al.*(2020) cite empirical evidence from Nigeria indicating that living far away from healthcare facilities not only results in lower health insurance enrolment but also, reduces the utilisation of these facilities. Moreover, the availability of hospital beds is vital to ensure that treatment can be provided.

In an effort to better understand the reasons for the inequalities in healthcare in sub-Saharan Africa, the ensuing sections will focus on the provision of healthcare in sub-Saharan countries, namely Ghana, Tanzania, Kenya and Nigeria.

2.2.2.1 Healthcare in Ghana

In Ghana, healthcare provision is mainly the responsibility of the government and is supervised by the Ministry of Health and Ghana Health Services. In an effort to enhance healthcare use in the country, the country implemented a national health insurance system, built hospitals, and trained health professionals. This is an indication of the commitment of the government to ensure that healthcare use in Ghana is improved (Agyemang-Duah *et al.,* 2019).

Healthcare is a mixture of private for-profit facilities, private non-profit facilities and public healthcare facilities as well as traditional healthcare providers. Public health facilities fall under and are run under the auspices of the government, and as such, it delivers the largest proportion of healthcare services in Ghana. Private, for-profit healthcare facilities are owned and funded by private individuals by means of payments for medical services rendered whereas private not-for-profit services are rendered by missions or faith-based facilities (Awoke *et al.,* 2017).

The introduction of the National Health Insurance Act has necessitated all Ghanaians to join the NHIS. Contributions to the NHIS by formal sector workers occur automatically by means of salary deductions. However, since payment to this scheme cannot be enforced, membership to the NHIS is voluntary for those in the informal sector. This in effect means that not all people from the informal sector benefit from the NHIS services since they do not contribute to the NHIS. Presently, Ghana in the process of introducing a one-time payment to replace the present annual premiums for those outside the formal sector (Mills *et al.,* 2012).

2.2.2.2 Healthcare in Tanzania

As the fourth most populous country in sub-Saharan Africa (57 million in 2017), Tanzania has made significant progress in economic growth and poverty reduction. However, despite this progress, more than a quarter of the population is still living below the poverty line. Furthermore, although the country has made substantial progress toward Universal Health Coverage (UHC), a number of challenges persist (Wang *et al.,* 2018).

After attaining independence in 1961, Tanzania adopted a free healthcare policy which was in place until the early 1990s when user fees were reintroduced, with by exemptions and waivers for the poor. The National Health Insurance Fund, aimed at formal public sector workers, was introduced in 1999, after which the community health fund was enacted 2001, which was aimed at the informal sector of the population. This was followed by the adoption of a ten-year primary healthcare development programme (2007 to 2017). The main focus of the aforementioned programme was to improve the primary healthcare delivery system. This was achieved by increasing the number of health facilities, particularly in rural areas. Plans are underway by the Tanzanian government to develop its first National Health Financing Strategy (HFS), aimed at developing a health financing system whereby access to needed care for all and the provision of financial protection against payments for healthcare is guaranteed (Mtei *et al.,* 2014; Wang *et al.,* 2018).

Similar to Ghana, Tanzania's publicly funded health services were free to its citizens. However, the introduction of mandatory health insurance schemes for formal sector employees has resulted in comprehensive healthcare benefits to its members. Furthermore, the National Social Security Fund has introduced a Social Health Insurance Benefit for private formal sector employees. Other schemes include a voluntary insurance scheme named the Community Health Fund (CHF) for rural dwellers, with a similar scheme being introduced for urban dwellers. Given the low level of coverage offered by insurance schemes, out-of-pocket payments by members of these schemes remain high. Tanzania is in the process of expanding its insurance coverage for those in the informal sector (Mills *et al.,* 2012).

Despite numerous efforts to improve the quality of care in Tanzania, the literature suggests that most facilities struggle to deliver high-quality services. A significant number of major barriers to accessing services have been uncovered, *inter alia*, including having to travel long distances to health facilities, poorly developed transportation systems, and unfriendly services. Other barriers relate to the referral system which is severely constrained by a small number of ambulances, unreliable logistics and communications, and inadequate community-based facilitated referral. It is important to note that health facilities in Tanzania are overseen by the Ministry of Health, which is responsible for drafting policies and guidelines, and the Ministry of Regional and Local Government, which is responsible for the ownership and running of primary health facilities (Yahya & Mohamed, 2018).

2.2.2.3 Healthcare in Kenya

Studies have shown that Kenyan's have been financially burdened by having to pay for healthcare as there is significantly low access to primary healthcare due to inadequate funding, fragmentation of resources, and inadequate health insurance coverage (Otieno *et al.,* 2020). Furthermore, Kenya's foreign debt continues to rise, and as a result, the Ministry of Health reported that the various county governments in Kenya had severe disparities when it comes to health infrastructure. For the entire country, the average number of healthcare workers per 10 000 persons was about seven, which is way below the WHO recommended minimum threshold of 23 healthcare workers for every 10,000 persons (WHO, 2018; Yiega, 2022).

This financial burden greatly affects the sick individual and their households, and the first step in mitigating this is by the government providing financial risk protection to reduce out-of-pocket health expenditure as envisaged in the Suitable Development Goals and Universal Healthcare (UHC) agendas which is crucial to improve access to primary healthcare in poor urban areas with

minimal resources (Otieno *et al*., 2020). Furthermore, individuals from Kenya's poorly resourced urban areas seek primary healthcare from private facilities as opposed to public facilities, due to the existence and availability of basic health infrastructure, medical equipment, availability of drugs, and other essential supplies in private care facilities (Otieno *et al.* 2020:7). Otieno *et al.* (2020) go on to state that if the aforementioned gaps are not addressed, it will grossly affect the accessibility of primary healthcare services and will serve as an aggravating factor in achieving universal health coverage (UHC), and that the Kenyan government must address these gaps and seek to regulate and strengthen the accessibility and quality of public healthcare facilities in under-resourced urban areas and settlements.

2.2.2.4 Healthcare in Nigeria

As the most populous nation in Africa, Nigeria has the strongest economy in Africa. However, this is paradoxical of its healthcare system, which is ranked 187th out 191 by the WHO (Otu, 2018). Furthermore, Nigeria's financial commitment to healthcare is poor even though the nation has a strong economic position compared to other sub-Saharan countries. Additionally, Nigeria's financing of healthcare has not increased over nearly five decades but has rather continued to decline (Otu, 2018).

A number of challenges seem to plague the Nigerian public healthcare sector that has impeded its performance. These challenges include low access to basic healthcare services, unstable policies, challenges related to financing, inadequate infrastructure, brain drain, conflict between different groups of healthcare professionals and many more. Other reasons as to why the Nigeria's public healthcare sector is unable to attain optimal performance is due to lack of strategic leadership. One of the main contributors is the low performance of public healthcare organisations as a result of inadequate funding of the public healthcare sector. Studies further conclude that the inadequate funding of the healthcare sector is the main reason for the challenges the sector is facing as well as its low level of performance (Abubakar & Kathuria, 2020). In support of this, Otu adds that despite Nigeria's superior financial position in Africa, there are hindrances to acquiring a budget for a solid healthcare system such as poverty, poor environmental quality, insurgency, insecurity, bureaucracy and corruption, and because Nigeria is greatly burdened with diseases, morbidity and mortality rates significantly higher than those of other sub-Saharan nations (Otu, 2018).

Nigeria's healthcare is provided in both the private and public sectors. Otu contends that due to the absence of an adequate budget for healthcare, primary healthcare facilities are only able to

provide preventative and curative care to out-patients and that secondary care is provided in government hospitals managed by the state (Otu, 2018).

Like many countries in SSA, Nigeria has the problem of sub-optimal healthcare facilities and resources. When it comes to healthcare spending, there is heavy reliance on out-of-pocket payments for healthcare services in Nigeria, despite the fact that Nigeria's government has introduced the National Health Insurance Scheme (NHIS) in 1999 to reform the healthcare sector. The goal of the NHIS is to improve the performance of the public healthcare sector through the provision of health insurance in the hope that it would lead to improved quality and cost-effective healthcare services. However, more than 90% of the population is uninsured, despite the establishment of the National Health Insurance Scheme (NHIS) and over 70% of the payment for healthcare services in Nigeria comes from out-of-pocket expenditure, meaning that people pay their healthcare bills from their own hard-earned income (Abdullahi & Gunawardena, 2021).

It is imperative for the researcher to evaluate the state of healthcare globally, as well as in SSA to compare it with the status of healthcare in South Africa. Due consideration has to be given to the economic status of SSA countries and South Africa, as well as its populations. Furthermore, a parallel needs to be drawn to indicate the different approaches to healthcare in an effort to understand what financially strong, yet less densely populated countries have done to ensure that their population receives quality and accessible healthcare. There are developing nations that are less financially stable than South Africa, with a significantly higher population. However, despite this, they are taking proactive measures to ensure that quality healthcare is accessible to all is citizens. In comparison, South Africa is deemed to be more financially stable, with a significantly lower population compared to other SSA counties, yet they are lagging behind in providing access to quality and equal healthcare. The following section will therefore explore the status of healthcare in South Africa.

2.2.3 Healthcare in South Africa

It is important for the researcher to look at the history of South Africa following the demise of Apartheid and to ascertain how the legacy of Apartheid has shaped healthcare in South Africa and the current status of healthcare provision in a democratic South Africa.

Section 27(1)(b) of the constitution of the Republic of South Africa binds the state to work towards the progressive realisation of the right to health. Yet 28 years after democracy, the country is still grappling with massive health inequities as perceived by the citizens.

Although Apartheid has been dismantled in early 1990, and replaced by a democratically elected government in 1994, its legacy of racial and socio-economic inequality seem to persist, despite the creation of government strategies and policies to redress imbalances and disparities which are particularly prevalent in healthcare (Bredenkamp *et al.,* 2021). The authors' research on changing inequalities in health-adjusted life expectancy by income and race in South Africa has uncovered that, although the racial gaps in 2016 were significantly smaller than in 2001, this was not the case for income-related inequality, which increased between 2001 and 2016. This would suggest that despite policies designed to bridge both race- and income-related inequalities in health outcomes, the inequalities between the poor and non-poor widened in the last 15 years. This is highly likely owing to the growing income-related inequality within the Black population group since a larger share of the Black population enjoys higher incomes as well as better health outcomes.

The South African health system has been described as a two-tiered system divided along socio-economic lines (Republic of South Africa Health Department, 2015:1). Health services in South Africa are delivered across three levels of government, namely, national, provincial and local. In addition, South Africa has three levels of hospitals: primary, secondary, and tertiary.

Whilst healthcare access for all is enshrined in the Constitution, a vast number of inequalities to access to healthcare continue to exist. South Africa's apartheid past therefore still has an influence on health, service, and resource inequities, which is further exacerbated by incompetence, corruption, under-funding and mismanagement, despite the many medical advances (Coovadia *et al.,* 2009; Harris *et al.,* 2011; Mills *et al.,* 2012; Benatar, 2013, Walsh, 2016; Benatar & Gill, 2021).

As with other SSA countries, South Africa is working towards the goal of National Health Insurance (NHI) which aims to provide more equitable access to high-quality individual health services to its citizens. The goal is to improve access to healthcare for the majority of South Africans which will ensure that the South African population will have access to quality healthcare regardless of their socioeconomic status or standing (Benatar & Gill, 2021; Mukwena & Manyisa, 2022). National Health Insurance, in essence, is a system in which everyone is covered by health insurance and people contribute according to their ability to pay and use health services based on their needs. The purpose of the NHI is to offer no fees at the point of service for all levels which will see every person accessing and receiving adequate healthcare when needed without being

concerned about user fees or out-of-pocket payments (Booysen & Hongoro, 2018; Chiwire *et al.,* 2021).

The growth of the private health sector in South Africa has fundamentally changed the structure of healthcare delivery. The exponential growth of private health insurers, private hospitals, and specialists account for almost half of the country's spending on healthcare, notwithstanding the fact that it only serves 16% of the population with the capacity to pay. Tariffs charged by South Africa's private hospitals are comparable with countries that are considerably richer, which compromises the affordability of a broad-based extension of healthcare for the population, and further perpetuates inequalities in terms of access to healthcare resources (Barber *et al.,* 2019). This is supported by Lorenzoni and Rubal (2016), whose paper on comparative hospital price levels using standard OECD-Eurostat methodology revealed that prices in private hospitals in South Africa are in line with those in high-income OECD countries such as France, the United Kingdom and Germany. Barron and Padarath (2017) posit that not only are health problems in South Africa exacerbated by the unequal distribution of health professionals between the private and public sectors but it is further impacted by the unequal distribution of public sector health professionals among the provinces.

In the South African healthcare context, there is a substantial gap between private and public healthcare provision. Whereas public healthcare is funded by the government, private healthcare is not. As a result, private healthcare is expensive with fewer facilities. In the public sector, primary healthcare (PHC) is based on a no-fee for service platform whereas government funds subsidise the secondary and tertiary services. Conversely, private providers of healthcare are for-profit at all levels of care and require payment for services. Operating primarily with reimbursements in the form of pooled funds from medical insurance or medical aid schemes and a voluntary prepayment system, it caters for those who are able to afford it. Furthermore, South Africa's private hospitals are able to offer world-class treatment as it has well-trained medical specialists working with technologically advanced equipment, which remains unaffordable to the majority of the country's population (Chiwire *et al.,* 2021) .

The public health system caters for an estimated 84% of the population who do not have medical insurance. Consequently, public health facilities are under severe pressure to provide healthcare service to most of the population with limited resources (Chiwire *et al.,* 2021). At public clinics in South Africa, Primary healthcare is thus tax-funded and thus free to the citizens, whilst payment for services at public hospitals is income-based, with the very poor receiving free care (Mills *et*

al., 2012). Research conducted by Maphumulo and Benghu (2018) has raised the following issues that negatively impact the quality of care provided by public institutions in South Africa: 1) prolonged waiting time because of shortage of human resources; 2) adverse events; 3) poor hygiene and poor infection control measures; 4) increased litigation because of avoidable errors; 5) shortage of resources in medicine and equipment ;and 6) poor recordkeeping.

Private insurance in South Africa covers mainly higher-income formal sector employees where enrolment is voluntary and implemented on an individual basis. The majority of general practitioners are in the private sector where they offer primary care to a small part of the population with insurance or occasional out-of-pocket payments. Whilst private insurance makes up 44% of total healthcare financing in South Africa, it covers only a minute portion of the population (Mills *et al.,* 2012.) According to Benatar and Gill (2021), 17% of South Africans have private health insurance, and care is provided by approximately 70% of the doctors in the country, whilst approximately 83% of the population are uninsured and served by 30% of the country's doctors. It can thus be deduced that there is an unequal distribution of human resources, as the majority of doctors have migrated to the private sector, leaving the public sector with a small number of doctors to provide healthcare and service to over 80% of the South African population. The ensuing section will focus on healthcare in the Western Cape Province since the unit of analysis was one tertiary hospital and one district hospital in this province.

2.2.4 Healthcare in the Western Cape Province

The public health system in South Africa can be described as a tiered system with a public and private sector. As a rich, urbanised province in the country, the Western Cape has over triple the number of doctors per capita than four of the most rural provinces. Limpopo Province has only one doctor per 5,000 people, according to the Health Professions Council of South Africa in 2010. Conversely, the private sector, employs around 28% of all nurses, 46% of GPs, and 56% of medical specialists, serving the wealthiest 15% of the population with private health insurance. All South African doctors train in the public sector, and as such, many commence with their careers in rural internships, This would suggest that health workers are migrating away from areas where healthcare is most needed. This, in turn has a negative effect on South Africa's ability to effectively tackle its public health crises, most notably its HIV and TB crises. Furthermore, it is imperative for South Africa to retain its health workers where they are most urgently needed (Ashmore, 2013).

Throughout the Western Cape are Community Health Centres (CHCs) which are situated throughout the Western Cape and serve as the entry point for the majority of patients who seek medical attention. CHCs are usually run by generalist physicians and sometimes by mid-level providers, and patients are either seen on an appointment basis, or on an emergency basis. Where patients are in need of urgent or emergency treatment at the CHCs , they are transferred to secondary hospitals for further care. Patients who are in need of the highest level of care, for example, specialised radiology or sub-specialist care are then transferred to a tertiary hospital (Richards & Jacquet, 2012).

2.2.5 Healthcare considerations for this study

Based on the above review the aspects relevant to the study are summarised and discussed next. There is a perception of a substantial gap in healthcare between Africa and the rest of the world, and as a result, it was imperative for the researcher to explore the current status of healthcare globally and in sub-Saharan Africa, to investigate the extent of the gap and how it compares to South Africa. Global healthcare research indicates that current healthcare systems in first-world countries have highly skilled medical professionals and better technology which provides the potential for extraordinary improvements to the healthcare systems. It is abundantly clear that this is not the case in SSA and South Africa.

Research shows that, globally, access to healthcare is highly dependent on income distribution. As a result, developed countries tend to have better access to healthcare compared to middle-income countries. First-world countries, therefore, have highly skilled medical professionals and better technology which enable them to make vast improvements to their healthcare systems. Furthermore, the standard of healthcare in North America and Europe is strong and is easily accessible to the population and are known for having the best quality healthcare.

In contrast, research has highlighted the weaknesses of healthcare systems in countries in low and middle-income countries. These weaknesses can be attributed to various factors, most notably a shortage of suitably qualified staff, particularly at the primary care level, low salaries, lack of equipment and infrastructure, including poor accessibility of health services, weak and overly centralised systems for planning and management, and bureaucracy. This not only applies to SSA, but also to South Africa, which, after 28 years of democracy, still grapples with health inequities. It was also important to look at how healthcare is provided in the various SSA countries compared to South Africa, and studies show great disparities between public and private healthcare provision.

Against this backdrop, this study focused on two hospitals in the public sector, in the Western Cape Province, which grapples with all of the aforementioned factors and weaknesses. Data were predominantly collected from the nurses who work in the public sector, who face many of the abovementioned factors on a daily basis, most notably the shortage of qualified medical staff (nurses and doctors), a general lack of equipment and infrastructure, and generally poor accessibility to healthcare. Furthermore, many of these factors have helped the researcher to formulate the interview questions.

2.3 Nursing

Nurses represent the single largest workforce in healthcare and as such, they play an important role in improving the quality of care. Greater reliance on ICTs in the healthcare sector has necessitated nurses to become proficient in the use of DHTs as part of their daily work activities. Since the unit of analysis for this study is the nurses' lived experience of using DHTs as part of their work practices, the role of the nurse and their lived experience is the focus of this study.

Irrespective of changing contexts, advancements in healthcare and the health needs of the population, nurses remain the foremost providers and co-ordinators of care. Nurses perform a wide variety of tasks, ranging from simple activities to cognitively challenging activities (Salmond & Echevarria, 2017; Orhan, 2019).

2.3.1 Nursing process

The nursing process is deemed an important aspect of nursing. It aims to promote reflective practice as well as critical thinking, the latter being a necessary aspect when it comes to problem-solving (González & Chaves, 2009). Pérez Rivas *et al.*(2016) describe the nursing process as a scientific method and a form of critical thinking, which, if applied by nurses helps, to accurately diagnose patients and offer interventions, leading to better patient outcomes. The nursing process aims to identify, diagnose, and treat actual or potential human responses to health and illness and can be described as a strategic approach to assessing and caring for patients. Furthermore, it is imperative that steps are followed in sequence, from start to finish, to ensure that the needs of the patient are adequately addressed (Potter *et al.,* 2004; Ead, 2019).

The concept of critical thinking in nursing has long been associated with the nursing process. As far back as 1994, Yahiro and Saylor were of the opinion that, to make sound nursing judgments, critical thinking is essential, and must be used (Yahiro & Saylor, 1994:352). The authors, therefore, define *critical thinking* in nursing as "reflective and reasonable thinking about nursing

problems without a single solution and is focused on deciding what to believe and do". In essence, this definition broadens the concept of critical thinking in nursing and would include reflection of thoughts and acknowledgement of the fact, when it comes to problem solving, there is no “one size fits all” solution. In fact, it would suggest that there can be various solutions to problems. It is for this reason that Ead (2019) concludes that the nurses process provides an important framework that engages critical thinking, ongoing assessment as well as reassessment of the patient’s status.

Given that the nursing process is viewed as a problem-solving technique, this is a widely accepted method in nursing care. Described as a nursing care plan, Pokorski *et al.* (2009:303) define the *nursing process* as a “systematic and dynamic way to deliver nursing care, operating through five interrelated steps or phases, namely, assessment, diagnosis, planning, implementation and evaluation”. Furthermore, the nursing process is regarded as a decision-making approach which promotes critical thinking in nursing. This process consists of five phases namely: assessment, diagnosis, planning, implementation and evaluation. It can thus be construed that the nursing process aims to identify, diagnose, and treat actual or potential human responses to health and illness. This definition is supported by Yildirim and Ozkahraman (2011) who further describe the nursing process is a scientific-problem solving model using the steps of assessment, nursing diagnosis or problem identification, planning, implementation, and evaluation in a step-by-step process to plan care for patients. It is therefore an organised, systematic approach used by nurses to meet the individualised healthcare needs of their patients.

The five steps which are used sequentially and repeatedly during patient care are assessment, diagnosis, planning, implementation, and evaluation. Ead (2019) and Toney-Butler and Thayer (2020) explain these steps as follows.

Assessment

This is the most important step in the nursing process, as it involves gathering key information to complete a comprehensive patient assessment.

Assessment, according to the authors, is the first step and involves critical thinking skills and data collection; subjective and objective. Subjective data involves verbal statements from the patient or caregiver. Objective data are measurable, tangible data such as vital signs, intake and output, and height and weight.

Diagnosis

Based on the assessment concluded in step 1, the assessment, the nurse will proceed to identify a nursing diagnosis.

The formulation of a nursing diagnosis by employing clinical judgment assists in the planning and implementation of patient care.

Planning

In this step, the nurse will plan how to address the problem which has been identified in the diagnosis step.

The planning stage is where goals and outcomes are formulated that directly impact patient care based on evidence-based practice (EDP) guidelines. These patient-specific goals and the attainment of such assist in ensuring a positive outcome. Nursing care plans are essential in this phase of goal setting.

Implementation

Implementation is the step that involves action or doing and the actual carrying out of nursing interventions outlined in the plan of care. This phase requires nursing interventions such as applying a cardiac monitor or oxygen, direct or indirect care, medication administration, standard treatment protocols and evidence-based practice (EDP) standards.

Evaluation

This final step of the nursing process is vital to a positive patient outcome. Whenever a healthcare provider intervenes or implements care, they must reassess or evaluate to ensure the desired outcome has been met. Reassessment may frequently be needed depending on overall patient condition. The plan of care may be adapted based on new assessment data (Ead, 2019; Toney-Butler & Thayer 2020).

2.3.2 Nursing practice

It is important to note that there is a distinction between the nursing process and nursing practice. Pope *et al.* (1995), when defining nursing practice, draw on the American Nurses Association's definition as a caring-based practice, which applies processes of diagnosis and treatment to human experiences and illness. As such, since nursing practices are care-based and executed by nursing processes, it is a problem-solving process. The nursing process, on the other hand, is viewed as a problem-solving technique, and a widely accepted method in nursing care, consisting

of five interrelated steps or phases, namely, assessment, diagnosis, planning, implementation, and evaluation (Pokorski *et al.,* 2009).

Clinical decision-making is a fundamental aspect of nurses' clinical practice as it directly impacts the health and well-being of each patient. Krishman (2018:73) defines *clinical decision-making* as a term frequently used to describe the fundamental roles of nurses in clinical settings as "…a process that nurses undertake on a daily basis when making judgments about the care they provide to patients". It can therefore be concluded that any decision a nurse takes, will ultimately have an impact on patient safety, care, and outcome (Johansen & O'Brien, 2015; Nibbelink & Bruwer, 2017; O'Neil *et al.,* 2005). In other words, nursing practice may be work experience that is direct and/or indirect patient care in clinical practice, nursing administration, education, research, or consultation in the specialty represented by the credential. The position is usually filled by a Registered Nurse. Nursing practice is generally influenced by the situation, in other words, it is influenced by time, place and purpose. As explained by Jarrin (2012:12) regarding the essence and experience of nursing – the author refers to the nurse-patient relationship and refers to how the work environment, which includes workplace culture, staffing, and availability of resources are factors that influence nurses' perceptions regarding the practice of nursing. Furthermore, the author states that "nursing is caring situated in space, place and time, and shaped by the internal and external environments of both the patient and the patient." In other words, caring is dependent upon where you are (meaning the time, space, and culture, and also the level of development of the individual). This refers to the individual nurse's training and experience, ethical and moral standing, as well as the context of the situation, whether it is fast-paced, for example, in an ICU or whether it is more relaxed, for example, working in a nursing home.

As the work environment for nurses continues to evolve, the demands on nurses increase along with the potential for nurses to become more distant from their patients.

This sub-section deals with the behavioural aspect of nursing to lead to lived experience. Because the lived experience is dependent on the context of the practice a situational inquiry is suggested to derive insights from the nurses' lived experiences for different situations in the demonstration cases.

The nursing profession has been influenced by the influx of technology, and as such, research indicates that nursing and technology are inextricably linked (Bagherian *et al.,* 2017). Healthcare in intensive care settings is more complex, as technical equipment like ventilators, infusion

pumps, monitors, and dialysis machines need to be carefully managed. Tunlind *et al.* (2015) regard *technology* as items, machinery and equipment which are connected to knowledge and management to maximise efficiency. The authors further reiterate that is not just the equipment per se, but rather, knowing how to use it and being able to integrate it into nursing care.

In most hospitals, intensive care units (ICUs) in particular, are highly technological environments. Patients in ICUs require specific technical nursing activities, such as attaching patients to life support equipment, and 24-hour supporting, treating and monitoring of patient's vital signs. Whilst attending to these activities, nurses are also required to attend to the physical as well as psychosocial needs of patients and their families (Needleman, 2013). It is therefore imperative for nurses to have the required technical skills as it forms an integral part of the caring process. Technology in an ICU also includes the use of medical-technical equipment. *Medical-technical equipment*, according to Tunlind *et al.* (2015:117), refers to "equipment that will detect, prevent, monitor, treat, compensate for injury and disability or alleviate disease." Nurses working in ICUs, therefore, perform much of their work through the use of medical-technical equipment. Research suggests that, in some way, technology may impact the nurse-patient relationship in that technology may come between the nurse and the patient, resulting in the patient feeling that technology overshadows their basic needs. The study conducted by Tunlind *et al.* found that the use of technology in modern intensive care facilitated several medical steps in the critical care nurse's work, enabling the nurse to more time to spend on the patient. Furthermore, the study found that technology was an important and necessary part of patient care, leading to enhanced patient care. The study further revealed, that, despite the advanced equipment used in the ICU, nurses did not always trust the technology, especially when medical equipment attached to the patient set off alarms indicating abnormal parameters. In such instances, nurses would feel obliged to evaluate the patient based on their clinical observation and they would then proceed to troubleshoot the equipment (Turnlind *et al.,* 2015).

2.3.3 Nurses and technology

A distinction has been drawn in section 2.3.2 between nursing practices and nursing process to show the correlation between it, as well as how technology is integrated into both nursing practices and processes.

Nursing practices are guided by certain standards established by professional associations and government agencies. The nursing practices are care-based and form part of a systematic framework carried out by nursing processes of patient assessment, diagnosis, planning,

intervention, and evaluation; it is a problem-solving process (Pope *et al.,* 1995). The nursing practice and process have not been materially altered in the 21st century. It does, however, incorporate technology in the carrying out of those processes. As stated in 2.3.1, Pérez Rivas *et al.* (2020) describe the nursing process as a scientific method and a form of critical thinking, which, if applied by nurses helps, to accurately diagnose patients and offer interventions, leading to better patient outcomes. In other words, the nursing process is a systematic guide to client-centred care consisting of five sequential steps.

The introduction of technology and its constantly evolving nature has resulted in nursing workflow being in a constant state of flux. As more new technologies are becoming available within nursing care that can improve the quality of care, reduce costs, or enhance working conditions, its benefits can only be achieved if technologies are used as intended (De Veer *et al.,* 2011; O'Mahoney *et al.,* 2014). Digital technologies open the door to many opportunities to overcome existing and prevalent problems in healthcare. A common challenge faced by the healthcare sector is a shortage of skilled nurses, and increased demand for long-term care (Krick *et al.,* 2019). The introduction of EHRs, CPOE systems, and other technological devices such as home dialysis equipment or new infusion pumps, has resulted in a drastic change in the amount, duration and location of nursing activities, as well as nursing staff's daily routines. (Cornell *et al.,* 2010; De Veer *et al.,* 2011).

Proficiency in the use of DHTs is therefore essential in today's nursing care, and the advantages of using DHTs in the nursing profession are limitless. It is therefore essential for nurses to improve their competencies (Eley *et al.* 2008; While & Drewsbury, 2011; Hack-Polay *et al.,* 2022).

To elaborate further on the competency of nurses to adopt digital technologies into their daily working activities, nurses must continuously utilise technology to access and manage records, and to provide care through electronic means such as e-medicine and telehealth platforms. These digital technologies provide a significant opportunity to improve, enhance, and transform healthcare (Brown *et al.*, 2020). However, to seize these opportunities, nurses need to be competent; they need to possess the requisite knowledge, skills, and resources to make use of technology and to integrate it into their daily working activities (Brown *et al.,* 2020).

Therefore, owing to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work processes. It can thus be argued that, due to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work processes.

Whilst the literature supports that these technologies have great benefits, the impact on nurses and their workflow is not well known.

2.4 Digital technologies

The field of digital technologies being developed or applied to support healthcare is extensive, and as a result, the use of digital technologies for health, has become a prominent field of practice in healthcare, employing a variety of routine and innovative types of information and communications technology (ICT) to address health needs. With healthcare costs increasing due to advances in medical science and technology, patients are also demanding better quality and personalised care which pressurises governments and healthcare providers to make quality care more accessible without increasing the cost of said care. It is recommended that a way of achieving this feat would be to place emphasis on self-care and patient empowerment which is supported by e-health services such as, but not limited to, personal health records (PHR) and remote monitoring of patients (Andersen *et al.,* 2019).

According to the WHO, the term *digital health* is rooted in eHealth, which is defined as "the general use of information and communications technologies (ICT) for health and is inclusive of both mHealth and eHealth" (WHO, 2016:viii). The World Health Assembly Resolution on Digital Health unanimously approved by WHO Member States in May 2018 collectively recognised and acknowledged the value and contribution of digital technologies to the advancement of universal health coverage (UHC) and other health aims of the Sustainable Development Goals (SDGs) (WHO, 2019). Perakslis and Ginsburg (2021) describe *digital health* as a wide range of technologies that include personal wearable devices, internal devices, and also include sensors that are used in people, homes, cars and communities. Through digital health, many health risks can be identified and mitigated, and as such, has the potential to improve overall health management. A number of studies have addressed the benefit of DHTs to nursing practice, as well as nursing education (Booth *et al.*, 2021; Krick *et al.*, 2019).

Digital technologies provide a number of opportunities to address health system challenges, and in doing so, offer the potential to enhance the coverage and quality of health practices and services. There exists a list of non-exhaustive barriers to the successful implementation of digital health interventions within the healthcare sector. The difficulties and aggravating factors pertaining to the implementation of digital health include interoperability, cost, compatibility with existing systems, disrupting interactions between nurses and patients, and poor planning (Ross *et al.,* 2018). This does not mean that the implementation of digital health interventions is

impossible; rather, it requires well thought out planning, funding, and education. This is supported by a study in which researchers developed and implemented an executable digital health intervention by gathering nursing staff's input, collecting staff feedback from qualitative interviews, and using this data, among others, to formulate a successful digital intervention. The researchers, however, found that the ambit of the intervention was too wide and this had to be amended as it was a barrier in an already limited-resourced environment (Ross *et al.,* 2018).

Digital health interventions may be used, for example, to facilitate targeted communications to individuals to generate demand and broaden contact coverage. Digital health interventions may also be targeted to health workers to give them more immediate access to clinical protocols through, for example, decision-support mechanisms or telemedicine consultations with other health workers (WHO, 2019).

The WHO state that digital health interventions allow health workers to expand their range of tasks as well as take on tasks previously assigned to higher-level workers. Health workers view digital health technologies as being more efficient since it is likely to increase the speed with which these technologies allow them to work (WHO, 2019).

In terms of ICT, digital technologies comprise a wide range of technologies, such as communication support, decision support, electronic health records (EHR)/electronic medical records (EMR), hospital (or care institution) information systems (HIS), specific software applications/apps, telecare, process planning/data exchange and target-specific interfaces (Kowatsch *et al.,* 2019). Other examples include the Personal Digital Assistant (PDA) , a mobile tool loaded with suitable functions and software applications that provide updated health-related information of the patients to the care provider anywhere and at any time, telehealth, an application of digital health and a service delivery approach, which refers to the type of ICT that provides long-distance clinical healthcare support, as well as health-care-related education and health administration, electronic messaging programmes which are designed to offer a secure and convenient way of electronic communication between the healthcare provider and the care recipient, secure messaging, is now provided in many her syste–s - a technology which allows patients and physicians to email each other in a data-secure environment (Wallwiener *et al.,* 2009; Ali *et al.,* 2022).

2.4.1 Digital technology types

The different types of DHTs – Health Information Systems (HIS), Electronic Health Records (EHRs) and Healthcare Decision Support – are discussed hereunder.

2.4.1.1 Health Information Systems (HIS)

The Health Information System (HIS) is a system or set of computerised tools that collect, store, manage, and transmit health data (Bagayoko *et al.,* 2020; Huter *et al.,* 2020).

The primary purpose of these tools is to support the transformation of health systems, to improve access to quality healthcare, and to assist in reducing costs. HIS is integral in healthcare for healthcare providers, health organisations, patients, and health consumers since it has the capacity to generate timely information about the patient and population's health to support healthcare provision and management at all levels. Furthermore, HIS has the ability to improve coordination of care, since information can be shared seamlessly between service providers. In addition, HIS's ability to process large amounts of epidemiological data enables the identification of trends resulting in the implementation of timeous public health interventions. Examples of HIS include electronic health records (EHR), clinical and hospital management, epidemiological and public health information, clinical decision support, and patient (Bagayoko *et al.,* 2020).

2.4.1.2 Electronic health record (EHR)

In recent years, electronic health records (EHRs) have been adopted by an increasing number of healthcare organisations worldwide, and particularly in lower-income countries (Ebnehoseini *et al.,* 2021; Ngugi *et al.,* 2021).

Being digital records of patient-related health information, EHR and EMR facilitate the storing and exchange of patient data within an institution, but primarily in hospitals. The EMR, according to Kierkegaard (2011) is the legal patient record created in hospitals and ambulatory surroundings and serves as the data source for the EHR. EMRs include functions such as patient information administration, medication administration, computerised physician order entry (CPOE), decision support or data results management systems, care documentation and sometimes nurse reminder systems. The EHR, on the other hand, exchanges information between two systems, whereby the main applications are electronic patient handover tools and the exchange of health information between different institutions or physicians (Huter *et al.,* 2021). Described as a linear electronic record, the EHR incorporates all the health information created and stored with each visit the patient makes to a health facility, thereby enabling the sharing of patient information

between points of care (Kierkegaard, 2011; Tsegaye & Flowerday, 2021). The terms *EHR* and *EMR* are sometimes used interchangeably; however, Kierkegaard (2011) cautions that there is a distinct difference. Whilst the EMR contains the information about care provided to a patient at one particular site, an EHR contains information from many or all THE institutions where the patient had been treated.

2.4.1.3 Healthcare decision support

Since the healthcare industry generate vast amounts of data, technology is used extensively to capture and transfer information. Healthcare decision support or computerised decision support systems are often directly integrated in EMR systems (Huter *et al.,* 2020). According to Rajalakshmi *et al.* (2011), a Decision Support System (DSS) is essentially a computer-based system, which assists in decision-making to ensure the correct diagnosis of any illness. Woo *et al.* (2014) describe the DSS as an expert system in the medical field, which is increasingly being used as an intelligent computing system to improve treatment efficiency by providing clinical guidelines and patient information to physicians and patients. It is important to note that it is possible for a CDSS to be cost-effective for healthcare providers through clinical interventions, shortening inpatient hospitalization, providing cheaper medication alternatives, and eliminating the need to re-run the same tests (Sutton *et al.,* 2020). However, Rajalakshmi *et al.* (2011) point out that, whilst medical diagnosis can be done in a variety of ways, ranging from patients' description of their symptoms, physical examination and or laboratory tests, there remains the chance of an incorrect diagnosis, resulting in drug reactions and allergies or even life-threatening situations. One way to combat this problem is through the help of the decision support system (DSS). Decision-making in healthcare essentially spans two areas, namely, patient management, diagnosis and treatment, record keeping, finance and inventory management (lower area). The other area involves higher level decision-making that gives the hospital a competitive edge. The shareholders that play an important role in lower-level decision-making consist of doctors and nurses. A study conducted by Chahar determined that DSS applications assist doctors to analyse patient data that can help in taking the decision-making process. Tools such data mining is used for conducting the examination for treatment. Further, it helps in formulating the process of diagnosis and improving the quality of treatment (Chahar, 2021). Baitharu and Pani (2016) discuss the importance of data mining techniques for healthcare decision support. Data mining refers to the method of analysing data from different angles and summarising said data into meaningful information using a number of analytical tools and techniques. These, in turn, are

useful in discerning correlations or patterns among a variety of fields in large relational databases. The authors' research focuses on this aspect of medical diagnosis by discerning patterns through the collected data of liver disorder patients to develop intelligent medical decision-support systems to assist physicians (Baitharu & Pani, 2016).

Besides using data, the system provides an easy-to-use interface, allowing for the decision-makers ''own insights". Commonly known as Clinical Decision Support Systems (CDSS) in the field of healthcare, DSSs are also commonly referred to as Clinical Decision Support Systems. A CDSS is put in place to improve the delivery of healthcare by informing medical decisions with targeted clinical knowledge, and patient's medical history and information through the use of CDSS software which is designed to assist in clinical decision-making by using an individual patient's health problems against a network of computerised clinical knowledge, which is then sent to the physician for a decision (Sutton *et al.,* 2020). CDSS does not have a default form that provides for standardised targeted cases but rather has a variety of forms, the purpose of which is to provide a non-exhaustive list of functions, such as reminders for further testing, informing patients of different treatment protocols, identify patients who qualify for research-based testing, reminding patients to fill their prescriptions and to take their medication, and ensuring preventative care, amongst others (Sutton *et al.,* 2020).

Defined as a software that helps in clinical decision-making, whereby the "characteristics of an individual patient are matched to a computerised clinical knowledge base and patient-specific assessment or recommendations are then presented to the clinical or the patient for a decision", the CDSS is said to help to improve patient care and efficiency of the healthcare providers. For example, a CDSS is able to send reminders of required chronic disease management services to clinicians within an electronic health record system, thereby providing screening recommendations to patients within a web-based personal health record system and delivering patient-specific recommendations to clinicians within a computerised provider order entry system (Rajalakshmi *et al.,* 2011).

2.4.1.4 Digital technologies summary

The table below is a summary of the digital technologies discussed in 2.4. The researcher thought it prudent to investigate the different technologies, as these are the types of digital technologies that the participants of this study, i.e. the nurses, nurse managers, and operations manager are exposed to on a daily basis, and ultimately engage with part of their daily work activities.

Table 1: Summary of DHT types

TYPE OF DHT	FUNCTION	PURPOSE
Health Information System (HIS)	A system or set of computerized tools that collect, store, manage, and transmit health data. (Bagayoko et al. 2020; Huter et al. 2021).	generate timely information about the patient and population's health to support healthcare provision and management at all levels.
Electronic Health Record (EHR)	Digital records of patient-related health information which includes all the patient's medical histories made with different health facilities.	Exchanges information between two systems, and facilitate the exchange of health information between different institutions or physicians.
Electronic Medical Record (EMR)	Digital records of patient-related health information.	patient information administration, medication administration, computerized physician order entry (CPOE), decision support or data results management systems, care documentation and sometimes nurse reminder systems.
Decision Support System (DSS)	An expert system in the medical field, which is increasingly being used as intelligent computing systems to improve treatment efficiency.	It provides clinical guidelines and patient information to physicians and patients. DSS applications assist doctors to analyze patient data that can help in taking the decision making process. Performs data mining - a method of analyzing data from different angles and summarizing said data it into meaningful information using a number of analytical tools and techniques.
Clinical Decision Support Systems (CDSS)	Inform medical decisions with targeted clinical knowledge, and patient's medical history and information through the use of CDSS software.	Software is designed to assist in clinical decision-making by using an individual patient's health problems against a network of computerised clinical knowledge, which is then sent to the physician for a decision

2.4.2 Digital health technology uses

2.4.2.1 Healthcare communication

Literature has highlighted the importance of effective communication as a key attribute in terms of the measurement of patient preferences and satisfaction with the delivery of healthcare services. The association between patient–provider communication and health outcomes is well document (Chichirez & Purcărea, 2018;Sheldon & Hilaire, 2015; Hiller *et al.,* 2015; Windover *et al.,* 2014). As a fundamental clinical skill, effective communication is the foundation for any relationship in healthcare, and to consistently deliver high quality care, it is imperative that this relationship is strong and meaningful. Since nurses across the world are engaged in innovative practice on a daily basis, effective communication is imperative when it comes to delivering safe, high-quality medical care. Communication between healthcare providers and patients affects

patient outcomes. Safe practice depends on effective communication, as it facilitates the establishment of a relationship of trust between the medical staff and the patient-customer. Furthermore, communication skills enable effective interactions between nurses and patients, and nurses and other healthcare workers (DeVoe *et al.,* 2008; Windover *et al.*, 2013; Sheldon & Hilaire, 2015; Chichirez & Purcărea, 2018).

Foronda *et al.* (2016) conducted an integrated review on interprofessional communication and suggested that nurses and physicians are trained differently and therefore have different communication styles. The distinct frustrations that nurses and physicians expressed with each other are outlined in their review. For example, physicians' frustrations with nursing communication include Nurses' disorganization with information; and Nurses' illogical flow of content. Distinct frustrations that nurses have with physician communication include the following: Physicians seemed inattentive; Physicians seemed unwilling to discuss goals of care; Physicians wanted to know the nurse's overall impression; Physicians wanted to hear relevant data. Nurses felt they could only discuss a list of signs and symptoms instead of stating the problem.

However, whilst the review highlights the differences in communication styles of nurses and physicians, it succinctly verifies that miscommunication results in poor patient outcomes. According to the authors, ineffective communication in healthcare could result in delayed treatment, misdiagnosis, medication errors, patient injury, or death. They further recommend that improving the effectiveness of communication in healthcare should be prioritised (Foronda *et al.,* 2016). This view builds on Coiera's (2006) view that ascribes communication failures as a large contributor to adverse clinical events and outcomes.

Windover *et al.* (2014) developed the REDE model as a conceptual framework for teaching relationship-based healthcare communication based on the three phases of Relationships, namely: Establishment, Development and Engagement (REDE). According to the authors, this framework was established on the premise that genuine relationships are an essential therapeutic agent, and therefore have the ability to positively impact both patient and provider. The authors state that whilst many healthcare communication models are in existence, the REDE model builds on skills that clinicians already possess and the model, therefore, characterises communication skills as tools in a toolbox, which are to be applied as and when needed. This model organises effective communication into three distinct phases: establishing the relationship (by creating a conducive environment for making a personal connection; developing the relationship (once the safe and secure environment has been created, the next phase is about getting to know the

patient and understanding their symptoms, thereby allowing the relationship to grow); and lastly, engaging the relationship (this phase aligns with the education and subsequent treatment part of the patient encounter and is meant to enhance health outcomes by improving patient comprehension and recall and their capacity to give informed consent, patient self-efficacy, adherence to treatment and the subsequent self-management of chronic conditions (Windover *et al.,* 2013). Similarly, Chichirez and Purcărea (2018) explain in their research on interpersonal communication in healthcare that in the healthcare system, communication becomes increasingly more of a therapeutic technique, thus pointing to a clinical skill that creates essential relationships and that may be beneficial to those involved, and therefore, having high communicative skills must be a priority for health professionals.

In exploring healthcare communication models in private physiotherapy practice, Hiller *et al.* (2015) draw on two established models of healthcare communication, namely, a physician-centred model and a patient-centred model. The former is the traditional communication for healthcare consultations, which is content-based and focuses on causes and explanations for the presenting condition. The latter is the process that is required to achieve patient-centred care, which is primarily focused on gathering information and tailoring treating in accordance with the patient's needs and perspectives. The practitioner, therefore, takes their cue as to what is important to patients themselves (Hiller *et al.,* 2015).

Effective communication involves teamwork, collaboration, and understanding each other's roles It is important that educators recognise that teaching sound communication skills and diversity training need to be incorporated into nursing curricula. Research suggested that training programmes with the use of standardised tools and simulation are effective in improving interprofessional communication skills. It is recommended that training include more than just communication techniques to address the broader related constructs of patient safety, valuing diversity, team science, and cultural humility (Foronda *et al.,* 2016).

2.4.2.2 Referral coordination

In healthcare, the timeous exchange of relevant information on the patient is vital to ensure the quality of care. The appropriate use of referral and reply letter, considered to be the main form of communication between primary care and out-patient secondary care are thus paramount to help avoid medical errors, test duplications and subsequent delays in diagnosis (Vargas *et al.,* 2018).

A number of studies have found that the quality of both referral and reply letters can be vastly improved. Of major concern is the apparent lack of a real exchange of information. Studies confirm that often, referral letters were shown to provide only a partial opportunity for the specialists to supply a focused reaction. Reply letters, on the other hand, very often contained only standard clinical details and little or no consideration of important diagnostic information, therapeutic considerations, or information given to patients/relatives. Often, important information is not included in referral letters. Faulty communication hampers the ability to take a complete history and to form diagnostic hypotheses and may cause consultants to repeat previously ordered tests or to recommend therapy that has already proved ineffective (Grol *et al.,* 2003; Campbell *et al.,* 2004; Martinusen, 2013).

Referrals in the outpatient setting are an essential component of primary care. However, paper-based referrals are particularly hard to track and are susceptible to loss in the fragmented outpatient environment where information transfer occurs between practices and often between physical locations. Singh *et al.* (2011), in the research on follow-up actions on electronic referral communication in a multispecialty outpatient setting have found that electronically transmitted referrals may overcome many of the risks intrinsic to the physical exchange and handling of paper-based requests. Furthermore, referrals by means of integrated electronic health records (EHRs) would allow practitioners to easily document the reasons for referral, facilitate subspecialist access to relevant clinical information, and allow subspecialists to readily communicate.

Hysong *et al.'s* (2011) research on successful coordination of electronic health record based-referrals have found that the use of information technology has significant potential to improve care coordination. Electronic referrals, according to the authors, are able to better ensure the delivery of referrals, improve documentation, and standardise the referral format when compared to other referral methods For instance, referrals may be more successful when transmitted through an integrated electronic health record, otherwise referred to e-referrals, allowing the primary care provider and subspecialist to exchange information electronically, and both have immediate access to the entire patient record. However, lapses in patient follow-up do seem to occur, which would suggest a need for improved communication and coordination of EHR-based referrals to maximise the benefits of the EHR referral process. The authors note that the barriers that are encountered with successful e-referrals were not ascribed to difficulties with the EHR technology per se, but rather to basic issues pertaining to coordination and communication. In other words, ensuring that all parties involved in the referral process need to have a clear

understanding of their role and how each party's individual contributions would ultimately impact the referral process as a whole (Hysong *et al.,* 2011). This is supported by research of Bettano *et al.* (2019), whose research on the use of electronic referrals to address health disparities and improve blood pressure control has demonstrated that an electronic referral system can successfully direct referrals to community organisations to address health disparities and ultimately improve health outcomes (Bettano *et al.,* 2019).

According to Cifra *et al.* (2020), clinicians require effective feedback on individual patient outcomes to improve their diagnosis and management skills; however, systems to support this type of feedback are underdeveloped. To improve and facilitate their diagnosis and management skills, clinicians need consistent, timely, and accurate feedback. Feedback helps clinicians become better calibrated, which would leads to more appropriate clinical decisions. Health IT has the potential to facilitate this process and overcome the barriers which hamper effective feedback. The authors conclude that, for IT-supported outcome feedback systems to facilitate positive healthcare outcomes, thoughtful and thorough integration into the technical aspects of the healthcare environment is imperative. However, this requires collaboration between healthcare organisations, informatics specialists, I vendors and policy makers.

2.4.2.3 Prescription and medication management

Prescription and medication management are digital approaches that help to facilitate the management of prescriptions, including tracking prescription orders and monitoring physical medication consumption (WHO, 2018). Compliance with medication has become a topic of much research, and various interventions have been proposed to improve patient compliance (Kramer *et al.,* 2006; Cramer *et al.,* 2008; Mann *et al.,* 2010; Chong *et al.,* 2011; Parker *et al.,* 2013; Grindrod *et al.,* 2014; Oliveira & Ramos, 2019).

As far back as 2003, the World Health Organisation (Who & Consultation, 2003) concluded that poor adherence to the treatment of chronic diseases is a worldwide phenomenon. As a result, poor adherence to long-term therapies will ultimately result in poor health outcomes and an increase in health costs. Medication nonadherence significantly impacts the health and wellbeing of individuals, particularly those with chronic disease.

Most of the care required for chronic conditions require patient self-management, medical technology to assist with monitoring, and lifestyle changes on the part of the patient. Consequently, patients face potentially life-threatening risks if they are not adequately supported.

It is therefore imperative that patients are adequately supported by the health system. Adherence may therefore be improved through the use of medical technology which may enhance the safety of patients. As a result, the WHO recommends that health systems evolve to meet these challenges (Who & Consultation, 2003).

The WHO further found that adherence is influenced by a number of factors, most notably the patient's ability social and economic factors, the healthcare system or team, the nature and characteristics of the disease and associate therapies and other patient related factors. The WHO report states that solving these problems is dependent on improving patients' adherence to therapies. Furthermore, since there is no effective, one-size-fits-all intervention strategy, interventions that are specifically geared towards targeting adherence to the particular illness-related demands are required.

For this to succeed, it is imperative for health professionals to be trained in adherence management. Training should be focused on knowledge (this refers to information on adherence), thinking (which refers to the clinical decision process), and action (referring to the behavioural tools for health professionals) (Who & Consultation, 2003).

For chronic conditions such as diabetes, hypertension and dyslipidaemia, it was found that up to one-half of individuals will stop taking a particular medication as prescribed within the first year (Grindrod *et al.,* 2014). A study conducted by Kramer *et al.* (2007) determined that in terms of compliance, patients filled 72% of prescriptions in the first year of treatment. The study of Kramer *et al.* (2007) on adherence to B-blocker therapy for one year after acute myocardial infarction in patients with commercial health insurance concluded that adherence to h-blocker therapy in the first year after myocardial infarction is poor, which suggests that factors other than medication cost are important determinants of long-term adherence.

A review conducted by de Oliveira and Ramos (2019) on adherence to fibromyalgia treatment suggests a large number of nonconformity of prescriptions. The study found that the patient's quality of life was always higher in patients with higher adherence to treatment and persistence.

Mobile Health (mHealth) technologies have transformed the world of medicine and the delivery of healthcare services in a remarkable manner and, in some instances, at an extremely rapid pace. As such, a number of studies cite mHealth as a rapidly emerging field with the potential to assist patients with medication adherence, with the help of enhanced communication with providers, monitoring treatment-related side effects and pain levels, and increased access to pain care

resources. As a result, the application of mobile computing and communication technology is rapidly expanding in the fields of healthcare and public health. (Free *et al.,* 2010; Parker *et al.,* 2013; Grindrod *et al.,* 2014; Wallis *et al.,* 2017).

Mobile Health or mHealth is referred to as the use of mobile phone technologies for health-related purposes (Bloom *et al.,* 2017). Since mHealth technologies are largely 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. Examples of mobile technologies include smartphones, cellular phones, sensors, pagers, personal digital assistants (PDA) and tablet computers (Blaya *et al.,* 2010; Gagnon *et al.,* 2016).

The WHO describes mHealth as broadly encompassing the use of mobile telecommunication and multimedia technologies as they are integrated within increasingly mobile and wireless healthcare delivery systems, and includes technologies like mobile phones, personal digital assistants (PDAs), and smartphones, patient monitoring devices, mobile telemedicine/telecare devices, MP3 players for mLearning and mobile computing (Mechael & Sloninsky, 2008).

Innovations in the field of mHealth are addressing a vast number of issues related to improving health aspects, such as the convenience, speed, and accuracy of diagnostic tests; monitoring chronic conditions, medication adherence, appointment keeping, and medical test result delivery. Furthermore, mHealth has further led to an improvement in patient-provider communication, health information communication, remote diagnosis, data collection, disease and emergency tracking, and access to health records. As a result, mHealth can and is already contributing to the mandate of WHO in terms of health promotion, supporting the health work force, and enhancing service delivery (Mechael & Sloninsky, 2008).

Parker *et al*.'s (2013) research sought to examine the willingness of older adults with chronic pain to adopt mHealth technologies and have found that adults over the age of 50 years are willing to use mHealth to assist with pain management. However, a number of perceived barriers and facilitators to adopting mHealth technologies were uncovered. Barriers include cost and perceived invasion of privacy, as well as functional barriers such as visual and auditory deficits and forgetfulness. The majority of participants, however, expressed a willingness and excitement to use mHealth, provided it is tailor-made and user-friendly for older adults. The authors express the need to understand older adults' perceived barriers and facilitators to mHealth, which, in turn, could inform device design and consumer adoption strategies thus leading to improved pain care in this rapidly expanding patient population. For mHealth interventions to be both effective and

accepted by older adults, this necessitate technologies that are custom-made for this particular group of users.

This view is supported by Grindrod *et al.* (2014). The latter's research, which focused on evaluating user perceptions of mobile medication management applications with older adults have shown that adults over the age of 50 years are also accessing mHealth in increasing numbers. The authors conclude that with adequate training, adults aged 50 and over can be capable and interested in using mHealth applications for their medication management. However, to adopt such technology, designers, programmers, and developers need to consider older adults as potential high-impact end-users and as a result, they need to be included the design process. The authors propose the inclusion of applications that provide high quality information on side effects or drug interactions, thereby reducing the risk of errors and omissions.

In assessing the attitudes of pharmacists, students and the general public on mHealth applications for medication adherence, Davies *et al.* (2014) have highlighted that mobile healthcare applications offer an innovative way to improve patient adherence to medication, thereby negating the problems associated with non-adherence. This form of technology is particularly valuable to patients with complex medication regimens and those with cognitive impairment along with carers. Furthermore, a systematic review conducted by Anglada-Martinez *et al.* (2014) on whether mHealth increases adherence to medication found that mHealth facilitates patient adherence to medication.

The adherence model proposed by the World Health Organization (WHO) illustrates the participation of some factors in the adherence process, namely aspects related to the healthcare team, factors related to the treatment itself, aspects related to the disease, the patient and socioeconomic factors (WHO, 2003). Medication management is a complex process, at high risk of error with life-threatening consequences, as is laboratory and diagnosis imaging management (WHO, 2018).

2.4.2.4 Laboratory & diagnosis imaging management

Laboratory and diagnosis imaging management is another digital approach to managing and exchanging laboratory and diagnostic orders and results (WHO, 2018). Laboratory testing is considered vital to modern healthcare as it serves as a tool for screening, diagnosis, prognosis, stratification of disease risk, treatment selection, and monitoring of disease progression or treatment response. Furthermore, it serves as a guide for hospital admissions and discharges

(Rubinstein *et al.,* 2018). In healthcare, different services and systems are involved in the provision of patient healthcare provision, namely clinical, diagnostic, and supporting cross-cutting services. To serve patients and to deliver continuous quality healthcare, these services and systems are interconnected and interdependent. The availability of laboratory tests, as well as accurate and reliable results, contributes significantly to the quality of patient treatment. As a result, laboratories are crucial because clinical services depend on them for decisions regarding patient management (Rusanganwa *et al.,* 2019).

According to Anonychuk *et al.* (2012), laboratory medicine is a medical specialty at the core of healthcare. As stated by the author, when utilised properly, laboratory medicine is able to generate knowledge, which has the potential to result in the facilitation of patient safety, improvement of patient outcomes, shortening of patient journeys and ultimately lead to more cost-effective healthcare. It therefore goes without saying that optimal use of laboratory medicine is reliant upon dynamic and authoritative leadership outside as well as inside the laboratory. Naugler and Church (2018) discuss the great technological advances that the clinical laboratory has undergone in recent years. From the development of automated laboratory analysers to development and widespread adoption of third-generation laboratory information systems, to the emergence of cheap data storage, resulting in many laboratories now storing clinical data indefinitely. However, given the high demand for laboratory medicine services, laboratory medicine specialists are under pressure to deliver a modern service that is both clinically efficient and cost-effective. But this can only be achieved by 'working smarter' – this would include eliminating waste, targeting clinical priorities, adopting automation and communication technology, altering the staff skill mix, networking services and sharing the costs with users (Anonychuk *et al.,* 2012). A number of studies cite the problem of inappropriate ordering or overutilisation of laboratory tests. Inappropriate laboratory utilisation includes both over-utilisation and under-utilisation. Examples of tests that are most subject to over-utilisation include routine automated tests such as complete blood counts and chemistry panels, whilst some tests, particularly screening and monitoring examinations such as cholesterol, haemoglobin and HIV testing are commonly under-utilised. Conversely, laboratories may perform tests not requested, provide poor turnaround of test results or collect incorrect samples (Janssens, 2010; Huck & Lewandrowski, 2014; Fryer & Smellie, 2013; Naugler, 2014; Plebani, 2018). Excessive laboratory utilisation, according to Yeh (2014), is a common problem in the hospital setting. Physicians control up to 80% of healthcare costs, exerting great influence. Yeh believes that overutilisation

can be ascribed to factors such as fear of missing a diagnosis, provider inexperience, peer pressure, financial rewards, practice inertia, and fear of legal punishment.

As a measure of control and in an attempt to streamline the utilisation, Janssens (2010) suggests the most promising new management tool, namely, computerised laboratory management systems (CDSS), which, in essence, is a reimbursement system based on the diagnosis–treatment combination (used in the Netherlands) and the allocation of a laboratory budget to those requesting laboratory services. Furthermore, Naugler (2014) suggests that the use of laboratory information systems and associated clinical decision support systems could present important tools in utilisation management, whilst Procop *et al.* (2015) devised and implemented a clinical decision support tool (CDST) (called the Hard Stop alert) that would block tests that were considered to be unnecessary more than once per day in clinical practice. Rubinstein *et al.* (2018), on the other hand, recommend the use of Computerised Provider Order Entry (CPOE) as a best practice to support appropriate clinical laboratory test utilisation.

2.4.2.5 Health system management

The role and contribution of the nurse in the hospital setting have evolved to meet the ever-increasing demands and complexity of patients. Similarly, the role of the nurse manager has expanded to meet the needs of the staff and patients in the nursing units and is considered by some to be the most demanding role in healthcare. Apart from their daily activities, they are also responsible for the management of resources, as well as the coordination and supervision of the nursing team.

According to Warshawsky and Rayens (2013), creating cultures that generate creativity, fostering relationships between hospital leaders and physicians, promoting patient safety, as well providing adequate staffing and supplying resources are critical to the success of nurse managers. This view is further expanded by Nelson (2017) who suggests that besides being responsible for the financial outcomes of the unit, nurse managers are also responsible for the experience of the patient, which includes both clinical and satisfaction outcomes. Furthermore, their responsibility includes providing a safe, engaging, positive work environment for the staff under their supervision. Nurse managers are also expected to foster relationships with and liaise with leaders of the various interdisciplinary teams throughout the hospital, as well as to promote physician engagement and partnership with nursing. In addition, nurse managers often lack sufficient authority to make decisions that impact the operations within their areas, which, as a result, could

undermine their authority, which, in turn, could lead to dissatisfaction with the work (Nelson, 2017).

Presotto *et al.* (2014) explain that the nurse manages patient care when the nurse plans it, delegates it or performs it, when interacting with the nursing team and with other professionals, and whilst adopting a participative attitude when interacting with the team and taking decisions. This should be done without imposing power, whilst simultaneously valuing the principles of team work and leadership. Furthermore, part of the management function is related to the administration of material resources, as well as the forecasting and provision of resources to provide adequate care.

It is well documented that the nurses' work environment is known for its operational pressure overload and constantly changing practices, which often lead to work overload, stress, work dissatisfaction, and ultimately burnout (Van Bogaert *et al.,* 2010; Warshawsky & Rayens, 2014; Van Bogaert *et al.,* 2014; Nelson, 2017; Cox, 2019). This is a result of nurse managers often placed in the position of managing conflicting demands as well as competing interests. Consequently, the decisions that nurse managers make may be perceived as favourable by one group while being considered unfavourable to another, placing the nurse manager in an awkward position.

Positioning nurse managers for success is vital for the achievement of exceptional patient outcomes, as well as for maintaining staff satisfaction and engagement. To achieve this success, the workload of nurse managers must be assessed and optimised. Senior hospital leaders must support the work of the nurse manager while providing opportunities for career growth and self-care.

Senior hospital leaders, in partnership with nurse managers, should consider ways to address nurse manager workload. Nurse manager satisfaction and retention are vital for the success of the hospital. Finding avenues to address concerns will increase nurse manager engagement, ultimately leading to increased staff engagement and better patient outcomes (Nelson, 2017).

2.4.3 Digital health technology issues

Over the last few decades, the volume of technology has increased significantly in many health systems around the world, and consequently, the impact of technology on the nursing role has become an increasing focus within nursing research. A large number of digital nursing technologies (DNTs) are currently being developed and tested in nursing practice, such as

electronic patient records and other online health information, triage and appointment booking systems Digital health promotion: disseminating health education messages via digital technologies, patient self-care and monitoring devices: apps, smartphones, smart objects and wearable technologies for monitoring and tracking bodily functions and activities, smart pillboxes, digital pills and implants containing microchips, electronic patches, digital wireless blood pressure monitors, ECG monitors and blood glucose testing devices. (Lupton, 2014; Krick *et al.,* 2019; Krick *et al.*, 2020).

Digital technologies continue to affect the nursing profession on a global scale. Nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare spectrum. Booth *et al.* (2021), in their study on how nurses should adapt to a digital future, focus on a number of benefits to nursing practice as a result of digital technologies. The following are examples: 1) telehealth programmes where nurses provide daily monitoring, coaching, and triage of patients with several chronic diseases have helped reduce emergency department admissions; 2) Mobile devices such as smartphones and health applications, make it possible for nurses to offer remote advice on pain management to adolescent patients with cancer and supplement aspects of nursing education by providing innovative pedagogical solutions for content delivery and remote learning opportunities.

A number of studies have shown that the use of DHTs as part of their daily work activities have proven has drastically improved patient care. Through the use of technology, tasks become easier, and time-efficient and improve nursing quality (Orhan, 2019; Fadel *et al.*, 2020; Seibert *et al.,* 2020). Govranos and Newton (2014) contend that for nurses to maintain professional development, they need continuous education to be integrated into the workplace. Studies further show that nurses generally have a positive attitude toward the use of technology as part of their daily work practice (Gürdes Topkaya & Kaya, 2015; Orhan, 2019; Gündogdu *et al.* 2018). Furthermore, Orhan's (2019) study further found nurses generally trust technological devices and think that devices produce accurate results in medical measurements, prefering to use devices rather than performing tasks manually.

However, despite substantial advances to date, challenges in nursing's use of digital technology seem to prevail. An overarching concern is that nurses have generally not kept abreast with rapid changes in digital technologies and their impact on society. This impacts the potential benefits which may accrue to nursing practice and patient care. To rise to these challenges and be prepared for the future, nursing must begin the immediate transformation into a digitally enabled

profession that can respond to the complex global challenges facing health systems and society at large (McBride-Henry *et al.,* 2022). As evident from the literature, a number of factors impact nurses' use of DHTs. The ensuing sections will endeavour to unpack some of these factors.

2.4.4 DHT USE - Factors impacting nurses' use of DHTs

2.4.4.1 Technology as a barrier between the nurse and the patient

The relationship between technology and caring is somewhat complex. In today's modern healthcare setting, there exists a symbiotic relationship between technology and caring, and an ICU demonstrates this symbiosis since technology is integrated into patient care. Furthermore, an ICU is heavily dependent on technology. Whilst technological tools are useful, technology cannot ever replace the human touch. It is also imperative for nurses to receive adequate training to use these technological tools. However, it is not uncommon for perceptions to arise that technology forms a barrier between the patient and the nurse. This is supported by research conducted by Almerud (2007) which found that ICU patients feel invisible as people, in spite of constant monitoring and observation.

Granados-Pembertty and Arias-Valencia suggest that care provided by nursing professionals cannot be replaced by a technological element. This means that the machine does not have the power to care for the patient, but rather, it is there to assist the patient. The nurse is the one who cares for the patient since the nurse is the one able to interpret and analyse, and ultimately decide what to do with the information.

According to Ali *et al.* (2022), due to the extensive use of digital health technologies in healthcare, it would also be critically important to ensure nurses, both currently in practice and future nurses, continue to be engaged and connected with their patients and to understand that digital health tools are a means to support rather than obstruct the care nurses provide. The WHO very aptly acknowledges, "we can digitalize health data, but we cannot digitalize the human side of nursing" (WHO, 2019).

According to Almerud *et al.* (2008), the readings of a machine may not be a true reflection of the patient: technology does not always provide a true picture, and nurses may often rely on their own intuition as opposed to confirmation from a machine. A number of studies have suggested that the constant use of technology may act as a barrier between the nurse and patient (Ludwick & Doucette, 2009; Granados-Pembertty & Arias-Valencia, 2013; Lapão, 2020; Barbosa *et al.*, 2021). However, research conducted by Kiekkas *et al.* (2006) has found that, according to critical

care nurses, equipment does not draw attention away from patients or cause them to lose their human sensitivity. However, nurses commented on the negative effects of technology in daily practice, such as increased patient risk due to human errors or mechanical faults, increased stress and decreased autonomy of nursing staff.

Research conducted by Ludwick and Doucette (2009) points out that the layout of an exam room, and more importantly, the placement of the computer monitor, can have an impact on the nurse-patient relationship, especially when a nurse turns away from the patient to enter clinical data into the system. In a number of instances, and under certain circumstances, nurses deviate from their normal practices and revert to foundational practices.

2.4.4.2 Workarounds

Literature suggests that many small- and medium-scale Electronic Health Record (EHR) implementations encounter problems as a result of users' difficulties to accommodate the new technology into their work practices. Consequently, end-users may either partially use a particular technology (in other words, only use the parts that they perceive as useful) or develop workarounds, or they may avoid using a technology altogether (Cresswell *et al.* 2012; Greenhalgh *et al.,* 2012; Greenhalgh *et al.,* 2010; Ludwick & Doucette, 2009).

Whilst DHTs have the potential to improve work practices for many patient care processes, there are instances where they do not support all clinical work. Consequently, users might perceive them as obstructions to delivering efficient patient care. Examples may include difficulty in finding necessary patient data or complex order entry processes, and as a result, in an attempt to avoid these obstructions and to complete the task at hand, staff would often develop workarounds (Flannigan *et al.,* 2013). Koppel *et al.* (2008:409) define *workarounds* as "actions that do not follow explicit or implicit rules, assumptions, workflow regulations, or intentions of system designers", and refer to non-standard procedures typically used as a result of deficiencies in system or workflow design.

A study conducted by Mather *et al.* (2019) found that nurses acknowledged that workarounds have occurred to accommodate the lack of access to the Internet by individual nurses providing direct care to patients. A study conducted by Koppel *et al.* (2008) on Barcode Medication Administration System (BMAS) Workarounds has found that some users deviate from prescribed BMAS-use protocols, In other words, staff does not follow explicit or implicit rules, workflow regulations or procedures prescribed by system designers. This is normally a result of deficiencies

in the system or workflow design. Koppel *et al.* further opine that workarounds often occur as a result of a misalignment of the available health IT with personnel, work practices, and the environment.

Furthermore, Flannigan *et al.* (2013) state that workarounds are largely harmless actions that do not necessarily impact work practices or affect data accuracy, nor does it necessarily circumvent health IT processes or procedures due to user interface flaws or human–technology integration factors or required actions to complete a particular task. The authors cite an example of a paper-based workaround as a clear example of an alternative work process developed for the sole purpose of enhancing efficiency and meeting specific information and task requirements in a situation in which the available electronic tools did not support nursing work. In this particular example, nursing coordinators in an inpatient setting would enter critical information on a clipboard at the end of each shift with the purpose of passing it on to the incoming nurse coordinator. Whilst the information captured on the clipboard supported their work and was easily accessible, the electronic health record was used less often than the information contained on the clipboard for that particular nursing shift.

Although workarounds may seem necessary and appropriate to DHT users and are not always problematic, it becomes an issue when it poses a threat to patient safety For example, workarounds used with barcoded medication administration systems to increase efficiency can result in giving the wrong medications to patients or giving the wrong doses.

The following sections will explore issues surrounding DNT design, development and implementation, the design and reality gap around DNTs, and nurses' lived experience with the use of DNTs.

2.4.4.3 Training [pertaining to use]

The use of technology influences how nurses do their work and ultimately interact with patients. A large number of *digital nursing technologies* (DNTs) are currently being developed and tested in nursing practice. Across the globe, there is a growing drive to implement ever more complex information technologies into healthcare settings, in the hope that these will help improve the quality, safety, and efficiency of healthcare. However, introducing technology within complex organisational systems such as healthcare is not a straightforward process.

Healthcare is increasingly dependent on information and communication technologies (ICTs), whose introduction is often characterised or hampered by limited adoption or adoption followed

by abandonment especially when part of a large, top-down change programme (Greenhalgh *et al.,* 2012; Sanders *et al.,* 2012; Greenhalgh *et al.,* 2010).

There is an indication in the literature that end-users are not averse to technology per se, rather, end-users may resist technologies if it interferes with their values, aspirations and roles, or simply if they find these technologies to be inadequate. Boussaa and Mukherji (2018) suggest that both perceived usefulness and perceived ease-of-use of healthcare technologies are significant in predicting the attitude of patients toward innovation and the intention to use it. Furthermore, they contend that the effect of the trust relationship between physicians and patients directly impacts the intention to use these technologies. Health workers' perceptions and experiences of digital health interventions are likely to be influenced by their level of digital literacy. Health workers who possess a high level of digital literacy would have positive perceptions whereas those with a low level of digital literacy would have negative perceptions in terms of technology usefulness, and as a result, they would shy away from and struggle to use the technology as they may feel intimidated and suffer anxiety because they do not understand the information being generated by these technologies (De Leeuw *et al.,* 2020).

According to the authors, some healthcare professionals have trouble coping efficiently with the demands of DHTs, both personally and professionally. Lagging behind in digital knowledge and skills hampers healthcare professionals from adhering to professional standards regarding the use of DHTs, and as a consequence, may cause professional performance problems, especially in the older professional population (De Leeuw *et al.,* 2020). The authors uncovered several barriers to obtaining basic digital skills and competencies as a result of a lack of general digital knowledge, and little or no formal digital training or education.

Studies show that nurses are keen to learn, as they want to use technology to improve healthcare and simultaneously enhance their careers (Eley *et al.*, 2008; De Leeuw *et al.,* 2020). To support this view, research by Lera *et al.* (2020) on nurses' attitudes toward lifelong learning via new technologies found that nurses believe that continuing education is paramount as their professional knowledge must periodically be enhanced and renewed. Lera *et al.* (2020) believe that nurses seek to continue their education for a variety of reasons. Whilst some may wish to improve their skills and abilities and the services they provide to their patients; others may simply desire to gain more knowledge or aspire to earn higher salaries or further their careers.

Patmon *et al.* (2016) studied nurses' perceptions towards the introduction of interactive patient engagement technology in clinical practice have found that nurses felt they missed important

training or that training was not long enough. This was largely attributed to training being scheduled during work hours, which made it difficult for nurses to attend the training sessions. It was further found that many nurses learned how to navigate the system from tips shared from their peers on the unit. The authors further recommended that hospitals need to provide sufficient training for nurses on the new system. In addition, nurses should be allowed sufficient time to navigate and explore all the functionalities (Patmon *et al.,* 2016).

Conversely, nurses who are digitally lagging often have had insufficient and ineffective digital education which often results in feelings of stress, frustration, incompetency, and postponement or avoidance of DHT use. It is therefore imperative that training be tailored to the needs of nurses, accompanied by sufficient on-the-job training and adequate peer support (De Leeuw *et al.,* 2020).

Following decades of using standard forms and following standard healthcare procedures, nurses will need to adapt to the use of DHTs and for successful implementation of DHTs in the healthcare system, nurses will require training. DHT and HIS are smart and their use thereof can be maximised by putting measures in place to make the systems user-friendly, consulting professionals in system and service development, and increasing healthcare workers' training in information management, electronic documentation, data protection and data security. The level of nurses' informatics competencies, supported by adequate in-house training, will increase significantly (Kinnunen, Heponiemi, Rajalahi *et al.,* 2019). There are however major factors that may stand in the way of a successful implementation of DHTs: the utter lack of time for nurses to attend training and master the high capacity of complex systems due to their shortage of staff, long working hours, heaviness of workload, and limited time and resources (Kinnunen *et al.* 2019).

The increasing value of well-trained health informatics is evidenced by studies conducted in Uganda and Botswana which found that training while working and mentorship are significant enablers for HIS in low- to middle-income countries (LMICs). It was also demonstrated that being trained while working improved performance by effectively and efficiently reporting key health indicators. This proved to be an efficient approach for strengthening the capacity for monitoring and evaluation as well as ensuring high-quality data within a national healthcare system (Khubone *et al.,* 2020). Outcomes of further studies might have an effect on creating training opportunities for nurses on health informatics as there is a dire need for it.

A study by Mather *et al.* (2019) demonstrates that nurses from professional organisations understand their health workforce but lack the agency to demand inclusion when it comes to decision-making that impacts nurses at organisational and individual levels.

2.5 DNT design and development

According to Patmon *et al.* (2016), organisations must show full support in all aspects of implementation and post-implementation. Part of this support should include the provision of sufficient and specifically tailored training for nurses on how to use new technologies to interact with their patients.

Ongoing communication during the first couple of months post-implementation, including tips to share with their colleagues and training on the new system, is essential in ensuring that nurses are utilising new technologies to their full capacity.

2.5.1 Digital health technologies design and development

The involvement of healthcare stakeholders in the planning design and implementation of digital systems is vital; however, this is not always done. This culminates in healthcare workers not being fully satisfied with the technologies because their needs have not been met (WHO, 2019).

Abundant literature exists on the non-inclusion of nurses in the design and development of DHTs. Consequently, nurses fail to contribute to the development of new technologies, and they are not involved in the decision-making process. This not only negatively impacts the quality of care that patients receive, but it also impacts the morale of nurses. Furthermore, a lack of inclusion not only negatively impacts the quality of care that patients receive, but also the overall efficiency of the healthcare system (Ludwick & Douchette, 2009; Boonstra & Broekhuis, 2010; Mather *et al.,* 2019).

As nurses comprise the largest group of stakeholders in the healthcare sphere, Mather *et al.* (2019) conducted research highlighting the urgent need for this group of health professionals to be fully engaged in the digital future of healthcare environment, and in doing so, become stakeholders at every level.

2.5.2 Digital technologies implementation

Ludwick and Doucette (2009) state that the design and implementation of digital technologies should be informed by users. This view is supported by Boonstra and Broekhuis (2010), citing the change process as a challenge as well as a problem. Gulati (2008) notes that, while this is the intention of the designed function of ICT for education, reality does not always live up to the hopes.

Ludwick and Douchette (2009) note that the quality of the implementation process is as important as the quality of the system being implemented, and stress that, to ensure successful implementation, it is imperative that health system usability, computer skills and the actual systems fit within the organisational culture and processes. In a study conducted by Kiekkas *et al.* (2006), nurses opine that machines are usually purchased and controlled by the medical profession and designed to meet the needs of medical practice rather than nursing. As a result, doctors guide nurses and give them instructions on how to use devices.

2.5.3 Digital health technology design, reality and implementation gaps

It is not entirely uncommon for health workers to experience issues surrounding the design of digital health technologies, since end-users are often left with technologies that do not meet their expectations. Whilst health workers deem it important to be involved in the planning, design and implementation of digital technologies, this is not always the case. The importance of nurses' participation in the process of technology development is frequently reiterated by stakeholders, which raises further concern.

However, actual participation has been described as negligible and limited as nurses' are often unable to identify and communicate their needs and ideas for the improvement of digital nursing technologies (DNT) in everyday care. The authors' study found a deep desire, mostly by nurses with additional management responsibilities, to participate in the development and testing of DNTs practice (Seibert *et al.,* 2020).

Mather *et al.* (2019) in their research on nurses as stakeholders in the adoption of mobile technology in Australian Healthcare Environments have found that as digital technology has been introduced into healthcare environments, nurses have struggled to be included in decision-making processes. Nurses feel disempowered as a result of failure not being given clear direction about access to, and use of, digital technology at systems, organisational, and individual levels.

In addition, lack of empowerment can also be attributed to the cost of preparing nurses to become digitally literate. According to Slevin *et al.* (2020), digital health technology promises to support patients and healthcare professionals in an effort to optimise the management of chronic obstructive pulmonary disease (COPD). The authors state that this is due to the lack of user-involvement in the development of DHT interventions in COPD; in other words, their needs and preferences are rarely considered in the design phase. Hamer and Cipriano (2013) note that health technology projects often use senior managers to advise on and set up projects, and very

often, these managers are unfamiliar with healthcare settings. They stressed the importance of involving those who provide direct care in the design, selection and testing of new technology. An integrative review by Brown *et al.* (2020) examining the factors influencing nurses' capacity and skills to use digital technology at work recommends the involvement of nursing staff in the process of developing technology and prioritising continuous education for nurses in an effort to increase their proficiency. The authors stress that involving senior nurses in the development of new technology, coupled with orientation of staff, will go a long way towards capacity building and the successful implementation of digital technology in nursing care. Furthermore, the involvement of nurses in the development process will enhance nurses' user experience.

It is therefore imperative for nurses to advocate for their involvement in all aspects of the design, implementation and evaluation of digital health technologies. Failure to do so will result in the implementation of DHTs which are not compatible with nurses' work practices, causing low morale and dissatisfaction.

2.6 Proposed conceptual framework

The proposed framework is based on the literature reviewed according to the research orientation.

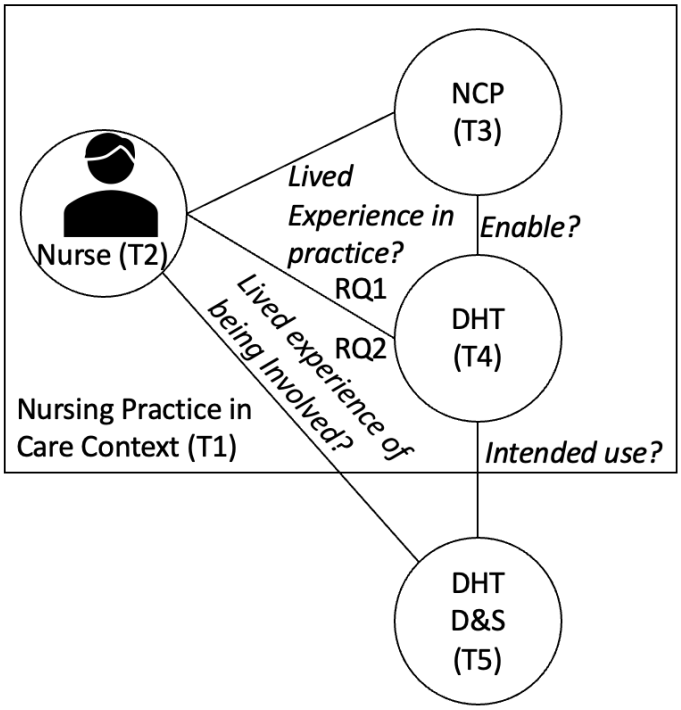


Figure 3: Proposed conceptual framework for the study

The figure above, representing the proposed conceptual framework, shows the relationship between the research problem and the research questions.

The conceptualisation of the study is based on five theoretical concepts:

- **Theoretical theme 1:** Nursing practice in the care context to consider the care situation in the specific context.
- **Theoretical theme 2:** The person using the digital health technologies in practice in the situational context of work, namely the nurse as the user.
- **Theoretical theme 3**: Nursing care processes as the activities that form part of the care process.
- **Theoretical theme 4**: The digital health technologies used by the nurse to enable the nursing care process.
- **Theoretical theme 5**: The DHT development and support processes and nurse involvement in the development and support processes versus the use of DHTs.

Research question 1 maps the lived experience of the nurse who uses DHT in the nursing care process when providing care to patients in a particular situation.

- *Theoretical lens:* lived experience of a nurse during NCP using DHT in a care situation.
- *Normalisation process theory:* to gain insights into the nurses' use of DHT from its introduction to it becoming part of the nurses' care practices and routine work.

Research question 2 maps the lived experience and the nurses' involvement in the development and support processes versus the use of DHTs.

- *Theoretical lens:* lived experience of the nurses' involvement in the DHT development process.

The focus of the study is where these five themes are joining together to establish the nurse's lived experience of using digital health technologies to enable the care processes.

Theoretical theme 1: The literature reviewed for this theme is discussed in sub-section 2.2 and dealt with healthcare in context. Nursing practice in the care context to consider the care situation in the specific context. As explained by Pope (1995) nursing practice is care-based and executed by nursing processes and is thus a problem-solving process. As Jarrin (2012) explains, nursing practice is generally influenced by the situation, meaning it is influenced by time, place and

purpose. In other words, the caring is dependent upon where you are (meaning the time, space and culture, and also the level of development of the individual). When discussing the nurse-patient relationship, the author refers to how the work environment (workplace culture, staffing, availability of resources) influence nurses' perceptions regarding the practice of nursing.

The participants for this study are drawn from two healthcare institutions, Hospital A and Hospital B, both public hospitals. The study focused on the ICU and Emergency Care Unit respectively, which are both highly technological environments of hospitals in the Western Cape in South Africa.

Theoretical themes 2 & 3: These themes are based on the literature reviewed that is discussed in sub-section 2.3. The person using digital health technologies in practice in the situational context of work, is the nurse as the user. It is clear from the literature that the introduction of technological devices has resulted in a drastic change in the amount, duration and location of nursing activities, as well as nursing staff's daily routines. As a result of the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of DHTs into their routine clinical work practices. The purpose of this study was to examine the lived experience of nurses using DHTs in practice. it is important to gather their perspectives and personal experiences to ascertain the extent to which the use of DHTs has been embedded into their daily work practices.

As an important aspect of nursing, the nursing process aims to promote the reflective practice as well as critical thinking. Furthermore, it aims to identify, diagnose, and treat actual or potential human responses to health and illness and can be described as a strategic approach to assessing and care for patients. It is thus imperative that steps are followed in sequence, from start to finish, to ensure that the needs of the patient are adequately addressed (Potter *et al.,* 2004; Ead, 2019). Since the nursing process forms an integral part of the nurses' care practices, their perceptions of using digital health technology from its introduction until it becomes an integral part of their practices, are an important consideration for this study. In addition, for the purposes of this study, it is important to ascertain the extent to which DHTs enable the nursing process and how it facilitates the nurses' work practices.

Theoretical theme 4: This theme based on the literature is discussed in sub-section 2.4. to indicate how the digital health technologies used by the nurse enable the nursing care process. There is abundant literature supporting that digital technologies provide a number of opportunities to address health system challenges, and in doing so, offer the potential to enhance the coverage

and quality of health practices and services. Nurses are therefore exposed to a variety of DHTs and as such, they need to incorporate these technologies into their daily work activities. It is important for this study to determine whether it facilitates or impedes their work. The literature emphasises the importance of nurses' use of DHTs when providing care across the healthcare sphere. The ICU and Emergency Care settings require competent nurses to help save and secure the lives of patients, and this would not be possible in the absence of technology. It is, therefore, for the purposes of this study, to gain the perceptions of nurses as they use DHTs in practice.

Theoretical theme 5: This theme is based on the literature discussed in sub-section 2.4.5. where the DHT development and support processes and the nurses' involvement in the development and support processes versus the use of DHTs are considered. A number of studies have been conducted on the non-inclusion of nurses in the design and development of DHTs. As a result of this, nurses fail to contribute to the development of new technologies, and they are not involved in the decision-making process. This not only negatively impacts the quality of care that patients receive, but it also impacts the morale of nurses. Furthermore, a lack of inclusion not only negatively impacts the quality of care that patients receive, but also the overall efficiency of the healthcare system (Ludwick & Douchette, 2009; Boonstra & Broekhuis, 2010; Mather *et al.*, 2019). Health workers inevitably experience issues surrounding the design of digital health technologies, and as a result, are often left with technologies that do not meet their expectations. This study is partly aimed at determining the extent to which nurses and nurse managers have been included in the design and development of DHTs. Furthermore, it is important to ascertain the level of alignment of the DHTs with their work practices versus their actual use of DHTs.

2.7 Chapter conclusion

This chapter sought to highlight the theoretical underpinnings for this study in an effort to ascertain the extent to which DHTs has been embedded into the daily lives and work activities of participants of this study. The study further aimed to understand the work activities of healthcare workers, particularly from a nursing perspective. As a result, the researcher considered a number of prominent IS theories, all of which are meritorious, but failed to depict the subjective experiences of nurses as they are generalised and the lived experience of nurses are not addressed. Subsequently, the researcher's choice of theory, namely the NPT, was adopted and used as an analytic lens to understand how nurses make sense of their work practices as the DHTs influence their lived experience of using DHTs, and to ascertain the level of alignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Pursuant to the discussion in Chapter 2 pertaining to the theoretical underpinnings, in this chapter, the researcher expounds on the processes that were followed to collect, analyse and interpret the empirical evidence and subsequent findings of this research.

The aim of this qualitative study was to understand, analyse and assess the nurses' lived experience of using DHTs as part of their work practices to better guide DHT design and implementation and offer additional insights to the body of scientific knowledge to optimise the use of DHTs in public healthcare institutions in South Africa. In addition, the normalised process theory will also be used as an analytical lens to gain insights in the nurses' experience of using DHTs in their work practices from when these technologies were being introduced to them becoming part of their practices. This chapter explains the research design and methods which were used to achieve the aims and answer the research questions put forth in this study. The procedures employed in this case study to collect, analyse and interpret data are described as well as the standards used to evaluate rigor and truth value. The protection of human subjects is also addressed in this chapter. Findings of this study analysed through the lens of the NPT will be presented in Chapter 5, and the findings of the thematic analysis, including the discussion, conclusions, and recommendations related to the findings of this research will be presented in Chapter 6.

3.2 Research aims and questions

This study explored the lived experiences of nurses working with DHTs in target hospitals, which comprised one tertiary hospital (henceforth referred to Hospital A) and one district hospital (henceforth referred to as Hospital B). Methods and procedures employed in this case study aimed to 1) understand the subjective transitional experiences of nurses working with DHTs as revealed by their stories about the conversion to digital health technologies (DHTs); 2) identify the challenges discussed in the stories about the process and related changes in the workplace; and 3) describe strategies the nurses used to help them adapt. Achieving the aims of this study provided answers to the following research questions: 1. *How do nurses make sense of their work practices as the DHTs influence their lived experience of using DHTs?* 2) *What is the level of alignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice?*

3.3 Study design and methods

Developed by Saunders *et al.* (2007), the research onion was developed to depict the stages the researcher needs to undergo to develop an effective methodology. The ensuing section will describe the various stages.

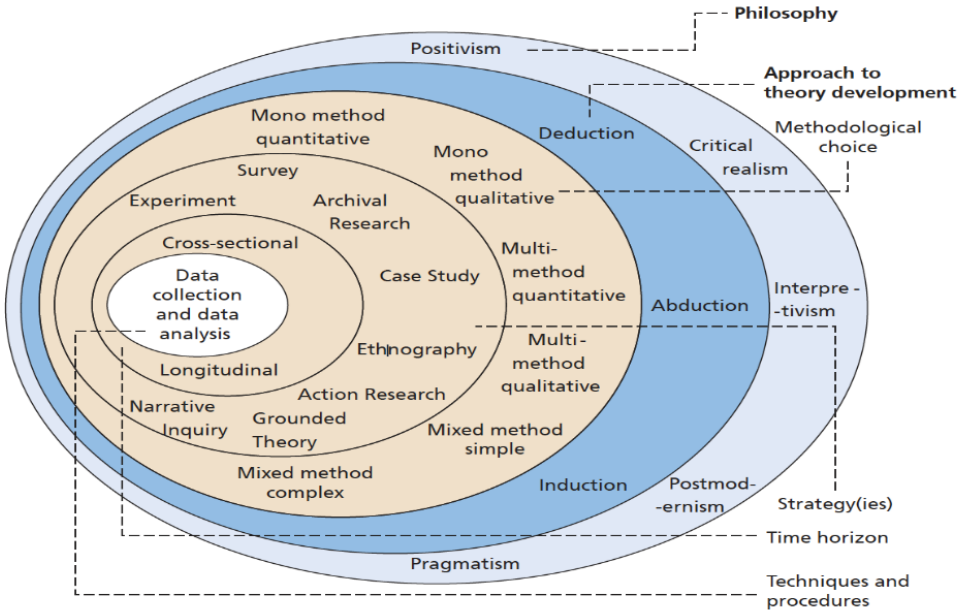


Figure 4: Research Onion (Saunders *et al.*, 2019)

3.3.1 Research design

Babbie and Mouton (2010:75) describe *research design* as a map that focuses on the end product, in other words, what type of study is being planned and what kind of result is to be expected. Traditionally, the map starts with a research problem or question. The authors further state that research design is focused on the basis of what type of phases are required to adequately address the research question. The authors clearly point out that research design is not to be confused with research methodology. Research methodology focuses on the research process as well as the type of tools and procedures that will be used. The research design, therefore, is the plan or blueprint of how an investigation is intended to be conducted. Bhattacherjee (2012) agrees, regarding research design as a comprehensive plan for data collection which aims to answer specific research questions or to test specific hypotheses. In essence, a research design should specify at least three processes: 1) the data collection

process, 2) the instrument development process, and 3) the sampling process. Saunders *et al.* (2019) refer to a *research design* as the general plan of how you will go about answering your research questions. The research design should contain clear objectives, derived from the research questions, and should specify the sources from which data are collected, with considerations to likelihood of constraints (e.g., access to data, time, location and money) as well as discussing ethical issues. Most importantly, it reflects the fact the researcher understands the valid reasons for taking certain decisions. The justification for the chosen research design is based on the research question(s) and objectives (outlined in sections 2 and 3) and should be consistent with the research philosophy.

3.3.2 Research philosophy and approach

Research philosophy, as described by Saunders *et al.* (2019), relates to the development of knowledge and the nature of that knowledge. Research philosophy contains the important assumptions about the way in which the researcher views the world. Cibangu (2010) describes a *paradigm* as a philosophy or set of assumptions, beliefs, world views or values used to justify the existence of knowledge and the choices of how it is studied in a scientific research. Furthermore, these assumptions will underpin the research strategy and the method that the researcher will choose as part of that strategy.

~~There are two major types of research philosophy, namely, ontology and epistemology. Ontology relates to the nature of reality and its characteristics. Ontology has two perspectives, namely, objectivism and subjectivism. Objectivism refers to how social entities exist independent of social actors, whilst subjectivism refers to understanding the meanings that individuals attach to social phenomena (Saunders *et al.,* 2019). Epistemology, on the other hand, refers to that which constitutes acceptable knowledge in a particular field of study (Creswell & Poth, 2016). In other words, it refers to the relationship between the researcher and what is being researched. With an epistemological assumption, researchers try to get as close as possible to the participants being studied. In qualitative studies, therefore, researchers conduct their studies in the 'field'. In this way they get to know where their participants live and work, which are important contexts for understanding what participants are saying. Subjective evidence is gathered based on individual views, in other words, the knowledge is known through the subjective experiences of people (Burke, 2007). Two popular epistemological research philosophies are widely discussed in research literature, namely, positivism and interpretivism.~~

Krauss (2005) explains that in a *positivist* approach, science is viewed as the way to understand the world well enough so that it can be predicted and controlled. To achieve this, deductive reasoning is used to propose theories that can be tested (Krauss, 2005). Saunders *et al.* (2018) note that a positivist researcher will therefore typically use existing theory to develop hypotheses. Positivism is derived from natural science and is characterised by the testing of hypothesis which is developed from existing theory and is therefore deductive in nature. It is based purely on facts that are gathered by means of direct observation and experience and is empirically measured using quantitative methods such as surveys and experiments. In the positivist paradigm, knowledge is acquired through survey and experiment, regardless of the context and related concepts such as feelings, opinions, values or cultures (Cibangu, 2010). To prevent influencing the findings of their researcher, a positivist researcher will therefore remain neutral and detached from the research.

However, Since this study was of a qualitative nature that largely depended on the subjective views, opinions and even sometimes, the culture of individuals (social actors) associated with the phenomenon of study; hence a positivist approach could not be adopted for this study. An alternative philosophy – interpretivism is discussed. was considered.

Walsham (2006) explains that interpretive methods of research are based on the premise that our knowledge of reality, which includes human action, is a social construction by human actors (Walsham, 2006). According to Flowers (2009), an *interpretivist paradigm* suggests the existence of multiple realities and that knowledge is relative to the individuals or social actors. Also, interpretivists believe that, in the social world, individuals and groups make sense of situations based on personal experiences, memories and expectations. In other words, interpretivists aim to make sense of, derive meaning and understand social realities from their subjective interpretation of other people's experiences and opinions in a certain context. Since the purpose of interpretivist research is to create new, richer understandings and interpretations of social worlds and their contexts, it was deemed appropriate to fulfil the aim of the research, which was to understand the nurses' lived experience associated with the use of DHTs to support their work practices in public hospitals. According to Saunders and Tosey (2013), interpretivism relates to the study of social phenomena in their natural environment. This philosophy focuses on conducting research amongst people as opposed to objects. Hence, interpretive research relies heavily on direct interaction with people. An interpretivist researcher enters the social world of

research subjects and understands the world from their point of view by adopting an empathetic stance (Saunders & Tosey, 2013).

Since this research project was aimed at the study of social actors (nurses and administrators) in their natural environment and focused on understanding the world from their point of view, the researcher has adopted an interpretive stance.

In essence, the researcher was more concerned with gathering rich insights into the subjective meanings of nurses' lived experience with the use of DHTs and how technologies influence their clinical work practices. To fully answer the research questions, it was important for the researcher to collaborate and spend as much time as possible with the participants to obtain first-hand information and evidence about the lived experiences of the nurses' use of DHTs in practice. Therefore, the study was of an inductive nature as it sought to draw from the concepts of the normalisation process theory (NPT) as a theoretical lens to analyse how new technology innovation can be embedded into existing routine nursing practices rather than build a new theory. The research methodology that informed a strategy of enquiry of this study is discussed in the ensuing section.

3.3.3 Methodological choice

An important choice for all researchers when they design their research is whether to use a quantitative or qualitative method or a mixture of both. Saunders and Tosey (2013) insist that researchers can choose a single data collection technique and a corresponding analysis procedure. For instance, in a mono-method quantitative design, data are gathered using questionnaires and analysed statistically while in a mono-method qualitative design, data are gathered through in-depth interviews and analysed as narratives (Creswell *et al.*, 2012). Alternatively, a multi-method can be used, where the researcher uses more than one quantitative data collection technique, for example, a questionnaire together with structured observation. In the case of multi-method qualitative designs, the researcher will use more than one qualitative data collection technique, such as in-depth interviews and diary accounts. Both the aforementioned quantitative and qualitative multi-methods are used with associated statistical analysis procedures. A mixed-method design, then, combines both qualitative and quantitative data collection techniques and analysis procedures. This means the researcher could start with a qualitative data collection and analysis (for example, a series of focus groups to help determine the breadth of possible factors) and follow this with quantitative data collection and analysis (for example, a questionnaire to determine the relative frequency). Alternatively, a researcher could

~~choose to use quantitative analysis techniques to analyse qualitative data quantitatively (for example comparing statistically the frequency of occurrence of different concepts in in-depth interview transcripts between different groups) or vice versa.~~

Quantitative research primarily deals with large sets of statistical numeric data while qualitative methodology makes use of textual data (Babbie & Mouton, 2010). An outline of key features helps distinguish qualitative research from quantitative research: 1) research is conducted in the natural setting of social actors, 2) the focus is on process rather than outcome, 3) the primary aim is in-depth descriptions and understanding of actions and events, 4) the main aim is understanding social action within its specific context as opposed to trying to generalise to some theoretical population (Babbie & Mouton, 2010). Creswell *et al.* (2012) agree that 1) qualitative researchers typically gather multiple forms of data, such as interviews, observations and documents as opposed to relying on a single source of data; and 2) the research process for qualitative researcher is emergent, or in other words, the initial research plan is flexible and may change. For example, questions may change, forms of data collection may be altered and the individuals studied and the sites visited may be modified during the process of conduct the study.

According to Babbie and Mouton (2010), qualitative researchers attempt to study and interpret human actions from the perspective of the social actors. The authors argued that the main goal of studies involved in this approach is defined as describing and understanding, as opposed to explaining human behaviour. This research project adopted a qualitative approach since the researcher studied human action from the perspective of the social actors (nurses and administrators) in their natural setting (hospital).

3.3.4 Qualitative research strategies of enquiry

According to Creswell *et al.* (2012), a number of research strategies or approaches exist in a qualitative enquiry and are briefly outlined below.

3.3.4.1 Narrative research

This type of research explores the life of an individual and narrates stories about individual experiences (Creswell *et al.,* 2012). It draws from the humanities, including anthropology, literature, history, psychology and sociology. One or more individuals are studied using primarily interviews and documents. Data are analysed by “restorying” (retelling) stories and developing themes, often using a chronology. Since the researcher aimed to understand nurses’ lived experience of using DHTs to support their work practices, and how it becomes embedded into

their daily work practices, the narrative research approach forms part of the discussion of the findings.

3.3.4.2 Grounded theory

This approach focuses on developing a theory grounded in data from the field. It involves grounding a theory in the views of the participants. Drawing from the field of sociology, *grounded theory* studies a process, an action or an interaction that involves many individuals. This approach relies primarily on interviews and usually involves between 20 and 60 people. Data are analysed through open coding, axial coding, and selective coding and the generation of a theory is usually illustrated in the form of a figure (Creswell *et al.,* 2012). As this study drew substantially from the normalisation process theory (NPT), a grounded theory strategy was therefore not suited for this research project.

3.3.4.3 Ethnography

Ethnography involves describing and interpreting a culture-sharing group. It describes and interprets the shared patterns of culture of a group. Drawing from anthropology and sociology, an ethnographic approach studies a group that shares the same culture and uses primarily observations and interviews; however, other sources may be collected during extended time in the field. Data are analysed through description of the culture-sharing group and themes about the group and largely describe how a culture-sharing group works (Creswell *et al.,* 2012). This study is about understanding the real-world case of nurses' use of DHTs to understand their lived experience of using DHTs to support their work practices, and therefore contrary to the principles of ethnography.

3.3.4.4 Case study

Easton (2010) describes a *case* as a research method that involves the investigation of one or a small number of social entities or situations by collecting data from multiple sources and developing a holistic description thereof. Furthermore, it offers the researcher an opportunity to understand a phenomenon in depth and comprehensively (Easton, 2010). According to Creswell *et al.* (2012), a case study approach involves developing an in-depth description and analysis of a case or multiple cases. Drawing from psychology, law, political science and medicine, a case study approach studies an event, a programme, an activity, or more than one individual and uses multiple sources, such as interviews, observations, documents and artefacts. Data are analysed

through a description of a case and themes of the case as well as cross-case themes. Again, the case study approach develops a detailed analysis of one or more cases (Creswell *et al.,* 2012).

Whilst the case study method would have assisted the researcher to understand a real-world case of nurses' use of DHTs to understand their lived experience of using DHTs to support their work activities, it would not have provided sufficient opportunity to understand individuals' perceptions while reserving bias and being open to emerging themes. Moreover, a case study approach would not have enabled the researcher to analyse the accounts of each participant to develop meaning-laden statements essential to the construct of the phenomenon being studied.

3.3.4.5 Interpretive phenomenology

Phenomenology focuses on understanding the essence of experience and descries the essence of a lived phenomenon (Creswell *et al., 2012*). Drawing from philosophy, psychology and education phenomenology focuses on studying several individuals who have shared the experience, using interviews with individuals, but documents and observations may also be considered (Creswell *et al.,* 2012). According to Neubauer *et al.* (2019), phenomenology is an approach to research that aims to describe the essence of a phenomenon by exploring it from the perspective of those who have experienced it, or in other words, what was experienced and how.

The authors describe three contemporary approaches to phenomenology: lifeworld research (which focuses on how daily experiences manifest in the lifeworld of individuals); post-intentional phenomenology (treating the phenomenon as the unit of analysis); and interpretive phenomenological analysis (IPA) (focusing on providing a detailed examination of the lived experience of a phenomenon through the lens of the participant's personal experiences and personal perception of objects and events). According to Charlick *et al.* (2016), phenomenological enquiry has two different approaches, namely, descriptive phenomenology and interpretive phenomenology. The aim of descriptive phenomenology is to solely describe a lived experience without attempting to attach meaning to it. This would require the researcher to, during the process of data collection and analysis, 'bracket,' or set aside their previous knowledge and investments, as well as the taken-for-granted world, to see phenomena as experienced. Interpretive phenomenology, on the other hand, aims to reveal and interpret the embedded meaning in a lived experience. This is because, as the authors aptly state, we cannot step 'outside' the world, as we are already engaged and involved in the world. Consequently, in interpretive phenomenology, the interpretation of people's meaning-making activities is always in relation to the researcher's perspective at a particular point in time, based on them being in the

world. Since interpretive phenomenology is interpretive it encourages the researchers to 'go beyond' immediately apparent content. Whilst this deeper and more interpretative analysis could seemingly draw the researchers away from the original meanings, it should be noted that the aim of interpretive phenomenology is to illustrate, inform, and master themes. This is achieved by firmly substantiating findings with direct quotes from participant accounts. interpretive phenomenology therefore allows the researcher to explore and interpret major life experiences whilst maintaining the focus locally, contextualised or on a specific phenomenon. The results from an interpretive phenomenological study are able to achieve two important objectives: 1) use broad knowledge principals and understand them in a local context, thus highlighting what works in 'your' setting, and not what works in 'most' settings; and 2) explore people in a particular context who have shared a particular experience and make claims at a group level – this is feasible because the results reflect a specific focus (Charlick *et al.,* 2016).

Data are thus analysed by examining for significant statements, meaning units, textual and structural descriptions, and descriptions of the "essence" of an experience. Since this research largely investigates the lived experience of nurses, it is not the sole focus of the study, as the routine embedding of DHTs is also being considered. Therefore an interpretive phenomenological approach was sufficient to justify the objective of this study. With this research study being qualitative in nature, interpretative phenomenology was an ideal methodology to use, particularly since this study focused on how individuals make sense of their DHTs used as part of their daily work activities.

This interpretive phenomenological approach has helped to achieve the aim of this study, and to answer the following research question and sub-questions: 1) *How do nurses make sense of their work practices as DHTs influence their work experience?* 2) *What is the level of alignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice?*

The approach addressed the stated problem and provided the researcher with an in-depth, detailed understanding of nurses' experiences with the use of DHTs. The interpretive phenomenological approach is based on the premise that the reality of phenomena is based on how it is perceived by the role players in a particular situation. Epistemologically, phenomenology posits that knowledge is subjective and can be understood through an inductive interpretation of the lived experiences of those involved. In essence, a phenomenological approach aims to develop a complete, accurate and clear description and understanding of a particular human experience by providing a rich, thick and complete description of human experiences and

meanings (Finlay, 2013). According to Frechette *et al.* (2020), an interpretive phenomenological study aims to explore the lived experience of a particular phenomenon, an individual level of analysis based on the understanding that social contexts are embedded within an individual's being. The central focus and research question of this study are based on the lived experiences of nurses working with DHTs. The main objective of this study was to increase the adoption of new information technology and began by an analysis of the lived experiences of nurses. This study addressed the stated problem using an interpretive phenomenological approach to have a detailed understanding of nurses' experiences of the use of DHTs.

The qualitative phenomenological study was the most appropriate research method to explore the lived experiences of experienced nurses who are presently using DHTs in practice. A fundamental belief of qualitative researchers is that multiple realities exist and create meaning for the individuals being studied. This implies that there are always multiple realities or perspectives to consider when trying to fully understand a particular situation (Speziale *et al.,* 2011). According to Moustakas (1994:58), "phenomenology is concerned with wholeness and with examining entities from many sides, angles, and perspectives". The method reveals the essence of an experience which is the aim of the study. Finlay (2009) notes that the phenomenological design provides an opportunity to understand individuals' perceptions while reserving bias and being open to emerging themes.

A phenomenological design was deemed appropriate for this study since qualitative phenomenological research platforms facilitate understanding the participants' points of view and in capturing a central phenomenon (Jootun *et al.,* 2009:42). This phenomenological study on the lived experiences of nurses has therefore focused on the perspective of nurses as end-users of DHTs. An interpretive study of nurses as end-users of DHTs has yielded important information about barriers, frustrations, needs, and preferences of nursing staff. Interpretive research with qualitative interviews was considered to be the most appropriate starting point, as it has provided access to nurses' subjective perceptions of DHTs. The data gained from the study was also useful in determining nurse users' specific needs and their preferences for modifications to the DHTs being used.

3.4 Aligning the research questions

It is important to align the research questions and aim of the study to the nature of the problem investigated to ensure that the right data are collected using appropriate methods. It is also important to analyse the data with the right theoretical lenses to gain the required insights during

the theorising process. This study is positioned in the fields of healthcare, social and behavioural sciences and ICT. The research questions are as follows:

Research question 1: *How do nurses experience their work practices influenced by using DHTs?*

Research question 2: *Why is there a misalignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice?*

The aim of the study is to gain insights into the lived experiences of the nurses practices in a specific situation and hence the choice of using an interpretive phenomenological strategy. Because the nursing process forms an integral part of the nurses' care practices, it is therefore at that point that the nurses' perceptions of using a digital health technology from its introduction until it becomes an integral part of their practices, are considered. The normalisation process theory is a theoretical lens for considering the implementation of new technologies and the process of how the users, in this case the nurses, adopt the technology as part of their practices. It is therefore an appropriate theory to use in addition to the interpretive phenomenological approach to gain insights in the process of technology implementation to the extent to which it is used as part of the practices.

Lived experience, situated practice and the normalisation process theory are discussed below to indicate how these were used as theoretical lenses for the theorising part of the study.

3.5 Theoretical lenses

There has been a great deal of debate in the social sciences about what 'theory' is and its perceived usefulness. Pettigrew and McKechnie (2001) define a *theory* as a structural system which is used in research to explain certain aspects of phenomena and provide answers to the why questions of the study, whilst Sales *et al.* (2006) define a *theory* (in the context of behaviour change) as a set of logical constructs that give answers to the questions ''why'' and ''how'' certain phenomenon exist.

May and Finch (2009:539) describe a *theory* as a "coherent conceptual arrangement that when it is operationalised, makes possible a rational description and taxonomy of phenomena and constructs by which their systematic explanation is possible" (May & Finch, 2009). It is clear from the above descriptions that theory must do more than just describe a set of phenomena, it should, in addition, focus on the following: a causal explanation, where one task acts upon another; transformative explanations where one thing interacts with another; and relational explanations where the presence or absence of one thing leads to a change in another. May *et al.* (2011) further

define a theory as a body of related ideas that forms the foundation for three kinds of conceptual work, viz. describing, explaining and predicting an observed phenomenon. In essence, a theory must provide the following: a) an accurate description of a particular phenomenon; b) systematic explanation of the form and significance of the causal and relational mechanisms of the phenomena defined by the theory; c) lead to knowledge claims; d) must provide a means of testing its knowledge claims; e) must be testable (i.e. by means of logical representations, simulations, experiments or empirical investigations). In addition, Bhattacherjee (2012) asserts that, whilst it is possible to predict events or behaviours through the use of certain predictors, without necessarily explaining why such events occur, theories should explain why things happen, as opposed to prescribing and predicting. The researcher's choice of theory to be used as analytical lens is introduced in the ensuing section.

3.5.1 Situated practice

Jarrin (2012:4), discussing the essence and experience of nursing, refers to the nurse-patient relationship and how the work environment – including workplace culture, staffing and availability of resources – impact nurses' perceptions regarding the practice of nursing. The author states that "nursing is caring situated in space, place, and time, shaped by the internal and external environments of both the nurse and the patient/client". In other words, caring is dependent upon where you are (meaning the time, space and culture, and also the level of development of the individual). This refers to the individual nurse's training and experience, ethical and moral standing, as well as the context of the situation, whether it is fast-paced, for example, in an ICU, or whether it is more relaxed, for example, working in a nursing home.

The environments that the author refers to include the following: 1) the state of mind, attention and personal beliefs of the individual; b) the level of training, skill and experience of the individual, c) the individual's norms (professional and societal) as well as the individual's value system; and d) the environment wherein the individual practices (Jarrin, 2012).

The use of technology, therefore, influences how nurses do their work and interact with patients. Tunlind *et al.* (2015:116) refer to *technology* as "items, machinery and equipment that are connected to knowledge and management to maximise efficiency. Technology is not only the equipment itself, but also the knowledge of how to use it and the ability to convert it into nursing care".

3.5.2 Lived experience

It is widely known (as previously discussed) that nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare spectrum. Caring for critically ill patients requires competent nurses to help save and secure the lives of patients, using technological developments while maintaining humanistic care. Managing equipment, such as ventilators, infusion pumps, monitors and dialysis machines makes healthcare in an intensive care setting more complex. Fadel *et al.* (2020) and Setyowati *et al.* (2022) have found that nurses are generally positive with regard to information technology because they understand that these technologies facilitate their work in terms of reduced paperwork, increased job satisfaction and improved quality of healthcare offered to patients.

Research conducted by Olausson *et al.* (2014) on nurses' lived experience in intensive care units (ICUs) posit that the relationship between the nurse and the ICU is reciprocal and also deeply emotional, as nurses share patients' and families' suffering as patients journey through the ICU. However, as two competencies are highlighted in an ICU environment – technical and emotional – a balance needs to be struck when caring for critically ill patients. Price (2013) aptly states that critical care practice is the combination of caring with technological activities".

There is much academic debate around technology standing in the way of caring and dehumanising the patient (Granados-Pembertty & Arias-Valencia, 2013; Lapão, 2020; Barbosa *et al.,* 2021). Similarly, it has been argued that the technical nature of ICU means that nurses may identify with the values as indicated by the technology instead of acknowledging their, as well as their patients, vulnerabilities (Carmel, 2006). Price (2013), however, suggests that caring in ICUs cannot take place in the absence of technology.

Limbu *et al.* (2019), in researching the lived experience of critical care nurses in Nepal, have found that caring in environments of low technology of care and insufficient resources could result in physical and psychological distress in intensive care nurses, which in turn, might affect the quality of critical care. Furthermore, caring with low technologies of care and insufficient human resources can hamper intensive care nurses from providing adequate care to critically ill patient.

3.5.3 The normalisation process theory (NPT)

The NPT focuses on the work that individuals and groups do to enable an intervention to become normalised (Murray *et al.* 2010). A comprehensive study conducted by May *et al.* (2018) on the uses and limits of the NPT on the implementation and integration of healthcare interventions,

have concluded that analysis using the NPT can effectively assist in explaining the success or failure of specific implementation projects, and as a result, researchers have found it useful and have thus applied it across a wide range of interventions. This theory therefore provides a conceptual framework that explains the processes whereby new health technologies and other complex interventions are can be routinely embedded (operationalised) into everyday work, and integrated (sustained) in practice (Mair *et al.*, 2012).

According to McEvoy *et al.* (2014), the NPT is a relatively new middle range theory which has mainly been applied in the post-hoc examination of project failures (McEvoy *et al.,* 2014). The NPT (as reported by May and Finch (2009) is based on the analysis of people's investments in their practices, in other words, their interaction with the things (objects) that they work with, amongst each other, and with dynamic elements of their environments. NPT is not focused on attitudes, but rather on action. *Normalisation* is defined as the embedding of a technique, technology, Heath or organisational change as a routine and taken-for-granted element of clinical practices (May & Finch, 2009). It defines the implementation, embedding and integration of any kind of clinical or organisational intervention as a social process that happens when participants (in the context of this project – referred to as the Department of Health/policy makers) deliberately initiate and seek to sustain a sequence of events that bring it into existence (in the context of this research project, it refers to the implementation of DHTs in public hospitals in Cape Town).

Normalisation focuses on the importance of stability, order and workability in professional and organisational behaviour in healthcare. note that normalisation is more flexible than diffusion for the following reasons: 1) the concept of normalisation recognises that technology and organisational change in healthcare settings are often imposed, and 2) that regardless of the source of the change being imposed, clinicians will often find creative and flexible ways to configure clinical practices to meet specific local situations and requirements (Heath *et al.*, 2003; Williams & Whittier, 2007).

According to May and Finch (2009), normalisation refers to the work that actors do as they engage with a group of practices and how practices become routinely embedded into already existing practices. Subsequently, Fligstein and McAdam (2012) argue that when implementing new DHTs, it is important for decision-makers (the Department of Health and policymakers) to secure the consent, cooperation and expertise of end-users to sustain the process, since the dynamics of implementation processes are complex. However, the NPT facilitates understanding by focusing

attention on the mechanisms through which participants invest and contribute to them. The ensuing section will outline the constructs and sub-constructs of the NPT.

3.5.3.1 Constructs of normalisation process theory (NPT)

In essence, the NPT provides a set of sociological tools to understand and explain the social processes that make up the implementation of material practices. However, to understand the embedding of practice, it is necessary to look at what people actually do and how they work. Against this backdrop, the NPT proposes that practices become routinely embedded by means of four constructs or mechanisms, viz. coherence, cognitive participation, collective action, and reflexive monitoring (May & Finch, 2009).

Coherence refers to making sense of work undertaken when a new technology is implemented (Mair *et al.*, 2012). It refers to a set of ideas about aspects of a new technology, which include its meaning, uses, and utility. For example, to ascertain whether users' perceptions on the new technology as deferring from existing practice, whether users have a shared view about its purpose, as well as an understanding of how the new technology will affect and benefit them (May & Finch, 2009; May, Sibley & Hunt, 2014). Finch *et al.* (2014) explain that coherence refers to how a particular practice is understood by participants, and how they compare with other practices, in other words, how is a particular practice understood by participants, and how do they compare it with other practices. As with the constructs of the NPT, coherence has four components, viz.

1) Differentiation (understanding how a set of practices and their objects differ from one another). This component seeks to ascertain whether there is a clear understanding of how a new e-health service differs from an existing practice, for example, how does an automated process differ from a paper-based system.

2) Communal specification (refers to people working together to build a shared understanding of the aims, objectives, and proposed benefits of a set of practices). This component seeks to assess whether individuals have a shared understanding of the aims, objectives and expected benefits of a particular e-health service, such as moving from a paper-based system to an automated system.

3) Individual specification (refers to individual participants working towards understanding their specific tasks and responsibilities around a set of practices). This component seeks to ascertain

whether individuals have a clear understanding of their specific tasks and responsibilities during the implementation of an e-health service.

4) Internalisation (refers to individuals understanding the value, benefits and importance of a set of practices and contributes to embedding the practice into their lived experience) (May & Finch, 2009; Mair *et al.,* 2012).

Cognitive participation focuses on the work undertaken to engage with potential users (actors) and obtaining their "buy-in" for the new proposed DHTs. In other words, how do participants come to take part in a particular practice, and what keeps them motivated to continue to take part in a particular practice (May & Finch, 2009). Cognitive participation, as nuanced by Murray *et al.* refers to the commitment and engagement by the participants. It also refers to whether the participants will see the point of the intervention and whether they will be prepared to invest time, energy and work in it (Murray *et al.*, 2010). The authors further propose the recruitment of local "champions" who possess the ability to promote the use of new e-health services, thereby encouraging participation and buy-in. Cognitive participation has four components:

1) Initiation (refers to work that brings a practice into action, in other words, whether or not key participants [actors] are working to drive them forward).

2) Enrolment (refers to actors working together and organising themselves to collectively participate in a new practice). In other words, is there buy-in by individuals into the idea the e-health service?

3) Legitimisation (involves interpreting and 'buying in' to that practice, as well as ensuring that other participants believe it is right for them to be involved, and that they are able to make a valuable contribution to the process). In other words, is there a belief amongst individuals that it is right for them to be involved?

4) Activation (refers to how a particular practice becomes operationalised). In other words, are individuals able to sustain involvement (May *et al.*, 2011; Mair *et al.*, 2012)?

Collective action refers to the operational work performed by individuals, groups of professionals or organisations in operationalising a new technology in practice (May & Finch, 2009). Finch *et al.* explore collective action with two questions: 1) How do participants make it work? and 2) How are their activities organised and structured? Collective action has four components:

1) Interactional workability (refers to how actors operationalise a particular practice in everyday settings). In other words, the allocation and performance of tasks.

2) Relational integration (refers to the way in which a practice is facilitated and understood within the networks of people around it).

3) Skill set workability (refers to the allocation and distribution of work, i.e. the division of labour that is built up around a set of practices as they are operationalised);

4) Contextual integration (refers to the incorporation of a practice within a social context) i.e., managing a set of practices by means of allocating different kinds of resources and adherence to protocols, policies and procedures.

Reflexive monitoring refers to formal or informal evaluations and appraisals by of the implementation process by the participants (actors) (May & Finch, 2009). Finch *et al.* describe reflexive monitoring as the means whereby participants evaluate a practice, and how this practice changes over time as well as its effects reflective monitoring has four components: 1) systemisation (refers to regular organised procedures for monitoring and continuous assessment of the process and the impact of the new practice within the organisational context, as well as determining the effectiveness and usefulness thereof for them); 2) communal appraisal (2018); 3) individual appraisal (judging the value and outcomes of a practice individually and collectively), 4) reconfiguration (appraisal of the practice, both individual and communal, regarding the use and utility of the practice which may lead to redefining or modifying some practices).

Examples of studies where the NPT has been applied are discussed below.

3.5.3.2 Applicability of NPT in similar studies

The NPT provides a solid framework for analysing the dynamic collective work and relationships involved in the implementation and social shaping of practices. Also, it addresses the question of how practices are implemented and routinely embedded into everyday life by means of analysis and explanation of a specific set of concrete behaviours and relations, outlined in the four constructs. In essence, NPT specifies the important mechanisms of an implementation process. According to May *et al.* (2014), a key problem for decision-makers in healthcare is understanding the conditions in which modified or new technologies, techniques, working practices, and organisational interventions – known as complex interventions – can become embedded as routine elements of clinical and organisation work in healthcare. May further iterate that decision-

makers need to consider whether a new innovation is workable and has the capacity to be successfully integrated into existing configurations of healthcare services.

The table below contains a summary of how the NPT has been used as a framework to study the embedding of new innovations.

Table 2: Summary of studies using NPT

Related study	NPT Use	Findings	Domain	Methods used
May and Finch, 2009	*To understand the processes whereby practices become routinely embedded in everyday life is a long-standing concern of sociology and the other social sciences.*	*Normalisation process theory provides a robust and replicable ecological framework for analysing the dynamic collective work and relationships involved in the implementation and social shaping of practices. It is a theory for empirical application rather than abstract critique*	Implementation and social shaping of practices	*Sets out a theory of normalisation processes that proposes a working model of implementation, embedding and integration in conditions marked by complexity and emergence*
Murray *et al.,* 2010	*The normalisation process theory (NPT) addresses the factors needed for successful implementation and integration of interventions into routine work (normalisation).*	*As a new theory, the NPT offers trialists a consistent framework that can be used to describe, assess and enhance implementation potential. The authors encourage trialists to consider using it in their next trial.*	Primary Healthcare	Questions asked for evaluation based on NPT constructs
May *et al.,* 2018	*To identify and characterise the uses and limits of NPT in research regarding the implementation and integration of healthcare interventions.* *To explore the contribution of the NPT towards understanding the dynamics of these processes.*	*This review demonstrates that researchers found the NPT useful and applied it across a wide range of interventions. It has been effectively used to aid intervention development and implementation planning as well as evaluating and understanding implementation processes themselves. In particular, NPT appears to have offered a valuable set of conceptual tools to aid understanding of implementation as a dynamic process.*		*A qualitative systematic review was conducted.*
McCrorie *et al.,* 2019.	*Global evidence suggests a range of benefits for introducing electronic health record (EHR) systems to improve patient care. However, implementing EHR within healthcare organisations is complex and, in the United Kingdom (UK), uptake has been slow*	*The findings may inform other hospitals and healthcare systems on actions that can be taken prior to EHR implementation to reduce concerns for quality and safety of patient care and improve the chance of successful implementation*	Electronic health record implementation	*Qualitative interviews*
McEvoy *et al.,* 2019	*Many international health policies recognise the World Health Organization's (2008) vision that communities should be involved in shaping primary healthcare services.*	*Participants of this study emphasised the benefits of funding, organisational support, training and networking to enact relevant activities. Health-promoting activities and healthcare consultation/information events were generally successful, but community representation on interdisciplinary Primary Care Teams proved to be more challenging.*	Community-based healthcare services	*Documentary evidence (study 1)* *Semi-structured interviews (studies 1 and 2) and focus groups (study 2).* *Data generation and analysis were informed by Participatory Learning and Action (PLA) Research Methodology and NPT*

Related study	NPT Use	Findings	Domain	Methods used
Mishuris *et al.,* 2019	*This study sought to determine the suitability of the NPT to assess the facilitators, barriers and 'work' of implementation of two clinical decision support (CDS) tools across diverse care settings.*	*The NPT toolkit can be adapted to a quantitative survey, when administered longitudinally. The NPT can be used over time to assess the continuous implementation barriers of a new electronic health record workflow. The insights gained from applying the NPT framework healthh IT intervention implementation can be used to improve the success of the implementation itself.*	Clinical decision support	*Baseline and 6-month follow-up quantitative surveys. The survey was adaptedfrom the NPT toolkit.*
Davis, 2020	*This study consisted of a pre-implementation evaluation of an integrated SDM personal health record system(e-PHR) that was underpinned by normalisation process theory (NPT). The theory provides a framework to analyse cognitive and behavioural mechanisms known to influence implementation's four process mechanisms and implementation success. Furthermore, the NPT provides a framework to anal their related constructs known to influence implementation success .*	*Additional investigation is needed to explore the collective action gaps to inform priorities and approaches for future implementation success.*	Personal Health Records for decision-making	Mixed methods, surveys and semi-structured interviews.
Huddlestone *et al.,* 2020	*The NPT provides a framework to understand how interventions are implemented, embedded, and integrated in healthcare settings*	NPT provides a flexible framework for the development and evaluation of complex healthcare interventions in UK primary care settings.	Primary Healthcare	*A systematic review of peer-reviewed literature using NPT in primary care settings in the United Kingdom (UK)*
Bradshaw *et al.,* 2021	*Most research has described barriers to, without explaining the causal mechanisms which underpin implementation. Implementation theories explain how, why, and in which contexts specific relationships between barriers/ enablers might improve implementation effectiveness but have rarely been used in palliative care outcomes research.*	*An understanding of distinct implementation challenges for specific outcome measures and how these may impact the quality and safety of care.*	*Person-centred Outcome Measures within palliative care settings*	*An exploratory qualitative study. Data were collected through semi-structured interviews and analysed using a Framework approach.*

Related study	NPT Use	Findings	Domain	Methods used
Corrigan *et al.,* 2021	*Using the normalisation process theory (NPT) to underpin development of a conceptual implementation framework for Continuity of Care (CoC) to improve the understanding of the implementation process. Methods: A literature review on CoC implementation and NPT development and use, combined with immersion in the implementation of CoC context.*	*A conceptual framework for the implementation of CoC is developed. There is utility in NPT as a means of understanding and conceptualising large-scale implementation of CoC.*	*Continuity of care in maternal health*	Literature search
Herber *et al.,* 2021	*This study aimed to identify the relevant factors to successfully implement a complex, theory-based heart failure (HF) self-care intervention into routine practice.*	*The results of this study uncovered numerous factors to consider for successful implementation of an intervention into routine practice. The findings are presented according to two major categories: (1) themes within the NPT framework and (2) themes beyond the NPT framework.*	*Self-management in healthcare*	*Semi-structured interviews to obtain key stakeholders' opinions based on the NPT framework, using thematic analysis.*
Knowles *et al.,* 2021	*This study aimed to generate implementation support recommendations for a new electronic patient-reported outcome measure (ePRO) in renal services.*	*The results of this study enabled the research team to become more aware of the key needs of both staff and patients. Working within sites enabled them to consider local resources and barriers. This produced 'core and custom' recommendations specifying core needs that could be met with customised local solutions. Furthermore, the study identified two over-arching themes which need to be considered when introducing new digital systems.* *(1) That data collection is physical (electronic systems need to fit into physical spaces and routines).* *(2) That data collection is intentional (system users must be convinced of the value of collecting the data).*	*Electronic patient reporting*	*Co-design methods that could be mapped to NPT constructs to generate relevant qualitative data.*
Nadav *et al.,* 2021	*To ensure successful implementations, it is important to understand the multi-professional perspective, especially because implementations are likely to increase even more The aim of this study is to examine health and social care professionals' experiences of digital service implementations and to identify factors that support successful implementations and should be considered in the future to ensure that*	*We introduce 14 practices for organisations and service providers on how to ensure sustainable implementation of new digital services and the smooth integration into routine work. Can be used by other countries when digitalising healthcare*	*Digital service implementation*	*Qualitative focus group interviews*

Related study	NPT Use	Findings	Domain	Methods used
	the services are integrated into professionals' routine work.			
Ohr *et al.,* 2021	*The aim of this study was to elicit the experiences of ACP RNs with the implementation of a normalised ACP (NACP) service in hospital and community care settings.*	*To introduce an NACP service into existing clinical systems is complex. The study demonstrated the capacity of RNs to engage in ACP processes, and their willingness to deliver an NACP service with a raft of locally specific enablers and barriers.*	*Advance Care Planning (ACP)*	*A qualitative descriptive study*
Macabasac *et al.,* 2022	*This article explores how ongoing (i.e., incomplete) national level reforms in health information management (HIM) shape the normalisation of electronic medical records (EMRs) in Philippine rural health work. This was achieved by drawing perspectives from the multi-level perspectives in sociotechnical transition and the normalisation process theory,*	*This article emphasised how complementing the idea of normalisation with sociotechnical transition may reveal the emergence of pressures from various institutions and stakeholders that advances (or impede) the normalisation of healthcare innovations.*	*Health Information Management and Electronic medical record implementation*	*An interpretive case study using observations and in-depth interviews*
McCarthy *et al.,* 2022	*Patient-held Health Information Technologies (HIT) can reduce medical error by improving communication between patients and the healthcare team.*	*Despite numerous proposed benefits, the roll-out of patient-held HIT solutions remains nascent, leaving considerable gaps in our understanding of the adoption challenges inherent. This paper adopts normalisation process theory to study the factors which support or impede the adoption and "normalisation" of patient-held HIT, particularly across the primary-secondary care interface.*	Normalisation across primary and secondary care	*Case study with semi-structured interviews*

The NPT has played a significant role in this qualitative research project as it has assisted in the research design, sampling and data collection. Furthermore, it has helped to inform, guide and structure the research focus and questions. Each construct was used to answer the main research questions and interpret the subsequent findings of this study as discussed in Chapter 6.

3.5.3.3 Rationale for theory selection

Understanding how new techniques for clinical practice and organisation of care can be effectively translated into practice is a practical problem for healthcare managers, health policy-makers and healthcare professionals. Implementing and embedding new technologies involves complex processes of change, and although there has been much enthusiasm for technological innovation around e-health policymakers and health officials, this has not been always been matched by uptake and utilisation in practice (Mair *et al.*, 2012).

Extensive investigations have been undertaken to examine the behavioural aspects of technology acceptance and use and draws upon several theoretical perspectives. A number of models and frameworks exist on how to effectively introduce innovations in healthcare.

Due to the rapid growth of IT in the healthcare industry, technology adoption theories have become a source of great importance to examine the factors that influence technology adoption amongst healthcare providers. Extensive and robust research has been undertaken which examines the behavioural aspects of technology adoption and use and which draws upon a number of theoretical perspectives such as the technology acceptance model (TAM), theory of reasoned action (TRA), theory of planned behaviour (TBA), innovation diffusion theory (IDT) and Unified Theory of Acceptance and Use of Technology (UTAUT) (e.g., Ajzen, 1991; Argawal & Prasad, 1998; Davis *et al.*, 1989; Rogers, 1995; Venkatesh, Morris, Davis & Davis, 2003). However, these theories have been applied to minimum studies pertaining to a detailed understanding of nurses' perceptions and lived experiences with respect to the acceptance of a new technology innovation. These are theories that account for different aspects of behavioural change and the diffusion of innovations, as well as describe behaviours and attitudes of users towards using a new technology. However, they do not offer detailed explanations to the implementation processes of embedding technology into practices per se (Ahlan & Ahmad, 2014).

Traditionally, technology adoption has been investigated using constructs such as usefulness and ease of use for the purposes of predicting an individual's acceptance of technologies. Whist these constructs and theories intensively describe the processes whereby innovations and its use can be diffused across the healthcare systems, it does not provide a framework for assessing the

conditions under which such interventions become routinely embedded in healthcare practices, or in other words, how it becomes routine, everyday elements in their daily life (May & Finch, 2009). In addition, a key problem for decision-makers in healthcare is understanding the conditions in which modified or new technologies, techniques, working practices, and organisational interventions – known as complex interventions – can become embedded as routine elements of clinical and organisation work in healthcare. The author further states that decision-makers need to consider if a new innovation is workable, and whether it has the sustaining capacity to be successfully integrated into existing or new configurations of health services.

May *et al.* (2007:148) regard *complex intervention* as "a deliberately initiated attempt to introduce new, or modify existing, patterns of collective action in healthcare". According to the authors, a deliberate intervention refers to an invention that is institutionally sanctioned (as is the case in a top-down approach referred to in Chapter 1); is formally or informally defined; consciously planned; and its intention is to result in a changed outcome. Often, initiators of a complex intervention may intend to change the ways in which people think, act and organise themselves in healthcare, or they may simply intend to start a process seeking a new outcome (May *et al.*, 2009). Research, however, highlights a substantial gap between the high hopes and expectations of policymakers and managers on the one hand, and the actual practice of implementation of these new technologies (Haux *et al.,* 2002; Timmons, 2003). Pope *et al.* (2013:2) notably state that "technological interventions do not slip seamlessly into established practice but instead they meet with resistance and rejection because they threaten established work and organisational routines or clash with established professional identifies and power relations".

Unfortunately, these theories do not depict the subjective experiences of nurses as they are generalised and the lived experiences of nurses are not addressed. It has to be noted that these theories of technology adoption lack an in-depth description of lived experience in technology adoption. This study therefore justifies the need for a phenomenological approach that focuses on the individual descriptions of lived experiences pertaining to the use of technology.

For this reason, this investigation adopted the normalisation process theory (NPT) because it elaborates how new technology innovation can be embedded into existing practices – in line with the research problem of this study.

3.6 Data collection

The main sources of data are scientific literature (secondary source) and interviews (primary source). The scientific literature included scholarly written articles, journals and conference papers by authors in the field of health informatics and technologies or related topics. According to Creswell *et al.* (2012), data collection involves a series of interrelated practices which are aimed at gathering information to answer the emerging research questions. These practices are: 1) locating the site or the individual to study; 2) gaining access and making rapport (in other words, gaining permission to study the site in a way that will enable easy collection of data); 3) purposeful sampling, which means deciding who to select as participants or sites for the study; 4) collecting data, using the following methods: observations, interviews, documents, audio-visual materials; 5) recording information, for example, having a predesigned form to record information collected during an interview or observation; 6) resolving field issues, which entails limited data collection and engaging in a pilot project to gain initial experiences; and 7) storing data, which relates to how data are organised and stored.

Data collection was conducted during from October 2017 to March 2018. A major advantage is that data were collected before the onset of the Covid-19 pandemic.

Since this research project is interpretive in nature, data were collected using a variety of techniques. The most frequently used technique is interviews (face-to-face, telephone, or focus groups). Another technique is observation. Observational techniques include direct observation, where the researcher was a neutral and passive external observer and was not involved in the phenomenon of interest (as in case research), and participant observation, where the researcher is an active participant in the phenomenon and her inputs or mere presence influence the phenomenon being studied (as in action research). For this study, the sources of data collection comprised of two categories: secondary data (literature review in Chapter 2) and primary data (interviews with participants engaged in the delivery of healthcare). The review of literature was a continuous activity throughout the course of this study.

In this study, the major data collection method associated with an interpretive phenomenological study was in-depth interviews and observation. Therefore, the study used in-depth interviews and observation to engage the selected participants, to collect data. The interviews enabled the researcher to obtain a large volume of subjective data, which was then interpreted to get in-depth information as understood and interpreted from the participants' points of view. In addition to interviews, observation was used to supplement primary gathered from interviews. The researcher deemed it necessary to first immerse herself in the environment in an attempt to

familiarise herself with the setting and the situations that ground the nurses' lived experience (time and place). Whilst it assisted the researcher to familiarise herself with the data, it also served to establish a bond with the nurses. Observation forms were designed and were used to capture events as they unfolded prior to the interviews. This assisted the researcher in taking field notes whilst observing participants in their environments during the study. The researcher was able to clearly observe participants, which assisted in gaining deeper insights into the phenomenon being studied. The researcher was able to observe the interactions between the various stakeholders, as well as the types of DHTs that were being used. This included non-verbal cues as well as operations in the actual work environment. Observatory notes were taken by the researcher and later used as notes about the situation in context during the analysis. This method was of significant value to the researcher as it allowed her to investigate social systems in terms of perceptions and behaviour of participants in the research context, namely, how nurses use DHTs as part of their daily work activities.

The interview instrument was developed based on a review of the literature, the research questions and also the normalisation process theory (NPT) as a guideline. To ensure the reliability of the results, the semi-structured in-depth interviews were repeated until a saturation point was achieved; several interviews were held with several of the identified participants until a level was reached where there was total confirmation that the data collected fully reflects the phenomenon being studied. The validity of the research instrument was ensured through a pre-test of the research instrument at a Hospital A.

The researcher engaged with the two hospitals to conduct pre-interviews to establish social interactions with both the nursing staff and the administration to create a rapport and ensure that the nurses are comfortable to answer the interview questions as exhaustively as possible. Consequently, the in-depth interviews enabled the researcher to answer the research questions and achieve the objectives set in the study. It should be noted that the two hospitals were chosen as demonstration cases for the study to collect sufficient data. However, the aim was never to compare the results since this is not a comparative study.

Interviews were digitally recorded and transcribed by the researcher. Participants were given the opportunity to review transcripts of the interview and to clarify, revise or delete any portions thereof if they wished to do so. Thereafter, the transcribed interviews were assigned a unique number to protect the anonymity of the participants.

3.6.1 Sampling

According to Saunders *et al.* (2019), it is important to use sampling techniques, regardless of the research questions and objectives. Occasionally, it may be possible to collect and analyse data from every possible case or group member (called a census). However, for many research questions and objectives, it will be impossible for researchers either to collect or to analyse all the data available to owing to restrictions of time, money and often access. Sampling techniques, therefore, provide a range of methods that enable researchers to reduce the amount of data needed to collect by considering only data from a sub-group rather than all possible cases or elements. Some research questions will require sample data to generalise about all the cases from which a sample has been selected.

Bhattacherjee (2012:66) explain *sampling* as the statistical process of selecting a subset (called a 'sample') of a population of interest for the purpose of making observations and statistical inferences about that particular population. According to Saunders *et al.* (2009:212), for some research questions it is possible to collect data from an entire population as it may be manageable in size. However, the authors caution that one should not assume that a census would necessarily provide more useful results than collecting data from a sample that represents the entire population. The arguments are that sampling provides a valid alternative to a census, particularly when it is not practical to survey the entire population if there are budget and time constraints (Saunders *et al.,* 2019).

Since it is not possible to study entire populations because of cost and feasibility, it is important to select a representative sample from the population of interest for observation and analysis. Furthermore, it is important to select a sample that is truly representative of the population to ensure that inferences derived from the sample can be generalised back to the population of interest. For an interpretive phenomenological study, purposive sampling is appropriate, with an average of 10 participants (Frechette *et al.,* 2020). According to Welman, Kruger and Mitchell, (2005), *population* refers to the individuals, groups, organisations, human products and events, or the conditions to which they are exposed. The authors further state that the population encompasses the total collection of all the units of analysis about which the researcher wishes to make specific conclusions.

Sampling techniques are divided into two types: probability or representative sampling and non-probability sampling. In probability sampling, every unit in the population has a chance of being selected in the sample, and this chance can be accurately determined (Bhattacherjee, 2012:66). In addition, Saunders *et al.* (2019) iterate that the chance or probability of each case being

selected from the population is known and is usually equal for all cases. As a result, probability sampling is often associated with survey and experimental research strategies. Examples of probability sampling include simple random sampling, systematic sampling, stratified sampling, cluster sampling, matched-pairs sampling, and multi-stage sampling (Bhattacherjee, 2012:67-68).

Non-probability sampling, alternatively, means the probability of each case being selected from the total population is not known and it is therefore impossible to answer research questions or to address the objectives that require the researcher to make statistical inferences about the characteristics of the population. It should be noted that research is generalisable from non-probability samples but not on statistical grounds. Examples of non-probability sampling include convenience sampling, quota sampling, expert sampling, snowball sampling. Since participants were selected as representatives of the primary population based on the phenomenon of study, convenience sampling, quota sampling and snowball sampling were not considered appropriate for this study.

Babbie and Mouton (2010:202) and Creswell *et al.* (2012) discuss another type of non-probability sampling, namely, *purposive sampling* (sometimes called a judgement sample), in which the researcher uses his or her own judgement in the selection of participants for the study. Purposive sampling therefore relies on researcher judgment in selecting samples from the population. As a result, empiricists criticised the purposive sampling as a biased sample (Creswell *et al.,* 2012). However, qualitative researchers embrace purposive sampling to obtain rich, in-depth information to answer the research questions. Although in nonprobability sampling methods, the study population does not have equal opportunity to be selected as a sample for the study, thereby making it unable to represent the entire population, its practicality made nonprobability sampling a popular sampling procedure in conducting research (Polit & Beck, 2012). Since the data collection method for this study was qualitative in nature, the researcher used non-probability sampling, via purposeful sampling, to identify and select end-users who use DHTs as part of their daily work activities. This technique assisted the researcher in identifying a sample size that would provide in-depth information which are aligned to the research objectives of this study. Creswell *et al.,* (2012) state that purposive sampling is based on biased judgement, especially in selecting participants who are perceived to have a comprehensive understanding of the knowledge gap being studied. This sampling technique is combined with snowballing, where the engaged participants suggest colleagues who possess the required knowledge of the issues being studied.

Researchers must also carefully choose the target population from which they wish to collect data, and a sampling strategy to select a sample from that population. For instance, should they survey

individuals or firms or workgroups within firms? What types of individuals or firms they wish to target? Sampling strategy is closely related to the unit of analysis in a research problem. While selecting a sample, reasonable care should be taken to avoid a biased sample (e.g., sample based on convenience).

3.6.2 Population

Using the classification of the Western Cape Government, healthcare institutions fall into three categories: primary clinics, secondary/district/provincial/ hospitals, or tertiary hospitals. The target population included nurses, nurse managers/operations managers, as well as a representative of the Chemical Engineering Department who were involved in the design and implementation process of DHTs and willing to participate in this study. There are two tertiary health institutions in the Western Cape and one of them was considered for the selection of participants and data collection. From the number of district hospitals situated in the Western Cape, one of them was considered for the selection of participants and data collection. This study focused on the tertiary hospitals because they take government priority in ICTs equipment distribution, thus the tertiary institutions can be expected to have a higher relative degree of implementation and use of DHTs than other public hospital levels. In addition, one district hospital where DHT projects are currently being piloted, was selected for this study. Kerr *et al.* (2010: 272) suggest that the optimum number of required subjects in a qualitative study evolves over time as the study progresses until data saturation is attained. For this study, a total of 28 participants: 14 from Hospital A and 8 from Hospital B. All participants were purposefully selected and interviewed until saturation was reached. In addition, participant observation was used across all participants to gain a deeper understanding of the research phenomena. A variety of criteria was applied during the selection of participants including the level of education, role, profession, job position/rank, work experience and station. Furthermore, participants were selected according to age (>18 years), and the number years' experience as a registered nurse. The age distribution of this category of participants ranged between 31-60 years, with 50% falling in the 31-40 age bracket, while 41-50 and 51-60 groups constituted 25% each (see table).

3.7 Data analysis

In qualitative data analysis, the emphasis is on "sense making" or understanding a phenomenon, as opposed to predicting or explaining (Bhattacherjee, 2012:113). Bryman (2004:399) contends that one of the main difficulties with qualitative research is that it generates large amounts of data, typically derived from interviews or participant observation. Unlike quantitative analysis, which is statistics driven and largely independent of the researcher, qualitative analysis is heavily

dependent on the researcher's analytic, integrative skills and personal knowledge of the social context where the data are collected. Data collection, according to Creswell *et al.* (20122), consists of preparing and organising the data for analysis, then reducing the data into themes by means of coding and finally representing the data into in figures, tables or a discussion.

Saunders *et al.* (2019) argue that data collection and analysis can be approached from an inductive or deductive perspective. When using a deductive approach, the researcher will seek to use existing theory to shape the approach adopted to the qualitative research process and to aspects of data analysis. When using an inductive approach the researcher will seek to build up a theory that is adequately grounded in data. This study drew from the normalisation process theory (NPT) as an analytical lens for the data collected to guide the inductive process of analysis.

In assisting researchers to get started, Yin proposes four general strategies. Firstly, researchers can rely on theoretical propositions that led to the case study. Secondly, instead of thinking of theoretical propositions, researchers can work with their data from the "ground up". This may assist researchers in deriving patterns or useful concepts from the data. Thirdly, researchers can develop a case description. This entails organising the case study according to a descriptive framework. Fourthly, researchers can examine plausible rival explanations by trying to define and test plausible rival explanations. This strategy generally works in conjunction with the three aforementioned strategies (Yin, 2014:136-142).

Yin describes five specific techniques for analysing case studies: time-series analysis, logic models, cross-case synthesis, pattern matching and explanation building.

Pattern matching, according to Yin, is one of the most desirable techniques in case study analysis. It involves comparing an empirically based pattern, based on the findings of one's case study with a predicted one made before data were collected. If the empirical and predicted patterns appear to be similar, the results can be used to strengthen its internal validity. explanation building, according to Yin, is a special type of pattern matching. The goal thereof is to analyse the case study data by building an explanation about the case. It involves an explanation of how and why has happened. Yin further elaborates that explanation building occurs in narrative form and cannot be precise.

Since this study was interpretive and qualitative in nature, pattern matching and explanation building were identified as the most suitable methods of analysing the vast amount of data that were collected through the in-depth interviews with nurses, nurse managers and other stakeholders at the public hospitals. Furthermore, the researcher used the NPT to organise the

data according to the constructs of the theory. In doing to, researcher also allowed for more themes to emerge that may not be covered by the NPT, which could provide important insights.

3.7.1 Thematic analysis of qualitative data

After qualitative data were collected for the purposes of this study, the researcher commenced with the analysis thereof, to extract meaningful information to answer the main research questions and address the objectives accordingly. Tong *et al.* (2007) states that theoretical frameworks in qualitative research include grounded theory, ethnography, phenomenology, discourse analysis, and content/thematic analysis. For the purpose of this study, thematic analysis was used to organise the data acquired from the participants.

Creswell *et al.* (2012) discuss six steps of data analysis and representation when conducting qualitative analysis:

1. Manage data by creating and organising data files.

2. A thorough review of the data by reading and rereading the transcripts, making notes or memoing to identify or detect emerging themes to form baseline codes.

3. Describing the researcher's personal meaning of the phenomenon by using epoché or bracketing methods to prevent potential research bias, thereby promoting rigor of the research.

4. Identifying and classifying data from participants' statements and grouping or categorisation of the statements into meaning units.

5. Interpreting the textural description to answer the question what happened?" and structural description to answer the question "how it is experienced?" and then construct overall meaning or essence of the experience. As the researcher attempts to answer the questions, the core meanings of the individuals' experiences will be revealed.

6. Representing the essence of the experience by using tables and figures for visualisation of statements and themes for easy understanding of readers.

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

In Chapter 5, the findings emanating from the themes are discussed in relation to the constructs of the NPT model, as described in section 3.4, whereas Chapter 6 discusses the findings emanating from the thematic analysis.

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.

3.7.2 Unit of analysis

The *unit of analysis*, according to Babbie and Mouton (2010:84) refers to the 'what' of the study, in other words, the object, phenomenon, entity, process or event that is being investigated. The authors further state that the unit of analysis in a study are typically also the units of observation. For this study, the unit of analysis is the nurses' lived experience of using DHTs as part of their work practices. The unit of observation for this study is the use of technology, in other words, how nurses make sense their interaction with DHTs as part of their work practices.

3.8 Data management

Data were collected from Hospitals A and B from the various participants of this study, after ethical clearance was obtained from the researcher's institution, the Department of Health and Hospitals A and B. Data were collected by means of interviews and observations (refer to section 3.9 below). Interviews were digitally recorded and transcribed, verbatim, by the researcher. Participants were given the opportunity to review transcripts of the interview and to clarify, revise or delete any portions thereof if they wished to do so. Thereafter, the transcribed interviews were assigned a unique number to protect the anonymity of the participants. Transcribed interviews and observation notes were saved on an external hard drive used solely for this research project and password protected. Only the researcher and her supervisor had access to the data. A list of interview questions, including the consent form will be submitted as supporting documentation for this research project.

Data were stored on a hard drive of the researcher and backup copies were made. Data were compiled into a data set. Only the researcher and supervisor have access to the data. Raw data were anonymised to remove any identifiable information from the data.

3.9 Ethical considerations

Ethical issues were considered throughout the course of this research project. Ethical clearance was obtained from the CPUT Faculty of Health and Wellness Ethics Committee, as well as from the CPUT Faculty of Informatics and Design Ethics Committee. Thereafter, permissions were obtained from the Western Cape Department of Health to conduct the research within the selected

tertiary and district hospitals. A cover letter accompanied the instrument which explained the purpose of the research and the concomitant data. Participants' views were respected and they were given an option not to respond if they so choose. All personal data of participants gathered during the research, as well as their responses, were treated as confidential. The anonymity of the participants was ensured as data were anonymised when coded. The information gathered was protected and was only available to the researcher. It was made clear to participants that they were under no obligation to participate and may choose to withdraw from the study or refuse to answer any questions at any time, without suffering any consequences. On withdrawal, any data that had been gathered would be destroyed.

3.10 Delineation of the research

This study is limited to only tertiary public hospitals, as well as district hospitals in the Western Cape Province. While the results of this study may be typical for hospitals in a similar geographic area, they may not be indicative of the practical challenges experienced in other public hospitals with different type of governance in other parts of South Africa. The demographics and cultural backgrounds, as well as the extent to which digital health technologies have been implemented, may vary in other locations. Also, the study investigated the use of and how implemented DHTs can be embedded in the existing routine clinical practices of nurses and not the process of adoption of the systems per se. Only nurses participated in the study because the focus was on their lived experiences. Other healthcare professionals, administrative persons, managers and support staff were not involved. Specific departments where technology is used were identified and the results only apply to such departments. No patients were involved and no patient data were collected or used.

3.11 Contribution of the study

Despite the numerous benefits associated with the use of information and communication technologies (ICTs) and the potential to improve patient care and safety, there are recurring use challenges. This study contributed on a practical level to determine the best practices in the involvement of the nursing workforce in the implementation processes of ICTs in the healthcare field. Also, it added further insights on how to approach health information technology (DHTs) implementation and its use by the nurse workforce which are the largest unit in a healthcare organisation. This may have a positive influence on the frequency of DHTs use in public hospitals in the country.

Further, the conclusion of this investigation has contributed towards bridging the gaps in the engagement processes between decision-makers and healthcare professionals in the public healthcare settings to include the nursing workforce in the procurement of new DHTs.

The theoretical contribution will be the knowledge contribution in the field of health informatics on nurses' lived experiences of using DHTs as part of their work practices. The study also aimed to extend the NPT as a framework for developing, evaluating and implementing complex interventions to also consider the use of complex interventions such as DHTs. On a methodological level, the researcher demonstrated how interpretive phenomenological analysis can be used in complex content in a hospital. Although IPA has been used for studies in South Africa, it seems that it has not yet been used in a hospital context.. Another contribution could be the in-situ lived experience in a public hospital in South Africa where the nurses' lived experiences are investigated in a real-life situation.

3.12 Chapter conclusion

This chapter provided a detailed description of the method that was used to conduct the study. The purpose of this qualitative, interpretive phenomenological study was to explore the lived experience of nurses use of DHTs as part of their daily work activities. This chapter also discussed the research design, philosophy and approach, methodological choice, data collection, data analysis, sample and setting, recruitment of the sample and unit of analysis. Ethical considerations were also highlighted, along with data collection procedures, interview questions and data analysis. Research rigor was discussed with a focus on trustworthiness: credibility, dependability, confirmability and transferability. The ensuing chapters will outline the results of the theoretical analysis through the lens of the NPT and the results of the thematic analysis.

CHAPTER 4: FIELDWORK

4.1 Introduction

This section serves to highlight the data collection process, the number of research participants, the data collection methods employed, the total number of interviews conducted and the point where data saturation was reached, respectively. Furthermore, this chapter presents the data analysis process, emergent themes, interpretation of concomitant results and the subsequent findings.

~~Two hospitals in Cape Town, Western Cape Province, were selected for this study. One hospital is a tertiary healthcare institution, the other a district hospital. To comply with the ethical clearance undertaking, which was signed by the researcher, and to ensure anonymity, the hospitals sites (or cases) where data were collected are henceforth referred to as to Hospital A (HA) and Hospital B (HB).~~

~~The researcher specifically chose to investigate the work activities of registered nurses and nurse managers who actively use technology as part of their daily work activities. For this purpose, the tertiary hospital was selected as it represents the public hospitals in the Western Cape Province of South Africa known for its innovative use of DHTs. Furthermore, the researcher's choice of Hospital B as a district hospital was influenced by the fact that it boasts several advancements in the implementation of new and innovative DHTs. Whilst both hospitals have implemented a series of DHTs, the researcher thought it prudent to investigate the extent to which nurses at these hospitals use DHTs as part of their daily work activities, given that tertiary hospitals receive priority in terms of funding for new ICTs~~.

The data collection and analysis structure is presented in Figure 5 below.

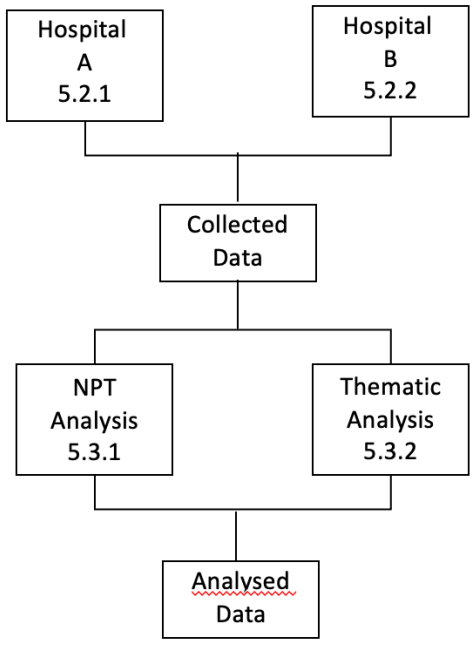


Figure 5: Data collection and analysis structure

Next, the demonstration cases wherein data were collected are described to provide the context for the study.

4.2 Demonstration cases for tertiary healthcare in South Africa

Two hospitals in the public health sector in the Western Cape Province were selected for the data collection since these hospitals were already using ICT in their care provision.

4.2.1 Case 1 Hospital A – Tertiary Healthcare in South Africa

Hospital A is one of two tertiary hospitals in Cape Town, South Africa. As the largest hospital in the Western Cape and the second-largest hospital in South Africa. Officially opened in 1976, Hospital A is known as an academic or teaching hospital. It was officially opened in 1976 and is the largest hospital in the Western Cape and the second-largest hospital in South Africa. It serves as a teaching hospital in conjunction with the Health Science Faculty of the University of Stellenbosch.

Hospital A is a tertiary hospital in Cape Town, South Africa. Since it boasts significant progress in the implementation of eHealth information systems in the Western Cape Province, this hospital was purposefully selected. Hospital A is referred to as an academic hospital that provides training for higher institution doctors and promotes research. Furthermore, Hospital A provides specialist care services that include day surgery; ear, nose and throat (ENT) care; mental healthcare; 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).

The hospital 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 suggests that one healthcare professional renders care services to more than 212 persons per year. With regard to 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 A has adopted and implemented DHTs for both clinical and administrative purposes. The DHTs used at Hospital A are 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 such as booking of agency nurses electronically.

Internal ethical clearance was obtained from CPUT's Faculty of Health and Wellness Sciences in April 2017, whereafter ethical clearance was sought from the Western Cape Department of Health. Subsequent permission was granted in August 2017 to conduct research at HA, and data collection took place from September to November 2017.

The researcher subsequently communicated with the Head of the ICU department at HA and was invited for an interview. After outlining the purpose for which the research was conducted, the researcher was put in touch with one of the nursing mentors in the ICU department, who ultimately assisted the researcher in sourcing appropriate participants for the study. A total of 20 participants were earmarked as participants for this study; however, a total of 14 participants responded positively and indicated their willingness to participate. The participants consisted of four nurses, and two nurse managers from the General ICU, six nurses from ICU and two nurse managers from the Cardiac ICU. Furthermore, one interview was held with an individual from the Chemical Engineering Department who provides technical support and maintenance of the equipment in the ICU.

Table 3: A brief overview of the participants that were used for purposes of this study

Code	Gender	Age	Position	No. of years as an RN	No. of years in current post	Qualifications
TA1	F	30	Registered Nurse	17	6	Diploma in Nursing
TA2	F	47	Registered Nurse	22	18	Diploma in General Nursing Diploma in Critical Care
TA3	F	59	Nurse Manager	33	38	Diploma in Nursing Diploma in Midwifery, Nursing Administration, Nursing Education, HIV Management
TA4	F	50	Registered Nurse	24	24	Diploma in Nursing Diploma in ICU – Critical Care
TA5	F	49	Nurse Manager	26	12	Diploma in Nursing Diploma in ICU – Critical Care Diploma in Nursing Administration
TA6	F	50	Registered Nurse	4	2.5	Diploma in Nursing
TB1	F	54	Registered Nurse	34	12	Diploma in Nursing Diploma in ICU – Critical Care
TB2	F	39	Registered Nurse	10	7	Diploma in Nursing
TB3	F	52	Registered Nurse	24	20	Diploma in Nursing Diploma in ICU – Critical Care
TB4	F	54	Registered Nurse	32	7	Diploma in Nursing Diploma – ICU – Critical Care
TB5	F	27	Registered Nurse	½	½	Bachelor of Nursing
TB6	F	52	Nurse Manager	30	6	Diploma in Nursing Diploma in ICU Critical Care
TB7	F	56	Nurse Manager	32	10	Diploma in Nursing Diploma in Midwifery Diploma in ICU – Critical Care
TB8	F	41	Registered Nurse	4	3	Diploma in Nursing
TB9	F	35	Manager – Clinical Equipment Dept	-	10	-

4.2.2 Case 2 Hospital B – District Healthcare in South Africa

Situated in a suburb in Cape Town, Hospital B is a large district hospital which services a community of approximately 700 000 people in its broader areas. Hospital B is aligned to the University of Cape Town's medical school and serves as a training facility for undergraduate and postgraduate students.

As the busiest hospital in the Cape Metropole, the hospital's Emergency Unit sees up to 4500 patients per month with 230 beds. Hospital B boasts several distinct specialities, most notably the Accident and Emergency Unit, General Outpatients, Medical adult ward, Obstetrics, Paediatrics, and a Surgical adult ward.

Ethical clearance was sought from the Western Cape Department of Health, and subsequent permission was granted in September 2017 to conduct research at HB. Since the researcher was

still in the process of collecting data at Hospital A, data collection at HB only commenced in January 2018. Unfortunately, the researcher suffered a personal bereavement on 26 January 2018, and as a result, data collection was suspended for approximately two months, but resumed in March and subsequently concluded in June 2018.

The researcher subsequently communicated with the Head of Nursing at HB and was invited for an interview. After outlining the purpose for which the research was conducted, the researcher was put in touch with one of the operations managers of the Emergency Unit.

As was the case with Hospital A, participants were purposefully selected and interviewed. Of 15 participants who were earmarked as participants for this study, a total of eight participants responded positively, indicating willingness to participate. The participants consisted of seven nurses and the operations manager of the Emergency Unit. Several attempts were made to conduct an interview with the technology champion, who is a consultant at the forefront of implementation of new technologies; however, due to his busy schedule, this interview unfortunately did not materialise.

Table 4: A brief overview of the participants that were used for purposes of this study

Code	Gender	Age	Position	No. of years as an RN	No. of years in current post	Qualifications
MPO1	F	49	Registered Nurse	28	4	Diploma in Nursing Diploma in ICU – Critical Care Diploma in Nursing Management
MP02	F	35	Registered Nurse	7	1	BCurr Diploma in Primary Healthcare
MP03	M	36	Registered Nurse	7	3	Diploma in Nursing Diploma in Nursing Management Diploma in Primary Healthcare
MP04	M	46	Operations Manager	21	7	Diploma in Nursing Diploma In Trauma Nursing
MP05	F	50	Registered Nurse	10	4	Diploma in Nursing Diploma in Psychiatry Diploma in Primary Healthcare
MP06	F	42	Registered Nurse	18	4	Diploma in Nursing Diploma in Trauma Nursing
MP07	F	42	Registered Nurse	7	4	BCurr Diploma in Trauma Nursing
MP08	F	27	Registered Nurse	4	3	BCurr

4.3 Data collection

For this study, the sources of data collection comprised two categories, namely secondary data (literature review in Chapter 2) and primary data (from interviews with participants engaged in the delivery of healthcare). The review of the literature was a continuous activity throughout the course of this study. The sections below will outline the following: 5.3.1 data collection process;

5.3.2 data collection instruments; 5.3.3 identifying and recruiting participants; 5.3.4 entering the field; 5.3.5 collecting data, 5.3.6 reflecting on the data collection process; 5.4 data analysis; 5.5 results of the NPT analysis and thematic analysis; 5.6 summary of key findings; and 5.7, chapter conclusion.

4.3.1 Data collection aligned to research questions

The interview questions were derived from the research questions to ensure that data collected can be used to address the identified research gap. The research question (RQ) key concept refers to the specific theoretical concepts related to each sub-research question. The interview questions were open-ended to allow the participants to elaborate on their experiences. In the next table, the research questions, research objectives, interview questions for data collection and the RQ key concept are outlined.

Table 5: Research questions aligned to interview questions

RESEARCH QUESTION (RQ) 1: HOW DO NURSES EXPERIENCE THEIR WORK PRACTICES INFLUENCED BY USING DHTs?			
Research sub-questions	**Research objectives**	**Interview questions for data collection**	**RQ key concept**
SUB QUESTION 1.1: How are DHTs incorporated into nurses' daily work practices?	Objective: To determine how DHTs influence nurses' work practices	1.1.1 How relevant is the information to nursing activities and providing care for patients?	Information relevancy
		1.1.2 What do you do with the information that is CAPTURED on these technologies? [Are they SHARED with other departments?] [how and where is the information STORED]	Information use
		1.1.3 How COMPATIBLE are these technologies with your existing work practices? [How does it fit into the overall clinical care?]	DHT compatibility
SUB QUESTION 1.2: For what purpose are DHTs used by nurses?	Objective: To ascertain why nurses use DHTs	1.2.1 Which technologies do you currently use? What are the names of these technologies?	Current DNT use
		1.2.2. What type of information is captured on these technologies?	Type information captured
SUB QUESTION 1.3: What are the perceptions and experiences of nurses in the use of DHTs?	Objective: To determine how nurses perceive and experience the use of DHTs as part of their daily work activities	1.3.1 What are your PERCEPTIONS/EXPERIENCES regarding the use of these technologies for your work activities?	DHT perceptions
		1.3.2 How were your current activities carried out BEFORE the introduction of the TECHNOLOGY?	Activity use before DHT
		1.3.3. How does the technology IMPACT ON THE NURSE-PATIENT RELATIONSHIP?	DHT impact on the Nurse-patient relationship

		1.3.4 Are you prepared to invest time and energy into LEARNING A NEW TECHNOLOGY? If yes, state why.	Willingness to learn new DHT
RESEARCH QUESTION 2: WHY IS THERE A MISALIGNMENT BETWEEN THE INTENDED USE OF DHTs AND THE LIVED EXPERIENCE OF NURSING USING DHTs IN PRACTICE?			
SUB QUESTION 2.1: What was the level of involvement of nurses in the design, development and implementation process of DHTs?	Objective: To evaluate the extent to which nurses were consulted in the design, development and implementation process of DHTs	2.1 Describe HOW these technologies were first INTRODUCED. Describe the PROCESS.	Nurses involvement in DHT development
SUB QUESTION 2.2: How were nurses' work practices, as part of their lived experience, considered during the design and implementation of DHTs?	Objective: To ascertain how nurses were supported in the design and implementation of DHTs	2.2.1 Did you need EXTENSIVE TRAINING to use the technology? Were your training needs assessed beforehand?	Training needs
		2.2.2 What type of IT SUPPORT is available to nurses?	Available support
SUB QUESTION 2.3: What are the dynamic elements of the DHT-integrated work practices of nurses that contribute to the design-reality gap between implemented DHTs and the nurses' lived experience of using DHTs?	Objective: To evaluate the elements that contribute to the design-reality gap between the intended use of DHTs and the work practices of nurses	2.3.1 Are you ever asked to contribute FEEDBACK about the technology once it has been in use for a while?	Feedback considered
		2.3.2 Can the technologies be ADAPTED OR IMPROVED based on the users' experience? If yes, explain HOW.	Need for DHT adaption

Next, the data collection process is explained.

4.3.2 Data collection process

~~In this study, the major data collection methods associated with an interpretive phenomenological study were in-depth interviews and observation. The study used in-depth interviews and observation to engage the selected participants to collect data. The interviews enabled the researcher to obtain a large volume of subjective data, which was then interpreted to gain in-depth information as understood and interpreted from the participants' points of view. In addition to interviews, observation was used to supplement primary data gathered from interviews. Observation forms were designed and relied on to capture events as they unfolded prior to the interviews. This assisted the researcher in taking field notes whilst observing participants in their environments during the study. The researcher was able to clearly observe participants, which assisted in gaining deeper insights into the phenomenon being studied. The researcher was able to observe the interactions between the various stakeholders, as well as the types of DHTs that were being used. This included non-verbal cues as well as operations in the actual work environment. Observatory notes were taken by the researcher and were later analysed. This~~

~~method was of great value to the researcher as it allowed her to investigate social systems in terms of perceptions and behaviour of participants in the research context, namely, how nurses use DHTs as part of their daily work activities.~~

~~The researcher engaged with the two hospitals to conduct pre-interviews to establish social interactions with both the nursing staff and the administration to create a rapport and ensure that the nurses are comfortable to answer the interview questions as exhaustively as possible. Consequently, the in-depth interviews enabled the researcher to answer the research questions and achieve the objectives set in the study.~~

4.3.3 Data collection instruments

The interview instrument was developed based on a review of the literature, the research questions and also the normalisation process theory (NPT) as a guideline. To ensure reliability of the results, the semi-structured in-depth interviews were repeated until a saturation point was achieved; in other words, several interviews were held with several of the identified participants until a level was reached where there was total confirmation that the data collected fully reflects the phenomenon being studied. The validity of the research instrument was ensured through a pre-test of the research instrument at a Hospital A.

4.3.4 Identifying and recruiting participants

Since the data collection method for this study was qualitative in nature, the researcher used non-probability sampling, via purposeful sampling, to identify and select only those particular end-users who use DHTs as part of their daily work activities. This technique assisted the researcher in identifying a sample size that would provide in-depth information which are aligned to the research objectives of this study. According to Creswell (2007), purposive sampling is based on biased judgement, especially in selecting participants who are perceived to have a comprehensive understanding of the knowledge gap being studied. This sampling technique was combined with snowballing, where the engaged participants would suggest colleagues who possess the required knowledge of the issues being studied.

The target population included nurse managers and operations manager at Hospitals A and B, as well as a representative of the Chemical Engineering Department at Hospital A, who was involved in the design and implementation process of DHTs and participated in this study. As previously stated, this study focused on the tertiary hospitals because they take government priority in ICTs equipment distribution, thus the tertiary institutions are expected to have a higher relative degree of implementation and use of DHTs than other public hospital levels. In addition,

one district hospital where DHT projects are currently being piloted was selected for this study. Kerr *et al.* (2010:272) suggest that the optimum number of required subjects in a qualitative study evolves over time as the study progresses until data saturation is attained.

A variety of criteria was applied during the selection of participants including the level of education, role, profession, job position/rank, work experience and station. Moreover, participants were selected according to age (>18 years), and the number years' experience as a registered nurse The age distribution of this category of participants ranged between 31-60 years, with 50% falling in the 31-40 age bracket, while 41-50 and 51-60 groups constituted 25% each. According to Polit and Beck (2012), a purposive sampling strategy is most commonly used in phenomenological research because it allows the researcher to select participants who have rich knowledge of the phenomenon. Frechette *et al.* (2020) suggests that purposive sampling is appropriate for an interpretive phenomenological study.

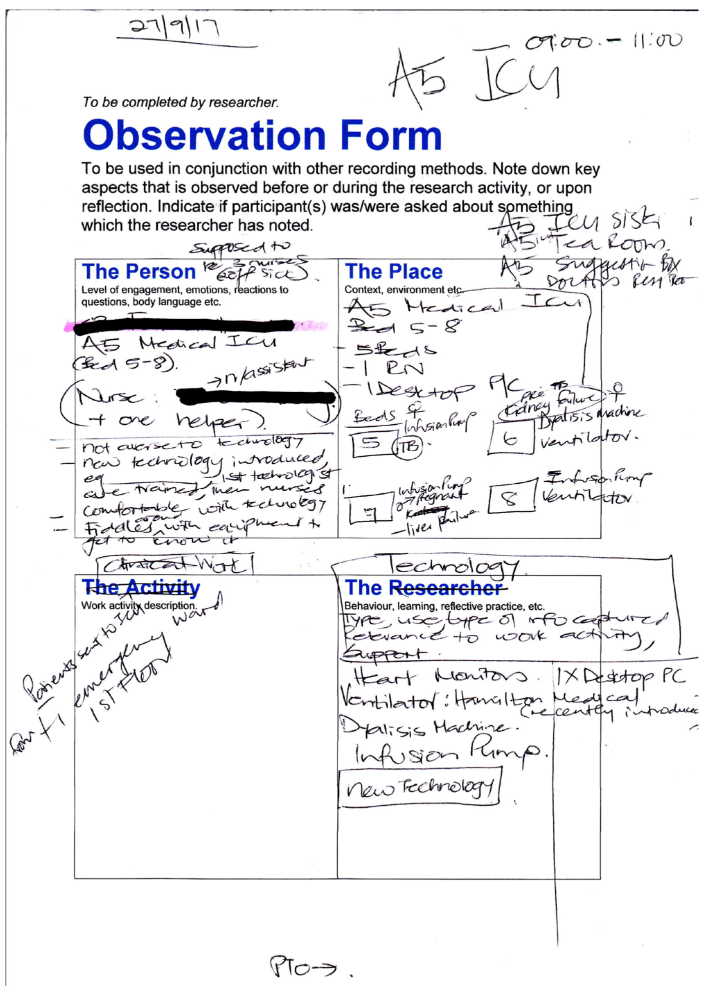
4.3.5 Entering the field

Once ethical clearance was obtained from the Department of Health and Hospitals A and B, respectively, the researcher made contact with the unit manager of the ICU at Hospital A. After meeting with the unit manager, the researcher was referred to the Nurse Mentor, and after outlining the aim and purpose of the research project, the researcher was then referred to the general ICU and the cardiac ICU. After consultations with the nurse managers of both ICUs, individual nurses who matched the criteria outlined in 5.5.3 were approached. Taking into consideration the extremely busy schedules of the nurses, appointments were scheduled for observation as well as interviews. Data collection at Hospital A was thus conducted during the period September and November 2017, and a total of 14 participants participated in this study. The participants consisted of four nurses, and two nurse managers from the General ICU; six nurses ICU and two nurse managers from the Cardiac ICU. In addition, one interview was held with an individual from the Chemical Engineering Department who provides technical support and maintenance of the equipment in the ICU. The researcher was well-received by the participants. They were eager to engage with the researcher and share their lived experience with using DHTs as part of their daily work activities.

Upon completion of data collection at Hospital A, the researcher proceeded to schedule an appointment with the Head of Nursing at Hospital B, and after once again outlining the aim and purpose of the research project as per the aforementioned Annexures, the researcher was referred to the unit manager of the Emergency Centre at Hospital B. After consulting with the unit manager (who was also a participant in this study), the researcher set about recruiting nurses

who met the criteria for this study as outlined in 5.5.3. Given that this was an emergency unit and the extremely busy schedules of the respective nurses, seven registered nurses and the unit manager agreed to participate in the study. Data collection at Hospital B was thus conducted from December 2017 to June 2018.

An important aspect of entering the field was that the researcher immersed herself in the environment of the hospitals by just being present before starting with the actual data collection. This allowed the nurses to get used to her and when the data collection started, a trust relationship already existed. It also allowed the researcher to get a sense of the rhythm of the environment and the conditions of the nurses' work. Although observations were not one of the data collection strategies, important observations were noted that were used later to contextualise the data and give a better understanding of the lived experiences in that situation. An example of such a form is presented in the next figure.


27/9/17
09:00 – 11:00
A5 ICU

To be completed by researcher.

Observation Form

To be used in conjunction with other recording methods. Note down key aspects that is observed before or during the research activity, or upon reflection. Indicate if participant(s) was/were asked about something which the researcher has noted.

The Person
Level of engagement, emotions, reactions to questions, body language etc.
[redacted]
A5 Medical ICU
(Bed 5-8).
Nurse: [redacted] → n/assistant
+ one helper
– not averse to technology
– new technology introduced
– Fiddles with equipment to get to know it

The Place
Context, environment etc.
A5 Medical ICU
Bed 5-8
– 5 Beds
– 1 RN
– 1 Desktop PC
Dialysis Machine
Ventilator
Infusion Pump
Ventilator

Technology

The Activity
Work activity description.

The Researcher
Behaviour, learning, reflective practice, etc.
Type, use, type of info captured
Relevance to work activity,
Support.
Heart Monitors. 1X Desktop PC
Ventilator: Hamilton Medical (recently introduced)
Dialysis Machine.
Infusion Pump.
New Technology

PTO →

Figure 6: Example of an observation form

4.3.6 Collecting data

Participants were purposefully selected and interviewed. As mentioned in 4.3.5 above, for Hospital A, of 20 participants who were earmarked as participants for this study, a total of 14 participants responded positively, indicating willingness to participate. The participants consisted of four nurses and two nurse managers from the General ICU, and six nurses ICU and two nurse managers from the Cardiac ICU. Furthermore, one interview was held with an individual from the Chemical Engineering Department who provides technical support and maintenance of the equipment in the ICU.

As was the case with Hospital A, participants at Hospital B were purposefully selected and interviewed. Of 15 participants who were earmarked as participants for this study, a total of eight participants responded positively and indicated their willingness to participate. The participants consisted of seven nurses and the operations manager of the Emergency Unit. Several attempts were made to conduct an interview with the technology champion, a consultant at the forefront at the implementation of new technologies; however, due to his very busy schedule, this interview unfortunately did not materialise.

During the interview sessions at both hospitals, the researcher endeavoured to refrain from asking leading questions, and instead, allowed the participants to freely narrate their experiences. During the interview, follow-up questions were posed. For example, the researcher would ask: Could you give me an example? How or what do you mean? Could you explain in a bit more detail? How did you feel about that? Can you describe that in more detail? The interviews were characterised by openness and flexibility, and the results of this study can attest to the fruitfulness of a descriptive method.

Interviews were digitally recorded and transcribed verbatim by the researcher. Meticulous care was taken to preserve the data that were collected. Data were saved on an external hard drive which was kept in a locked drawer at the researcher's home. Furthermore, documents were password-protected and only the researcher and her supervisor had access to this data. Each interview was transcribed, compared with written notes and observations, then saved, and participants were anonymised by being assigned a particular code. Each transcript was saved under this unique code. Participants were given the opportunity to review transcripts of the interview to clarify, revise or delete any portions thereof if they wished to do so.

According to Saunders *et al.* (2018), when the researcher begins to hear the same comments again and again, data saturation is being reached. It is then time to stop collecting information

and to start analysing what has been collected. Data saturation was attained with the 14 participants at Hospital A, and similarly, with Hospital B.

4.3.7 Reflecting on the data collection process

The researcher suffered a personal bereavement during January of 2018, and as a result, had to postpone data collection. It is for this reason that data collection at Hospital B could only be concluded by June 2018. The researcher is grateful that data collection occurred before the onset of the Covid-19 pandemic. In addition, the researcher was deeply affected by the loss of a child as a result of the pandemic, which severely impacted the completion of this study.

The first challenge experienced by the researcher was the process of obtaining ethical clearance. At that particular time, ethical clearance had to be obtained via the Faculty of Health and Wellness as well as via the Faculty of Informatics and Design. This process proved to be time-consuming and tedious. Once internal ethics clearance was obtained, ethical clearance and permission then had to be obtained from the Western Cape Department of Health. This process started early in 2017, and the researcher had applied for sabbatical leave from February to December 2017 to collect the data and subsequently complete the study. As a result, because of the various processes that had to be undertaken to obtain the necessary ethical clearance and permission, permission to conduct research at Hospitals A and B was only obtained in August 2017 and September 2017, respectively.

Secondly, collecting data from participants in an ICU and EC setting was challenging, since both environments are highly charged and often unpredictable. Interviews were arranged with each participant at Hospital A and Hospital B, and each interview was approximately 45 minutes in duration. However, trying to gain an in-depth understanding of the phenomenon being studied was problematic, since the participants' very busy time schedules needed to be taken into account. Very often, scheduled appointments had to be rescheduled several times due to the unavailability of participants, or an emergency in the ICU or EC. Furthermore, appointments had to be arranged during the participants' lunch breaks which were often delayed and interviews were often conducted in the crowded and noisy communal tea room. Since the researcher also made use of participant observation, she would often be asked to vacate the EC at Hospital B when a resuscitation had to be performed. Whilst the researcher suggested that interviews could take place during their off-days at a coffee shop of their choice, participants were not keen and thus opted for interviews to take place during their lunch breaks. It should be noted that the researcher was not allowed to take any photographs.

It is important to note that two types of data analysis were performed for this study, namely a theoretical analysis using the NPT as analytical lens, and a thematic analysis of the data collected. The sections below will outline the process undertaken for each type of analysis.

4.3.8 NPT analysis

The NPT has played a significant role in this qualitative research project as it has assisted in the research design, sampling and data collection. Furthermore, it has helped to inform, guide and structure the research focus and questions. Each construct was used to answer the main research questions and interpret the subsequent findings of this study, which is discussed in Chapter 7.

The first phase of analysis is about familiarising oneself with the data. To this end, each recorded interview was transcribed verbatim, and the researcher spent a great deal of time reading and re-reading each transcript carefully. This method proved to be extremely helpful, since interviews with nurses were conducted during their lunch break, and there were often many distractions.

It was important to have a good comprehension of the NPT constructs to use them when analysing the data. Each core construct was interpreted in terms of the explanation of its associated NPT constructs. After the explanations provided by May *et al.* (2007) for the core NPT were interpreted, the NPT constructs were mapped to the interview questions (IQ) and explanations were formulated.

Table 6: NPT constructs as used in this study adapted from May (2006)

NPT Core Construct	NPT core construct explanation	NPT construct mapped to interview question (IQ)	NPT construct explanation
Coherence **Interpreted as meaning & sense-making**	**Coherence** is the sense-making work that people do individually and collectively when they are faced with the problem of operationalising some set of practices. Interpreted as: Distinct, Clear purpose; Shared sense of purpose; Is it valued? Does it fit into overall goals & activities?	Differentiation **IQ1.3.2**	**1.1 Differentiation**: **Practices and objects are different from each other before and after technology is introduced.**
		Communal specification **IQ1.1.2**	**1.2 Communal specification**: **Do individuals have a shared understanding of aims, objectives & expected benefits of technology?**
		Individual specification **IQ1.1.3**	**1.3 Individual specification**: **Do individuals have clear understanding of their specific tasks & responsibilities in the implementation of new technologies?**

		Internationalisation **IQ1.1.2** **IQ1.2.2**	**1.4 Internalisation**: **Understanding the value, benefits & importance of the technology.**
Cognitive participation **Interpreted as commitment & engagement**	**Cognitive Participation** is the relational work that people do to build and sustain a community of practice around a new technology or complex intervention. Like all NPT constructs, it has four components. Interpreted as: Is technology a good idea? Do they see the point? Are they prepared to invest time & money into learning new technology?	Initiation **IQ1.2.2**	**2.1 Initiation**: **Willingness of key participants to drive implementation forward.**
		Enrolment **IQ1.3.2** **IQ1.3.4**	**2.2 Enrolment**: **Is there "buy-in" from individuals with the technologies?**
		Legitimisation IQ2.1.1 **IQ1.3.3**	**2.3 Legitimation**: ***Is it right for them to be involved with new technology?***
		Activation **IQ2.2.1** **IQ2.3.1** **IQ2.3.2**	**2.4 Activation**: ***Collectively define actions and procedures need to sustain a practice and stay involved/Can individuals sustain involvement?***
Collective Action **Interpreted as work done to make technology functions**	**Collective Action** is the **operational work** that people do to enact a set of practices, whether these represent a new technology or complex healthcare intervention. Like all NPT constructs, it has four components. These were the first NPT constructs to be developed and their names reflect qualities of technologies or complex interventions, rather than the character of the work that these involve. Interpreted as: Does the technology promote or impede work? Is extensive training needed? Compatibility with existing work practices? Impact on the division of labour.	Interactional workability **IQ1.3.2** **IQ1.3.3**	**3.1 Interactional Workability**: **Is the new technology making work easier or more difficult?**
		Relational integration **Q1.1.3** **Q 1.3.3**	3.2 **Relational Integration**: **How well does it fit into existing relationships?/ Do individuals have confidence in the system?**
		Skill set workability **IQ2.2.1** **IQ2.3.2**	**3.3 Skill set Workability**: ***How does technology affect roles and responsibilities or training needs?***
		Contextual integration **IQ2.2.2**	**3.4 Contextual Integration**: **Can the practice be supported? Does it align with the overall goals & capacities? Is there organisational support?**
Reflexive monitoring **Interpreted as reflection & appraisal of technology**	**Reflexive Monitoring** is the **appraisal work** that people do to assess and understand the ways that a new set of practices affect them and others around them. Like all NPT constructs, it has four components: Interpreted as: Perception after use for some time; Is it advantageous? What are the effects? Can users give feedback? Can procedures be adapted/improved? How was work done before technology?	Systematisation **IQ1.3.1** **IQ2.3.1**	**4.1 Systematisation**: **Formal evaluation of new practices/How are the benefits or problems identified/measured?**
		Communal appraisal **IQ2.3.1** **IQ2.2.2** **IQ1.3.2**	**4.2 Communal appraisal**: **when individuals ask co-workers? What do you think of X? Is this for me?**
		Individual appraisal **IQ1.3.3**	**4.3 Individual appraisal**: **when individuals ask co-workers? What do you think of X? Is this for me? How do groups judge the value of the technology? How do individuals appraise the effects on them and their work environment?**

		Reconfiguration IQ1.3.1 IQ1.3.3 IQ2.3.1	**4.4 Reconfiguration**: Do individuals try to alter the new service (initiate workarounds)?

The second phase involved identifying the concepts and themes that emanated from and creating the thematic framework. Kiger and Varpio (2020) describe a *theme* as a dynamic pattern (or meaning) constructed from data sets that answer research questions, rather than simply a description or classification of a code.

After reading the transcripts several times, the researcher then began to highlight themes, and subsequently created in vivo codes for them. Saldaña (2012:74) posits that the term *in vivo* refers to "in that which is alive". The author further states that "and as a code refers to a word or short phrase from the actual language found in the qualitative data record". In other words, it refers to the terms used by the actual participants. Saldana (2012:74) also states that in vivo coding has also been named as "Literal Coding" and "Verbatim Coding".

After reading the transcripts, the in vivo codes were compared with the relevant NPT constructs, whereafter the relevant NPT codes were assigned thereto. The researcher was mindful when assigning codes and tried her utmost to use the authentic voices of the participants, instead of merely forcing the data into the NPT framework. By reviewing key and relevant passages, followed by highlighting and selecting in vivo codes, the researcher was able to then ascertain which NPT codes were most suitable. The ensuing section will outline the selection of the NPT coding categories.

Selection of NPT coding categories

The following coding framework was used to assign codes to the various NPT constructs to select the NPT coding categories (May *et al.,* 2007).

4.3.8.1 Construct - Coherence (C)

The application of the first NPT construct, coherence, shows the work of nurses in their understanding of how technology fits into their work practices. To this end, data were coded to the category of coherence if it described sense making by the participants. The construct of coherence is broken down into further segments as follows and is supported by extracts from the interviews.

C1 – differentiation: understanding how a set of practices and their objects differ from one another, in other words, do participants see this as a new way working? Participants at HA and HB were asked about the types of DHTs used as part of their daily activities and it was apparent

that nurses are exposed to a variety of technologies and that they positively appreciate these technologies, to the extent that they cannot perform their work without it. When asked how their work was carried out before technology, the overwhelming response was that technology has become such an integral part of their working lives that they simply cannot perform their work without it. This sub-construct overlaps with RM2 and RM3 - Communal Appraisal and Individual Appraisal respectively.

> *I am always open to learning new things and technology is the way forward. It improves the care you can deliver, the information you receive from the patient through the technology. (TB05)*
>
> *Yes, I am prepared, especially in ICU, to make the work easier and to give good quality nursing care. I will say personally, I'm prepared to learn. (TB06)*
>
> *It was very difficult, especially when taking blood samples, you had to write out a lot of labels. It was really bad. (TA01)*
>
> *It was time-consuming before technology. We took too long to attend to patients. With this technology it is very easy because, for example, with HB it took three minutes; however, now it takes a few seconds. Once a patient receives a finger prick, the result is available within a few seconds. Previously it would take a few minutes, and it was also not very accurate, and often someone else had to come and confirm the results. (MP05)*
>
> *The service delivery is quicker, and the waiting time is shorter. I can also see on the doctor's computer because we are linked. (MP08)*

C2 - communal specification: refers to people working together to build a shared understanding of the aims, objectives, and proposed benefits of a set of practices. In other words, do all those involved agree about the purpose of the DHTs being used? When asked about the relevance of the information captured digitally to their nursing activities and subsequent provision of care to their patients, responses indicated that valuable information is captured by the various types of DHTs used by nursing as part of their daily work activities. This sub-construct overlaps with CP4 – Activation. Nurses are thus extremely aware of the value and importance of these DHTs and how it impacts their lived experience.

> *Very relevant because it will determine your next action. It tells you information about your patient which will determine how you nurse that patient or if you need to inform the doctor or if there is a change in the condition. It is very relevant. (TB05)*
>
> *We can sit at the desk and we can see all the patients' dysrhythmia (heart rate and rhythm) and we can act whenever there is a problem. We can print it out or go to the doctor and report what we have seen and we can handle the problem. (TB01)*

The system makes a determination, for example, if the patient says he or she has an abdominal pain, we do a pregnancy test, as perhaps the patient is pregnant. We enter this information onto the system – depending on what the patient tells us. It is 100% relevant in terms of how we care for our patients. (MP03)

Hectis system is the most relevant thing at the moment. This hospital has a lot of patients so we cannot survive without it. (MP08)

C3 - Individual specification: refers to individual participants working towards understanding their specific tasks and responsibilities around a set of practices, meaning, is there an understanding amongst individuals what tasks the DHTs require of them? Participants were therefore again asked about the relevance of the information captured digitally to their nursing activities and subsequent provision of care to their patients. This sub-construct overlaps with CP4 – Activation.

It is very relevant especially for the stock that we order, the diet list that we do, our off duties, the quality assurance - so for me it is relevant for the work that I do on the computer. (TA02)

It's very important. The ECG monitor, you can immediately see the patient is not in the normal heart rhythm, so now you can do a formal ECG and inform the doctor. With heart patients, we don't want them to have a fast heart rate, so there is medication to bring it down. So the monitor will inform you that the pulse is too fast or too slow. (TA03)

It can accurately predict the severity of the patient's condition. Sometimes as nurses you can't always tell how sick the patient is. However, with this technology, if a patient is rated orange, it can tell you that the patient has chest pain and you can immediately do an ECG. (MP02)

It makes my job easier. I am the one who pushed for electronic reporting for nursing. (MP06)

C4 – Internalisation: refers to individuals understanding the value, benefits and importance of a set of practices and contributes to embedding the practice into their lived experience. In other word, do all the stakeholders grasp the potential benefits and value of the DHTs which they are using? When participants were asked about their perceptions or experiences in the use of DHTs as part of their daily work activities, the overwhelming response is that technology makes life easier, and facilitates their work, thus improving patient care. This sub-construct overlaps with CA1 – Interactional Workability; RM2 & RM3 – Communal and Individual Appraisal.

I feel technology is a good help and it makes our work very easy. I don't feel that it is a barrier that comes between me and my nursing care. …I don't think that technology can take over nursing care, really. We don't feel that the monitor can't be wrong. (TA06)

We have the technology that improves continuously, and new technology is improved, and we receive monitors that work better, but we also physically look at our patients. It's not just about technology, but rather about the physical patient. We enquire as to how they feel. If we see their BP is high and heart rate is incorrect, we don't take it at face value. We go to the patient and ask how they feel, do they have pain. If the BP is very high and I feel that I want to measure it manually, then I will do so to see how the monitor's BP differs from the physical BP cuff. I look at everything both manually and with the help of the monitor. (TB01)

We get to learn about diagnosis, medical terms, we learn what the abbreviations mean. Now we can convey information to other colleagues and departments. You have easy access and its safe and confidential and secure. (MP05)

I love technology because it makes my life easier. I was motivating the resistant staff to try out the new technology. I am used to technology as I used it in ICU at my previous job. We started using this system last year, there was some resistance. (MP07)

4.3.8.2 Construct - Cognitive Participation (CP)

The second NPT construct, cognitive participation, refers to the commitment and engagement by the participants, in other words, the process and work that individuals undertake to promote engagement with DHTs. It also refers to whether the participants will see the point of the use of technology and whether they will be prepared to invest time, energy and work in it. Data were therefore coded to the category of cognitive participation where participants focused on the work undertaken so as to engage with potential users and obtaining their “buy-in” for the use of technology as part of their daily work activities.

The construct of cognitive participation is further subdivided into the sub-constructs as set out below.

CP1 – Initiation: This refers to work that brings a practice into action, or in other words, whether or not key participants (actors) are working to drive them forward, and whether they are willing and able to engage others in the implementation. To this end, participants were asked whether they were willing to invest time and energy into learning new technologies. Participants overwhelming responded in the affirmative. Because participants positively appreciate technology, and they see the value in it, not only for their patients, but for themselves, they are willing to invest time and money into learning new technologies. This sub-construct overlaps with CP2 – Enrolment, and CP4 – Activation.

Yes, I am prepared, especially in ICU, to make the work easier and to give good quality nursing care. I will say personally, I'm prepared to learn. (TA04)

Yes, I am prepared, especially in ICU, to make the work easier and to give good quality nursing care. I will say personally, I'm prepared to learn. (TB04)

I am prepared if there is new technology introduced. (MP02)

I would love to learn new technology. I need to know the patient's results. I often order x-rays, and I interpret the x-rays and blood results, and sometimes you need to proper training. (MP03)

CP2 – Enrolment: This sub-construct refers to actors (nurses) working together and organising themselves to collectively participate in a new practice, whether there is "buy-in" and whether they believe that they are the correct people to drive forward the implementation? This construct overlaps with CP1 – Initiation, and to ascertain whether there was buy-in amongst participants. As a result, when asked whether participants are willing to invest time and money to learning new technologies, thus driving the process forward, the responses were overwhelmingly in the affirmative. This construct further overlaps with C1 – Differentiation, where participants were asked how their work was carried out before technology. As mentioned, participants overwhelmingly responded that technology has become such an integral part of their working lives that they simply cannot perform their work without it.

CP3 – Legitimisation: This sub-construct involves interpreting and 'buying in' to that practice, as well as ensuring that other participants believe it is right for them to be involved, and that they are able to make a valuable contribution to the process), in other words, is there a belief amongst individuals that it is right for them to be involved? This sub-construct partly overlap with the sub-constructs, C1 – Initiation, and CP2 -Enrolment, pertaining to whether there is buy-in amongst participants and whether it is right for them to be involved in ongoing advancement and use/introduction of DHTs as part of their daily work activities. In addition, participants were asked how compatible DHTs are with their existing work activities. As can be deduced from the quotes below, the responses from participants was overwhelmingly positive and proves that the DHTs that they currently use are compatible with their daily work activities.

It makes a lot of things easy for us. We still look for a thermometer, but every monitor has one. It improves care giving much quicker than what you would do something manually. (TB03)

With these monitors, if you can't be there at 13:00 you can go back to check what the patient's vitals were at 13:00. So I will say it fits in very well. (TB06)

It is very relevant for us and very accurate because it can give you the time of arrival of the patient, the time awaited in triage. What time the patient was triaged, what time the patient was seen by the doctor and the waiting period of the patient is captured. When the patient is discharged, it also shows that the patient was in EC and now he or she is discharged. If the patient goes to another

ward or an overnight ward, it also tells you that this patient is no longer in EC but has moved to another ward. It is very accurate. (MP02)

It fits into our overall clinical care of the patient. Everybody, the doctors, us and the clerks we have access. The clerks will see how many patients are waiting to be discharged. If a patient was discharged 3 days ago, and the folder is still missing, they are able to see. For example, we don't have a patient for more than 18 hours, so we look for the patient. (MP07)

CP4 – Activation: This refers to how a particular practice, i.e., the use of technology, becomes operationalised. To clarify, are participants able to identify what tasks and activities are required to sustain the use of DHTs as part of their daily work activities. This subconstruct overlaps with CP1 – Initiation, CP2 – Enrolment, in terms of whether participants are willing to spend time and energy into learning new technologies. It furthermore overlaps with C2 – Communal Specification, with respect to ascertaining the relevance of the information captured digitally to their nursing activities and subsequent provision of care to their patients. As mentioned, responses indicated that valuable information is captured by the various types of DHTs used by nursing as part of their daily work activities. Nurses are thus extremely aware of the value and importance of these DHTs and how it impacts their lived experience.

4.3.8.3 Construct - Collective Action (CA)

Data were coded to the category of collective action if it pertained to the operational work performed by individuals, groups of professionals or organisations in operationalising a new technology in practice. In other words, how participants made it work, and how their activities are organised and structured, the work done by individuals and organisations to enact the new practice. Collective action has four components, as outlined below.

CA1 – Interactional workability: This sub-construct refers to how actors operationalise a particular practice in everyday settings, in other words, interaction with the healthcare system, new healthcare technologies and patients, and whether the use of DHTs make it easier or harder to complete tasks. To this end, participants were asked about the nurse-patient relationship, as well as their perceptions/experience of using DHTs. This sub-construct overlaps with C4: Internalisation; CA3: Skillset workability; RM2: Communal Appraisal; RM3: Individual Appraisal. There is overall consensus amongst participants that DHTs facilitate their work and in turn, optimises patient care. Furthermore, participants have highly positive perceptions about the various technologies, and despite some shortcomings (for example, lack of training, lack of log-in credentials), they have expressed overall confidence in the system.

CA2 – Relational integration: This refers to the way in which a practice is facilitated and understood within the networks of people around it. In other words: How well does the new implementation fit in with existing relationships? Does it promote trust and accountability within groups or does it create divisions and mistrust? Do those involved in the implementation have confidence in the new way of working? To this end, participants were asked about the nurse-patient relationship and whether technology becomes a barrier between them and their patients. The overwhelming response was that technology is an enabler and not a barrier. This sub-construct overlaps with CA3 – Skillset Workability.

> *You need the technology because it guides you to what the needs of the patient are. You have to give basic nursing care also, you are rendering that also, and the ventilator and cardiac monitor - these are also a way of communication. Your ventilator speaks to you, so does the cardiac monitor. It does not impact negatively on the patient, and it is not a barrier at all. (TA02).*
>
> *It saves time, also helps us to treat patients with a heart attack. We can do an ECG as soon as possible. If the patient needs to get the streptokinase, that can be done as soon as possible, so it saves time. It does not take time away from patients. For me, I think it's really helping, unless we misuse it, like for instance, when I was a student, we would play games on the computers, so if you do it the wrong way, then it can take time away from your patient. (TB08)*
>
> *It does not come between me and my patient. I focus on my patient when I do my observations. My last observation is asking the patient to pass urine. When the patient is busy with this, then I have time to capture everything on the computer. So I do not lose that personal contact with the patient. (MP02)*
>
> *It does not take time away from the patient. With triage, you are right next to the patient, you are communicating with them, it takes three minutes to triage and then you are able to update all information (on the computer) while the patient goes for the urine test. You actually have more time with the patient. Patients are happy and complimenting us because we don't do so much writing and the process is quicker. (MP07)*

CA3 – Skill set workability: This sub-construct refers to the allocation and distribution of work, i.e., the degree to which the new initiatives fit into existing work practices, skill sets and perceived role; and whether the participants who use the DHTs have the correct skills and training for the job.

This construct partially overlaps with CA2 – Relational Integration, where participants were asked about the impact of technology on the nurse-patient relationship. Secondly, the construct partially overlaps with C4 – Internalisation, where participants were asked about their perceptions or experiences in the use of DHTs as part of their daily work activities. To ascertain whether

participants had the correct skills and whether they received the correct training for the job, they were asked whether their training needs were assessed and whether they receive regular training. The response varied – the majority of participants strongly cited the lack of training as a barrier that prevents them from deriving maximum benefits from the DHTs that they are using. Similarly, many participants also cited the lack of log-in credentials as a notable barrier and hampered them in their care giving. Many participants were of the opinion that, if they had their own log-in credentials, they would be able to access patient blood results and would not have to wait on a doctor to log into the system so they may access the results.

> *We had to figure things out for ourselves. But because we sometimes relieve in ICU, we more or less had an idea of how it worked. We also ask the technologists in ICU if we need help. We have not had any formal training, not even a demonstration. My perception is that because we relieve in ICU, we are supposed to know how it works. So basically we would go next door to ICU to fetch one of the sisters to show us how the monitors work. (TA04)*
>
> *When I started so it was just the nurses, the other Sisters, my colleagues, who would show me. I never went for any formal training. No one comes around to assess our training needs. There is no programme in place for regular training. Every year they will give us a list where we can go if we want basic computer training, but since I came here, nobody went on any of the courses. (TB08)*
>
> *.Life would be easier if I had my own login and password because I could print my own stickers and make my life easier. Everybody gets a password and everyone runs to you to get their work.. I would like to have a password to do a simple task of printing stickers. I have to phone them because I need a password. I haven't been able to do this. For MODS, I ask one of the sisters in charge who has a password to do it. I can get it done, but it's frustrating. (TB04)*
>
> *If they can just help us with the passwords, that is the main problem. If that happens, we will use the computer more often. If I could access the blood results myself, it would not make better necessarily, because the problem we have is that every time we have to phone the Lab if there is no doctor. So not necessarily, but it would be much better if you know you need your patient's blood results, and you can go see if it's out or not. Unlike us sitting on the phone, sometimes nobody is answering the phone. So it will make it easier in a way. (TB08)*
>
> *You must be trained to use the technology. There is a basic triage course and thereafter it was no further training. Dr X just sat down with us, he switched on and first he programmed our personnel details on there, thereafter we logged in every time we entered the system. We have our own usernames and passwords. (MP02)*
>
> *We had brief training sessions where we were shown how to work the system. There was always someone to guide us. There were doctors who already knew the system, as well as others who were computer literate. So they were the champions for the system. I cannot recall any nurse that*

was sent for any other form of training. We were only exposed to training on the e-register technology. There is no ongoing training programme at the hospital. (MP08)

CA4 – Contextual integration: This sub-construct refers to the incorporation of a practice within a social context, i.e. the degree to which implementation aligns with the overall goals and capacity of the organisation. In other words: Does the organisation have the financial and technical capacity to support the new practice? To this end, participants were asked about the type of technical support which is available to them to facilitate their work. From the responses, the researcher can deduce that there is adequate support for nurses in the form of a helpdesk, an IT department, and also, at Hospital B, a technology champion who drives the process of implementing the latest technology.

We usually phone the helpdesk, especially if we can't go into our NIMS or HeathApps. Their response time is normally very good and quick. The longest that I have waited is two to three hours, they normally respond very quickly. If the monitors break down, we will go to the technologists, otherwise the company must come in. (TA04)

Whenever there is a problem with the central monitor, the IT department will immediately assist to sort out the problem as this technology is of utmost importance to the ICU. For problems with the computer, the helpdesk is contacted and often remote support is given. (TB01)

We've got a help desk for the computers and for the electronics we have an electronic dept. that we call and they come immediately for the monitors. Helpdesk is for IT related complaints. Response time is immediate, especially for the monitors. (TB03)

We phone Dr X who is the one in control of the technology. Even if the e-register is not working completely, Dr X is able to call for assistance. It doesn't even take 30 minutes for the system to be up and running again even if he is not in the hospital. There is no IT helpdesk on site for this technology. (MP02)

The IT dept is always available. They are located on the premises. If there is a problem, you can call them. (MP03)

4.3.8.4 Construct - Reflexive monitoring (RM)

Data were coded to the construct of reflexive monitoring where formal or informal evaluations and appraisals of the implementation process was undertaken by the participants (actors). In other words, are there mechanisms available to enable assessment of advantages and disadvantages DHTs being used by nurses and assessing users' comprehension of the effects of using DHTs as part of the daily work activities.

Reflective monitoring has four subdivisions as discussed hereunder.

RM1 – Systemisation: This sub-construct refers to regular organised procedures for monitoring and continuous assessment of the process and the impact of the new practice within the organisational context, as well as determining the effectiveness and usefulness thereof for nurses. This sub-construct therefore seeks to ascertain whether nurses are able to judge the effectiveness of the DHTs that they are using. To achieve this outcome, participants were asked whether they thought DHTs could be adapted and improved, based on their experience therewith. It is clear that nurses, based on their vast experience in using DHTs as part of their daily activities, have come to know and appreciate the advantages and disadvantages thereof, to the extent that they have concrete ideas on how these technologies can be improved or optimised; however, they are not afforded the opportunity to do so.

> *I think they can cut out the digital thermometers and use the temperature probe to continuously check the patient's temperature because when the patient is here in ICU, where you have to measure the temperature hourly, because the patients are very sick and septic, you can check if the temperature goes up or down continuously. I think they can improve on that. The other thing is the monitor itself - it needs to be upgraded so that we can have a printout of the patient's vitals if we need one. The temperature probe comes with the monitor - it can be connected to the monitor and onto the patient. (TA06)*
>
> *We have an ECG machine that does ECGs using the correct paper to print, but we cannot print it from the monitor. It would have been good if the monitor could do everything, because we do not send our patients to do an ECG. Rather, we print it, the electrodes stay on the patient, and if there is an abnormality, we can print immediately to capture the dysrhythmia. The function could not be adapted because of the paper, but I believe that the company can work on it, to get the correct paper so that we can print it on the blocked paper. (TB01)*
>
> *Dynamac – the BP machines. At other hospitals especially private hospitals they have better Dynamacs than we have here in the public hospital. Sometimes the machines come with all the functions, ie heart rate, temperature. If one Dynamac can perform all these functions it will make things easier because you gather all the patients details in one go. Instead we have separate machines to perform all these functions. (MP03)*
>
> *Definitely, with the management report there are some things we can change. Some information is more relevant to doctors than nurses, so I will do the report for the next few months and provide feedback in terms of my experience and what changes can be made. That is why it is piloted here and I will report back. (MP06)*

Secondly, participants were asked whether they were afforded an opportunity to provide feedback on the DHTs that they use daily. The responses varied. In some instances, participants were

asked for feedback on certain DHTs but this was not a regular occurrence. On the rare occasion that they are allowed to provide feedback, this would be limited to certain technologies only.

> *Yes, sometimes. The reps always bring their products and we have to test it out and see if it works for our ICU or not. Then we just fill in the form and say it works or it doesn't work. There is some form of evaluation. (TA02)*
>
> *Not really. The only time when our IVACS came and when the new ventilator comes and they showed us how to use it, and then after a while the rep will come again and ask feedback on how we find it, what problems we have. That is the only time, only with IVACS and ventilators. (TA04)*
>
> *There are guys coming around from the manufacturers, but nobody ever asked me. If we have problems with the monitor, there are always people coming to work on it. But no one comes to ask how does this work for you? How does it compare to the previous one? (TB02)*
>
> *I have been using e-register since the end of 2016 or early 2017. Our operations manager always asks us for feedback on the technology with regard to complaints and we are asked for input on how things can be improved. When they initiated the new system, they asked us often for feedback. Now they ask us for feedback once in a while. (MP03)*
>
> *Not too often as we would like it to happen. I feel like if we do give feedback it isn't really taken into consideration. Sometimes feedback is just part of the process. I have never had an experience where nurses opinions are actually taken into account. It is not done formally. It is done in general meetings where feedback is asked, I would say once every six months. (MP08)*

RM2 – Communal appraisal; RM3 – Individual appraisal: This refers to judging the value and outcomes of a practice individually and collectively. In other words, how stakeholders judge the effectiveness of the intervention, both individually as well as collectively. These two sub-constructs overlap with the following: C1 – Differentiation: where participants' views were sought about how their tasks were performed before technology; CP3 – Legitimisation: where participants were asked how compatible the DHTs are with the current work activities; C4 – Internalisation: where participants elaborated on their perceptions or experiences in the use of DHTs as part of their daily work activities.

RM4 – Reconfiguration: This refers to the appraisal of the practice, both individual and communal, regarding the use and utility of the practice which may lead to redefining or modifying some practices, and the occurrence of workarounds. This sub-construct therefore sought to ascertain whether participants were able to modify the DHTs based on evaluation and experience. This sub-construct overlaps with RM1 – Systemisation, where participants were asked whether they were given the opportunity to provide feedback on existing technologies, and whether they

are afforded the opportunity to share ideas on how existing technologies can be enhanced or improved to optimise their existing practices. From the responses, it is clear that nurses have concrete recommendations on how DHTs can be improved, and optimise their work activities; however, they are not afforded the opportunity to do so.

4.3.9 Summary from the NPT analysis

The normalisation process theory (NPT) served as a theoretical lens to interpret the findings of this research project, as it provided a conceptual framework that served to explain the processes whereby new health technologies and other complex interventions can be routinely embedded (operationalised) into everyday work, and integrated (sustained) in practice. Furthermore, it has served to elaborate how new technology innovation can be embedded into existing practices – in line with the research problem of this study.

When interpreting the data the researcher can conclude that, when applying the construct of coherence (sense making), in an effort to ascertain the degree to which participants made sense of their work, collectively as well as individually; participants have a sense of purpose; that DHTs are valued and that these DHTs fit into their overall goals and activities.

When applying the construct of cognitive participation, the researcher sought to ascertain whether participants thought the use of DHTs is a good idea, whether they saw the point of using it, and whether they were prepared to invest time & money into learning new technology. The researcher can conclude that there is buy-in from all participants, and unanimity in terms of the benefits of DHTs, and a willingness to sustain the practice of using DHTs because it facilitates their work and enhances patient care. However, a number of barriers have been identified which may hamper them in deriving the maximum benefit of DHTs and potentially impact on the care that is provided to their patients.

When interpreting the data through the concept of collective action in an attempt to ascertain whether DHTs promote or impede the work of nurses, whether DHTs is compatible with their work practices and the impact thereof on the division of labour, the researcher can conclude that, based on the responses from participants, technology facilitates nursing care as well as nursing administration, and this impacts positively on the nurses as they have expressed confidence in the system. There is adequate support available to nurses as end-users of DHTs in the form of an IT Department, an IT Helpdesk, or a technology champion who drives the forward of integrating technology into everyday work practices. However, a large number of participants have overwhelmingly stated that the lack of formal training is a concern that hampers their ability to

fully capitalise on the benefits that new technologies may bring. Another aspect is that they sometimes do not trust technology, and would, at times, resort to manual procedures or foundational practices, should the need arise.

When applying the construct of reflexive monitoring, in an effort to ascertain whether participants are given the opportunity to appraise the various DHTs that they use as part of their daily work practices, to understand how a new set of practices, i.e. the use of DHTs as part of their daily work activities, how it affect them and others around them, the researcher can conclude that all participants have highly positive perceptions about the various technologies. However, it is abundantly clear that there are very limited opportunities for participants to provide feedback or provide input into the acquisition of new technologies or on existing technologies. This is problematic, because in some instances, DHTs are not aligned to their daily work practices and they do not have an avenue to address this issue.

4.3.10 Thematic analysis

The second analysis was a thematic analysis of the data collected. Thematic analysis is a suitable method for analysing experiences, thoughts or behaviours in a set of data (Kiger & Varpio, 2020). The analysis of the qualitative data obtained through interviews and observations, and which include perceptions, attitudes, beliefs and opinions of participants regarding the phenomenon of this study, was undertaken by means of a thematic analysis.

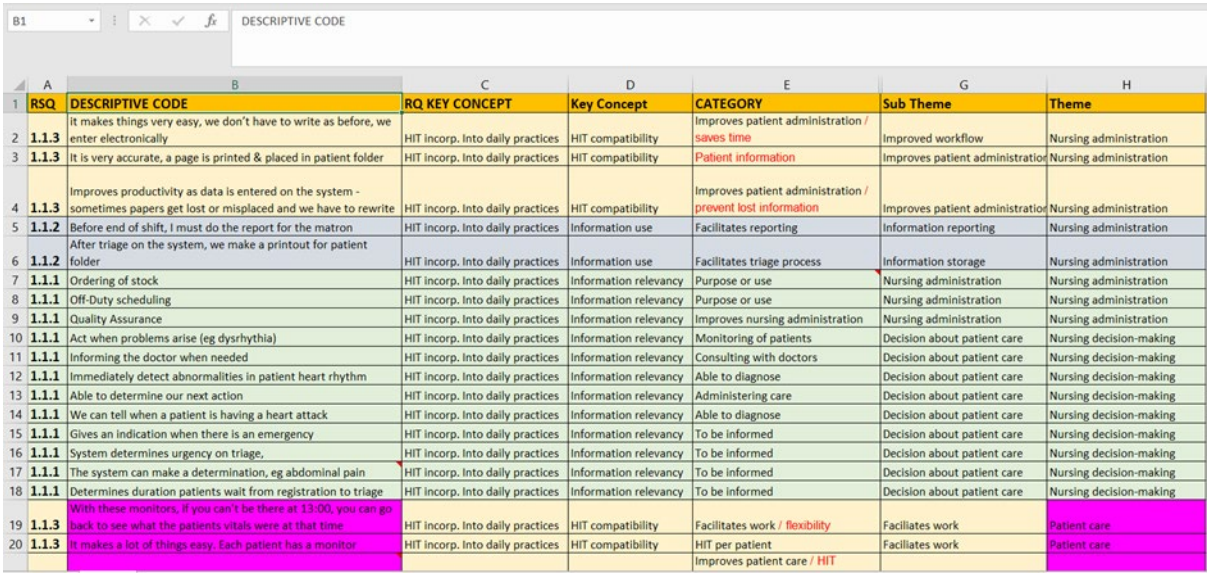
The semi-structured interviews, conducted during participants' lunch breaks, each lasted approximately 45 minutes in duration. The researcher listened and re-listened intensely to the recordings of the interviews, whereafter recorded interviews were transcribed from audio to verbatim text. The researcher then examined the raw textual data line by line in an attempt to identify distinct events, incidents, ideas, actions, perceptions and interactions of relevance that are coded as concepts. A coding process was applied whereby the words or phrases were assigned descriptive codes. The researcher made use of descriptive codes to tag the emerging attributes, viz., keywords or phrases as it relates to the issue that is being investigated, and thereafter, to categorise the themes. According to Saldana (2009:8), "To codify is to arrange things in a systematic order, to make something part of a system or classification, to categorise". According to Neuman (2006), there are several different types of coding: selective coding, axial coding or open coding.

Open coding aims to identify concepts or key ideas that are hidden in textual data, which are possibly related to the phenomenon being studied. Axial coding, on the other hand, involves

linking data together to reveal codes, categories and subcategories embedded within participants' voices within the collected data. Whilst open coding is distinct from axial coding, both can be performed simultaneously (Bhattacherjee, 2012). For the purpose of this study, open and axial coding were applied, ultimately providing the researcher with the ability to sort and organise the data from the interviews and arrive at the concomitant themes.

According to Rogers, many qualitative studies generate themes as a result of the coding process as well as analytic reflection (Rogers, 2018). Furthermore, Saldana (2016) posits that themes can be linked to categories and subcategories, and as such, every sub-theme that emanated was broken into its categories and sub categories and this was interpreted to point to a certain theme. Themes, categories and sub-categories as evident in Table 7 below were subjected to further analysis to establish their links, centrality and relationships.

Table 7: Extract from the coding sheet



B1 DESCRIPTIVE CODE

	A	B	C	D	E	G	H
1	RSQ	DESCRIPTIVE CODE	RQ KEY CONCEPT	Key Concept	CATEGORY	Sub Theme	Theme
2	1.1.3	it makes things very easy, we don't have to write as before, we enter electronically	HIT incorp. Into daily practices	HIT compatibility	Improves patient administration / saves time	Improved workflow	Nursing administration
3	1.1.3	It is very accurate, a page is printed & placed in patient folder	HIT incorp. Into daily practices	HIT compatibility	Patient information	Improves patient administratior	Nursing administration
4	1.1.3	Improves productivity as data is entered on the system - sometimes papers get lost or misplaced and we have to rewrite	HIT incorp. Into daily practices	HIT compatibility	Improves patient administration / prevent lost information	Improves patient administratior	Nursing administration
5	1.1.2	Before end of shift, I must do the report for the matron	HIT incorp. Into daily practices	Information use	Facilitates reporting	Information reporting	Nursing administration
6	1.1.2	After triage on the system, we make a printout for patient folder	HIT incorp. Into daily practices	Information use	Facilitates triage process	Information storage	Nursing administration
7	1.1.1	Ordering of stock	HIT incorp. Into daily practices	Information relevancy	Purpose or use	Nursing administration	Nursing administration
8	1.1.1	Off-Duty scheduling	HIT incorp. Into daily practices	Information relevancy	Purpose or use	Nursing administration	Nursing administration
9	1.1.1	Quality Assurance	HIT incorp. Into daily practices	Information relevancy	Improves nursing administration	Nursing administration	Nursing administration
10	1.1.1	Act when problems arise (eg dysrhythia)	HIT incorp. Into daily practices	Information relevancy	Monitoring of patients	Decision about patient care	Nursing decision-making
11	1.1.1	Informing the doctor when needed	HIT incorp. Into daily practices	Information relevancy	Consulting with doctors	Decision about patient care	Nursing decision-making
12	1.1.1	Immediately detect abnormalities in patient heart rhythm	HIT incorp. Into daily practices	Information relevancy	Able to diagnose	Decision about patient care	Nursing decision-making
13	1.1.1	Able to determine our next action	HIT incorp. Into daily practices	Information relevancy	Administering care	Decision about patient care	Nursing decision-making
14	1.1.1	We can tell when a patient is having a heart attack	HIT incorp. Into daily practices	Information relevancy	Able to diagnose	Decision about patient care	Nursing decision-making
15	1.1.1	Gives an indication when there is an emergency	HIT incorp. Into daily practices	Information relevancy	To be informed	Decision about patient care	Nursing decision-making
16	1.1.1	System determines urgency on triage,	HIT incorp. Into daily practices	Information relevancy	To be informed	Decision about patient care	Nursing decision-making
17	1.1.1	The system can make a determination, eg abdominal pain	HIT incorp. Into daily practices	Information relevancy	To be informed	Decision about patient care	Nursing decision-making
18	1.1.1	Determines duration patients wait from registration to triage	HIT incorp. Into daily practices	Information relevancy	To be informed	Decision about patient care	Nursing decision-making
19	1.1.3	With these monitors, if you can't be there at 13:00, you can go back to see what the patients vitals were at that time	HIT incorp. Into daily practices	HIT compatibility	Facilitates work / flexibility	Facilitates work	Patient care
20	1.1.3	It makes a lot of things easy. Each patient has a monitor	HIT incorp. Into daily practices	HIT compatibility	HIT per patient	Facilitates work	Patient care
					Improves patient care / HIT		

The themes of this study emerged from the interviews conducted with 22 participants (17 registered nurses, four nurse managers and one operations manager) regarding the use of DHTs as part of their daily work activities. These individuals willingly shared their valuable time and experience with the researcher during their interviews and observation sessions. The accounts of their experiences were an integral and essential part of this research process to gain a deeper understanding of their lived experience with DHTs.

From the coding process, 10 major themes emerged: 1) decision-making, 2) adapting to change, 3) HIT use, 4) HIT access, 5) HIT development, 6) information, 7) nursing administration, 8) patient care, 9) training, and 10) workarounds. Two-hundred-and-sixty-one (261) descriptive

codes were created from the responses. These codes were further grouped and categorised into one hundred-and-four (104) categories and from these categories into seventy-three (73) sub-themes. The sub-themes were grouped into forty-two (42) initial themes. These initial themes were then considered in terms of similar and duplicate theme names and descriptions that resulted into the final 10 themes. These themes are a representation of the participants' lived experiences and relationships with DHTs as part of their daily work activities. A conceptual representation of the themes is illustrated in the Table below. It is important to note that each participant's experience was unique and individual and was in no way restricted to one single theme. To some extent, all themes were expressed in each of the individual and cumulative experiences of the participants, which are supported by excerpts from the interviews in the ensuing discussions of each theme.

The following table presents a summary of the main themes, related sub-themes and counts to indicate the number of occurrences of each.

Table 8: Main themes with associated initial themes and counts

Final theme / Initial theme	Count of codes
1. Adapt to change	23
Adapt to change	23
2. Decision-making	16
Decision-making based on triage	1
Nursing decision-making	9
Decision-making at the point of triage	5
Decision-making based on triage	1
3. DHT access	20
Connectivity	2
Own Login credentials	2
Technology Integration	16
4. DHT development & support	44
Barrier to patient care	6
Dedicated IT Support	27
Nurses' Involvement in DHT Introduction	11
5. DHT use	53
Feedback on DHT	15
DHT adaption	16
DHTs facilitate decision-making	1
DHTs facilitate information sharing	2
DHTs facilitate nursing administration	1

	DHTs facilitate patient care	8
	DHTs improve nursing administration	4
	Positively appreciate technology	5
	Resistance to DHTs	1
6. Information		29
	Facilitates reporting	1
	Information availability	4
	Information reporting	1
	Information sharing	4
	Information storage	6
	Patient information	12
	Protected information	1
7. Nursing administration		6
	Nursing administration	6
8. Patient care		40
	Patient care	21
	Patient Care through DHT	19
9. Training		16
	Barrier to technology	12
	Lack of training	3
	Training	1
10. Workarounds		14
	Initiate workarounds	14
Grand Total		**261**

4.3.10.1 Theme 1 – Decision-making

Decision-making is the first theme derived from the data. This theme captures nurses' ability to make decisions from two perspectives: 1) decision-making based on observation and 2) decision-making based on triage. A variety of DHTs are used by nurses in both hospitals as part of their daily work activity, namely, ventilators, cardiac monitors, telemetry devices, desktop computers, ECG machines, multi-functional devices, eRegister, thermometers and HB machines. Observing patients and charting their progress is a fundamental part of any nurse's job. Through the use of the various DHTs, nurses are able to make decisions based on their observations. For example, an ECG machine is used to diagnose whether a patient is having a heart attack, whereafter the nurse decides on the appropriate course of treatment. Similarly, the eRegister assigns priority to

the order in which patients are attended according to their vital signs and then assigns a colour code for the nurse to prioritise.

> *The moment a patient is connected to a monitor, then all alarms are activated and we can immediately hear and see when there is a problem. (TB01)*
>
> *Also with the heart rate and dysrhythmia we can react as soon as possible if we need to. (TB08)*
>
> *The system makes a determination, for example, if the patient says she has an abdominal pain, we do a pregnancy test, as perhaps the patient is pregnant. (MP03)*
>
> *Determines the durations patients wait from registration to triage. (MP05)*

Before the electronic triage system was in place at Hospital B, nurses would triage patients manually, which was time-consuming. With the electronic system of triaging, time is saved, and the waiting period for the patient is drastically reduced. The system can accurately predict the severity of the patient's condition, especially since nurses cannot always accurately determine the severity of a patient's condition. However, with this technology, if a patient is rated in the orange category, it could suggest that the patient has chest pain and the nurse can immediately perform an ECG. If the patient has a hypoglycaemia, the system will instruct the nurse to perform a urine test. If respiration point is 1 or more, the nurse is prompted to check the oxygen level of the patient.

4.3.10.2 Theme 2 - Adapting to change

Adapting to change is the second theme that emanated from the data. Given the abundance of literature on the benefits of DHTs in providing quality of care to their patients, nurses have expressed their willingness to adapt to change. Whilst some nurses cited initial reservations at the introduction of new technologies, others responded overwhelmingly positively and have unequivocally stated their willingness to learn new technologies, as cited by the following participants.

> *Knowledge is power, I feel that the more we know, the better we are able to apply nursing care. We live in a time where technology is the order of the day and we only want to make our work easier. I am eager to learn about technology but I am being deprived of this opportunity. (TB01)*
>
> *I am always open to learning new things and technology is the way forward. It improves the care you can deliver, the information you receive from the patient through the technology. (TB05)*
>
> *I would love to learn new technology. I need to know the patient's results. I often order x-rays, and I interpret the x-rays and blood results, and sometimes you need to proper training. I order xrays*

and blood tests and I have access and the means to order these tests electronically on e-register. I am able to go back into the system to see a patients results if needed. (MP03)

Yes, I know there are a lot of things to learn. Whatever I've learned is self-taught, or I Googled. Computer literacy courses is reserved for clerks and we are more focused on the nursing side of things. Its only since last year that we have been given a chance to choose courses to attend for personal development. Getting time off for training is a major challenge. Getting replacement staff is a problem. I would do it if I get an opportunity. (MP06)

4.3.10.3 Theme 3 – DHT use

The third theme to emanate from the data is DHT use.

As nurses use the various technologies as part of their daily work activities, it became evident that they positively appreciate the DHTs and as such, have integrated these technologies into their patient care.

Nurses have expressed a high degree of awareness of the immense benefits associated with the use of DHTs. Based on the nature of the DHTs which are available to nurses in an ICU and EC setting, it can be concluded that these technologies facilitate their decision-making and optimise patient care. Participants appreciate and value the DHTs and are willing to invest time to learn new technologies.

Yes, I am prepared, especially in ICU, to make the work easier and to give good quality nursing care. (TA01)

Yes, I am always open to learning new things and technology is the way forward. It improves the care you can deliver, the information you receive from the patient through the technology. (TB04)

I am happy to learn about new technology. (MP01)

Yes, definitely. What would life be without technology. (MP08)

There is overwhelming consensus amongst participants that technology has become integral to the delivery of patient care, especially in the ICU, to the extent that they cannot do their jobs without it and often compare their present, technology-driven environment to the past, when most of their tasks were undertaken manually. Some of the benefits cited include that recordkeeping is improved and information is easily accessible which improves productivity.

It was very difficult, especially when taking blood samples, you had to write out a lot of labels. (TA01)

So we stand in one place and can observe over 20 patients' vital signs at once and act immediately when there is a problem. (TB01)

The service delivery is quicker, and the waiting time is shorter. I can also see on the doctor's computer because we are linked. (MP05)

Previously it would take a few minutes, and it was also not very accurate, and often someone else had to come and confirm the results. Today, finger prick results are available within 10 seconds. (MP05)

It is evident from the data that technology has made work easier, improved workflow and increased productivity. Furthermore, participants are of the opinion that DHTs have a positive impact on the nurse-patient relationship as these technologies do not hinder their work.

It does not take away from the personal care at all. There is still a lot of nursing care that you have to do yourself. (TA01)

The technology is not seen as a barrier. In cardiology, it is too important because it gives us information about what the patient needs now. (TB03)

It does not hinder me. If a patient needs me now, I can save what I am doing on the system and I can tend to that patient. (MP01)

It does not take time away from the patient. With triage, you are right next to the patient, you are communicating with them, it takes three minutes to triage and then you are able to update all information while the patient goes for the urine test. (MP07)

Participants have become skilled as DHTs have been integrated into their daily work activities. As a result, many participants have a number of concrete ideas on how DNTs can further optimise their work practices. For example, a number of nurses expressed a desire to have their own login credentials, as this will facilitate their work, especially when they have to look up a patient's blood or x-ray results. Currently, they have to wait for a doctor to look up the results or sometimes they use a doctor's login credentials. Other forms of improvement include email notification from the laboratory to indicate that a patient's blood results are available, the printing of ECGs directly from the central monitor, and a lack of electronic reporting.

The other thing is the monitor itself - it needs to be upgraded so that we can have a printout of the patient's vitals if we need one. The temperature probe comes with the monitor - it can be connected to the monitor and onto the patient. (TA06)

The monitor can print an ECG but , because we do not have the proper paper to count the blocks, it will not show an abnormality….We have an ECG machine that does ECGs using the correct paper to print, but we cannot print it from the monitor. It would have been good if the monitor could

do everything, because we do not send our patients to do an ECG. Rather, we print it, the electrodes stay on the patient, and if there is an abnormality, we can print immediately to capture the dysrhythmia. (TB01)

Definitely, with the management report there are some things we can change. Some information is more relevant to doctors than nurses, so I will do the report for the next few months and provide feedback in terms of my experience and what changes can be made. (MP06)

When I take the report to the Matron I do it physically. I would like to be able to send the report electronically to the Matron. I have to queue to wait, and that wastes time as I have patients to see. This is done at the end of the shift. (MP07)

When asked whether they are allowed to give feedback on existing DHTs and how these technologies can be enhanced or improved, nurses overwhelmingly responded that there are very few opportunities for them to provide such feedback. For those who have had an opportunity to provide feedback, these opportunities were limited and restricted to certain technologies only.

The only time when our IVACS came and when the new ventilator comes and they showed us how to use it, and then after a while the rep will come again and ask feedback on how we find it, what problems we have. That is the only time, only with IVACS and ventilators. (TA04)

The technologists always try new stuff with the ventilators and then they come back to get feedback. (TA06)

I have been using e-register since the end of 2016 or early 2017. Our operations manager always asks us for feedback on the technology with regard to complaints and we are asked for input on how things can be improved. (MP03)

I have never had an experience where nurses opinions are actually taken into account. It is not done formally. It is done in general meetings where feedback is asked, I would say once every six months. (MP08)

4.3.10.4 Theme 4 - DHT access

The fourth theme that emanated from the data is DHT access, emphasising concern amongst participants. Despite the buy-in from nurses regarding the use of technologies, there are a few barriers that hinder their ability to derive maximum benefit and pass such benefit on to patients. This theme therefore unmasked a number of barriers in terms of access to some DHTs, *inter alia*, an insufficient number of computers, limited time assigned to the triage process, a lack of log in credentials, limited training opportunities, long response time when technologies need repair, poor connectivity, occasional patient resistance to the use of technology, the (sometimes negative) effect of DHTs on the nurse-patient relationship, and the need for electronic reporting as opposed

to manual reporting. One nurse reported on the time-consuming nature of manual reporting, and stated that if there are 70 patients on a particular day, the nurse has to go through each patient's folder to give accurate stats in terms of the length of stay of each patient in the EC. This process could be facilitated with the introduction of an electronic reporting system, which was in the process of being piloted at Hospital B.

> *Technology can be a barrier if you have to struggle. If you have your password and if it only takes five minutes, it's okay. But if you must go and look at the info and it is not there, or it is off line or it takes me half an hour, it takes time away from my patients. (TB02)*
>
> *It can be a negative experience because patients detest these things on their bodies. It happens all the time. Patients sometimes hate the technology infringing on their movement, especially the BP cuff, ECG dots. (TB04)*
>
> *There are times that I don't like it because with the hospital, if something breaks, it takes a long time to be repaired. If we send one of the monitors down for repairs we have to wait a while for it to come back. (TA04)*
>
> *Manual reporting takes a lot of time – about 2 hours. Electronic reporting is made easier because whatever you need to ask the patient is already captured electronically. Whatever the programmer put in, is already there. We just fill in the dates. (MP07)*
>
> *The only challenge that I have experienced, especially in the EC, is when there is a power failure and we are off-line. We don't have back up, so we have to switch to manual. (MP03)*
>
> *If there are ways to improve the network, it would be great. Cable theft is a big problem. (MP08)*

Computers are used to, *inter alia*, record patient information and for triage purposes. However, a lack of computers at Hospital B has a negative effect on the nurse-patient relationship in some parts of the EC. This is particularly problematic as, at the point of triage, the computer is not in the same room where the nurse and patient are. Information is then captured manually, whereafter the nurse has to get up to walk to the computer, which is in a different room, whilst leaving the patient alone. Nurses see this as a barrier between them and the patient. Another nurse has expressed frustration at the lack of printers and finds it easier to write down a patient's statistics whilst in the process of triage. The nurse has explained that it takes her two minutes to triage manually, whereas it takes longer when it is done electronically. In this part of the EC, there are four computers that are used by everyone, including doctors.

> *It affects the nurse-patient relationship. You now have a specific time frame in which to triage the patient so you have to rush. In this way you don't have that nurse-patient relationship. (MP03)*

It does take time away from the patient, because, before, when we triaged the patient manually, we used to stand with the patient and talk to them whilst writing things down. Now we have to walk away from the patient to go to the PC. (MP08)

A highly notable barrier is the lack of training. Most nurses have cited a lack of formal training as a barrier that hinders their work. Most training is in the form of peer-to-peer training, or in other words, learning by doing. If there is formal training, it is usually for two or three days at most. Another barrier reported by nurses is not having their own login credentials. Nurses feel that if they had access to check patients' results themselves, it will improve patient care. Instead, they have to wait for a doctor to log in and provide them with the patient's blood results, or results of X-rays.

We had to figure things out for ourselves. We also ask the technologists in ICU if we need help. (TA04)

For NIMS and Health Apps, we went to the Datalan, there is an office on the ground floor, and they gave us formal training. The training was two days long. It was not really so sufficient because there's a lot of stuff [updates] that came afterwards, and we didn't receive new training. (TA04)

No formal training, I was just orientated a day or two and the sister in charge just showed me how the monitor works and to get used to the ICU to orientate me. (TA06)

No one here taught me how to use it. With the cardiac monitor, you just learn as you go on. There wasn't any specific person that came and taught me how to do things. You just figure things out. Staff train each other. If there's something that I know, I would teach someone else. If there is a new staff member, older staff members would assist. There is no formal training on how to use the ECG machine or cardiac monitor. Every day you sit and play around to figure out how things work. (TB04)

It's on-the-job learning. I have not had formal training in terms of using the cardiac monitor. I am just shown how to use it. (TB05)

You must be trained to use the technology. There is a basic triage course and thereafter it was no further training. (MP02)

Our training needs were not assessed beforehand, only when they started the training. There were some who could work on the Hectis system, but others needed further training. It was an ongoing process. If you had any issues individually, they would train you individually. (MP06)

Several nurses in both Hospitals A and B have expressed concern that they are not adequately exposed to technology and have expressed a need to be able to access patient results from the laboratory using their own login credentials.

There is not much exposure for nurses to use other technology as some of the technology requires proper training. Sometimes nurses don't have time for training, but I think it is good for nurses to know how to use these technologies. (MP03).

I would like to have a password in order to do a simple task of printing stickers. I have to phone them because I need a password. I haven't been able to do this. For MODS, I ask one of the sisters in charge who has a password to do it. I can get it done, but it's frustrating. (TB04)

If I had my own login and password it would be easy so that I don't have to remember someone else's so in that respect it would be easier. Sometimes other computers require login details that you don't have. (TB05)

If I could access the blood results myself, it would not make better necessarily, because the problem we have is that every time we have to phone the Lab if there is no doctor. So not necessarily, but it would be much better if you know you need your patient's blood results, and you can go see if it's out or not. Unlike us sitting on the phone, sometimes nobody is answering the phone. So it will make it easier in a way. (TB08)

Nurses at Hospital B are able to register and admit patients on the system, which enhances service delivery. However, while some have their own login credentials, some still encounter problems.

My login does not work for NIMS. It is very important for us to use NIMS for agency staff. It is a big hindrance. I have my own log in credentials, but Hectis is still going to be changed, we currently log in with surname and initial, this is problematic. Anyone can log in with your details. They are going to change it to using PERSAL numbers in order to ensure confidentiality and security. (MP06)

4.3.10.5 Theme 5 - DHT development (introduction)

The fifth theme to emanate from the data is DHT introduction/development/deployment. When participants were asked how DHTs were introduced/deployed, the overwhelming response from Hospital A was that there was no prior consultation with nurses before the introduction of new technologies. However, the three nurse managers who were interviewed at Hospital A were unanimous that there was not sufficient consultation with nurses or nurse managers with regard to the introduction of new technologies. One nurse manager stated it is problematic when nurses are not consulted. She stated that, when doctors decided on a particular type of ECG monitor, they were not consulted, nor were their opinions sought. She is of the opinion that, had they been consulted, she would have advised that the money could have been better spent on a better, less expensive type of monitor. This participants did, however, state that their opinions were sought regarding the building of the new hospital and where the High Care and ICU would be situated.

However, the operations manager interviewed at Hospital B stated that there was some form of consultation with him and senior nurses.

Three nurse managers were interviewed at Hospital A with regard to how new technologies were introduced and the degree to which they were involved or consulted in the introduction of new DHTs. Nurse managers were informed in various ways, for example, via managerial meetings and via the area manager. They, in turn, informed the nurses in their respective departments, via staff meetings. The operations manager at Hospital B was interviewed and he was informed by one of the consultants in the EC.

> *Via the managerial meetings that we have and then we receive training. (NM01)*
>
> *The area manager informs us of what she gets from top management. (NM02)*
>
> *When CLINICOM was introduced, we were informed at the meeting. (NM04)*
>
> *Introduced by Dr X, one of our EC doctors, because we needed a system that speeds the triage process. (OM01)*

Whilst some nurses at Hospital A stated that these DHTs were already present when they joined the hospital, others with a number of years of service admitted that no input was sought from nurses in terms of the introduction of new technologies. Some nurses stated that new technologies will be brought in, followed by a brief demonstration by a technologist.

> *Most of the time we are not informed about new technology. It is mostly said in meetings where discussions are held and when you look again, it's here. (TA04)*
>
> *When I came here, the systems were already here. (TB01)*
>
> *Everything was here when I came. (TB05)*
>
> *When we started with the new monitors they got the technologist from the company to give us a lecture on how to work with and operate the new monitors. (TB01)*
>
> *Sometimes the nurse manager will inform us that they will change something, maybe next week. That is the only notification we get. (TB08)*
>
> *I wasn't on duty when technologies were introduced, when they came to show the clerk and unit manager how to capture information, staff attendance. My colleagues showed me. (MP01)*

Nurses at Hospital B stated that they were sometimes informed of the introduction of new technologies by the operations manager, and by one of the consultants, Dr X, who is the champion for one of the technologies being piloted at Hospital B. Before the introduction of this prominent aforementioned DHT at Hospital B, there was some form of consultation with some of the nurses.

According to the participant, sessions were held and some consultations took place where they presented their requirements, for example, the information about the triage sheets. However, not all their stipulated requirements were implemented, for example, a request was made for a double-sided recording page to write their nursing notes at the back without having two pages, as well as the introduction of a fluids chart.

The operations manager at Hospital B opined that more can be done to involve nurses in the implementation processes, particularly with regard to the introduction of the electronic nursing report, as a clear understanding of the nursing process is key. An important distinction was made during the nursing discussions as to the purpose of the nursing report, which is to report on daily events and is not focused on providing statistical information. The operations manager pointed out that there is a different report that deals with statistics.

> *Dr X, the consultant, informed us of this technology. (MP02)*
>
> *We were informed by our operational manager about the new technology. (MP03)*
>
> *Hectis system was introduced by one of our consultants. He trained people, like train-the- trainer method. (MP08)*
>
> *If we receive any new technology into the unit, then usually the reps of the companies come on a specific date and time to introduce new technologies. (MP01)*
>
> *We used to talk a lot about introducing an electronic system. It started as an idea and the consultant travels a lot, and he brought in a new system. (MP06)*

It is evident that nurses are not actively involved in or consulted on the introduction of new technologies. Even nurse managers are not adequately informed thereof, except via their respective area managers or at departmental meetings.

4.3.10.6 Theme 6 – Information [availability, storage, sharing, usefulness]

The sixth theme to emanate from the data is Information and the relevance thereof. This theme highlighted the value of information, facilitated through the use of DHTs as part of nurses' daily work activities. Concepts emerging from this theme focus on the different ways in which information play a pivotal role in the everyday work activities of nurses. The ensuing sections will highlight the impact of the availability of information, how information is stored, shared, protected, and reported.

Through the use of a variety of DHTs, valuable information is captured in the ICUs at Hospital A as well as the EC in Hospital B. DHTs comprise computers (used for the management of nursing staff rosters, ordering of consumables, email), ventilators (for monitoring oxygen levels) IVAC

machines (used to administer medications) ECG machines (to monitor the function of the heart) HB monitors (to check haemoglobin levels), thermometers (to measure body temperature), cardiac monitors at each individual bed (monitoring vital functions such as heart rates, blood pressure, saturation, pulse, and respiration), central cardiac monitors situated at the nurses' station (monitoring all patients' vital signs, such as heart rate, heart rhythm, blood pressure and other vital statistics), multifunctional devices (used for printing stickers, reports, faxing ECGs to doctors, printing admission forms, patient consent forms), eRegister (electronic register), instead of having a physical register, the patient is registered on the system. On the system the nurses add the results of their triage results and doctors will immediately know the colour of the patient immediately after the patient was triaged.

Given the variety of technologies used, nurses are acutely aware of the value, benefits and importance of these technologies and how it influences their lived experience. When asked about the relevance, compatibility and the purpose of DHTs in relation to their work activities, the reactions of participants reflect a clear understanding of their specific tasks and responsibilities and how DHTs influence their existing work practices. Nurses agree that technology has become an integral part of patient care, particularly in the ICU, because it saves time, it facilitates the monitoring of patients, improves patient administration and access to patient information. Some nurses in Hospital A have reported that the cardiac monitors save time when they do their observations, since information is captured and stored on the monitors and can be accessed at any time. This highlights the importance of the availability of information.

> *Cardiac monitor – it has a history part so you can go back and see what the patient's vital signs are and you can also check the history and get the information about the patient. (TA02)*
>
> *With these monitors, if you can't be there at 13:00 you can go back to check what the patient's vitals were at 13:00. (TA06)*
>
> *On the monitor there is a date and a time and also a history so that we can go back and see what the previous rhythm was and how to treat it. (TB01)*
>
> *So now we can sit at the desk and we can see all the patients' dysrhythmia (heart rate and rhythm) and we can act whenever there is a problem. We can print it out or go to the doctor and report what we have seen and we can handle the problem. (TB01)*
>
> *With heart patients, we don't want them to have a fast heart rate, so there is medication to bring it down. So the monitor will inform you that the pulse is too fast or too slow. That is very important. (TB03)*

It is quite relevant because with the ECGs, a patient comes in with chest pains, the doctor or even us can tell whether it is a heart attack or if it is normal. So we can tell if it's a heart attack then the patient can stay and be treated accordingly or the patient could be moved somewhere else. Also with the heart rate and dysrhythmia we can react as soon as possible if we need to. (TB08)

Because DHTs are incorporated into the daily work activities of nurses, the result is improved recordkeeping, since, at Hospital A, information is saved on the cardiac monitors. This information is supplemented by the written record, as a result of the daily charting during patient observation sessions. Once the patient is discharged, the written record is captured on the computer (ECM system) by the clerks.

We need the stats; we can't send a patient off without a death certificate. (TA01)

The information is saved on the monitors and we can go back and see. …We also have our written record. Our observation chart is done hourly so we capture our information and we do our records in the nursing process. When a patient is discharged it goes to medical record. (TA02)

At Hospital B, information is captured and saved on the eRegister. Once a triage has been completed in the EC, a printout is handed to the doctor. At the same time, this information is available on the doctor's computer. A printout is also placed in the patient's folder. As a result, all relevant patient information is available in the folder for other practitioners to access, should the need arise. This facilitates data capturing, and facilitates access to patient information, thereby facilitating the dissemination of information. Information is normally kept for 24 hours until the patient has been seen by a doctor. Since all the information is captured and stored electronically in the EC (Hospital B), it facilitates the reporting process, where the nurse submits a report to the matron at the end of every shift.

After we capture the information, at the end of the shift, from 18:00 I must do the report which goes to the Matron's office. Then it goes higher up in the department to see the stats. The report is still done manually. The headcount is done manually, but the data is easy to get. (MP07)

On the computer, there is a list of patients to be seen, then the doctor selects from the list on the computer. When you go to the patient's folder, all information is printed on the paper and doctors can see what was done, what are the patient's stats. (MP08)

To me it is important I can see if someone is allergic or needs special attention, or if someone is HIV positive. The confidentiality and privacy aspect is important. (MP05)

Hectis completely replaced the manual triage system. In EC our main thing is the triage and we can actually monitor the time, from the time of registration to the time the patient is triaged.

Statistically this is important, to see if a patient waits longer than an hour for triage, at the touch of a button. (MP06)

Hectis system is the most relevant thing at the moment. This hospital has a lot of patients so we cannot survive without it. (MP08)

Nurses in the EC at Hospital B, therefore, understand their particular tasks and responsibilities when it comes to the DHTs. The electronic method of triage, for example, has resulted in improved patient care, improved nursing administration, as well as easy access to patient information. Caregiving is improved, as electronic triage saves time as compared to the old, manual method of performing triage. Nurses use an electronic register, instead of having a physical register, to register a patient on the system. The eRegister provides vital information, such as when the patient arrived, the time the patient spent waiting to be triaged, as well as the time when the patient was seen by a doctor. Consequently, nurses add the results of their triage on the system, and doctors will immediately know the status (indicated by a particular colour code) of the patient soon after the patient was triaged. This enable nurses to track the flow of the patients after they have been triaged, in other words, which patient has been seen by a doctor, which patient was referred to whichever department or discipline, or referred to another ward, or another hospital, or discharged. Once the patient is discharged, it is clearly reflected on the system. Similarly, when a patient moves to another ward, it will immediately reflect that the patient is no longer in the EC. Every nurse, doctor and clerk has access to the eRegister, and in this manner, the management of patient information is enhanced.

Previously the nurses were triaging the patients incorrectly. Sometimes the patient is very sick and then the colour code is green. If you are listed as green, the waiting period is long. With this new technology, there is a side that is called the moderators. You can triage your patient in this way. You put all your observations and it will give you an indication if there is an emergency, or if the patient presents as urgent, the colour coding is changed from green to the appropriate code. (MP02)

It is very relevant for us and very accurate because it can give you the time of arrival of the patient, the time awaited in triage. What time the patient was triaged, what time the patient was seen by the doctor and the waiting period of the patient is captured. (MP02)

When the patient is discharged, it also shows that the patient was in EC and now he or she is discharged. If the patient goes to another ward or an overnight ward, it also tells you that this patient is no longer in EC but has moved to another ward. It is very accurate. (MP02)

We don't have to write as before, you enter electronically. Sometimes papers get lost or misplaced, then you have to rewrite it. However, it is on the system, it improves productivity. It used to take 15 minutes to triage a patient, but now it is easy and takes less time. (MP03)

It's quicker; you can go back to check if a child was here two days ago. Everything is accessible for a period of time, so you can have access, also if a patient has to go home and is waiting for results. (MP05)

4.3.10.7 Theme 7 - Nursing administration

Nursing administration, a key performance area, is the seventh theme to emanate from the data. Valuable information is captured on a variety of technologies, which comprise computers (used for the management of nursing staff rosters, ordering of consumables), ventilators (for monitoring oxygen levels) IVAC machines (used to administer intravenous medications) ECG machines (to monitor the function of the heart) HB monitors (to check haemoglobin), thermometers (to measure body temperature), cardiac monitors at each individual bed (monitoring vital functions such as heart rates, blood pressure, saturation, pulse, and respiration), central cardiac monitors situated at the nurses' station (monitoring all patients' vital signs, such as heart rate, heart rhythm, blood pressure and other vital statistics), muti-functional devices (used for printing stickers, reports, faxing ECGs to doctors, admission forms, patient consent forms), eRegister (electronic register, instead of having a physical register, the patient is registered on the system).

Nurse managers at Hospital A use DHTs to perform a number of administrative tasks such as recording absenteeism, scheduling an off-duty roster, personnel placement, ordering of consumables, reporting, ordering patient diets and recording of bedsores and pressure sores. Nurse managers are also tasked with training individuals to perform certain administrative tasks on their behalf, such as ordering of consumables. The Nursing Information System (NIMS) is used for this purpose. Nurse managers have their own login credentials.

Say I am completing SPMS (self performance management system), the reports are on there, so if a report is missing I can just print it from there. It is very relevant. (TA05).

I have my own login and password. Currently I do off duty on NIMS as well as placing of personnel. I use the health apps for the ordering of my stock that is in our stores and our buy-outs. I use it for both. But if you do experience problems with the computer, I also have a paper book that I can order on. I have my own login and password. (TA03)

NIMS we also use when we just want to report bed sores and absenteeism. We also use NIMS for the leave planning that we do. We do the mods diets on the computer. I have my own logon credentials that only I use. (TB06)

Most of the time I use the computer because I need to check my emails and patients' diets which must be changed and CLINICOM for stock ordering. I have email so I have my own username and password. (TB07)

According to the protocol you are only allowed to train two other persons, other than the manager, to do stock ordering. So there are three of us who are registered to do the ordering. Ordering is done twice per month. (TA03)

According to the operations manager at Hospital B, all managers in the hospital have their own login credentials, and consequently access to the Hospital Emergency Centre Tracking Information System (Hectis). When a manager sits at a computer, the manager can immediately see the situation in the EC, and how many patients have been referred to their respective departments, namely, medical, surgical or paediatrics. The operations manager actively uses Hectis. The main advantage for nurses is the electronic register, instead of having a physical register, where the patient is registered directly on the system. In this way, the nurses add the results of their triage results on the system, and doctors will know the status (represented by a specific colour) of the patient immediately after the patient was triaged. This allows them to track the flow of patients after they have been triaged, seen by doctor, referred to whichever discipline, or referred to another ward, or another hospital or discharged. According to the operations manager, this can be ascribed to the effectiveness of the triage process since it gives nurses a clear indication as to which patient is ready to be moved out of the unit. This improves the flow of patients in the unit: the nurse always has a clear picture of the status of the patients in the EC.

It shows our effectiveness in being able to triage a patient correctly. It gives the nurse an idea as to which patient is ready to be moved out of the unit. It improves the flow management in the unit. (MP04)

The nurse always has a visual as to which presentation falls into a particular colour. So just by meeting and greeting a patient they can already consider what the initial colour code is, so it allows to understand the colour coding system better. (MP04)

At Hospital A, some nurses are tasked by their respective nurse manager to perform administrative tasks such as ordering of consumables, scheduling of staff, quality assurance and reporting, and ordering patient diets. These nurses have their own login credentials and are able to use the Nursing Information Management System (NIMS) for this purpose.

We use it [the computer] for off-duties, to order stock, emails that come from government or from our HR dept. For our infection prevention control (IPC). (TA04)

I have my own log in and password. I am designated to order stock because I relieve the nurse manager and also because I did the course. We used CLINICOM which is now health apps. We use that also and for that you also need a password. (TA04)

On NIMS we do off duties. If patients have bedsores and stuff we must put it on NIMS, any quality assurance, complaints must be put on NIMS. I actively use MODS because we do a list every day. We print a sheet to check if all the patients are on the list and if their diets are correct. (TA04)

I use the computer to check the blood results, to print stickers, to print the final report if a patient dies. Then it is also used to check if you are looking for a patient in the hospital, to check where the patient is, in which ward, to admit the patient, to do the patient's diet. (TA06)

We recall information so we look at lab results on the computer. I have had occasion to recall results, but I do not have my own password. I use one of the other sister's passwords. (TB05)

Health information technologies are incorporated into the daily work activities of nurses, resulting in improved nursing administration, as well as recordkeeping, since information is saved on the cardiac monitors at Hospital A and eRegister at Hospital B. This information is supplemented by the written record, as a result of the daily charting during patient observation sessions. Once the patient is discharged, the written record is captured on the computer (ECM system) by the clerks.

We record it in the nursing process. The information is saved on the monitors and we can go back and see. We also have our written record. Our observation chart is done hourly so we capture our information and we do our records in the nursing process. When a patient is discharged it goes to medical record. Nowadays it is also saved on the computer. written records goes to a clerk, then it is captured on the computer. (TA01)

Cardiac monitor – it has a history part so you can go back and see what the patient's vital signs are and you can also check the history and get the information about the patient. For example, if you were busy, you can go into the history and see at a specific time what a patient's BP was. (TA02)

We also chart manually, like BP is charted hourly and if there are abnormalities we do write it in the continuous report and report it to the doctor. All manual paper goes to records, are scanned and put onto ECM. (TB03)

In the EC (Hospital B), once a triage has been completed, a printout is made and handed to the doctor. At the same time, this information is available on the doctor's computer. A printout is also placed in the patient's folder. As a result, all relevant patient information is available in the folder for other practitioners to access, should the need arise. Nursing administration is enhanced, as this facilitates data capturing, and facilitates access to patient information. Information is normally kept for 24 hours until the patient has been seen by a doctor. Since all the information is captured

electronically in the EC (Hospital B), it facilitates the reporting process, where the nurse submits a report to the matron at the end of every shift.

Similarly, upon discharge, the system will show that the patient was in the EC and that said patient has been discharged. It improves productivity as information is captured on the system, as sometimes, papers get lost or is misplaced. Nurses have stated that it used to take 15 minutes to triage a patient, and with the new technology, is takes less time. Nursing administration is improved because doctors, nurses and clerks have access to the system. If, for example, a patient was discharged three days ago, and the folder cannot be located, this does not pose a problem, since the information will have been saved on the system for easy access. This facilitates the access to information and improves the management of information.

> *Patients are seen according to their colour coding in this hospital. Everything is entered on the computer and it is programmed to give you the colour code of the patient based on the observations you enter into the system. (MP02)*
>
> *After triage, we print the information, so when the patient goes to see the doctor there is a printout. The doctor also has access to the information electronically. (MP03)*
>
> *I will divide the folders to be triaged, to be triaged, to be seen box, doctor will come to fetch the folder to see who needs immediate care. I will report to the doctor who is the most urgent and who can wait. If there are any abnormalities, I must report immediately if there's any abnormality. (MP05)*
>
> *Our new triage system, electronic report system, management report system. Monitors are all electronic: blood pressure, CO2, blood sugar, haemoglobin, are all done electronically. I can check to see how long a patient is waiting – we are able to track the patient. (MP07)*
>
> *We book x-rays, check lab results. For lab results we access the NHLS. (MP08)*

Nurses, therefore, have a clear and unambiguous understanding of the value of the information that is captured by means of the various technologies, as well as the importance of managing such information. As a result, the various technologies facilitate recordkeeping, data capturing as well as access to patient information, whilst at the same time maintaining confidentiality. This enhances nursing administration, one of the key performance areas of the nurse.

4.3.10.8 Theme 8 - Patient care

All nurses interviewed have acknowledged the positive impact of technology on the delivery of care to their patients. Consequently, patient care is the eighth theme to emanate from the data. All participants agree that the introduction of technology has resulted in improved productivity, improved workflow and ultimately, improved patient care. Nurses agree that technology has

become an integral part of patient care, particularly in the ICU, because it saves time, facilitates the monitoring of patients, and improves patient administration and access to patient information. Some nurses at Hospital A have reported that the cardiac monitors save time when they do their observations. Sometimes, owing to time constraints, they cannot do their observations at a particular time. Given that the cardiac monitor continuously monitors patient vitals, nurses have the option of accessing the information on the monitor at any given time. For example, if a nurse could not do a patient's observations at 13:00, the nurse has the option of checking the patient history on the monitor, to ascertain what the patient's heart rate, or blood pressure was at 13:00. This is an example of how the compatible the technology is with their existing work practices and how it improves work and the monitoring of patients.

Furthermore, the central monitor allows nurses to stand in one place where they can observe the vital signs of approximately 20 patients, without being at the patient's bedside. Similarly, when measuring the patient's haemoglobin levels by means of a finger prick, the results are available within a matter of seconds, whereas previously, it would take a few minutes, and was not always accurate. Often another nurse was requested to confirm the result. The same applies to when measuring a patient's temperature with the new thermometers. The results are available within 10 seconds as opposed to a few minutes.

> *With these monitors, if you can't be there at 13:00 you can go back to check what the patient's vitals were at 13:00. (TA06)*
>
> *For the number of years that I am in the unit, we did not have a central monitor, then we had to physically stand with the patient and see how the heart looks. Each patient had their own monitor but we had to physically go to the patient to see the heart rate, BP. Now with the central monitor, we stand in one place. (TB01)*
>
> *It is so much easier. So we stand in one place and can observe over 20 patients' vital signs at once and act immediately when there is a problem. (TB08)*

Before the introduction of DHTs, would nurses spend a considerable amount of time performing procedures manually, which consequently took time away from their patient care. Nurses lament the difficulty, for example, of having to write out numerous labels when taking blood samples, and that diets had to be written out manually.

> *It was very difficult, especially when taking blood samples, you had to write out a lot of labels. (TA01)*

We had to do everything manually, you had to write out your diet list, you had to tick off your book, we had lots of papers to fill in when someone was absent. With observations you had to do a manual blood pressure, pulses, so that is how we had to do it. Lots of paperwork. (TA04)

The workload is much better since they got the new thermometers that give you a reading and that time you had to shake the thermometer and nurses complained that they got pains in their wrists from shaking the thermometer. So it's really good to have the digital thermometer so we don't have to shake anymore. (TA06)

In addition, nurses at Hospital B have reported that technology has improved service delivery. When a patient is triaged in the emergency room, the procedure is done electronically. Since all the computers are linked, the operations manager can immediately see whether a patient has been in the waiting room for longer than 20 minutes. There is also a system in place whereby patients who are 60 years and older are given preference, and their waiting time is reduced. The introduction of this new triage system also allows for better reporting. Previously patients were triaged manually, and the nurse had to estimate the urgency based on the patient's symptoms. The new system is programmed to assist with this process and is able to triage a patient more accuracy and according to the level of urgency. This not only saves time, but allows for improved delivery of patient care, as the waiting times have become shorter.

To us it is saving time when it comes to way we were doing this before. Initially we did everything manually, but with this new technology, it saves time and the waiting period for the patient is reduced. (MP02)

Sometimes as nurses you can't always tell how sick the patient is. However, with this technology, if a patient is rated orange, it can tell you that the patient has chest pain and you can immediately do an ECG. (MP02)

With this new technology … You put all your observations and it will give you an indication if there is an emergency. For example, if the patient comes with burns, the vital signs shows the patient is green. However, once you click burns or other on the discriminator, automatically the colour coding changes from green to yellow. Which means that patient will be seen sooner than everyone else. (MP02)

In EC our main thing is the triage and we can actually monitor the time, from the time of registration to the time the patient is triaged. Statistically this is important, to see if a patient waits longer than an hour for triage, at the touch of a button. It gives you a lot of information and statistics about how many patients are walk ins, how many are referred from GP and CHC, because when they register the patient that information is done on CLINICOM and it comes onto HECTIS as well. (MP06)

It was time-consuming before technology. We took too long to attend to patients. With this technology it is very easy because, for example, with HB it took three minutes; however, now it takes a few seconds. Once a patient receives a finger prick, the result is available within a few seconds. Previously it would take a few minutes, and it was also not very accurate. (MP03)

It is evident from the data that technology has been integrated into patient care, and as a result, patient care is enhanced. Nurses view DHTs such as ventilators and cardiac monitors as a means of communication that guide them in terms of what the patient's needs are. DHTs are seen to have a positive impact on patient care, because they enhance the treatment that they are able to deliver to their patients, and therefore, nurses do not feel that the technology comes between them and their patients. Rather, it facilitates the capturing of patient data as well as access thereto. Nurses have unanimously expressed their need for technology to provide better patient care, as prior to the introduction of technology, many tasks were conducted manually, which was not only time-consuming, but took time away from their patients.

A few participants have however stated that the technology adversely affects the nurse-patient relationship, especially at Hospital B, where they have a specific period within which to triage a patient. As a result, they feel under pressure to adhere to these timelines.

4.3.10.9 Theme 9 – Training

One barrier, namely, a lack of training, has emanated as the ninth theme. A lack of formal training is a general concern for most nurses, and consequently, most nurses have cited a lack of formal training as a barrier that hinders their work.

Nurses have overwhelmingly indicated that their training needs were not assessed prior to the introduction of any new technology. Furthermore, nurses at Hospital A have indicated that there is a lack of formal training and that most training is in the form of peer training. Other nurses have stated that their experience at private hospitals has helped them in understanding how DHTs work and most of them are self-taught. If there is formal training, it is usually for two or three days at most. In some cases, where new types of DHTs, such as ventilators, are introduced, a company representative or one of the hospital technologists will briefly show nurses how the technologies work.

Basically the reps are here to explain it to us, and we also have the doctors and the technologists, so even if we have any questions regarding the ventilators, we can even ask the technologists and also the doctors. (TA02)

We also ask the technologists in ICU if we need help. We have not had any formal training, not even a demonstration. (TA04)

A month or more after it was installed the people of the (monitor) company, the reps, came to train us. Our training needs were not assessed. (TB03)

For NIMS and Health Apps, we went to the Datalan, there is an office on the ground floor, and they gave us formal training. The training was two days long. It was not really so sufficient because there's a lot of stuff [updates] that came afterwards, and we didn't receive new training. (TA04)

No formal training, I was just orientated a day or two and the sister in charge just showed me how the monitor works and to get used to the ICU to orientate me. (TA06)

"When I started so it was just the nurses, the other Sisters, my colleagues, who would show me. I never went for any formal training. No one comes around to assess our training needs. (TB08)

We just heard we were getting monitors; these were installed and we have people who can do workshops who showed us the basics. Formal training only occurred after a few months. (TB03)

With the cardiac monitor, you just learn as you go on There wasn't any specific person that came and taught me how to do things. You just figure things out. Staff train each other. If there's something that I know, I would teach someone else. If there is a new staff member, older staff members would assist. There is no formal training on how to use the ECG machine or cardiac monitor. Every day you sit and play around to figure out how things work. (TB02)

Yes, but it's on-the-job learning. I have not had formal training in terms of using the cardiac monitor. I am just shown how to use it. (TB05)

Most people with the basic ICU background you could work with one experienced member of staff for a week. If no ICU background whatsoever, it is more challenging. (TB04)

Nurse managers at Hospital A confirmed that training needs to be work-related. Two nurse managers mentioned a monthly schedule for generic training (for example, safe injection practices) and modular training (related to specific modules, such as ICU training). Training needs have to be specified at the beginning of each year. One nurse manager made mention of a mentor for trainee nurses and confirmed that training does not take place very often.

There is generic training and then we have modular training as well which takes place on a monthly basis. The generic training is for all personnel of the hospital. (TA03)

Generic training per month then there is modular training every day. (TA05)

The last training we had was for the infusion pumps that was maybe a year or six months ago. We have a mentor for the trainee nurse and she organises our training and also we try to get training in by our area manager as we go on Thursdays and she always has someone who comes in, either the reps or the sisters or anybody would come and give us something. (TB06)

At the time when CLINICOM was introduced, we went for training. That was when it was a full day of training, but today it is no longer the case. It is only about 2 or 3 hours. The training is conducted by someone in IT. (TB07)

Nurses in the Cardiac ICU have stated that they would like to have formal training for new nurses, instead of peer-to-peer training, as this is time-consuming. Nurses feel that if new nurses receive formal training, these nurses will have a better understanding of the technology, and it would lessen the workload of those nurses who have to provide training to newcomers.

Furthermore, many nurses are appreciative of the DHTs, and have expressed their desire to learn more about technology but are not afforded the opportunity because of staff shortages. They feel they would benefit more from the DHTs if they had more opportunities for training.

There is scheduled training during the month but it isn't always possible for us to go because we are short on staff. There is computer training available, but they can't send all staff because of shortages. (TA06)

I would really like to have formal training because sometimes there are stuff that you can check on the computer, if you want to maybe study a case of a patient, or see a diagnosis, but we don't have the time to do that. I would personally like to use more technology. (TA06)

I am eager to learn about technology but I am being deprived of this opportunity. (TB01)

We need to change as things change because we write less, or they want us to write less and do work on the computer and stuff more, but we need to be introduced to it our taught more formally, like this is how it is done. Is everybody on par, are you able to log in, this is where you log in, this is where you look for this and that. I think we must go for workshops; I think that would help. But the problem is that there is a snowball (effect) - how are we going to go for workshops - who will look after the patients? (TB02)

We could benefit more from technology. More training could be provided. Doing everything on the computer without printing and going paperless would be nice. Doing the whole admission on the system would be nice. I can imagine a time when there is less writing - I would look forward to it. (TB08)

As is the case with Hospital A, nurses at Hospital B have overwhelmingly indicated that there is a lack of formal training. They have to rely on company representatives to show them how to operate new technologies, and the eRegister, training was informal, and conducted by one of the consultants, Dr X. Nurses have indicated that they underwent basic triage training, but that there was no follow up training. The consultant who was instrumental in acquiring the system had brief training sessions with nurses. Nurses at Hospital B also overwhelmingly stated that at no point

were their training needs assessed. However, the majority of nurses indicated that it was easy to learn, as some of them were shown how to operate the system during a single work shift.

> *I have not received any official training. So when I came here, I knew the basics. If we receive any new technology into the unit, then usually the reps of the companies come on a specific date and time to introduce new technologies. We are able to ask questions if needed. (MP01)*
>
> *We had brief training sessions where we were shown how to work the system. There was always someone to guide us. There were doctors who already knew the system, as well as others who were computer literate. So they were the champions for the system. I cannot recall any nurse that was sent for any other form of training. We were only exposed to training on the e-register technology. There is no ongoing training programme at the hospital. (MP03)*
>
> *An IT specialist came to do the training. We were trained individually, we had a crash course, while we were working. He did it with the whole EC staff. (MP05)*
>
> *Training for the Hectis system was not extensive. There was group training of about 3 at a time for night shift, and then the consultant would show us and each one would get a turn to train others. Some of our older nurses who are not computer savvy had some trouble getting used to the system. I found it easy to learn. (MP07)*
>
> *Our training needs were not assessed beforehand, only when they started the training. There were some who could work on the Hectis system, but others needed further training. It was an ongoing process. If you had any issues individually, they would train you individually. (MP07)*
>
> *We had to orientate ourselves as nurses, as it wasn't a provincial thing, it was only for our hospital. It wasn't intense training. We had to be computer literate, so many people struggled in the beginning. Now everyone is competent. (MP08)*

According to the operations manager, there was some form of on-the-job training, where Dr X arranged for some from the Information Management Department to monitor staff who have been informally trained to use the triage system. He spent about a week or two with staff to guide and lead staff on how to use the system.

> *It was in-service training. We were called in together, and Dr X got someone from the Information Management Dept who spent time working with us staff members. He would shadow us while we were busy with a patient to see how we logged in how we did the triage. (MP04)*

Like nurses in Hospital A, nurses in Hospital B also expressed a strong appreciation for DHTs and are willing and eager to undergo further training to upskill themselves. However, some have indicated that training has to be aligned with their work.

There is Western Cape governmental training that they forward to HR. A list of training for the year. The manager will then book us on specific dates. We get to choose what we want to do. I would like to do a basic computer course and thereafter, improve my computer skills. (MP01)

There is not much exposure for nurses to use other technology as some of the technology requires proper training. Sometimes nurses don't have time for training, but I think it is good for nurses to know how to use these technologies. (MP03)

It would be nice if we are more trained in technology. The eRegister is a start. Our training needs were not assessed in the past, but based on your level of education, they will tell you, at the beginning of the year, that you must go for training. We are then allowed to stipulate our needs, but they can only choose three nurses to go. Training must be directly related to your work. (MP05)

Nurses are not sufficiently exposed to technology because we have a lot of old nursing staff who don't get computer training. We only have minimal training, like for Hectis, but does not take into consideration the nurses who were never exposed to computers. They are reluctant to use the technologies because they are scared of doing something wrong. They were never explained the basic computer functions. I think they should have been sent for computer training so that they could get up to date with technology. (MP08)

4.3.10.10 Theme 10 - Workarounds

Whilst the data has overwhelmingly shown that technology has been successfully integrated into nursing care, there are instances where nurses do not fully trust technology, and as a result, workarounds have emanated as the 10th theme. Whilst nurses positively appreciate technology, they often do not trust said technology, and would then initiate workarounds. For example, when a patient's temperature is measured, and a nurse does not feel comfortable with the reading, she would physically feel the patient's forehead to verify. Similarly, if a nurse measures a patient's blood pressure and is not comfortable with the result, the nurse will reapply the BP cuff or even perform a manual blood pressure reading.

We don't feel that the monitor can't be wrong. We make sure that it is the correct blood pressure or temperature because sometimes the thermometer show the temperature but then you feel that the patient is very hot and you then fetch something else to make sure that the temperature is correct. (TA06)

Even the BP, if the monitor shows that BP and you look at the patient and you feel it can't be right, then you do it manually, you also feel the pulse manually. (TA06)

It's not just about technology, but rather about the physical patient. We enquire as to how they feel. If we see their BP is high and heart rate is incorrect, we don't take it at face value. We go to the patient and ask how they feel, do they have pain. If the BP is very high and I feel that I want to

measure it manually, then I will do so to see how the monitor's BP differs from the physical BP cuff. I look at everything both manually and with the help of the monitor. (TB01)

If you suddenly get an observation or a reading on one of your machines that does not make sense, redo it. Get someone else to check it. Reapply the BP cuff, make sure that your stickers on the chest is on the right place, learn to spot the obvious things and then of course nurse the machines and machines will nurse the patient. Touch the patient. If he has a pulse of 160, count the T-waves again. (TB04)

But certain things you still need to be able to do manually, for instance, the electronic blood pressure cuff you - need to learn how to use it manually, even though it is a part of technology, and they want to introduce some sort of X-ray that you can use to put into intravenous lines that if you can't visually see it, that it will sort of make it visible, but you should still be able to know how to do without it, because technology can fail. (TB05)

In other instances, there may be a problem with the cardiac monitor, which would necessitate the nurse to look at the clinical picture of the patient. If, for example, the monitor shows an a-systole reading (in other words, when there is no heartbeat), the nurse will go to the patient to ascertain whether the patient is breathing. It may be possible that the machine has malfunctioned, or it may be that the electrodes which are attached to the patient may have dislodged, which would prompt the nurse to physically check the patient's clinical signs and if they do not see any abnormality, they may re-affix the electrodes.

What we also do is, sometimes there may be a problem on the monitor. Then we look at the clinical picture of the patient. If the monitor shows an a-systole, we will go to the patient to see if the patient is breathing, and we will know that it is a fault on the monitor. It may also be that electrodes may have moved or became loose, then we will look at the patient's clinical signs and if we see that the patient is normal, then we will reconnect the electrodes. (TB01)

In Hospital B, nurses often initiate workarounds in the case of loadshedding or power failures. In such cases, nurses would often resort to manual procedures, for example, a manual triage process, or opening physical folders until the system is operational.

With this new technology, the only challenge that I have experienced, especially in the EC, is when there is a power failure and we are off-line. We don't have back up, so we have to switch to manual. (MP03)

When the system is down, we have to do things manually. We have temporary folder numbers until the system is up and running. (MP07)

Like yesterday when the system was down, we had to revert to doing things manually, and take out the books again. The books are not readily available, because people often misplace them.

We had to look for the books, we did this twice, in the morning and evening. It took a lot of time since the system went down twice. We had to readmit the patients on the system. (MP08)

4.3.11 Summary of key findings from the thematic analysis

In this sub-section the key findings from the thematic analysis are summarised and briefly discussed.

4.3.11.1 Theme 1: Decision-making

According to key data findings, decision-making occurs from two perspectives, namely, decision-making based on observation, and decision-making based on triage, The key findings of the data indicate that, given the variety of DHTs used, nurses are able to make decisions based on their observations, as they often use their knowledge, intuition and experience to make decisions. This is as a result of their acute situational awareness. Furthermore, the electronic triage system saves time and drastically reduces the waiting period as the system can accurately predict the severity of the patient's condition and rate the patient in order of severity/importance. The findings further indicate that, based on the nature of the DHTs which are used by nurses in the ICU and EC settings, DHTs facilitate nurses in their decision-making and as a result, patient care is optimised.

4.3.11.2 Theme 2 - Adapt to change

Key findings from the data reflect a high degree of awareness of the immense benefits of DHTs in terms of how it optimises work practices of the participants. Participants have overwhelmingly expressed their desire to learning new technology, not only to provide better care to patients, but also to enhance their own knowledge and skill.

4.3.11.3 Theme 3 - DHT use

Key findings from the data indicates that there is consensus amongst the participants regarding the benefits of using DHTs as part of nurses' daily work activities. Furthermore, since DHTs have become an integral part of their lives, and that many of them have become very skilled as they use DHTs, they have expressed concrete ideas on how some DHTs could be adapted to optimise their work.

Another key finding which emanated from the data is that the majority of participants have stated that DHTs does not hinder the nurse-patient relationship. According to the majority of participants, the use of technology improved the nurse-patient interaction and provides a high degree of convenience, particularly in the Cardiac ICU, where the use of cardiac monitors allow nurses to monitor patients' vital signs continuously and transmit data in real-time as well as remotely.

4.3.11.4 Theme 4 - DHT access

When analysing the data, a key finding to emerge was that there is buy-in from nurses regarding the use of technologies, and that technology undoubtedly plays a significant role, particularly in the ICU and EC setting, where nurses are able to make better decisions and as a result, optimise patient care.

However, another key finding to emerge is the number of barriers that hinder participants' ability to derive maximum benefit and pass such benefit on to their patients. These barriers include: an insufficient number of computers, limited time assigned to the triage process, a lack of own log-in credentials, limited training opportunities, long response time when technologies need repair, poor connectivity and (the sometimes negative) effect of DHTs on the nurse-patient relationship, and the need for electronic reporting to replace manual reporting.

4.3.11.5 Theme 5 – DHT development/introduction

Key findings from the literature suggest that there is minimal to zero consultation with nurses before the introduction of new technologies, nor are their opinions sought. Nurses and managers at both hospitals are unanimous that it is imperative for nurses to be included in the process of developing new technologies.

4.3.11.6 Theme 6 – Information

A key finding of the data indicate unanimous agreement amongst participants that technology has become an integral part of patient care, more so in the ICU, as it saves time, it facilitates the monitoring of patients, improves patient administration and more importantly, provides timeous access to patient information. As a result, nurses are able to monitor patients more closely and adjust their treatment plans as needed,, Some of the benefits of information availability include improved recordkeeping, easy access to and the seamless flow of information, improved productivity as the time spent with patients is reduced.

4.3.11.7 Theme 7 - Nursing administration

Key findings of the data indicate that, since DHTs has been incorporated into the daily work activities of nurses, there is notable improvement in nursing administration as well as recordkeeping, particularly at Hospital A where the NIMS system is used for a variety of administrative tasks related to both patients and staff. In addition, DHTs help to ensure that patient information is accurately and consistently recorded, which is essential for providing quality patient care.

For example, when patients are triaged in Hospital B, this occurs according to their needs while those who can wait are seen an a more orderly fashion. This facilitates the flow of patients through the EC. The nursing administration system is optimised for doctors, nurses and clerks, as all three groups have access to the system, which makes it easy for them to communicate and collaborate. The system is designed to streamline tasks and improve efficiency. This fosters collaboration and communication within departments as well as with other departments. Nurses therefore have a clear and unambiguous understanding of the value of the information that is being captured by means of the various technologies and as such, recordkeeping, data capturing, and access to patient information is facilitated, this enhances nursing administration, since it is one of the key performance areas of the nurse.

4.3.11.8 Theme 8 - Patient care

Key findings of the data overwhelmingly point to the positive impact of technology, especially where the technology improved the nurse-patient relationship. The use of DHTs provide convenience, particularly the cardiac monitors have positive benefits for monitoring patients' vital signs continuously and transmitting data in real-time as well as remote monitoring (i.e. monitoring the patient from the central monitor, without physically at the patient's bedside). A small number of participants have expressed that technology negatively affects the nurse-patient relationship, particularly where there is a shortage of computers, and computers are shared amongst staff, or when the computer is in a different location and the nurse has to leave the patient alone to update details on the computer. Another example is the limited time frame within which to conduct the triage process, and once this time frame is exceeded, the nurse is under pressure to complete the process, which means that they would spend less time with the patient. However, overall, it was found that technology is an integral part of care in both the ICU and EC setting.

4.3.11.9 Theme 9 – Training

Key findings of the data overwhelmingly indicate that nurses' training needs were not assessed prior to the introduction of new technologies. Whilst nurses positively appreciate technology, the lack of training is a major barrier that seems to hinder their ability to derive maximum benefit and pass such benefit on to their patients. Training is often in the form of peer-to-peer training or learn-by doing, which is not ideal. Concerning the organisation of training programmes, the results indicated that training is organised at a moderate rate of frequency, and due to their situated practice, nurses are often not keen to capitalise on it. The situation is further exacerbated by frequent staff shortages which deter them from attending formal training programmes. Participants also cited lack of time, family commitments and lack of support from management.

4.3.11.10 Theme 10 – Workarounds

Based on key findings of the data, technology has made work easier and improved workflow and productivity. Nurses regard DHTs such as ventilators and cardiac monitors as a means of communication and guides them to what the needs of the patients are. Nurses feel that technology has a positive impact on the nurse-patient relationship, and whilst they are in agreement that technology does not negatively affect the nurse-patient relationship, they nevertheless do not fully trust technology and as a result, have experienced technical problems with some of the DHTs. This has led to them to resort to initiating workarounds to provide the best care for their patients. This means that, where necessary, nurses would resort to their foundational practices, for example, physically taking a patient's blood pressure or physically looking at the clinical picture of the patient instead of accepting the outcome of the cardiac monitor. Similarly, nurses revert to manual practices in the event of loadshedding or power failures, or when the system is down due to cable theft.

4.4 Chapter conclusion

Analysing the data by firstly using the NPT as an analytical lens, and secondly by means of a thematic analysis has afforded the researcher a deep understanding and insight of and into the lived experiences of nurses as they experience DHTs as part of their daily work activities.

The evidence overwhelmingly suggests that DHTs have permeated nurses' lives and as such have become embedded into their everyday lives. It is further evident that nurses' work activities are still largely paper-based with a combination of support provided by the various digital health technologies. Whilst clinical notes and observations are largely paper based (and later scanned), electronic systems are used to monitor patients, perform triage, register patients electronically, and perform a variety of administrative duties.

Analysing the data using the NPT as an analytical lens and by means of a thematic analysis has afforded the researcher a deep understanding of the lived experience of nurses as they experience and use DHTs as part of their daily work activities.

The 10 themes which emanated from the analysis is a representation the many ways whereby DHTs facilitate nurses' jobs. Whilst there is overwhelming consensus that technology is positively received by participants, and that the benefits are immense, an array of barriers have been identified which prevent participants from deriving maximum benefits from the DHTs being used. Furthermore, this is exacerbated by the lack of inclusion of nurses in the development and implementation of new technologies.

In the next chapter, the researcher will provide an interpretive discussion of the findings of this study and how the thematic analysis correlate with the constructs of the NPT and also how it correlates with existing literature.

CHAPTER 5: DISCUSSION

5.1 Introduction

This qualitative study aimed to understand, analyse and assess the nurses' lived experience of using DHTs as part of their work practices to better guide DHT design and implementation and offer additional insights to the body of scientific knowledge to optimise the use of DHTs in public healthcare institutions in South Africa.

To address the research questions of this study, point 6.1 introduces the section; 6.2 summarises the results based on the NPT and thematic analysis; 6.3 combines the results discussion; 6.4 maps the results of the conceptual framework; and 6.5 concludes the chapter.

5.2 Summary of results

In this section, the researcher highlights the emergent themes emanating from the interviews with participants at both Hospitals A and B. Furthermore, the researcher demonstrates the correlation of the emergent themes with the NPT, which provided an analytical lens to further explore the data.

5.2.1 Summary of results based on the NPT analysis

Table 9: Summary of the findings of the NPT analysis mapped to the themes and literature

1. COHERENCE		
Coherence key finding: Participants have a sense of purpose; they have a deep understanding of the DHTs how they it into their overall goals and activities, and how these technologies impact their work practices.		
NPT Sub-Construct	**Summary of Findings**	**Mapping with Themes and Literature**
C1 Differentiation: An important element of sense-making work is to understand how a set of practices and their objects are different from each other. ***Before and after technology***	All participants deeply value the DHTs that they use as part of their daily work activities, and it fits into their work practices. When comparing the old method of performing their work to currently using technology as part of their daily work activities, participants are deeply appreciative of technology and have a strong sense of purpose. The use of technology, therefore, allows them to spend more time with their patients, which ties in with the theme: PATIENT CARE. From the responses of participants, it is evident that the introduction of technology has resulted in improved workflow and productivity. They are acutely aware of the value, benefits, relevance and importance of the DHTs and how it impacts their lived experience, to the extent that they stress the fact that they would not be able to perform their duties without it. Similarly, they are keen to invest time and energy into learning new technologies. This ties in with the theme, ADAPTIVE TO CHANGE. Participants are unanimous that the use of DHTs as part of their daily work activities not only saves time (before technology, procedures were performed manually), but it results in improved service delivery, as waiting times have become significantly shorter. This ties in with the theme, DHT USE. Each participant has a clear understanding of tasks and responsibilities and is in agreement that the respective DHTs are compatible with their existing work practices. Participants have a shared understanding of the value of information, and the importance of effectively managing information. This ties in with the theme: INFORMATION. Understanding the importance of information management is integral since it facilitates reporting processes, which forms part of the theme NURSING ADMINISTRATION.	ADAPTING TO CHANGE Cresswell *et al.* 2012 Greenhalgh & Wyatt, 2012 Mather *et al.* 2019 INFORMATION Bagayoko *et al.* 2020 Cifra *et al.* 2020 Huter *et al.* 2021 NURSING ADMINISTRATION Nelson, 2017 Cox, 2019 Booth *et al.* 2021 PATIENT CARE Rivas, 2016 Chichirez & Purcarea, 2018 Oliveira & Ramos, 2019 DHT USE Tunlind *et al.* 2014 Olausen *et al.* 2014 Limbu *et al.* 2018
C2 Communal specification: Sense-making relies on people working together to build a shared understanding of the aims, objectives, and expected benefits of a set of practices. ***Do individuals have a shared understanding of aims, objectives & expected benefits of technology?***		
C3 Individual specification: Sense-making has an individual component too. Here participants in coherence work need to do things that will help them understand their specific tasks and responsibilities around a set of practices. ***Do individuals have clear understanding of their specific tasks & responsibilities in the implementation of new technologies?***		
C4 Internalisation: Finally, sense-making involves people in work that is about understanding the value, benefits and importance of a set of practices ***Understanding the value, benefits, & importance of the technology***		

2. COGNITIVE PARTICIPATION		
Cognitive participation key finding: There appears to be buy-in from participants to the extent that participants feel the need to invest time and energy into learning new technologies. However, a number of barriers were uncovered which hamper participants' ability to sustain their involvement in the use of DHTs.		
NPT Sub-Construct	**Summary of Findings**	**Mapping with Themes and Literature**
CP1 Enrolment: Participants may need to organise or reorganise themselves and others to collectively contribute to the work involved in new practices. This is complex work that may involve rethinking individual and group relationships between people and things. ***Is there "buy-in" from individuals with regard to the technologies?***	A common theme that emanated from the interviews is the fact that there is complete "buy-in" when it comes to the use of DNTs. This is evidenced by the willingness of participants to invest time and money in learning new technologies, since they understand the importance of keeping abreast of technological developments. This ties in with the themes: ADAPT TO CHANGE and DHT USE. Adversely, in terms of the sub-construct Activation, a number of barriers are hampering participants' ability to sustain their involvement in the use of DHTs. Whilst there is buy-in, participants' training needs often feel that they lack adequate exposure to technology, and this is exacerbated by the fact that their training needs are often not considered. Training is currently in the form of "learning by doing" or peer-to-peer training. There are formal training sessions; however, their situated practice does not allow them the time to embark on formal training. This ties in with the theme: TRAINING. Another barrier identified is the fact that many participants do not have their own log-in credentials, and that this has proven to be a hinderance, as they often have to wait for a doctor to log in before they can have access to patients' results. This impacts on their productivity and the care that is given to patients. This ties in with the theme: DHT ACCESS. A further barrier is the lack of opportunity to evaluate the respective DHTs. A number of participants had concrete ideas in terms of how DHTs could be improved or enhanced, but they are not afforded the opportunity to do so. Similarly, nurses' opinions were not sought when new technologies were introduced. This can be mapped to the theme: DHT DEVELOPMENT/ INTRODUCTION.	ADAPT TO CHANGE Ludwick & Douchette, 2009 Granados-Pembertty *et al.* 2013 DHT USE Carmel, 2005 Jarvin, 2012 Price, 2013 TRAINING Topkaya & Kaya, 2015 Patmon *et al.* 2016 Gundogdu *et al.* 2018 DHT DEVELOPMENT / INTRODUCTION Mather *et al.* 2019; Ludwick & Doucette,2009; Boonstra and Broekhuis, 2010; Greenhalgh & Wyatt, 2012 Sanders *et al.*, 2012 DHT ACCESS Lupton, 2014; Krick *et al.* 2019; Krick *et al.* 2020;
CP2 Activation: Once it is underway, participants need to collectively define the actions and procedures needed to sustain a practice and to stay involved. *In fact, staying on the case is vital to sustaining clinical interventions.* ***Collectively define ACTIONS & PROCEDURES need to sustain a practice and stay involved. Can individuals sustain involvement?***		
CP3 Initiation: When a set of practices is new or modified, a core problem is whether or not key participants are working to drive them forward. ***Willingness of key participants to drive implementation forward.***		

2. COGNITIVE PARTICIPATION		
Cognitive participation key finding: There appears to be buy-in from participants to the extent that participants feel the need to invest time and energy into learning new technologies. However, a number of barriers were uncovered which hamper participants' ability to sustain their involvement in the use of DHTs.		
NPT Sub-Construct	**Summary of Findings**	**Mapping with Themes and Literature**
CP4 Legitimation: An important component of relational work around participation is the work of ensuring that other participants believe it is right for them to be involved, and that they can make a valid contribution to it. ***Is it right for them to be involved with new technology***		

3. COLLECTIVE ACTION		
Collective action key finding: Participants have expressed confidence in the system and positively appreciate technology. The many benefits derived from DHTs enhance patient care and facilitate access to and the management of information. Overall, technology makes their work easier.		
NPT Sub-Construct	**Interpretation**	**Mapping with Themes and Literature**
CA1 Interactional workability: This refers to the interactional work that people do with each other, with artefacts, and with other elements of a set of practices, when they seek to operationalise them in everyday settings. ***Is the new technology making work easier or more difficult?***	There is a strong theme in all the participants' interviews that DHTs have been integrated into patient care. To a large extent, participants have expressed confidence in the system and view it as a means of communication, which enhances patient care. This can be mapped to the theme: PATIENT CARE. Participants have also expressed that sometimes they do not trust technology, and would initiate workarounds, especially when equipment malfunctions. Experienced nurses therefore often revert to their foundational practices when the need arises. In other words, they would initiate workarounds by reverting to their foundational practices when the need arises. This ties in with the theme: WORKAROUNDS. Participants are confident with using the DHTs and felt that it facilitates access to information and improves the management of information. Since DHTs capture valuable patient information, the flow of information is improved, since doctors nurses and clerks have access to the information. This can be mapped to the theme: INFORMATION.	PATIENT CARE Flannagan *et al.* 2013 Grindrod *et al.* 2014 Anglada-Martinez *et al.* 2014 Rivas, 2016 WORKAROUNDS Gresswell *et al.* 2012 Flannigan *et al.* 2013 Mather *et al.* 2019 INFORMATION Baiharu & Pai, 2016 Vargas *et al.* 2018 Bettano *et al.* 2019 WHO, 2019
CA2 Relational Integration: This refers to the knowledge work that people do to build accountability and maintain confidence in a set of practices and in each other as they use them.		

3. COLLECTIVE ACTION		
Collective action key finding: Participants have expressed confidence in the system and positively appreciate technology. The many benefits derived from DHTs enhance patient care and facilitate access to and the management of information. Overall, technology makes their work easier.		
NPT Sub-Construct	**Interpretation**	**Mapping with Themes and Literature**
How well does it fit into existing relationships?/ Do individuals have confidence in the system?	Adequate technical support is provided by means of the IT department, as well as the IT Helpdesk, or a dedicated staff member who is the champion for the new system and is always on hand to assist. This ties in with the theme: DHT ACCESS A lack of formal training seem to permeate a number of constructs, and participants have reiterated the fact that training needs are often not ascertained, and if there is training available, participants are often unable to capitalise on the opportunities due to their situated practice. This ties in with the theme: TRAINING.	TRAINING Gavranos & Newton, 2014 Topkaya & Kaya, 2015 Patmon *et al.* 2016 DHT ACCESS Fadel *et al.* 2020; Seibert *et al.* 2020; Booth, 2021
CA3 Skill set Workability: This refers to the allocation work that underpins the division of labour that is built up around a set of practices as they are operationalised in the real world. *Who gets to do the work is an important element of any set of practices?* ***How does technology affect roles and responsibilities or training needs?***		
CA4 Contextual Integration: This refers to the resource work - managing a set of practices through the allocation of different kinds of resources and the execution of protocols, policies and procedures. ***Can the practice be supported? Does it align with the overall goals & capacities? Is there organisational support?***		

4. REFLEXIVE MONITORING		
Reflexive monitoring key finding: Participants are receptive to the use of DHTs and do not see it as a barrier between them and their patients. However, concern was expressed at the non-inclusion of nurses in the design and development of DHTs, and the fact that there is no channel for nurses to appraise the DHTs used as part of their daily work practices.		
NPT Sub-Construct	**Summary Findings**	**Mapping with Themes and Literature**
RM1 Systematisation: participants in any set of practices may seek to determine how effective and useful it is for them and for others, and this involves the work of collecting information in a variety of ways. ***Formal evaluation of new practices/How are the benefits or problems identified/measured?***	Based on the analysis of the participants' responses, participants were overwhelmingly receptive to using the digital health technologies. However, concern was expressed at the lack of opportunity to evaluate the DHTs or provide feedback on how it can be adapted or enhanced. Participants felt that their feedback or evaluation would hold great potential for themselves as end-users of these technologies. This can be mapped to the theme: DHT DEVELOPMENT/INTRODUCTION and ADAPT TO CHANGE. The majority have stated that DHTs does not negatively affect the nurse-patient relationship. Some participants have reflected on how they were able to improve their own knowledge and experienced personal growth in the process of using DNTs as part of their daily work practices. This can be mapped to the themes: ADAPT TO CHANGE, PATIENT CARE and DHT USE. A number of factors have led to participants to modify some of their work practices and have expressed that they sometimes do not trust technology, and would sometimes initiate workarounds, in other words, revert to foundational practices. This ties in with the theme: WORKAROUNDS.	ADAPT TO CHANGE McBride *et al.* 2021 Ludwick & Douchette, 2009 Granados-Pembertty *et al.* 2013 PATIENT CARE Ludwick & Douchette, 2009 Chong *et al.* 2011 Flannagan *et al.* 2013 Grindrod *et al.* 2014 WORKAROUNDS Koppel *et al.* 2008 Greenhalgh *et al.* 2009 Greenhalgh & Wyatt,, 2012 DHT DEVELOPMENT / INTRODUCTION Mather *et al.* 2019; Ludwick & Doucette,2009; Boonstra and Broekhuis, 2010; Greenhalgh & Wyatt, 2012 DHT USE Carmel, 2005 Jarvin, 2012 Price, 2013
RM2 Communal appraisal: participants work together - sometimes in formal collaboratives, sometimes in informal groups to evaluate the worth of a set of practices. They may use many different means to do this drawing on a variety of experiential and systematised information. ***When individuals ask co-workers? What do you think of X? Is this for me?***		
RM3 Individual appraisal: Participants in a new set of practices also work experientially as individuals to appraise its effects on them and the contexts in which they are set. From this work stem actions through which individuals express their personal relationships to new technologies or complex interventions. ***When individuals ask co-workers? What do you think of X? Is this for me? How do groups judge the value of the technology? How do individuals appraise the effects on them and their work environment?***		

4. REFLEXIVE MONITORING		
Reflexive monitoring key finding: Participants are receptive to the use of DHTs and do not see it as a barrier between them and their patients. However, concern was expressed at the non-inclusion of nurses in the design and development of DHTs, and the fact that there is no channel for nurses to appraise the DHTs used as part of their daily work practices.		
NPT Sub-Construct	**Summary Findings**	**Mapping with Themes and Literature**
RM4 Reconfiguration: appraisal work by individuals or groups may lead to attempts to redefine procedures or modify practices - and even to change the shape of a new technology itself. ***Do individuals try to alter the new service (initiate workarounds)?***		

5.2.2 Discussion of the key findings of the NPT analysis

They key finding for each of the four main constructs appear at the top of the table for that construct. Each sub-construct has its own findings that are linked to the themes of the thematic analysis and related literature.

5.2.3 Summary of results based on thematic analysis

The next table outlines a summary of the key themes, findings and evidence from the data and subsequent mapping to the literature.

Table 10: Thematic findings summary

THEMES, FINDINGS & EVIDENCE FROM THE DATA			
THEMES FROM THE DATA	**KEY FINDINGS**	**EVIDENCE FROM THE DATA**	**MAPPED TO THE LITERATURE**
1. Decision-making	Nurses often use their knowledge, intuition and experience to make decisions, based on their awareness of a particular situation. Therefore, given the nature of the DHTs available to nurses in an ICU and EC setting, these technologies facilitate nurses in their decision-making and optimises patient care.	*"The moment a patient is connected to a monitor, then all alarms are activated and we can immediately hear and see when there is a problem." (TB01)* *"The system makes a determination, for example, if the patient says she has an abdominal pain, we do a pregnancy test, as perhaps the patient is pregnant. (MP03)*	**2.5 Nursing Practice** Chahar, 2021 Krishman (2018) Nibbelink & Bruwer (2017). Johansen & O'Brien (2015)
2. Adapting to change	Reactions reflected a high degree of awareness of the immense benefits of DHTs and how it optimises work practices of participants. Whilst there was initial resistance, predominantly due to fear of the unknown, many fears have been allayed once participants came to appreciate the value of DHTs.	*"I am always open to learning new things and technology is the way forward. It improves the care you can deliver, the information you receive from the patient through the technology." (TB05)* *"I would love to learn new technology. I need to know the patient's results. I often order xrays, and I interpret the xrays and blood results, and sometimes you need to proper training. I order xrays and blood tests and I have access and the means to order these tests electronically on e-register. I am able to go back into the system to see a patients results if needed." (MP03)*	McBride *et al.* 2021 Ludwick & Douchette, 2009 Granados-Pembertty *et al.* 2013 Barbosa *et al.* 2021 Ali *et al.* 2022 Cresswell *et al.* 2012 Greenhalgh & Wyatt, 2012 Mather *et al.* 2019
3. DHT use	Participants have stated that DNTs does not hinder the nurse-patient relationship. Whilst there is consensus on the benefits of using DHTs as part of their work activities, participants have expressed concrete ideas on how to further optimises their work practices through the use of DHTs, for example, having their own log in credentials to look up patients' results, having their own email addresses, and having an opportunity to provide feedback on DHTs that are currently being used. It was noted that very few nurses have their own log in credentials.	*"It does not take away from the personal care at all. There is still a lot of nursing care that you have to do yourself." (TA01)* *""The monitor can print an ECG but , because we do not have the proper paper to count the blocks, it will not show an abnormality. ….We have an ECG machine that does ECGs using the correct paper to print, but we cannot print it from the monitor. It would have been good if the monitor could do everything, because we do not send our patients to do an ECG." (TB01)*	**3.2.2 DHT Use** Carmel, 2005 Jarvin, 2012 Price, 2013 Granados-Pembertty & Arias-Valencia, 2013 Tunlind *et al.* 2014 Olausen *et al.* 2014 Limbu *et al.* 2018

THEMES, FINDINGS & EVIDENCE FROM THE DATA			
THEMES FROM THE DATA	**KEY FINDINGS**	**EVIDENCE FROM THE DATA**	**MAPPED TO THE LITERATURE**
4. DHT access	The participants notably highlighted the following barriers that hampered their DHT use and access: insufficient number of computers, limited time assigned to the triage process, a lack of log in credentials, limited training opportunities, long response time when technologies need repair, poor connectivity, occasional patient resistance to the use of technology, and the (sometimes negative) effect of DHTs on the nurse-patient relationship, and the need for electronic reporting as opposed to manual reporting.	*"Technology can be a barrier if you have to struggle. If you have your password and if it only takes five minutes, it's okay. But if you must go and look at the info and it is not there, or it is off line or it takes me half an hour, it takes time away from my patients."* (TB02) *"No one here taught me how to use it. With the cardiac monitor, you just learn as you go on. There wasn't any specific person that came and taught me how to do things. You just figure things out. Staff train each other. If there's something that I know, I would teach someone else. If there is a new staff member, older staff members would assist. There is no formal training on how to use the ECG machine or cardiac monitor. Every day you sit and play around to figure out how things work." (TB04)* *"It does take time away from the patient, because, before, when we triaged the patient manually, we used to stand with the patient and talk to them whilst writing things down. Now we have to walk away from the patient to go to the PC." (MP08)*	Lupton, 2014; Krick *et al.* 2019; Krick *et al.* 2020; Fadel *et al.* 2020; Seibert *et al.* 2020; Booth, 2021
5. DHT development & support	Whilst the importance and relevance of nurses' participation in the process of technology development is frequently stressed by developers, scientists and funding bodies, their actual participation has been described as negligible. Furthermore, nurses often fail to identify and communicate their needs and ideas for application scenarios or improvements to DNT in everyday care practice. Responses were gathered from nurse managers at Hospital A and the Operations Manager at Hospital B. As end-users of DHTs, it is imperative that nurses be included in the process of developing new technologies.	*"The area manager informs us of what she gets from top management." (NM02)* *"Introduced by Dr X, one of our EC doctors, because we needed a system that speeds the triage process." (OM01)* *"Sometimes the nurse manager will inform us that they will change something, maybe next week. That is the only notification we get." (TB08)* *"We were informed by our operational manager about the new technology." (MP03)*	**3.2.3 DHT Design & Reality Gap** Slevin *et al.* 2020 Seibert *et al.* 2020; Mather *et al.* 2019; Ludwick & Doucette,2009; Boonstra and Broekhuis, 2010; Greenhalgh & Wyatt, 2012 Sanders *et al.*, 2012 Greenhalgh *et al.* 2010 Gulati,2008
6. Information	The results indicate unanimous agreement amongst participants that technology has become an integral part of patient care, particularly in the ICU, because it saves time, it facilitates the monitoring of patients, improves patient administration and access to patient information. Some of the benefits of information availability are: improved recordkeeping, easy access to and flow of information, improved productivity as DHTs reduce time spent with patients.	*"The information is saved on the monitors and we can go back and see. …We also have our written record. Our observation chart is done hourly so we capture our information and we do our records in the nursing process. When a patient is discharged it goes to medical record." (TA02)* *"When the patient is discharged, it also shows that the patient was in EC and now he or she is discharged. If the patient goes to another ward or an overnight ward, it also tells you that this patient is no longer in EC but has moved to another ward. It is very accurate." (MP02)*	Singh *et al.* 2010 Rajalakshani *et al.* 2011 Baiharu & Pai, 2016 Vargas *et al.* 2018 Bettano *et al.* 2019 WHO, 2019 Bagayoko *et al.* 2020 Cifra *et al.* 2020 Huter *et al.* 2021

THEMES, FINDINGS & EVIDENCE FROM THE DATA			
THEMES FROM THE DATA	**KEY FINDINGS**	**EVIDENCE FROM THE DATA**	**MAPPED TO THE LITERATURE**
7. Nursing administration	Since DHTs are incorporated into the daily work activities of nurses, there is notable improvement in nursing administration, as well as recordkeeping. Nursing administration is optimised because doctors, nurses and clerks have access to the system.	*"I have my own login and password. Currently I do off duty on NIMS as well as placing of personnel. I use the health apps for the ordering of my stock that is in our stores and our buy-outs. I use it for both. But if you do experience problems with the computer, I also have a paper book that I can order on. I have my own login and password." (TA03)* *"It shows our effectiveness in being able to triage a patient correctly. It gives the nurse an idea as to which patient is ready to be moved out of the unit. It improves the flow management in the unit". (MP04)*	Van Bogaert *et al.* 2009 Beastal, 2012 Warshawsky & Rayens, 2013 Van Bogaert *et al.* 2014 Presotto *et al.* 2015 Nelson, 2017 Cox, 2019 Booth *et al.* 2021
8. Patient care	The positive impact of technology, particularly where the technology improved nurse-patient interaction is evident from the participants' responses The use of technological devices provides convenience, particularly cardiac monitors have positive benefits by monitoring the patient's vital signs continuously and transmitting data in real-time as well as remote monitoring.	*"Each patient had their own monitor but we had to physically go to the patient to see the heart rate, BP. Now with the central monitor, we stand in one place. It is so much easier. So we stand in one place and can observe over 20 patients' vital signs at once and act immediately when there is a problem." (TB08)* *"In EC our main thing is the triage and we can actually monitor the time, from the time of registration to the time the patient is triaged. Statistically this is important, to see if a patient waits longer than an hour for triage, at the touch of a button. It gives you a lot of information and statistics about how many patients are walk ins, how many are referred from GP and CHC, because when they register the patient that information is done on CLINICOM and it comes onto HECTIS as well." (MP06)*	Grol *et al.* 2003 Campbell *et al.* 2004 Kramer *et al.* 2007 Ludwick & Douchette, 2009 Chong *et al.* 2011 Flannagan *et al.* 2013 Grindrod *et al.* 2014 Anglada-Martinez *et al.* 2014 Rivas, 2016 Chichirez & Purcarea, 2018 Oliveira & Ramos, 2019 WHO, 2019 Seibert *et al.* 2020 Barbosa *et al.* 2021 Ali *et al.* 2022

THEMES, FINDINGS & EVIDENCE FROM THE DATA			
THEMES FROM THE DATA	**KEY FINDINGS**	**EVIDENCE FROM THE DATA**	**MAPPED TO THE LITERATURE**
9. Training	Nurses have overwhelmingly indicated that their training needs were not assessed prior to the introduction of any new technology. Whilst nurses positively appreciate technology, the lack of training is a major barrier that seems to hinder their ability to derive maximum benefit and pass such benefit on to their patients. Training is in the form of peer-to-peer or learning-by-doing, which is not ideal. Concerning the organisation of training programmes, the results showed they are organised at a moderate frequency; however, nurses are not keen to capitalise on it, due to their situated practice. There are often staff shortages, which deters them from attending formal training programmes. Participants also cited lack of time, family obligations, lack of support from both the workplace and managers.	*"For NIMS and Health Apps, we went to the Datalan, there is an office on the ground floor, and they gave us formal training. The training was two days long. It was not really so sufficient because there's a lot of stuff [updates] that came afterwards, and we didn't receive new training." (TA04)* *"With the cardiac monitor, you just learn as you go on There wasn't any specific person that came and taught me how to do things. You just figure things out. Staff train each other. If there's something that I know, I would teach someone else. If there is a new staff member, older staff members would assist. There is no formal training on how to use the ECG machine or cardiac monitor. Every day you sit and play around to figure out how things work." (TB02)* *"There is scheduled training during the month but it isn't always possible for us to go because we are short on staff. There is computer training available, but they can't send all staff because of shortages." (TA06)* *"We had brief training sessions where we were shown how to work the system. There was always someone to guide us. There were doctors who already knew the system, as well as others who were computer literate. So they were the champions for the system. I cannot recall any nurse that was sent for any other form of training. We were only exposed to training on the e-register technology. There is no ongoing training programme at the hospital." (MP03)*	Eley *et al.* 2008 Gavranos & Newton, 2014 Topkaya & Kaya, 2015 Patmon *et al.* 2016 Gundogdu *et al.* 2018 Orhan & Serin, 2019 Lera *et al.* 2019 De Leeuw *et al.* 2020 Fadel *et al.* 2020 Seibert *et al.* 2020
10. Workarounds	It is clear from the data that technology has made work easier and improved workflow and productivity. Nurses see technologies such as ventilators and cardiac monitors as a means of communication and guides them to what the needs of the patients are. Nurses feel that technology has a positive impact on the nurse-patient relationship, and whilst they are in agreement that technology does not negatively affect the nurse-patient relationship, they nevertheless do not fully trust technology and as a result, have experienced technical problems with some of the DHTs. This has led to them to resort to initiating workarounds to provide the best care for their patients. This means that, where necessary, nurses would resort to their foundational practices, for example, physically taking a patient's blood pressure or physically looking at the clinical picture of the patient instead of accepting the outcome of the cardiac monitor.	*"It's not just about technology, but rather about the physical patient. We enquire as to how they feel. If we see their BP is high and heart rate is incorrect, we don't take it at face value. We go to the patient and ask how they feel, do they have pain. If the BP is very high and I feel that I want to measure it manually, then I will do so to see how the monitor's BP differs from the physical BP cuff. I look at everything both manually and with the help of the monitor." (TB01)* *"What we also do is, sometimes there may be a problem on the monitor. Then we look at the clinical picture of the patient. If the monitor shows an a-systole, we will go to the patient to see if the patient is breathing, and we will know that it is a fault on the monitor. It may also be that electrodes may have moved or became loose, then we will look at the patient's clinical signs and if we see that the patient is normal, then we will reconnect the electrodes." (TB01)* *"Like yesterday when the system was down, we had to revert to doing things manually, and take out the books again. The books are not readily available, because people often misplace them. We had to look for the books, we did this twice, in the morning and evening. It took a lot*	Koppel *et al.* 2008 Greenhalgh *et al.* 2009 Greenhalgh & Wyatt,, 2012 Gresswell *et al.* 2012 Flannigan *et al.* 2013 Mather *et al.* 2019

THEMES, FINDINGS & EVIDENCE FROM THE DATA			
THEMES FROM THE DATA	**KEY FINDINGS**	**EVIDENCE FROM THE DATA**	**MAPPED TO THE LITERATURE**
		of time since the system went down twice. We had to readmit the patients on the system." (MP08)	

5.2.3.1 Discussion of Theme 1 : Decision-making

As the literature points out, clinical decision-making is a fundamental aspect of nurses' clinical practice, and as such, their decision-making directly impacts patients' safety, care and outcome (Johansen & O'Brien, 2015; Nibbelink & Bruwer, 2017).

Clinical decision-making requires nurses to be knowledgeable in relevant aspects of nursing, to have access to reliable sources of information and to work in a supportive environment (O'Neill, Dluby, & Chun, 2005). A more comprehensive definition from a longitudinal phenomenological study of nurses' perceptions of clinical decision-making conducted by Standing defines it as a complex process which involves observation, information processing, critical thinking, problem solving, clinical judgment, reflective practice, ethical values, professional accountability, science and evidence-based practice to select the best course of action that will optimise a patient's health and minimise potential harm (Standing, 2008). This definition encompasses the multi-faceted range of knowledge and skills required for effective clinical decision-making.

Furthermore, the nursing process, which is also deemed to be an important aspect of nursing, is viewed as a problem solving and decision-making technique, and thus widely accepted in nursing care (Pokorski *et al.* 2009; Yildirim & Ozkahraman, 2011). As outlined by Pokorski *et al.* 2009; Ead, 2019; and Toney-Butler and Thayer (2020), the nursing process is a scientific-problem solving model consisting of the several sequential steps: assessment, diagnosis, planning, implementation and development. The nursing process therefore aims to identify, diagnose and treat actual or potential human responses to health and illness.

It is important to note that, in essence, decision-making in healthcare spans two areas. Firstly, the lower area comprises patient management, diagnosis and treatment, record keeping, finance and inventory management. The main role-players in lower-level decision-making are doctors and nurses. Secondly, the higher-level decision-making involves the types of decisions taken at a higher level, and that contribute to the competitive advantage of the hospital (Chahar, 2021).

According to key data findings, decision-making occurs from two perspectives, namely, decision-making based on observation and decision-making based on triage, The key findings of the data indicate that, given the variety of DHTs used, nurses are able to make decisions based on their observations, as they often use their knowledge, intuition and experience to make decisions. This stems from their acute situational awareness. Furthermore, the electronic triage system saves

time and drastically reduces the waiting period as the system can accurately predict the severity of the patient's condition and rate the patient in order of severity/importance. The findings further indicate that, based on the nature of the DHTs which are used by nurses in the ICU and EC settings, DHTs facilitate nurses in their decision-making and as a result, patient care is optimised.

When analysing the data through the lens of the NPT, the theme correlates with the NPT construct of Collective Action. In other words, it served to ascertain whether DHTs promote or impede the work of nurses, whether it is compatible with work practices and the impact thereof on the division of labour. In particular, it relates to the sub-construct of skill set workability, which refers to the degree in which the technology fits into existing work practices, skill sets and the nurses' perceived work role. Furthermore, it enhances their existing roles and skills, thereby enabling them to provide better care and service to their patients.

5.2.3.2 Discussion of Theme 2 - Adapt to change

The literature points out that digital technologies permeate the nursing profession on a global scale, and nurses are required to use a variety of DHTs when providing healthcare to their patients. As a result, nurses have had to adapt in response to complex global challenges faced by health systems and society (Lupton, 2014; Krick *et al.,* 2019; Krick *et al.,* 2020; Booth *et al.,* 2021).

The literature further supports that nurses are keen to use technology to improve healthcare, provide better care to their patients and advance their careers (Eley *et al.,* 2008; De Leeuw *et al.,* 2020; Lera *et al.,* 2020). To support this view, Govranos and Newton (2014) contend that for nurses to maintain professional development, they need continuous education integrated into the workplace.

As discussed in 5.5.3.2, the data reflect a high degree of awareness of the immense benefits of DHTs in terms of how it optimises the work practices of the participants. Participants have overwhelmingly expressed their desire to learn new technology, not only to provide better care to patients but also to enhance their own knowledge and skill.

When analysed through the lens of the NPT of Coherence, it is evident from the responses of participants that the introduction of technology has resulted in improved workflow and productivity. Participants are acutely aware of the importance of DHTs and their impact on their lived experience, to the extent that they would not be able to adequately perform their work without this technology. Similarly, the overwhelming response is that participants are keen to invest time and

energy into learning new technologies. From this, the researcher infers that participants are adaptive and open to change.

Another common theme emanating from the data is that there is buy-in from participants in terms of the use of DHTs. This is evidenced by their willingness to invest time and money into learning new technologies since they understand the importance of keeping abreast of technological developments. Furthermore, some participants have reflected on how they are able to improve their own knowledge and skills, and that they have experienced personal growth in the process of using DHTs as part of their daily work practices. This ties in with the NPT construct of Cognitive Participation which sought to ascertain whether the use of DHTs is a good idea, whether they saw the point of using it and whether they were prepared to invest time and money into learning new technology. Furthermore, it can be linked to the NPT construct of Reflexive Monitoring which sought to ascertain nurses' perceptions on whether they understand the ways in which a new set of practices affect them and others around them, whether they find these practices advantageous, and more importantly, whether they are afforded the opportunity to appraise these technologies. The latter will be discussed in subsequent themes.

5.2.3.3 Discussion of Theme 3 - DHT Use

The literature has indicated that the use of DHTs as part of nurses' daily work activities has drastically improved patient care. This is evidenced because, through the use of technology, nursing tasks have become easier and more time-efficient. Overall, nursing quality has improved (Orhan, 2019; Fadel *et al.,* 2020; Seibert *et al.,* 2020). Studies further show that nurses generally have a positive attitude towards the use of technology as part of their daily work practice (Topkaya & Kaya, 2015; Orhan, 2019; Gündoğdu *et al.*, 2018). Furthermore, Orhan & Serin's study found nurses generally trust technological devices, and think that devices produce accurate results in medical measurements and would prefer to use devices rather than perform their tasks manually (Orhan, 2019)

Whilst the benefits of DHTs are emphasised in the literature, a number of studies have suggested that the constant use of technology may act as a barrier between the nurse and patient (Ludwick & Doucette, 2009; Granados-Pembertty & Arias-Valencia, 2013; Lapão, 2020; Barbosa, Abbott & Dal Sasso, 2021). This view is supported by Almerud (2007A) who found that ICU patients feel invisible as people, in spite of constant monitoring and observation. However, research conducted by Kriekkas *et al. (*2006) contradicts this view. According to their study, views expressed by critical care nurses indicate that equipment does not draw attention away from

patients or cause them to lose their human sensitivity. Nurses did, however, comment on the negative effects of technology in daily practice, for example, the increased patient risk due to human errors or mechanical faults, increased stress and decreased autonomy of nursing staff. Whilst it is acknowledged that an ICU is heavily dependent on technology, and that technological tools are useful, technology cannot ever replace the human touch. It is also imperative for nurses to be adequately trained to use these technological tools. However, it is not uncommon for perceptions to arise that technology forms a barrier between the patient and the nurse.

Key findings from the data indicates that there is consensus amongst the participants regarding the benefits of using DHTs as part of nurses' daily work activities. Furthermore, since DHTs has become an integral part of their lives, and many nurses have grown highly skilled in their use of DHTs, they have expressed concrete ideas on how some DHTs could be adapted to optimise their work. For example, some participants have expressed the need to have their own log-on credentials to access patient results instead of waiting for a doctor to do so. Other forms of improvement include having their own email addresses which would enable them to receive email notifications from the laboratory regarding patients' blood results, or printing of ECGs directly from the central monitor, which they are currently not able to do. However, the overwhelming response from the participants was that they are not afforded an opportunity to provide on the DHTs that they are currently using. It should, however, be noted that, the few who are afforded an opportunity to provide feedback, these opportunities are very limited and confined to certain technologies only. Participants were of the opinion that their feedback or evaluation would hold great potential for themselves as end-users of DHTs.

Another key finding emanating from the data is that the majority of participants have stated that DHTs do not hinder the nurse-patient relationship. According to the majority of participants, the use of technology improved the nurse-patient interaction and provides a high degree of convenience, particularly in the Cardiac ICU, where the use of cardiac monitors allow nurses to monitor patients' vital signs continuously and transmit data in real-time as well as remotely.

Data were analysed through the lens of the NPT construct, Coherence, to ascertain whether participants have a sense of purpose, and whether DHTs fit into their overall goals and activities, and through the lens of Cognitive Participation, in an effort to ascertain whether they thought that the use of DHTs was a good idea, whether they saw the point of using it. The researcher can confirm that participants were unanimous that there is buy-in amongst all participants as they are willing to invest time and money into learning new technologies. Additionally, the use of DHTs as

part of their daily work activities not only saves time, but results in improved service delivery, since waiting times have become significantly shorter.

Data were also analysed through the lens of the NPT construct, Reflexive Monitoring, to assess the perceptions of nurses after they have used DHTs for a period of time, whether they found it advantageous, and how they appraise the effects of DHTs on them and their work environment. The majority of nurses were of the opinion that DHTs have a positive effect on the nurse-patient relationship to the extent that they are able to provide better care to their patients. They do not feel that technology comes between them and the patient. In fact, some responses were that when a patient requires assistance, the nurse can easily save the work on the computer and tend to the patient. Conversely, one participant pointed out that technology interfere with the nurse-patient relationship. According to this participant, there is a timeframe within which to perform the triage process, and once this time is exceeded, or impacted because of an emergency, the nurse has to rush and as a result, spends less time with the patient. The same participant pointed out that, due to a lack of resources, particularly where computers are shared amongst colleagues, and especially where the computer is in a different location, the patient is often left alone when the nurse has to enter data onto the compute.

5.2.3.4 Discussion of Theme - DHT Access

There is overwhelming proof in the literature that nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare spectrum. However, managing equipment, such as ventilators, infusion pumps, monitors and dialysis machines makes healthcare in an intensive care setting more complex. Consequently, Fadel (2020) and Setyowati *et al.*(2022) have found that nurses are generally positive with regard to information technology because they understand that these technologies facilitate their work in terms of reduced paper work, increased job satisfaction and improved quality of healthcare to for patients.

However, research conducted by Limbu *et al.*(2018), in researching the lived experience of critical care nurses in Nepal, have found that providing nursing care in environments where there is low technology and insufficient resources could result in physical and psychological distress in intensive care nurses. This, in turn, might have an impact ibn the quality of critical care. In addition, caring with low technologies of care and insufficient human resources can negatively impact intensive care nurses and hamper them from providing adequate care to the critically ill patient.

When analysing the data, a key finding to emerge was that, although there is buy-in from nurses regarding the use of technologies, there are a number of barriers that hinder their ability to derive maximum benefit and pass such benefit on to patients.

Participants notably highlighted the following barriers that hampered their DHT use and access: an insufficient number of computers, the limited time assigned to the triage process, a lack of own log-in credentials, limited training opportunities, the long response time when technologies need repair, poor connectivity and (the sometimes negative) effect of DHTs on the nurse-patient relationship, and the need for electronic reporting to replace manual reporting.

When analysing the data through the lens of the NPT construct, Cognitive Participation, to ascertain whether there is buy-in from participants regarding the technologies, whether they can individually and collective sustain their involvement with the use of DHTs, it can be concluded that the barriers highlighted by participants are hampering their ability to sustain their involvement in the use of DHTs. A notable barrier that emanated is that nurses' opinions were not sought when new technologies were introduced. This is highlighted in that nurses are seldom asked to evaluate or appraise the technologies which they use in their daily work activities.

When analysing the data through the lens of the NPT construct, Collective Action, which sought to assess whether DHTs promote or impede the work of nurses, whether DHTs are compatible with their work practices and the impact thereof on the division of labour, there is overwhelming consensus that, to a large extent, DHTs facilitate the nurses' job and has a positive impact on the nurse-patient relationship. Furthermore, there is adequate technical support provided by means of the IT department, as well as the IT helpdesk or a dedicated staff member who is the champion for the new system and is always on hand to assist.

5.2.3.5 Discussion of Theme - DHT Development/Introduction

Nurses are increasingly required to use a variety of digital health technologies when providing direct care across the healthcare sphere. However, health workers, and particularly nurses, often experience issues surrounding the design of digital health technologies, resulting in having to use a range of technologies that does not meet their expectations. Seibert *et al.* 2020) state that, whilst health workers deem it important to be involved in the planning, design and implementation of digital technologies, this is not always the case. Actual participation has been described as negligible and limited as nurses are often unable to identify and communicate their needs and ideas for the improvement of digital nursing technologies (DHT) in everyday care. The authors'

study found a deep desire, mostly by nurses with additional management responsibilities, to participate in the development and testing of DHTs practice Given that nurses are the largest group of stakeholders in the healthcare sphere, Mather *et al*.'s (2019) research highlights the urgent need for this group of health professionals to be fully engaged in the digital future of healthcare environment, and in doing so, become stakeholders at every level. This view is supported by the WHO, regarding The importance of involvement healthcare stakeholders in the planning design and implementation of digital systems; however, this is not always done, which often resulted in healthcare workers not being fully satisfied with the technologies as their needs have not been met (WHO, 2019).

The design and implementation of digital technologies should be informed by users (Ludwick & Doucette, 2009; Boonstra & Broekhuis, 2010). In the same vein, Gulati (2008) contends that while this is the intention or the designed function of ICT for education, the reality does not always live up to the hopes. Ludwick and Douchette (2009) suggests that the quality of the implementation process is as important as the quality of the system being implemented, and stress that, to ensure successful implementation, it is imperative that health system usability, computer skills and the actual systems fit within the organisational culture and processes. According to Kiekkas *et al.* (2006), nurses know that machines are usually purchased and controlled by the medical profession and designed to meet the needs of medical practice rather than nursing. As a result, doctors guide nurses and give them instructions on how to use devices.

Key findings from the literature suggest that there is minimal to zero consultation with nurses before the introduction of new technologies, nor are their opinions sought. Nurses and managers at both hospitals are unanimous that it is imperative for nurses to be included in the process of developing new technologies.

The key findings were correlated with the NPT constructs of Cognitive Participation and Reflexive Monitoring, to ascertain whether it is right for them to be involved with new technology, and also, whether they understand the ways in which a new set of practices affect them and others around them. The findings concur with the NPT constructs, whereby nurses' opinions are not sought prior to the introduction of new technologies. Furthermore, they are not afforded sufficient opportunities to appraise the existing technologies. Participants have stressed that their feedback or evaluation would hold great potential, not only for themselves, but may guide future development of DHTs to ensure greater alignment thereof with their work activities.

5.2.3.6 Discussion of Theme – Information

The field of digital technologies as it applies to the provision of healthcare is extensive, and a vast number of innovative types of information and communications technologies (ICTs) are being developed. Digital technologies comprise a wide range of technologies, including communication support, decision support, electronic health records, hospital information systems and personal digital assistants (PDAs) (Kowatsch *et al.* 2019; Wallwiener *et al.* 2009).

The healthcare industry generates vast amounts of data and makes extensive use of technology to capture and transfer information. An important aspect of nursing and the nursing process is the management of patient information since the timeous exchange of relevant information of a patient is essential to ensure quality of care. Critical patient information is conveyed in a variety of forms, for example through the electronic health record, healthcare decision support systems, referral co-ordination, prescription and medication management, laboratory and diagnosis management.

A key finding of the data indicate unanimous agreement amongst participants that technology has become an integral part of patient care, more so in the ICU, as it saves time, it facilitates the monitoring of patients, improves patient administration and more importantly, provides timeous access to patient information. Some of the benefits of information availability include improved recordkeeping, easy access to and the seamless flow of information, improved productivity as the time spent with patients is reduced.

When analysed through the lens of the NPT construct, Coherence, to ascertain the degree to which participants are able to make sense of their work, and the construct of Collective Action, to ascertain whether DHTs facilitate or impede their work, it can be concluded that each participant has a clear understanding of tasks and responsibilities. Nurses are in agreement that the respective DHTs are compatible with their existing work practices. Participants have a shared understanding of the value of and the importance of information and the effective management thereof. Participants are confident with using the DHTs and are unanimous that it facilitates access to information and improves the management thereof. Since DHTs capture valuable patient information, it eases the flow of information, as doctors, nurses and clerks have access thereto.

5.2.3.7 Discussion of Theme - Nursing Administration

The nursing profession has been influenced by the influx of technology and the benefits of using DHTs in the nursing profession are well documented. Research indicates that nursing and technology are inextricably linked (Bagherian, 2017). In intensive care settings such as the ICU, technical equipment such as ventilators, infusion pumps, heart monitors and dialysis machines need to be managed. In defining technology, Tunlind *et al.* (2015) describe it as machinery and equipment which are connected to knowledge in management, so as to maximise efficiency. It can be concluded that it about more than just equipment, rather, being able to use it effectively and being able to integrate it into nursing care.

By nature, the ICU environment is highly technological, since patients require specific care, such as being provided with life support equipment, coupled with supporting, treating and monitoring their progress for 24 hours.

The nursing process is thus viewed as an important aspect of nursing and involves reflective practice and critical thinking – both necessary aspects in problem solving. According to Rivas *et al.* (2016), the nursing process can be viewed as a scientific method as well as a form of critical thinking since it helps to accurately diagnose patients and offer a variety of interventions. As the role and contribution of the nurse has evolved to meet the ever-increasing demands and complexity of patients, so has the role of the nurse manager. The latter's role has expanded to meet the needs of staff and patients in the unit, and is by nature, a demanding role in healthcare. Nelson (2017) states that, in addition to being responsible for the financial outcomes of the unit, the nurse manager is also responsible for the experience of the patient, in addition to ensuring a safe and positive work environment for the staff under their supervision. Furthermore, their management function includes the administration of material resources as well as the forecasting and provision of resources to provide adequate care within their respective units. There is limited information in the literature regarding nursing administration and the administrative duties of nurses and nurse managers and how DHTs facilitate their administrative tasks.

Key findings of the data indicate that, since DHTs has been incorporated into the daily work activities of nurses, there is notable improvement in nursing administration as well as recordkeeping. Valuable data are captured on computers (used for the management of nursing staff rosters, ordering of consumables, general reporting, ordering patient diets), ventilators (to monitor patient oxygen levels) ECG monitors (to monitor the patient heart function), individual and central cardiac monitors (monitoring vital functions like heart rates, blood pressure, saturation,

pulse, and respiration), the e-Register (electronic register used to register a patient onto the system). Nurse managers have assigned dedicated nursing staff to perform certain administrative tasks on their behalf, such as ordering of consumables on the NIMS system). Nursing administration is thus optimised because doctors, nurses and clerks have access to the system. Nurses therefore have a clear and unambiguous understanding of the value of the information that is being captured by means of the various technologies and as such, recordkeeping, data capturing and access to patient information is facilitated, this enhances nursing administration, since it is one of the key performance areas of the nurse.

When analysing the data through the NPT construct of Coherence, to ascertain how these technologies affect their existing work practices, the findings concur with the findings of the data in that technology has become an integral part of patient care, especially in the ICU as it saves time. Furthermore, it facilitates the monitoring of patients, improve patient administration and access to information. Each nurse has an acute understanding of his or her particular task and responsibility. For example, through the electronic triage process, patient care, patient administration and access to patient information is optimised. Similarly, the eRegister provides vital patient on patient arrival times, time spent waiting to be triaged as well as when the patient was actually seen by a doctor, because nurses can track the flow of patients. This facilitates the reporting process, because the information is easily accessible when the nurse has to prepare and submit their report to the matron at the end of the day.

5.2.3.8 Discussion of Theme - Patient Care

Jarrin (2012:4) aptly states that “nursing is caring situated in space, place and time, shaped by the internal and external environments of both the nurse and the patient/client”.

It is no surprise then that the use of technology impacts on how nurses perform their duties and interact with patients. Tunland *et al.* (2014), when referring to technology as items, machinery and equipment connected to knowledge and management with the intent to maximise efficiency, very aptly states that it is not only about equipment per se, but also encompasses the knowledge of how to use it and subsequently translating it to nursing care.

Caring for critically ill patients therefore not only requires nursing competency, but also using technology whilst at the same time maintaining humanistic care. Research indicates that the relationship between the nurse and the ICU is reciprocal in nature, charged with emotion, because the nurse share in the patient and the family’s suffering as patients journey through the ICU

(Olausson *et al.* 2014). It is therefore imperative that a balance is struck between the technological environment and the emotion of the nurse when caring for critically ill patients. It is for this reason that Price (2013) succinctly states that critical care practice as a mixture of caring and technological activities. Conversely, there is much academic deliberation around the fact that technology may negatively affect the nurse-patient relationship (Ludwick & Doucette, 2009; Granados-Pembertty & Arias-Valencia, 2013; Lapão, 2020; Barbosa *et al.,* 2021). To counter this, Price (2013) reiterates that the importance of technology in the ICU setting and that caring is not possible in the absence thereof. Furthermore, Kriekkas *et al.* (2006) have found that according to critical care nurses, equipment does not draw attention away from patients or cause them to lose their human sensitivity. However, nurses commented on the negative effects of technology in daily practice, such as increased patient risk due to human errors or mechanical faults, increased stress and decreased autonomy of nursing staff.

Key findings of the data overwhelmingly point to the positive impact of technology, especially where the technology improved the nurse-patient relationship. The use of DHTs provide convenience, particularly the cardiac monitors have positive benefits for monitoring patients' vital signs continuously and transmitting data in real-time as well as remote monitoring (i.e. monitoring the patient from the central monitor, without physically at the patient's bedside). A small number of participants have expressed that technology negatively affects the nurse-patient relationship, particularly where there is a shortage of computers, and computers are shared amongst staff, or when the computer is in a different location and the nurse has to leave the patient alone to update details on the computer. Another example is the limited time frame within which to conduct the triage process, and once this time frame is exceeded, the nurse is under pressure to complete the process, which means spending less time with the patient.

When analysing the data through the lens of the NPT constructs of Coherence, Collective Action and Reflexive Monitoring, there is a correlation with the key findings of the data. The use of technology allows participants to spend more time with their patients. Participants have expressed confidence in the technologies and view them as a means of communication, which enhances patient care. Whilst the majority of participants have stated that DHTs do not negatively affect the nurse-patient relationship, a small number have cited examples of how it sometimes comes between them and the patient.

5.2.3.9 Discussion of Theme – Training

As discussed under section 3.2, It is abundantly clear that, through the use of technology, the nurses' tasks become easier and more time-efficient, and as a result, the quality of care is improved (Orhan, 2019; Fadel *et al.,* 2020; Seibert *et al.,* 2020). However, against this backdrop, Govranos and Newton (2014) contend that for nurses to maintain professional development, they need continuous education integrated into the workplace. Studies further show that nurses generally have a positive attitude towards the use of technology as part of their daily work practice (Topkaya & Kaya, 2015; Orhan, 2019; Gündoğdu *et al.*, 2018). Furthermore, Orhan and Serin's study determined that nurses generally trust technological devices and think that devices produce accurate results in medical measurements and would prefer to use devices rather than perform their tasks manually (Orhan, 2019).

A study by Patmon *et al.* indicates that nurses felt they missed important training or that training was not long enough. This was largely attributed to training scheduled during work hours, which made it difficult for nurses to attend the training sessions. It was further found that many nurses learned how to navigate the system from tips shared from their peers on the unit. The authors further recommended that hospitals provide sufficient training for nurses on the new system. In addition, nurses should be allowed sufficient time to navigate and explore all the functionalities (Patmon *et al.,* 2016). For staff to accept new technology and actively use it, training is important, and whilst some health workers may experience difficulties in understanding and using digital health technologies, training and familiarity with these technologies can help overcome these difficulties (WHO, 2019).

However, in spite of substantial advances to date, challenges in nurses' use of digital technology seem to prevail. Of notable concern is that nurses have generally not kept abreast with rapid changes in digital technologies and their impact on society. This impacts the potential benefits which may accrue to nursing practice and patient care. To rise to these challenges and be prepared for the future, nursing must begin immediate transformation into a digitally-enabled profession that can respond to the complex global challenges facing health systems and society at large (Booth *et al.,* 2021).

Key findings of the data overwhelmingly indicate that nurses' training needs were not assessed prior to the introduction of new technologies. Whilst nurses positively appreciate technology, the lack of training is a major barrier that seems to hinder their ability to derive maximum benefit and pass such benefit on to their patients. Training is often in the form of peer-to-peer training or learn-

by doing, which is not ideal. Concerning the organisation of training programmes, the results indicated that training is organised at a moderate rate of frequency, and due to their situated practice, nurses are often not keen to capitalise on it. The situation is further exacerbated in that there are often staff shortages which deter them from attending formal training programmes. Participants also cited a lack of time, family commitments and lack of support from management. The key findings of the data correlate with the NPT constructs, Collective Action and Cognitive Participation.

5.2.3.10 Discussion of Theme – Workarounds

As discussed under section 3.2, DHTs have the potential to improve work practices for many patient care processes, However, there are instances where they do not support all clinical work, and as a result, users might view them as obstructions to delivering efficient patient care. For example, when nurses experience difficulty in finding necessary patient data, or are faced with complex order entry processes, in an attempt to avoid these obstructions and to complete the task at hand, staff would often develop workarounds (Flannigan *et al.,* 2013).

Similarly, end-users may either partially use a particular technology (in other words, only use the parts they perceive as useful) or develop workarounds, or they may avoid using technology altogether (Cresswell *et al.,* 2012; Greenhalgh & Wyatt, 2012; Greenhalgh *et al.,* 2010; Ludwick & Doucette, 2009). It can thus be deduced that workarounds occur because nurses do not follow explicit or implicit rules, workflow regulations, or procedures prescribed by system designers. According to Koppel *et al.,* this is normally due to deficiencies in the system or workflow design. Typically, workarounds occur as a result of a misalignment of the available health IT with personnel, work practices and the environment.

Based on key findings of the data, technology has made work easier and improved workflow and productivity. Nurses regard DHTs such as ventilators and cardiac monitors as a means of communication which guide them to the needs of the patients. Nurses feel that technology has a positive impact on the nurse-patient relationship, and whilst they are in agreement that technology does not negatively affect the nurse-patient relationship, they nevertheless do not fully trust technology, having experienced technical problems with some of the DHTs. Occasionally they resort to initiating workarounds to provide the best care for their patients. Where necessary, nurses resort to their foundational practices, for example, physically taking a patient's blood pressure or physically looking at the clinical picture of the patient instead of accepting the outcome

of the cardiac monitor. Similarly, nurses revert to manual practices in the case of loadshedding or power failures, or when the system is down due to cable theft.

The key findings correlate with the NPT constructs of Cognitive Participation and Reflexive Monitoring in that a number of factors have led participants to modify some work practices after they have expressed that they do not fully trust technology, and would, based on the clinical picture of the patient and coupled with their own intuition, resort to their foundational practices.

5.3 Combined results discussion

In this sub-section, the combined results are discussed using the 10 themes of the thematic analysis while also mapped to the results derived from the NPT analysis. Although similarities were considered, the mapping of each NPT sub-construct was not necessarily aligned with the data themes because the focus of this study was not on verifying the NPT theory but rather to use it as an additional theoretical lens during the analysis of the data.

The first consideration was whether any findings from the NPT analysis do not have a similar finding from the thematic analysis. It is important to note that when the researcher analysed the data through the lens of the NPT, all our constructs, including sub-constructs were used. Whilst the researcher was investigating the applicability of the NPT in similar studies, the researcher found that most studies only used one construct, for example, Collective Action (Murray *et al.,* 2010; McCarthy *et al.,* 2022). When mapping the findings of the NPT to the thematic analysis, an important finding is that, whilst the NPT serves as a conceptual framework to explain the processes whereby new health technologies and other complex interventions can be routinely embedded or operationalised into every day work, and subsequently sustained in practice, the NPT constructs only focus on the implementation of new health technologies and not on the design and development thereof. The NPT therefore does not make provision for the design and development of complex interventions. A possible reason could be that the framework was designed to be used from an end-user perspective and not from the perspective of the developer.

The next consideration is whether there are findings from the thematic analysis that were not present from the NPT analysis. The theme, decision-making, when mapped to the constructs of the NPT, could only be linked to the construct, Collective Action. This construct served to ascertain whether DHTs promote or impede the work of nurses, whether it is compatible with work practices and the impact thereof on the division of labour. In particular, it relates to the sub-construct of skill set workability, which refers to the degree in which the technology fits into existing work practices,

skill sets and the nurses' perceived work role. Furthermore, it enhances their existing roles and skills, thereby enabling them to provide better care and service to their patients. However, the construct does not explicitly focus on the decision-making aspect of nurses' jobs.

The next consideration is to determine which findings from both the thematic and NPT analysis are similar. The theme, DHT use, could be mapped to all four NPT constructs. This is significant, because key findings from the data indicates that there is consensus amongst the participants regarding the benefits of using DHTs as part of nurses' daily work activities. Furthermore, since DHTs have become an integral part of their lives, and many nurses have become very skilled in DHTs use, they have expressed concrete ideas on how some DHTs could be adapted to optimise their work. From this, the researcher can deduce that DHTs have been embedded into the work practices of nurses.

Two themes, Adapt to change and Patient care, could be mapped to three of the four NPT constructs. Notably, the construct of Coherence features in each of the aforementioned themes. From this it can be deduced that participants are able to make sense of their work, and that they have a sense of purpose, both individually and collectively. They have positive perceptions of the DHTs to the extent that they cannot imagine performing their work activities without these technologies.

The final consideration is to determine whether the use of both theoretical analysis approaches resulted in gaining deeper insights. Using both the NPT and the thematic analysis has strengthened the study and has provided the researcher with insight into the lived experiences of nurses as they experience the use of DHTs in practice. The use of the NPT was particularly useful because, not only did it help the researcher formulate the research questions, but it provided a structured framework through which the data could be analysed, which further strengthened the findings of this study.

When mapping the themes to the theoretical themes, the findings indicate that four of the themes (Adapt to change, DHT access, DHT use and Workarounds) could be mapped to theoretical themes T1, T2, T3 and T4. Furthermore, four of the themes (Decision making, Information, Nurse Administration, and Patient Care) could be mapped to theoretical themes T1, T2 and T3. A notable finding is that two themes (DHT development and Support and Training) could only be mapped to one theoretical theme. This would indicate a clear gap with the DHT D&S where the nurses were not involved in the development that resulted in access and use issues where the implemented DHT is not well-aligned to the design and development. As a result, nurses end up

with technologies that are not aligned to their work practices, and they are not afforded an opportunity or avenue to appraise these technologies or provide input on how it can be enhanced once these technologies are implemented.

5.4 Results mapped to the conceptual framework

In this sub-section, the findings are mapped with the conceptual framework to establish to what extent the data supports the focus of the study. The research questions are formulated to address the identified research gap and each question addresses a specific aspect of the study.

Research question 1 maps to the lived experience of the nurse who uses DHT in the nursing care process when providing care to patients in a particular situation.

- Theoretical lens: lived experience of nurse during NCP using DHT in a care situation.
- Normalised process theory: to gain insights in the nurses' use of DHT from introduction to full incorporation into nursing care practices.

Research question 2 maps to the nurses' involvement in the development and support processes versus the use of DHTs.

- *Theoretical lens:* lived experience of nurse involvement in the DHT Development process.

The focus of the study is where these five themes join together to establish the nurses' lived experiences of using digital heath technologies to enable the care processes.

Next the findings as they are mapped with the conceptual framework are discussed and although the discussion is per theoretical theme, interrelationships are also considered.

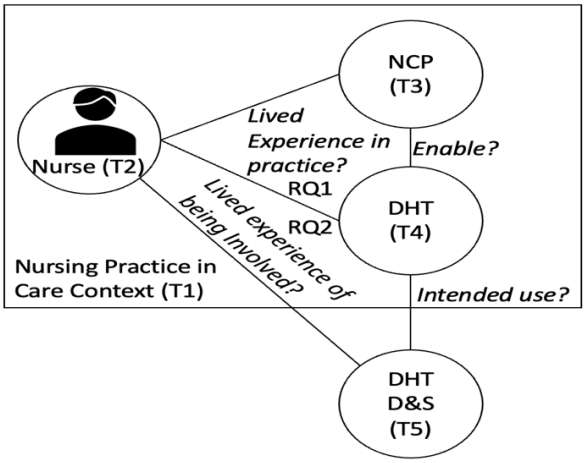


Figure 7: Proposed conceptual framework

5.4.1 Theoretical theme 1: nursing practice in the care context to consider the care situation in the specific context

As mentioned in the literature, nursing practices are guided by certain standards established by professional associations and government agencies. The nursing practices are care-based and form part of a systematic framework carried out by nursing processes of patient assessment, diagnosis, planning, intervention and evaluation; it is a problem-solving process (Pope *et al.,* 1995). In other words, the nursing practice may be work experience that is direct or indirect patient care in clinical practice, nursing administration, education, research or consultation in the specialty represented by the credential.

It is clear that the implementation of sophisticated technology will inevitably affect nursing practice. For example, there have been fears that intensified use of technology will dehumanise and depersonalise nursing practice. However, the findings from the analysis show clearly that digital technology has a largely positive impact on nursing practice, particularly on the nurse-patient relationship. Nurses have stated overwhelmingly that technology does not come between them and their patients. Nurses build a relationship with their patients, to the extent that they sometimes do not trust technology and would rather do a physical examination to ensure that their assessment of a patient is in accordance with the results displayed by a particular DHT. To "know your patient" is thus the very essence of nursing practice.

This ties in with the key findings of the construct, Coherence, which is that participants have a sense of purpose; they have a deep understanding of the DHTs, how they it into their overall goals and activities. and how it impacts their work practices. Furthermore, it resonates with the construct, Cognitive Participation, in that there is complete buy-in from participants to the extent that participants feel the need to invest time and energy into learning new technologies. However, a number of barriers were uncovered which hamper participants' ability to sustain their involvement in the use of DHTs.

5.4.2 Theoretical theme 2: the person using digital health technologies in practice in the situational context of work, namely the nurse as the user

As the largest and most important role-player in healthcare, nurses' acceptance of DHTs is vital. As a result, nurses must continuously utilise technology to access and manage records and provide care using electronic means. The results of this study indicate positive views on the use

of DHTs as part of their daily work practices and they show great acceptance to these technologies. The results further indicate a belief amongst nurses that continuing education is essential and their professional knowledge must periodically be enriched and renewed in order to stay abreast in the field of ICT. The use of DHTs as part of their daily work activities not only saves time, but results in improved service delivery since waiting times have become significantly shorter.

This theoretical theme ties in with the key finding of the NPT construct of Collective Action, in that participants have expressed confidence in the system and positively appreciate technology. The many benefits derived from DHTs enhance patient care and facilitate access to and the management of information. Overall, technology makes their work easier.

5.4.3 Theoretical theme 3: nursing care processes as the activities that form part of the care process

As discussed in the literature, the nursing process is a series of sequential and systematic steps taken to deliver healthcare: assessment, diagnosis, planning, implementation and evaluation. In other words, the nursing process is a systematic, step-by-step process to plan care for patients, used by nurses to meet the individualised healthcare needs of their patients (Yildirim & Ozkahraman, 2011; Toney-Butler & Thayer ,2020). This is a problem-solving process used to identify, prevent and treat actual or potential health problems and promote wellness.

The findings of this study indicate that the use of the nursing process is indeed beneficial to patient care. The triage process at Hospital B, for instance, is an example of a nursing process, where patients are triaged via an electronic system: they are assessed, and a preliminary diagnosis is provided by the system, after which the doctor will see the patient for implementation and evaluation. Similarly, the nursing process is followed in the Cardiac ICU, whereby patients are assessed by the nurse using a variety of DHTs; whereafter, the nurse will identify a diagnosis. The nurse will then formulate a plan in terms of how to address the particular problem identified during the diagnosis process. The next step would be implementation, where, for example, in the ICU setting, the nurse would connect the patient to a cardiac monitor if the patient presented with symptoms of a heart attack. An evaluation, which is the final step in the nursing process, will then be performed by the nurse. This could be a reassessment to evaluate whether the desired outcome had been met, namely, to save a patient from incurring further damage to his or her heart after having suffered a heart attack. The nurse-patient relationship is very important in this instance.

This theoretical theme ties in with the key findings of the NPT construct Cognitive Participation that there is complete buy-in from participants to the extent that participants feel the need to invest time and energy into learning new technologies. However, a number of barriers were uncovered which hamper participants' ability to sustain their involvement in the use of DHTs.

5.4.4 Theoretical theme 4: the digital health technologies used by the nurse to enable the nursing care process

A variety of DHTs are used at both Hospitals A and B: cardiac monitors, IVAC machines, ventilators, ECG machines, desktop computer, HB monitors, eRegister, Hectis system and Nursing Information Management (NIMS) system. Most of these DHTs have been in the hospital for some time, such as ECG machines, desktop computers, IVAC machines, cardiac monitors, and HB Monitors. Newer technologies such as the eRegister and NIMS are the more recently implemented DHTs which nurses now use as part of their daily work activities. It is an acknowledged that an ICU is heavily dependent on technology, but although technological tools are useful, technology cannot ever replace the human touch. It is also imperative for nurses to be adequately trained to use these technological tools. The findings have shown that, whilst nurses are exposed to a host of DHTs, training on new technologies is not a priority. Any training is in the form of peer-to-peer and on-the-job training. Nurses have lamented the lack of training opportunities and have expressed the need for formal training. However, at the same time, nurses have also indicated that due to staff shortages, it is not always possible to attend training. The results also indicate that nurses generally trust technological and positively appreciate technology as it makes their jobs easier and saves time. Nurses are keen to broaden their knowledge and have indicated that they are willing to invest time and energy to learning new technology.

This theoretical theme ties in with the key finding of the NPT construct of Collective Action, in that participants have expressed confidence in the system and positively appreciate technology. The many benefits derived from DHTs enhance patient care and facilitate access to and the management of information. Overall, technology makes their work easier.

5.4.5 Theoretical theme 5: the DHT development and support processes and nurse involvement in the development and support processes versus the use of DHTs

It is clear from data analysis that nurses are largely excluded from input into the design, policymaking and decision-making processes, yet they are often at the receiving end of the negative effects of these processes. There is abundant literature that highlights the urgent need

for nurses to be fully engaged in the digital future of healthcare environment, and in doing so, become stakeholders at every level, a view that is also supported by the WHO (Mather *et al.,* 2019; WHO, 2019; Boonstra & Broekhuis, 2010; Ludwick & Doucette, 2009). The results are unanimous that nurses, as the eventual end-users and champions of the DHTs, should be involved in DHT design and implementation. However, as it stands, their involvement is minimal to non-existent. Furthermore, nurses are not afforded an opportunity to evaluate existing DHTs, nor provide feedback on how existing DHTs can be optimised to derive greater benefit therefrom. Involving nurses in the design and implementation processes would be highly beneficial to guide future development of DHTs to ensure greater alignment thereof with their work activities.

As mentioned earlier, a shortcoming in the NPT framework is that the constructs only focus on the implementation of new health technologies, and not on the design and development thereof. The NPT does therefore not make provision for the design and development of complex interventions. When mapping this theoretical theme to the key findings of the NPT, it partly ties in with the findings pertaining to Reflexive Monitoring, particularly nurses' ability to appraise implemented DHTs or provide feedback on how DHTs can be enhanced. Participants are receptive to the use of DHTs and do not see technologies as a barrier between them and their patients. However, concern was expressed at the non-inclusion of nurses in the design and development of DHTs, and that there is no channel for nurses to appraise the DHTs used as part of their daily work practices.

5.5 Chapter conclusion

The aim of this chapter was to address the research questions. The combined results were discussed using the 10 themes of the thematic analysis but also mapped to the results derived from the NPT analysis.

When mapping the findings of the NPT to the thematic analysis, an important finding is that while the NPT provides a conceptual framework that explains the processes by which new health technologies and other complex interventions can be routinely embedded or operationalised into every day work, and subsequently sustained in practice, the NPT constructs only focus on the implementation of new health technologies and not on the design and development thereof. The findings also indicate that the theme, decision-making, derived from the thematic analysis that was not adequately covered by the NPT. From this, it can be deduced that the construct does not explicitly focus on the decision-making aspect of nurses' jobs.

A significant finding that emanated from the study is that the theme, DHT use, could be mapped to all four NPT constructs. The researcher can conclude that the use of both the NPT and the thematic analysis has strengthened the study by providing the researcher with rich insight into the lived experiences of nurses as they experience the use of DHTs in practice. In addition, it provided a structured framework through which the data could be analysed, further strengthening the findings of this study.

The ensuing chapter will conclude the study and provide recommendations for further research.

CHAPTER 6: CONCLUSIONS & FURTHER RESEARCH

6.1 Introduction

The purpose of this chapter is to conclude the thesis and provide recommendations for further research. The chapter is introduced in 6.1, whereafter an overview of the research conducted is presented in 6.2. The research questions are revisited in 6.3, followed by an evaluation of interpretive research in 6.4. A reflection on the research is presented in 6.5, followed by the contributions of this study in 6.6. Recommendations for further research is presented in 6.7 whereafter the chapter will be concluded in 6.8.

6.2 Overview of research conducted

The aim of this qualitative study was to understand, analyse and assess nurses' lived experience of using DHTs as part of their work practices in an attempt to better guide DHT design and implementation and offer additional insights to the body of scientific knowledge to optimise the use of DHET's in public healthcare institutions in South Africa. In addition, the normalisation process theory (NPT) was applied as an analytical lens to gain insights in the nurses' experiences of using DHTs in their work practices from when the introduction of these technologies to their embedded use in their practices. This study thus explored the lived experiences of nurses working with DHTs in target hospitals, consisting of one tertiary hospital (referred to as Hospital A) and one district hospital (referred to as Hospital B).

This study adopted an interpretive phenomenological approach which has helped to achieve the aim of this study, and to answer the following research questions: 1) How do nurses make sense of their work practices as DHTs influence their work experience? 2) What is the level of alignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice? Furthermore, the approach addressed the stated problem and provided the researcher with an in-depth, detailed understanding of nurses' experiences of the use of DHTs.

In-depth interviews and observation were used to engage the selected participants in an effort to collect data. The data collection method for this study was qualitative in nature, and as a result, the researcher used non-probability sampling, via purposeful sampling, to identify and select end-users who use DHTs as part of their daily work activities. This technique assisted the researcher in identifying a sample size that would provide in-depth information aligned to the research

objectives of this study. The target population for this study consisted of nurses, nurse managers/operations manager as well as a representative of the Chemical Engineering Department who were involved in the design and implementation process of DHTs and participated in this study.

This study comprised a total of 28 participants: 14 from Hospital A, and 8 from Hospital B. All participants were purposefully selected and interviewed until saturation was reached. The researcher used the NPT to organise the data according to the constructs of the theory, and in addition, a thematic analysis was used to organise the data acquired from the participants. The unit of analysis this study was the nurses' lived experience of using DHTs as part of their work practices. The unit of observation for this study was the use of technology, or in other words, how nurses made sense of their interaction with DHTs as part of their work practices.

The following section will revisit the research questions for this study.

6.3 Research questions revisited

The table below presents the mapping of the derived data themes with the key concepts covered by the interview questions.

Table 11: Data themes mapped to key concepts

	Count of Initial Theme	Column Labels										
	Final theme	Adapt to change	Decision-making	DHT access	DHT development & support	DHT use	Information	Nursing administration	Patient care	Training	Work-arounds	Grand Total
1.1.1	Information relevancy		9				6	3	3			21
1.1.2	Information use						16					16
1.1.3	DHT compatibility						6	3	8			17
1.2.1	DHT Current use		7			16	1					24
1.3.1	DHT Perceptions	12		7		5			11	8	11	54
1.3.2	Activity before HITs								12			12
1.3.3	DHT Impact on Nurse-Patient relationship			9	6	1			6	5	3	30
1.3.4	Willingness to learn new DHTs	11								2		13
2.1.1	Nurses involvement in DHT development				11							11
2.2.2	Available support				27							27
2.3.1	Feedback considered					15						15
2.3.2	Need for DHT adaption			4		16				1		21
	Grand Total	23	16	20	44	53	29	6	40	16	14	261

A total of 10 data themes emanated from this study. The yellow shaded part of the table represents the key concepts and data themes mapping of research question 1. The green shaded part represents the key concepts and data themes relating to research question 2. The grey shaded cells represent the data themes that appear in both research questions 1 and 2. This means that participants' answers, when coded, were not limited to the interview question posed. Each cell represents the number of codes associated with the data theme and key concept.

As can be seen from the table, DHT use is the most prominent theme, with the highest number of occurrences (54), followed by DHT development and support (44). In the ensuing sections, the researcher will use the analysis depicted in the abovementioned table to answer the research sub-questions.

Research question 1: *How do nurses experience their work practices influenced by DHTs?* This question is based on the lived experiences of nurses who use DHT in the nursing care process when providing care to patients in a particular situation.

Sub-question 1.1: *How are DHTs incorporated into nurses' work activities?*

Key concepts for this sub-question are information relevancy, information use and DHT compatibility. The results from this sub-question tie in with three themes, namely, Decision-making (9), Information (28), Nursing Administration (6) and Patient Care (11).

As the end-user, using the digital health technologies in practice in the situational context of work, nurses have found DHTs to be relevant to their work and compatible with their existing work practices. This is evident from the results as it fits into their existing roles and skills, thereby enabling them to provide better care and service to their patients. Similarly, findings show that technology has become an integral part of patient care. Overall, Patient Care features prominently in the above table with 40 codes/occurrences. From this, it is evident that DHTs have been fully incorporated in their daily work activities as patient care is enhanced.

Sub-question 1.2: *For what purposes are DHTs used by nurses?*

Key concepts for this question are DHT current use and type of information captured. Results from this sub-question are mapped to the following themes: Decision-making (7), DHT use (16) and Information (1). It is evident that the nurses have a highly positive appreciation for the DHTs used as part of their daily work practices because these technologies enhance decision-making and provide critical information to enable them to prioritise patient care. The use of DHTs as part of nurses' daily work activities has drastically improved patient care. With technology, nurses' tasks have become easier and more time-efficient, and nursing quality has improved. It is noted that DHT use has featured 16 times, and 53 times overall, which makes it the theme with the greatest number of occurrences.

Sub-question 1.3: *What are the perceptions and experiences of nurses in the use of DHTs?*

Key concepts for this sub-question are DHT perceptions, activity before DHTs, DHT impact on the nurse-patient relationship, and willingness to learn new DHTs. Results from this sub-question are mapped to the following themes: Adapt to change (23), DHT access (16), DHT Development and Support (6), DHT use (6), Patient Care (29), Training (15) and Workarounds (14). The results indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs. It is noteworthy that the theme, Adapt to Change, has a high number of occurrences (23), as does Patient Care (29). This is indicative that nurses positively appreciate the DHTs, as evident in their desire to learn new technology, not only to optimise patient care but to augment their own knowledge and skill.

The findings indicate that DHTs have been fully incorporated into their daily work activities as patient care is optimised. Nurses, as end-users, have found DHTs to be relevant to their work practices and compatible with their existing work practices. It was found that, through the use of technology, nurses' tasks have become easier, more time-efficient, and as a result, nursing quality is improved. Nurses positively appreciate the DHTs; this is evident in their desire to learn new technology, not only to optimise patient care, but to augment their own knowledge and skill. The findings further indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs; as noted above, this is substantiated by their desire to learn new technology, not only to optimise patient care, but to augment their own knowledge and skill.

Research question 2: *Why is there a misalignment between the intended use of DHTs and the lived experience of nurses using DHTs in practice?* This question is based on the lived experience of nurses in terms of their involvement in the development and support processes versus the use of DHTs.

Sub-question 2.1: *What was the level of involvement of nurses in the design, development and implementation process of DHTs?*

The key concept for this sub-question is Nurses involvement in DHT development and the result from the analysis is mapped to the theme DHT Development and Support (11). The results indicate overwhelmingly that nurses feel it is right for them to be involved with new technology, more so, because they understand the ways in which a new set of practices affects them and others around them. Data indicate that nurses' input is not sought before the introduction of new technologies, they are merely informed via the nurse managers (whose input is also not sought)

that implementation of new technologies is underway. In addition, they are not afforded sufficient opportunities to appraise the existing technologies even though participants have stressed that their feedback or evaluation would hold great potential, not only for themselves, but to guide future development of DHTs to ensure greater alignment thereof with their work activities.

Although the number of codes for this them is only 11, it noteworthy that this theme has the second highest number of occurrences (44) after DHT use.

Sub-question 2.2: *How were nurses' work practices, as part of their lived experience, considered during the design and implementation of DHTs?*

The key concept for this sub-question is available support and the result from the analysis is mapped to the theme DHT Development and Support (27). This theme received a significantly high number of codes which indicates the importance of nurses' involvement in the design and implementation of new DHTs. Also, important to note is the fact nurses' training needs does not seem to be a priority, and training is often informal, in the form of peer-to-peer or on-the-job training. What is noteworthy is that although nurses are not involved in the development of DHTs, they nevertheless use these DHTs and are happy with IT the support structures available to them.

Sub-question 2.3: *What are the dynamic elements of the DHT-integrated work practices of nurses that contribute to the design-reality gap between implemented DHTs and the nurses' lived experience of using DHTs?*

Feedback considered and Need for DHT adaption are the two key concepts for this sub-question. The result of the analysis can thus be mapped to the following themes: DHT Access (4), DHT use (31) and Training (1). It is clear from the high number of codes under the theme DHT use, that because DHTs are embedded into daily work practices, nurses have grown highly skilled and proficient in using DHTs, to the extent that they have credible ideas about how DHTs could be optimised to enhance their work. However, they are not afforded an opportunity to do so.

The findings indicate that nurses' input is not sought before the introduction of new technologies, they are merely informed via the nurse managers (whose input is also not sought) that implementation of new technologies is underway. The findings clearly show that nurses' work practices were not considered when DHTs were developed, and as such, training needs do not seem to be a priority, before or after implementation. Although nurses are not involved in the development of DHTs, they nevertheless use these DHTs and are happy with IT the support structures that are available.

Because DHTs are embedded in daily work practices, nurses have grown highly skilled and proficient in using DHTs, to the extent that they have credible ideas about how DHTs could be optimised to enhance their work. However, they are not afforded an opportunity to do so. This contributes to the design-reality gap as, in some instances, DHTs do not adequately support their work practices, which ultimately leads to frustration and as a result, workarounds are instituted. This indicates a clear gap with the DHT D&S where the nurses were not involved in the development that resulted in access and use issues where the implemented DHT is not well-aligned to the design and development.

6.4 Summary of research questions

A summary of the research questions, the sub-research questions associated objectives and respective answers appear in the following table.

Table 12: Summary of research questions and answers

Research Question 1 (RQ1): **How do nurses experience their work practices influenced by DHTs. This question is based on the lived experience of the nurse who uses DHT in the nursing care process when providing care to patients in a particular situation.**	
Sub-Questions	**Objective**
RSQ1: How are DHTs incorporated into nurses' work activities	To determine how DHTs influence nurses' work activities.
RSQ2: For what purposes are DHTs used by nurses?	To ascertain why nurses use DHTs.
RSQ3: What are the perceptions and experiences of nurses in the use of DHTs?	To determine how nurses perceive and experience the use of DHTs in practice.
RESEARCH QUESTION 1 ANSWERED: *The findings indicate that DHTs have been fully incorporated/embedded into their daily work activities as patient care is optimised. As end users, nurses have found DHTs relevant to their work practices and compatible with their existing work practices. It was found that, through the use of technology, the nurses' tasks have become easier, and more time-efficient, and, as a result, nursing quality is improved. Nurses positively appreciate the DHTs, and this is evident in their desire to learn new technology, not only to optimise patient care but to augment their knowledge and skill. The findings further indicate positive perceptions from nurses to the extent that they cannot do their work without DHTs and this is substantiated by their desire to learn new technology, not only to optimize patient care but to augment their knowledge and skill.*	
ch Question 2 (RQ 2): **Why is there a misalignment between the intended use of DHTs and the Lived Experience of nurses using DHTs in practice? This question is based on the Lived experience of nurses in terms of their involvement in the development and support processes versus the use of DHTs**	
Sub-Questions	**Objective**
RSQ1: What was the level of involvement of nurses in the design, development and implementation process of DHTs?	To identify nurses' level of involvement in the design and implementation of DHTs.

RSQ2: How were nurses' work practices, as part of their lived experience, considered during the design and implementation of DHTs?	To ascertain the extent to which nurses were considered in the design and implementation of DHTs.
RSQ3: What are the dynamic elements of the DHT-integrated work practices of nurses that contribute to the design-reality gap between implemented DHTs and the nurses' lived experience of using DHTs?	To evaluate the elements that contribute to the design-reality gap between the intended use of DHTs and the work practices of nurses.
RESEARCH QUESTION 2 ANSWERED: *The findings indicate that nurses' input is not sought before the introduction of new technologies, they are merely informed by the nurse managers (whose input is also not sought) that the implementation of new technologies is underway. The findings clearly show that nurses' work practices were not considered when DHTs were developed, and as such, training needs do not seem to be a priority, before and after implementation. Although nurses are not involved in the development of DHTs, they nevertheless use these DHTs and are happy with IT and the support structures that are available to them.* *Based on the fact that DHTs are embedded into daily work practices, nurses have become highly skilled and proficient in using DHTs, to the extent that they have credible ideas about how DHTs could be optimised to enhance their work. However, they are not afforded an opportunity to do so. This contributes to the design-reality gap as, in some instances, DHTs do not adequately support their work practices, which ultimately leads to frustration, and as a result, workarounds are instituted. This would indicate a clear gap with the DHT D&S where the nurses were not involved in the development, resulting in access and use issues where the implemented DHT is not well-aligned with the design and development.*	

6.5 Evaluating interpretive research

According to the literature, the interpretive research has gained popularity in the field of information system (IS)-related research (Cardoso & Ramos, 2012). Klein and Myers (1999) propose a set of principles for conducting and evaluating interpretive research that provide fair and appropriate criteria for assessing the validity and reliability of IS such studies. The respective principles and how they relate to this study are discussed below.

The Fundamental Principle of the Hermeneutic Circle: According to this principle, all human understanding is achieved by iterating (repeating) between considering the interdependent meaning of parts and the whole that they form. In other words, our understanding of a text as a whole is based on our understanding of each individual part, including our understanding of how each individual part refers to the whole or entire text. The answers in the form of codes represent the individual parts of the responses that were then combined into the categories and eventual themes to represent the whole. In each case, the evidence supporting the coding and categorising processes allow others to follow the logic of how insights were gained. The researcher started the process with a vague notion of what the meaning could be that was enhanced by relevant

literature to eventually find meaning by considering the concepts in a real-life situation. This represents an iterative recontextualising process.

The Principle of Contextualisation: This refers to the need for a critical reflection of the social and historical background of the research setting to ensure that the intended audience can see how the current situation under investigation came about. When the researcher conducted a review of the literature, it was important to look at the status of healthcare on a global scale, in sub-Saharan Africa, in South Africa, and subsequently in the Western Cape, where this study was conducted. Furthermore, it was vital to have an understanding of the historical and societal context and factors that contribute to inequities in healthcare, particularly in middle-to-lower income countries. With this background understanding, the researcher was prepared to consider the participants' lived experiences in real-life situations.

The Principle of Interaction Between the Researchers and the Subjects: This refers to the need for critical reflection pertaining to the research materials (or "data") that were socially constructed through the interaction between the researchers and participants, in other words, the process is undertaken to identify and recruit participants and subsequently entering the field to collect data. After ethical clearance was obtained, the researcher prepared to enter the field by setting up appointments with the two hospitals to recruit nurses who met the criteria for this study. This is discussed under 4.3.4 and 4.3.5, respectively. The researcher, through her preparation and presence, was able to earn the trust of the participants to allow them to freely share their own lived experiences.

The Principle of Abstraction and Generalisation: This refers to the unique details revealed by the data interpretation through the application of the fundamental principle of the hermeneutic circle and the principle of contextualisation and two to theoretical, general concepts that describe the nature of human understanding and social action. Using the existing body of knowledge about the topic provided the researcher with generalised and abstract knowledge to use to guide the data collection and analysis. The situated-in-practice data were then used in a theorising process to derive the abstract findings that could be applied to general practice as opposed to the local practices of the demonstration cases.

The Principle of Dialogical Reasoning: This refers to the possibility of contradictions between the theoretical preconceptions guiding the research design and actual findings where subsequent cycles of revision may be required. Using two theoretical lenses provides an opportunity to derive

two sets of findings that were then combined to consider similarities and differences. In the discussion, the findings were compared to the literature findings to derive concluding meanings.

The Principle of Multiple Interpretations: This refers to possible differences in interpretations among the participants where there are multiple narratives or stories of the same sequence of events under study. The interview questions for this study were open-ended and participants were free to recount their individual experiences in terms of how they experience DHTs in practice. Data were collected until saturation was reached, in other words, when no new information was forthcoming. The participants interpreted the interview questions by relating these to the actual lived experience and based their answers on their own interpretations.

The Principle of Suspicion: This refers to being sensitive to potential "biases" and systematic "distortions" in the narratives collected from the participants. The researcher endeavoured to stick to the interview questions, and where participants deviated, the researcher gently nudged them to return to the questions being posed (Klein & Myers, 1999).

A review conducted by Yadaf (2022:684) presents a series of evaluative guidelines to assist qualitative researchers in identifying some of the essential indicators of high-quality qualitative research. The author presents what he terms ‘‘Eight big-Tent criteria for excellent qualitative research’’. Originally crafted by Tracy (2010), Yadaf (2022) present eight criteria of qualitative quality and posit that each criteria may be achieved through a variety of flexible craft skills, which would be dependent on the goals of the study as well as the preferences or skills of the researcher.

According to the authors, qualitative methodological research is deemed to be of a high quality if it has the following characteristics: (a) worthy topic, (b) rich rigor, (c) sincerity, (d) credibility, (e) resonance, (f) significant contribution, (g) ethics, and (h) meaningful coherence. A few of these characteristics as they relate to this study, are explained hereunder.

A topic is considered worthy if it is relevant, timely, significant and interesting. The title of this dissertation: “The alignment between nurses’ clinical work activities and their lived experiences of using digital health technologies (DHTs) in practice” fulfils this criteria because it is relevant to the healthcare sector and of significance to the participants of this study, namely, the nurses, as it highlights their lived experiences of using DHTs in practice.

High-quality qualitative research is characterised by a rich complexity of abundance—in contrast to quantitative research where the focus is on precision. This study adopted a phenomenological

approach which aimed to develop a complete, accurate and clear description and understanding of a particular human experience by providing a rich, thick and complete description of human experiences and meanings.

Rigor also refers to the care taken with data collection and analysis processes. Qualitative analysis is heavily dependent on the researcher's analytic, integrative skills and personal knowledge of the social context where data are collected. As this study was interpretive and qualitative in nature, pattern matching and explanation building were considered to be the most suitable methods of analysing the vast amount of data that was collected through the in-depth interviews with nurses, nurse managers and other stakeholders at the public hospitals. In addition, the researcher used the NPT to organise the data according to the constructs of the theory.

Credibility refers to the trustworthiness and plausibility of the research findings. Research is characterised by thick descriptions and member reflections. By providing a rich, thick and complete description of human experiences and meanings, the researcher was able to develop a complete, accurate and clear description and understanding of the lived experiences of nurses as they experience DHTs in practice.

Ethics in qualitative research, include procedural (involving human subjects), situational and cultural ethics, and exiting ethics (refers to leaving the scene and sharing the research). Ethical issues were considered throughout the course of this research project, and ethical clearance was obtained from the CPUT Faculty of Health and Wellness Ethics Committee, as well as from the CPUT Faculty of Informatics and Design Ethics Committee. Furthermore, ethics clearance had to be obtained from the Department of Health and from the two hospitals where data were collected. In addition, a covering letter accompanied the instrument which explained the purpose of the research and the concomitant data.

Significant contribution refers to the extent to which the contribution provides a significant theoretical, methodological or practical contribution. The theoretical, methodological and practical contributions are discussed under 6.6.3.

6.6 Reflection on research

A challenging part of this journey was the tedious process of obtaining ethical clearance. The researcher first had to apply for clearance via the Faculty of Health and Wellness, thereafter from the Faculty of Informatics and Design (where the researcher is registered), thereafter from the Department of Health, and then subsequently from the two hospitals where data were collected.

As stated in 4.3.7, this process started early in 2017, and the researcher had applied for sabbatical leave from February to December 2017 to collect the data and subsequently complete the study. As a result, because of the various processes that had to be undertaken to obtain the necessary ethical clearance and permission, subsequent permission to conduct research at Hospitals A and B was only obtained in August 2017 and September 2017, respectively. During this time, the research continued to explore the literature and write various chapters of the thesis.

The researcher suffered a bereavement in January 2018, which impacted the data collection process, which was placed on hold for two months. Due to personal circumstances, the researcher subsequently applied for an interruption of study for 2018 and resumed again in 2019. Furthermore, the researcher was close to completion when she was dramatically affected by the loss of a child to the Covid-19 pandemic in 2021. As a result, completion of the study had to be shifted from August 2021 to March 2022. This was the most difficult challenge; however, the researcher was determined and motivated to complete the study.

Further challenges include the difficulty in securing interviews with nurses, due to their very busy work schedules. It sometimes took several attempts and several visits to the ICU and Emergency Unit to finally set up an appointment for an interview. An important lesson which the researcher had to learn was to exercise extreme patience when pre-arranged interviews were cancelled at the last minute due to unforeseen circumstances or emergencies in the ICU or Emergency Unit or being evicted from the Emergency Unit in an unceremonious manner due to a resuscitation being performed. A further challenge was having to work in isolation due to the lockdown measures imposed as a result of the Covid-19 pandemic. It was extremely difficult to remain focused in the absence of interaction and motivation from peers. However, because the researcher was determined to complete the thesis, she persevered.

There were notable highlights. For example, the researcher was well received at both hospitals and nurses were keen to share their experiences in the hope that some of the technological barriers they experience will be resolved based on the outcome and recommendations of the study. Through this journey, the researcher has developed a keen interest in the field of IS which she hopes to pursue in future.

6.7 Contributions

The knowledge contribution of this study is the use of the theories, lived experience, interpretive phenomenology and normalised process theory as theoretical lenses to guide the data collection

and analysis based on the in-situ lived experience of nurses in public hospitals. The theorising process was based on analysing the situational empirical data of nursing care practices in a real-life situation. It contributes to the knowledge of using the results of both the interpretive phenomenology analysis and normalised process analysis to gain deeper insights in the lived experiences of nurses using digital health technologies in practice from their introduction to the level of them enabling routine work. Although there is existing knowledge about the design and the reality gap of health technologies, the contribution is that it has not yet been studied from a lived experience perspective.

This study has made a theoretical, methodological, and practical distribution which are discussed hereunder.

6.7.1 Theoretical Contribution

The knowledge contribution of this study is the use of the theories, lived experience, interpretive phenomenology, and normalised process theory, as theoretical lenses to guide the data collection and analysis based on the in-situ lived experience of nurses in public hospitals. The theorizing process was based on analysing the situational empirical data of nursing care practices in a real-life situation. It contributes the knowledge of using the results of both the interpretive phenomenology analysis and normalized process analysis to gain deeper insights into the lived experiences of nurses using digital health technologies in practice from their introduction to the level of enabling routine work.

To better understand the data collected from the interviews, the contribution is the fact that two thematic analyses were conducted from a social sciences perspective, and another analysis using the normalization process theory as an analytical lens. The theoretical concepts and the conceptual framework for this study guided the data collection, based on the literature review that was conducted. In this manner, the researcher was able to remain focused and aligned without deviating from the thematic concepts.

This study made a significant theoretical contribution in the sphere of Health Sciences, to understanding how DHTs are used and the findings may assist to inform future research and policymaking in this area. Whilst the study has found that DHTs can play a valuable role in complex environments, such as public hospitals in South Africa, the study also identified some challenges associated therewith. These include a need for clear guidelines and organizational structures, which would also include adequate training and support for users.

The design-reality gap is a major challenge for health technology developers, and an important aspect to consider when designing new technologies. The results of this study have highlighted a clear gap in the DHT design and support where the nurses were not involved in the development. This resulted in access and use issues where the implemented DHT is not well-aligned with the design and development. Although there is existing knowledge about the design-reality gap of health technologies, the contribution is that it has not yet been studied from a lived experience perspective.

6.1.2 Methodological contribution

The methodological contribution of this study was evident in the use of interpretive phenomenological analysis of the collected data and its subsequent outcome in the descriptive analysis within the context of public healthcare as discussed in chapter five. Furthermore, this study contributes on a methodological level since the researcher collected data in a high-intensity environment, namely, two public hospitals which are highly complex, given the inequalities between private and public hospitals. Furthermore, this study was carried out in an ICU and Emergency Center in public hospitals, which are highly charged, pressurized environments. As a result, collecting data was challenging, given their very busy schedules. Whilst the observation technique helped the researcher get a sense of the environment of the nurses' lived experience and how they behave in the workplace, an important aspect was getting to know the participants and building a relationship with them. The researcher, therefore, had to enter the field very humbly and immerse herself in the environment to gain the trust of the participants. This was essential to get accurate and honest information from them. The researcher also had to be very patient and respectful to build a good rapport. This was just as much the researcher’s lived experience as well as that of the participants. This factor had an impact on how the participants reacted and responded. The researcher’s own experiences also shaped her understanding of the participants’ experiences. In essence, the researcher’s lived experience had a profound impact on the research itself.

6.1.3 Practical contribution

The practical contribution of this study is the identification of the needs and roles of nurses in the design and development processes of digital health technologies, the need for them to be involved during the design of new technologies; their training needs; and to capitalise on their willingness

to adapt their practices with the incorporation of new technologies in their nursing practices for these to become part of their routine work.

Nurses are at the front of healthcare, and their work is essential to keep patients safe and healthy. However, their work is also demanding and stressful. From a social and behavioral sciences perspective, it is imperative to understand nurses' lived experiences in practice. This includes understanding the challenges they face, the stressors they encounter, and how they cope with the demands of their work. By understanding the lived experiences of nurses, management can support them in their work and ensure that they can provide the best possible care for their patients. Therefore, rather than teaching nurses to use technology, it is more important to understand their lived experiences and how technology can become part of their routine work as enabling their practices. This understanding can help inform the development of new technologies and how they can be used to improve patient care. In addition, by understanding the lived experiences of nurses, or rather, by operationalizing lived experience, mechanisms can be put in place whereby they can be supported in their work.

Furthermore, developers need to involve end users as they are experts in their practices. By involving end users in the design and development process, developers can gain a better understanding of the users' needs and how they can use the DHTs. This understanding can further help developers to create technologies that are more user-friendly and efficient. Furthermore, involving end users in the design and development process can help to build a sense of ownership and buy-in for proposed new developments.

The inclusion of nurses as end users, therefore, holds the potential to save time and costs in facilitating training at the pre-and post-implementation stages. Having nurses on board from the outset would ensure that the DHTs are designed with their needs in mind, which in turn would lead to a smoother and more efficient rollout of DHTs and ultimately result in cost savings.

6.8 Further research

An important finding is that whilst the NPT provides a conceptual framework that explains the processes whereby new health technologies and other complex interventions can be routinely embedded or operationalised into everyday work, and subsequently sustained in practice, the constructs only focus on the implementation of new health technologies, and not on the design and development thereof.

The findings of this study further emphasised the need for nurses to be involved in the decision-making process of designing and developing new interventions. There is a need for further research to establish why the NPT only focuses on the implementation of new interventions and to provide guidelines on how the constructs could be redefined to consider this aspect. Involving nurses in the design and implementation processes would be highly beneficial to guide future development of DHTs to ensure greater alignment thereof with their work activities; hence, further research is recommended.

The findings of this study uncovered several barriers which hampers participants' ability to sustain nurses' involvement in the use of DHTs. It is recommended that further interpretive, phenomenological studies on the involvement of nurses in the design and development process be conducted to mitigate the gap that exists between intended use of DHTs and actual use thereof.

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APPENDIX/APPENDICES

APPENDIX A – ETHICS CERTIFICATE

APPENDIX B – PERMISSION LETTER

Western Cape Government
Health

STRATEGY & HEALTH SUPPORT
Health.Research@westerncape.gov.za
tel: +27 21 483 6857; fax: +27 21 483 9895
5th Floor, Norton Rose House,, 8 Riebeek Street, Cape Town, 8001
www.capegateway.gov.za

REFERENCE: WC_2017RP54_482
ENQUIRIES: Ms Charlene Roderick

Cape Peninsula University of Technology

Keizersgracht and. Tennant Street

Zonnebloem

Cape Town

8000

For attention: Mrs Faeda Mohsam, Prof Retha de la Harpe

Re: **The alignment between the nurses' clinical work activities and their lived experiences of using HITs in practice.**

Thank you for submitting your proposal to undertake the above-mentioned study. We are pleased to inform you that the department has granted you approval for your research.

Please contact following people to assist you with any further enquiries in accessing the following sites:

Mitchells Plain Hospital	**Mr Hans Human**	**021 377 4306**

Kindly ensure that the following are adhered to:

1. Arrangements can be made with managers, providing that normal activities at requested facilities are not interrupted.
2. Researchers, in accessing provincial health facilities, are expressing consent to provide the department with an electronic copy of the final feedback (**annexure 9**) within six months of completion of research. This can be submitted to the provincial Research Co-ordinator (Health.Research@westerncape.gov.za).

APPENDIX C – INFORMED CONSENT

INFORMED CONSENT FORM

LEAD RESEARCHER: FAEDA MOHSAM

BACKGROUND OF RESEARCH: In the healthcare field, technology innovations have been introduced which are referred to as health information technologies (HITs). Owing to the increasing use of technology in the healthcare sector, there is a growing need for nurses to incorporate the use of HITs into their routine clinical work processes. Hence, nurses' acceptance of HITs and lived experiences play a significant role in the public healthcare institutions. Studies have suggested that well-implemented healthcare information technologies (HITs) can greatly enhance the nursing workflow which will lead to quality of patient care in public healthcare institutions. However, a number of studies have indicated that if the HITs did not support the workflow of end-users, it would not be used properly or efficiently. It is therefore imperative for nurse end-users to be involved in any on-going development and evaluation of HITs. Yet, the supposed best design and conditions to enable the seamless use of HITs remain challenging. Consequently, there is little research available regarding how the use of HITs affect the work of nurses once they are implemented.

This research looks at the alignment between the nurses' clinical work activities and their lived experiences of using HITs in practice in public hospitals in Western Cape.

(explain the background, context and relevance of the research)

PROCEDURES OF THIS STUDY: It is entirely **voluntary** for you to take part in the study. During the study, the researcher will interview you individually to better understand your lived experiences of using HITs as part of your everyday clinical work activities at your respective hospital. Some of you may be asked to participate in a second interview to comment particular issues or patterns that may arise. Being interviewed once does not obligate you to take part in any later interviews. In addition to the interviews, the researcher learns about your lived experience by observing the collection, use and reporting of information using HITs, as well as analysing documents. The interviews will be recorded and transcribed (typed on paper afterwards). You will be able to receive a paper copy of your transcribed interview if you want to.

The study is not interested in patient data itself but its collection, use and reporting using HITs.

Participating in the research does not pose any physical or psychological stress to the participants

according to the researcher's knowledge.

PUBLICATION: The researcher aims to share the knowledge that the research will produce. This means that she will, in addition to the Dissertation, try to publish one or more article(s), report(s) or other documents about the results in international and/or local scientific publications or give presentations in appropriate events and/or seminars. 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 quotes will be reported anonymously or under pseudonym concerning your profession (for example Nurse X, Administrator X). Similarly, we wish you not to mention anybody (co-workers, patients) by name. Such replies will be also anonymised. 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 current researchers/research team.
- 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.
- 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 give my consent to be observed.
- 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 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 has freely given informed consent.

RESEARCHERS CONTACT DETAILS:

Ms. Faeda Mohsam

Tel: 074 101 1978

Email: mohsamf@cput.ac.za

INVESTIGATOR'S SIGNATURE:

DATE:

APPENDIX D: INTERVIEW GUIDE

INTERVIEW QUESTIONS

Biographical Data

Name: _____

No. of years employed as a nurse: _____

Name of hospital employed at: _____

Highest qualification: _____

Research Question 1

How do nurses make sense of their work practices as the HITs influence their lived experience of using HITs?

Sub-questions

How are HITs incorporated into nurses' daily work practices?

For what purpose are HITs used by nurses?

What are the perceptions and experiences of nurses in the use of HITs?

1. Which information technologies are being used? What are the names of these technologies?
2. What are they used for in general?
3. What are nursing work activities? [Provide a breakdown of what each activity entails]
4. How does work activities relate to one another?
5. How does work activities fit into overall clinical care?
6. What are the features of the current system? What are they used for specifically?

7. How do you use HITs for your own work activities?
8. Are you prepared to invest time and energy into learning a new technology? If yes, state why.
9. What sort of information is captured on these technologies?
10. How relevant is the information to nursing activities and providing care for patients?
11. Why are these technologies being used?
12. How were nurses activities carried out before the introduction of HITs?

Research Question 2

What is the level of alignment between the intended use of HITs and the lived experience of nurses using HITs in practice?

Sub-questions

How are the different stakeholders involved in the design and implementation of HITs?

What was the level of involvement of nurses in the design, development and implementation process of HITs?

How are the nurses' work practices, as part of their lived experience, considered during the design and implementation of HITs?

What are the dynamic elements of the HIT-integrated work practices of nurses that contribute towards the design-reality gap between implemented HITs and nurses' lived experience of using HITs?

1. Describe how the HITs were introduced. Describe the process.
2. How do these HITs assist/facilitate their work activities?
3. What is the general feeling amongst the nurses about the use of HITs? [What is the technology mostly used for by nurses]
4. Did you need extensive training to use the HITs? Were your training needs assessed beforehand?
5. What are your perceptions/experiences with the use of these technologies for your work activities?
6. What type of IT support is available to nurses?
7. Do you use HITs to communicate with other clinical departments? Please explain how.
8. How compatible is it with existing work practices?

9. What impact does these new technologies have on division of labour, resources, power, and responsibility between different professional groups?
10. How do users perceive the HITs after it has been in use for a while?
11. Can users/staff contribute feedback about the HITs once it is in use?
12. Can the HITs be adapted or improved on the basis of users' experience?

APPENDIX E – CERTIFICATE OF AUTHENTICATION

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ChickPeaEnglish@gmail.com
ChickPea Proofreading & Editing

49A York Close, Parklands, 7441
Western Cape, South Africa

Certificate of Authenticity

CERTIFICATE: COA131222RDLH: Faeda Mohsam

17 December 2022

To Whom It May Concern

This is to certify that "**ALIGNMENT BETWEEN NURSES' CLINICAL WORK ACTIVITIES AND THEIR LIVED EXPERIENCES OF USING DIGITAL HEALTH TECHNOLOGIES (DHTs) IN PRACTICE**" by **Faeda Mohsam** for the Faculty of Informatics and Design at the Cape Peninsula University of Technology (CPUT), under the supervision of Dr Retha de la Harpe, has been professionally edited by Dr. Laura Budler Kleinhans of ChickPea Proofreading and Editing Services for Students and Professionals.

Job Number	Document Title
0131222RDLH	ALIGNMENT BETWEEN NURSES' CLINICAL WORK ACTIVITIES AND THEIR LIVED EXPERIENCES OF USING DIGITAL HEALTH TECHNOLOGIES (DHTs) IN PRACTICE

Dr. Laura Budler Kleinhans
CEO ChickPea Proofreading & Editing

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