THE IMPACT OF DIGITAL TECHNOLOGY ON HEALTHCARE FACILITIES IN A SOUTH AFRICAN EASTERN CAPE RURAL ENVIRONMENT

by

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DECLARATION

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ABSTRACT

Digital technology (DT) is transforming the healthcare industry, offering solutions to enhance access, efficiency, and patient outcomes. DT has the potential to bridge longstanding challenges in healthcare facilities in rural areas. Despite its growing adoption, there is limited research on how DT is impacting healthcare facilities in rural areas of South Africa, particularly in the Eastern Cape. This study explores the impact of DT on healthcare facilities in a rural environment in the Eastern Cape, South Africa. A dual-strategy methodology that combines a systematic literature review (SLR) and empirical data collection was used. The SLR is guided by inductive reasoning, while the empirical component is guided by deductive and inductive reasoning. This study employed a qualitative method. Studies for the SLR were sourced globally between 2020 and 2024, with 55 studies meeting the inclusion criteria. The empirical component involved interviews at four rural case study sites, engaging 19 participants in various roles within rural healthcare facilities. The qualitative data were analysed thematically using ATLAS.ti v9. The findings revealed that several digital technologies are in place in rural healthcare, such as eHealth, mHealth, Telehealth, and Telemedicine platforms. Additionally, the study found context-specific digital tools such as the District Health Information System, Human Management System 2, e-Tick register, Health Patient Registration System, and Lab Trak, amongst others. Moreover, the study uncovered operational challenges such as system backlogs, and potential data duplication and loss, all linked to poor internet connectivity. Furthermore, the study identified that unstable internet connections and power cut-offs are major challenges to effective adoption in rural healthcare. Importantly, a novel theme, ‘Digital health enablers’ (DHEs), emerged from the empirical data. These DHEs encompass both infrastructure-based solutions and informal practices to support the adoption of DT in rural healthcare facilities. This study contributes theoretically to the existing body of knowledge by identifying facility-level enablers and demonstrating how connectivity reliability interacts with staff capabilities in rural healthcare. Additionally, the study extends the existing digital health framework by incorporating DHEs such as solar power, UPS, facility-based fibre and W-Fi connectivity, and backup generators. Methodologically, the study contributes through a dual-strategy that integrates an SLR with multiple case studies in rural health, providing a replicable approach for similar infrastructure-constrained contexts. Finally, this study offers evidence-based guidance for policymakers on strengthening DT adoption in rural healthcare facilities through targeted investments in connectivity, infrastructure, and capacity-building.

Keywords: Digitisation, digital technology, digital health technology, eHealth, mHealth, rural healthcare, systematic literature review, telehealth, telemedicine.

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DEDICATION

I dedicate this thesis to my mother, Nobahle Jim, my husband, Sakhele Ngesimani, and my son, Liyabusa Ngesimani. It was my heart's desire to make my family proud, and with this mindset, I persevered until I reached the goal of my research journey.

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ABBREVIATIONS AND ACRONYMS

Abbreviations	Definitions
AI	Artificial Intelligence
AIES	AI-based Emergency Service
AIPS	AI-based Patient Support System
ARVs	Antiretroviral drugs
CCMDD	Central Chronic Medicine Dispensing and Distribution
COVID-19	Coronavirus Disease of 2019
CPUT	Cape Peninsula University of Technology
EC	Eastern Cape
EHRs	Electronic Health Records
e-Tick	Electronic-Tick
DHE	Digital Health Enabler
DHIS2	District Health Information System version 2
DHS	District Health System
DHCF	Digital Health Framework
DIT	Diffusion of Innovation Theory
DoH	Department of Health
DTT	Digital Technology and transformation
eHealth	Electronic Heath
EHRs	Electronic Health Records
EST	Ecological Systems Theory
HBM	Health Belief Model
HF	Human Factors
NHI	National Health Institute
HIE	Health Information Exchange
HIV	Human Immunodeficiency Virus
HMS2	Health Management System version 2
HPRS	Health Patient Registration System
ICT	Information and Communication Technology
IHSR	Institute for Health Systems Research
IPR	Interview Protocol Refinement
ISP	IntelliSpace Perinatal
IT	Information Technology
LOGIS	Logistical Information System
mHealth	Mobile Health
MRQ	Main Research Question

Abbreviations	Definitions
NHLS-Lab trak	National Health Laboratory Services – Lab trak
OHSC	Office of Health Standards Compliance
PB	Perceived Benefits
PC	Perceived Challenges
PERSAL	Personnel and Salary
POPIA	Protection of Personal Information Act
PP	Processes and Patterns
RO	Research Objective
SA	South Africa
SCT	Social Cognitive Theory
SMS	Short Message Service
SNP	Socially-driven Mobile Healthcare
RO	Research Objective
SLR	Systematic Literature Review
TAM	Technology Acceptance Model
TB	Tuberculosis
TIER.Net	Three Interlinked Electronic Registers.Net
UPS	Uninterruptible Power Supply
VC	Video Conferencing
Wi-Fi	Wireless Fidelity

CHAPTER 1: INTRODUCTION

1.1 Introduction and background

The urgent need for healthcare treatment and prevention during the 2019 COVID-19 pandemic has led to increased deployment of digital technology (DT) in rural areas (Abdolkhani et al., 2022). This global paradigm shift in many healthcare systems has created unusual challenges and opportunities (Mbunge et al., 2022). The escalation in the use of DT in healthcare has attracted the attention of many researchers (Hassounah et al., 2020; Abdolkhani et al., 2022; Mbunge et al., 2022). However, there is limited knowledge in using a set of guidelines for digital technologies (DTs) in the healthcare space in South Africa (SA).

Therefore, this study explores the impact of DT on healthcare facilities in a South African Eastern Cape rural environment. This section serves as an introduction by first highlighting the background and context of the study. Section 1.1 sets the introduction and background of the study. Section 1.2 clarifies the key terms used in the study. Section 1.3 highlights the ethical considerations of the study. The significance and contribution of the study are highlighted in Section 1.4. Then, Section 1.5 focuses on the limitations and delimitations of the study. Section 1.6 highlights the thesis structure. Finally, Section 1.7 provides a summary of the study.

1.1.1 Background and context of the study

This study focuses on rural clinics and rural hospitals in the Eastern Cape province of South Africa. These healthcare facilities form the backbone of delivering healthcare services in rural areas. According to Kraemer-Mbula et al. (2015), rural health systems are typically built around the needs of their users. They argue that rural clinics are the centre of the formal health system in rural areas and tend to be closer to rural communities, making them easier for users to access. At the same time, rural hospitals remain important local healthcare centres, usually with qualified professionals, medical equipment, and medical supplies available.

The healthcare industry is identified as one of the biggest industries of the economy in many countries (Tian et al., 2019). The healthcare sector is divided into public and private sectors (Young, 2016). The public healthcare sector comprises primary, secondary, and tertiary care practices (Young, 2016). The provincial department of health (DoH) manages the public healthcare. The South African public sector is organised according to nine provinces (Mahlathi & Dlamini, 2015) as follows: Gauteng (GP), Eastern Cape (EC), Free State (FS), KwaZulu-Natal (KZN), Limpopo (LP), Mpumalanga (MP), North West (NW), Northern Cape (NC), and Western Cape (WC). People may contact the public and private health services. However, contact with private health facilities depends on affordability. Patients contact healthcare facilities via the District Health System (DHS) (Barron & Asia, 2001), which ideally delivers

primary healthcare (Mahlathi & Dlamini, 2015).

The study focuses on the rural areas of the Eastern Cape (EC). The EC is situated on the east coast of South Africa (SA) (Ndayi & Gondje-Dacka, 2015). It is listed as the second-largest province in SA and has the third-largest population. Bhisho is the headquarters of the EC (Britannica Kids, 2026). The third-most populous province in South Africa is the Western Cape, with about 7.56 million people as of the 2024 mid-year estimates (Statistics SA, 2024). Cradock, Graaf-Reinet, Makhanda, East London, Gqeberha, Port St Johns, and Umtata represent larger towns and cities. The EC is divided into six district municipalities: Alfred Nzo, Amathole, Chris Hani, Joe Gqabi, OR Tambo, and Sarah Baartman (Owolabi et al., 2019). The six district municipalities are further divided into 31 sub-district municipalities. Figure 1-1 illustrates the geographical location of the four case studies on the map of South Africa. This study is based in the Mnquma sub-district municipality.

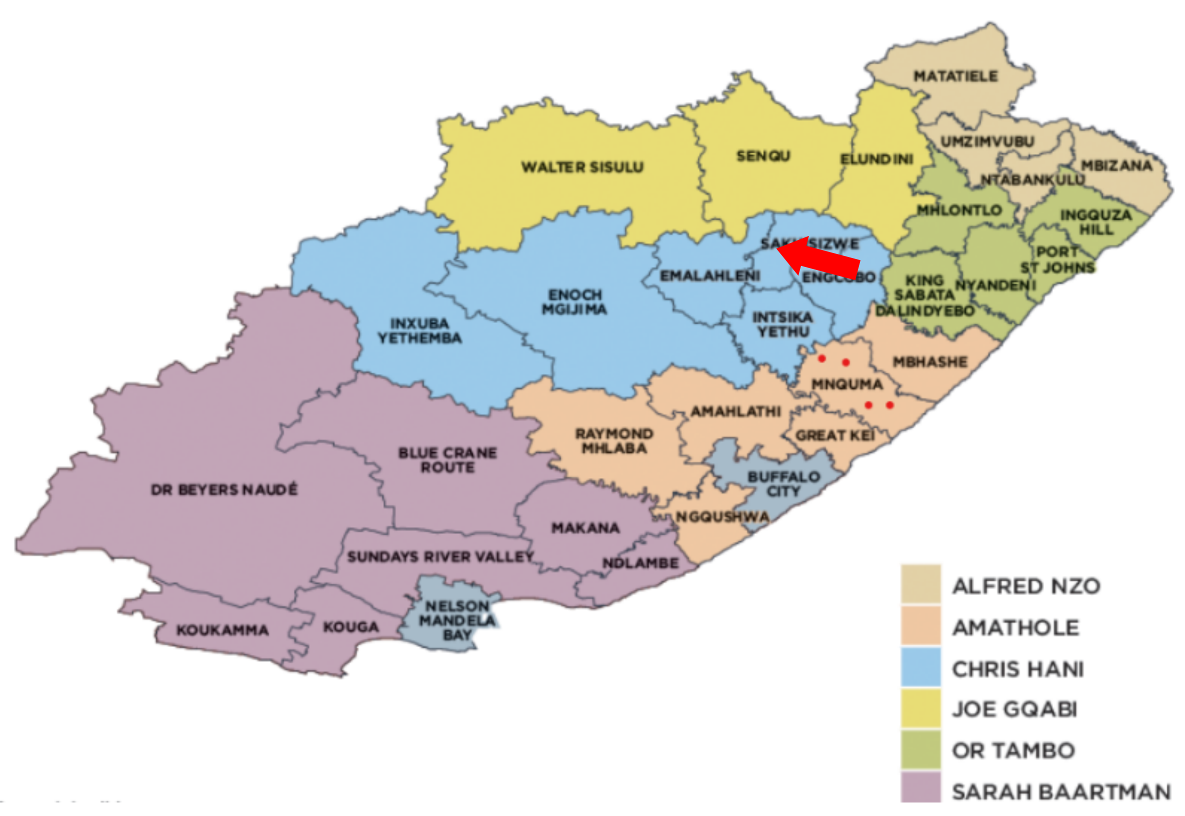


Figure 1-1: Geographical location of the four case studies in the Eastern Cape Province

Healthcare has undergone a paradigm shift, with increased use of DTs. Digital welfare has used terminologies like digital innovation, digital transformation, and DT, amongst others. This study focuses on DT. Aruleba and Jere (2022) indicate that previously, rural communities were isolated and had inadequate access to ICT infrastructure and services. They add that the inefficient use and lack of rural facilities and services are considered disadvantageous when

comparing rural and urban areas. The health demands in South African rural communities are high, and they are increasingly facing health problems (Kraemer-Mbula et al., 2015). In addition, rural hospitals in SA face critical limitations regarding equipment, qualified doctors, and resources. Aruleba and Jere (2022) comment that internet service is sometimes unavailable in rural areas. The authors add that due to such problems, the private sector and investors are not interested in rural projects.

1.1.2 Problem statement

Despite the growing adoption of digital technologies in rural areas, their success remains inconsistent and under-researched. There is a call for researchers to investigate the success levels of mobile health applications and DTs delivered and implemented in developing countries (Sharma & Kshetri, 2020). In South Africa, researchers such as Mbunge et al. (2022) emphasise the urgent need to address several critical areas. These include consolidating DTs within health systems to strengthen remote healthcare and building stronger community networks to bridge the digital divide in rural areas. Additionally, Mbunge et al. (2022) emphasise the importance of increased awareness that DTs can facilitate remote healthcare and of providing training for healthcare professionals.

Moreover, Hassounah et al. (2020) highlight a need for researchers to investigate and analyse successes and pitfalls in various sectors and among various stakeholders, including healthcare professionals (HCPs). This includes identifying the obstacles and challenges of the digital era for various sectors, staff, and consumers. Furthermore, Hélène et al. (2021) posit that additional interdisciplinary research is needed to improve understanding of differences in the use of DTs across countries.

In summary, these real-world global experiences highlight the need for a synthesised framework of guidelines to support quality-driven healthcare facilities that enable the successful use of DT (Harpur, 2018). Challenges such as ineffective delivery of digital health, network difficulties that cause intermittent internet connectivity, low digital literacy, and poor infrastructure can hinder the effective use of DT. These issues reveal how DT can hinder healthcare effectiveness, ultimately affecting the lives of rural healthcare patients. Without sufficient digital skills, funding, training, and understanding of digital health systems, healthcare may remain poor in rural communities. Additionally, healthcare professionals may be negatively affected if these digital challenges are not addressed in rural healthcare contexts. Moreover, if the problem is not addressed, the consequences of DT could negatively impact patients in these rural contexts. Furthermore, DT may negatively impact healthcare staff who are responsible for the services in the communities.

The Fourth Industrial Revolution (4IR) has significantly influenced many healthcare systems

worldwide. However, the body of knowledge remains scant on the impact of digital technology on healthcare facilities in a rural environment of the South African Eastern Cape. This gap in the literature highlights the need to explore the impact of digital technology on healthcare facilities in a South African Eastern Cape rural environment.

1.1.3 Aim of the study

This study comprises a dual-purpose strategy. The first strategy is to systematically collect relevant literature through a literature review. The second, empirically-based strategy applies the SLR outcomes to form the foundation of the exploratory case study design (Harpur, 2018). These theoretical and empirical strategies explore the impact of digital technology on healthcare facilities in a rural environment in the South Eastern Cape. Consequently, this study explores the impact of digital technology on healthcare facilities in a rural area of the Eastern Cape, South Africa.

1.1.4 Rationale

The study aims to inform and guide medical decision-makers and health professionals working in rural communities in South Africa on how healthcare facilities should adapt to make the best use of digital technologies to enhance the quality of their services. Furthermore, it highlights shortcomings in digitalisation by establishing an initial framework synthesised from SLR outcomes. These outcomes underpin emergent themes and further framework evolution achieved through a multiple-case, case-study strategy, the empirical component of the study.

1.1.5 Research questions and objectives

Two main research questions (MRQ1) guide the theoretical component of the study, and MRQ2 and five secondary questions (SQ 2.1, SQ 2.2, SQ 2.3, SQ 2.4 and SQ 2.5) guide the empirical component of the study. The five SQs address the second main research question, while the first relates primarily to the outcomes of a planned systematic literature review (SLR), establishing a theoretical foundation for the study. Table 1-1 shows the correlation between this study's research questions (RQs) and research objectives (ROs).

Table 1-1: Relationship between research questions and objectives

Research Questions	Research Objectives
MRQ1: What is known about the role of digital technologies in healthcare contexts in rural communities?	
MRQ2: How does digital technology impact healthcare facilities in rural communities in South Africa?	
SQ 2.1: What digital technologies are currently in place in healthcare facilities?	**RO 2.1:** To explore digital technologies currently in place in healthcare facilities.
SQ 2.2: What is the significance of digital technology in healthcare facilities?	**RO 2.2:** To examine the significance of digital technology in healthcare facilities.
SQ 2.3: What challenges emerge when adopting digital technology?	**RO 2.3:** To investigate challenges that emerge when adopting digital technology.
SQ 2.4: What strategies contribute to the successful adoption of digital technology?	**RO 2.4:** To gain information about the success of the adoption of digital technology.
SQ 2.5: What is the nature of the impact of adopting digital technology in rural communities?	**RO 2.5:** To explore the nature of the impact of adopting digital technology in rural communities.

Note: MRQ = Main research question; SQ = Secondary question; RO = Research objective

The RQs and ROs tabulated in Table 1-1 concretise the essence of the study. They additionally guide the research design and methods outlined in Chapter 3. The research questions provide components that led towards a framework for digitalising healthcare in rural communities.

1.1.6 Scope of the research

The study collects data through an SLR of existing literature and four case studies. The four case studies include one hospital, one Community Health Centre (CHC), and two clinics in the rural areas of the Eastern Cape province of South Africa. This selection is based on a purposively selected set of case studies convenient to the researcher's situation and the study's context. This selection considered the rural areas of the Eastern Cape. It indicates the exclusion of hospitals, Community Health Centres, and clinics in urban areas of South Africa. Furthermore, the sample excluded data collection from patients and technology suppliers.

1.2 Clarification of the key terms

- **Digital technology:** Digital technology involves the use of advanced information and communication technology (ICT) to collect, store, analyse, and distribute information (Yu et al., 2022).
- **Healthcare facilities:** Healthcare facilities are places where medical services are delivered. These include clinics, hospitals, outpatient centres, and specialised institutions like maternity units and mental health centres.
- **Rural areas:** Based on the 2020 census and the updated classification released in 2022, rural areas consist of open land and communities with fewer than 2,000 housing units and 5,000 inhabitants.

1.3 Ethical considerations

The researcher followed ethical guidelines during the study by upholding truthfulness and reliability (Mack et al., 2005). For ethical clearance, the study adhered to the guidelines provided by the Research Ethics Committee of the Cape Peninsula University of Technology (CPUT). The researcher received a pre-approval letter from the Eastern Cape Department of Health. After the defence, the researcher received the final approval letter to conduct research on healthcare facilities. Among other ethical measures taken to protect the participants and the purpose of the research, the participants were informed about guaranteed confidentiality and the right of withdrawal from the study. Furthermore, the researcher ensured that all interviews were kept confidential and private per the Protection of Personal Information Act (POPIA) regulations (De Bruyn, 2014).

1.4 Significance and contribution of the study

This study fills important knowledge gaps in understanding how the adoption of DT impacts rural communities in the Eastern Cape province. Additionally, the study addresses the divide between theory and practice by providing a detailed framework for understanding the adoption of DT in healthcare facilities in rural areas. This study contributes to the body of knowledge in several ways. First, it extends the existing digital health framework in Section 2.2.7 by incorporating digital health enablers (DHEs), such as solar power, UPS systems, fibre connectivity, and backup generators. Second, this study provides a deeper understanding of operational issues, demonstrating how perceived challenges, such as unstable internet connectivity, can lead to data duplication and backlog. The emphasis on infrastructure enablers highlights the foundational needs for successful digital heath adoption in rural healthcare. Third, the study identified a phased adoption process, decision-making workflows, and referral patterns. These findings add nuance to existing models of digital transformation, which often overlook the operational realities of rural healthcare communities. Fourth, the study offers actionable insights for policymakers, HCPs, and technology developers. Fifth, the study grounds its insights in empirical evidence from the rural healthcare facilities in the Eastern Cape province. This improves the applicability and relevance of digital health theories for policy, practice, and future research. Additionally, the study underscores the need for user-centric approaches. In particular, this is relevant for addressing digital literacy gaps, age-related differences in technology use, and varying user perceptions. Altogether, these contributions fill notable gaps in the literature and demonstrate both the theoretical and practical significance of the study.

1.5 Limitations and delimitations

The SLR underpinning the study forms the theoretical foundation for the study. A data

collection strategy guiding the literature review included reputable and pertinent sources published between 2020 and 2024. This study is limited to a small sample size, which may not fully capture the diverse experiences of healthcare professionals in rural communities of the Eastern Cape in South Africa under the local municipality of Mnquma. The focus on four case studies affects the generalisability of the findings to other contexts. Furthermore, only nineteen participants participated in semi-structured interviews for this study.

1.6 Thesis structure

This section outlines the thesis chapters and includes an illustrative diagram in Figure 1-2 to reflect their interconnections.

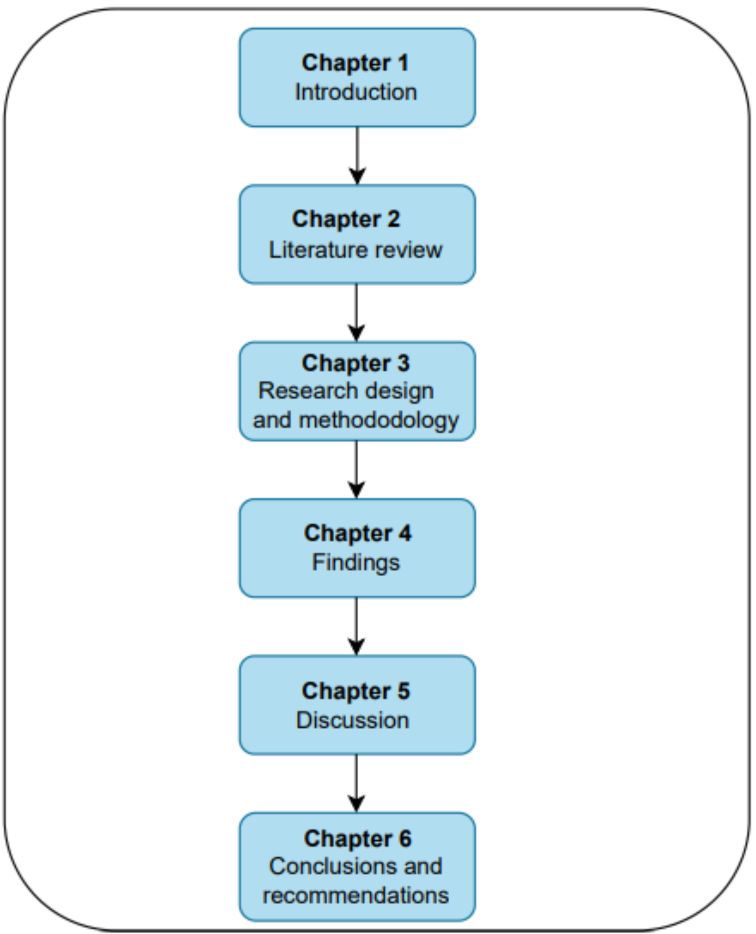


Figure 1-2: Thesis structure

Chapter 1: Introduction

Chapter 1 provides an overview of the problem statement, aim, rationale, research questions, research objectives, and the scope of the research.

Chapter 2: Literature review

Chapter 2 presents an overview of the key theories that underpin the conceptual framework,

key themes in the literature, research gaps, synthesis of the literature, and the overview of the research strategy.

Chapter 3: Research design and methodology

This study employs a dual-method approach comprised of the theoretical component (SLR) and the empirical data collection methods to explore the impact of digital technology on healthcare facilities in a rural community. The SLR component involves collecting the secondary data. It offers a structured and in-depth synthesis of existing academic literature, highlighting the patterns, themes, and gaps in the existing body of knowledge. The SLR informs the design of the empirical component.

The empirical component involves collecting primary data from the selected four case studies. The study adopted a qualitative approach to collect primary data through interviews. This dual-method enabled the researcher to gain rich insight into both the theoretical and empirical perspectives. A conceptual framework guides the integration of the two methods to DT's impact on healthcare facilities. A detailed methodology is discussed in Chapter 3 of this study. Figure 1-3 illustrates the dual-method employed in the study, theoretical perspectives (SLR) and empirical perspectives.

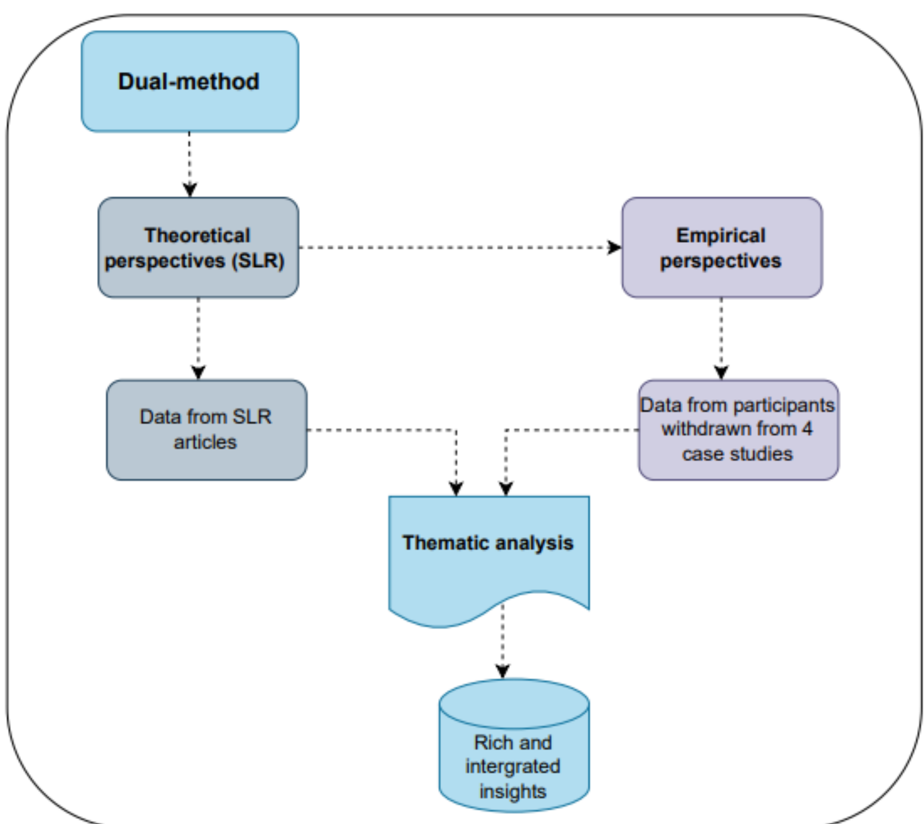


Figure 1-3: Dual-method – SLR and empirical data

Chapter 4: Findings

Chapter 4 presents the findings from the theoretical (SLR) and empirical perspectives.

Chapter 5: Discussion

Chapter 5 discusses the theoretical perspectives and empirical findings established in Chapter 4.

Chapter 6: Conclusions and recommendations

Chapter 6 summarises the main findings, links them to the questions and objectives, sets out contributions, highlights limitations, and offers recommendations for future research.

1.7 Chapter summary

This chapter provides a summary of the thesis. Topics covered include the introduction and background, clarification of the key terms, thesis structure, ethical considerations, significance and contribution of the study, and limitations and delimitations.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This study conducts a literature review to present an overview of the existing body of knowledge regarding the problem under investigation, which sets the contextual and conceptual foundation for the study. A more detailed and structured review is presented in Chapter 3 through a systematic literature review (SLR), which directly informs the empirical phase of the research. This chapter is structured as follows: section 2.2 provides an overview of the key theories underpinning this study. Section 2.3 outlines the emerging key themes informing the literature. Section 2.4 highlights the research gaps. Section 2.5 synthesises the literature. Section 2.6 highlights the overall research strategy. Section 2.7 provides the summary of the chapter.

2.2 Overview of key theories

This section explains five key theories that underpin the conceptual framework guiding this study. Theories and models serve as a framework to guide the research design and help interpret the research findings (Kim & Crowston, 2011).

These include:

- The Diffusion of Innovations Theory – adoption and integration (Rogers, 1983),
- The Technology Acceptance Model – acceptance and willingness (Davis, 1985),
- Social Cognitive Theory – new behaviour patterns (Bandura, 1986),
- Health Belief Model – benefits of digitalisation (Rosenstock, 1974), and
- Ecological Systems Theory – integration (Bronfenbrenner, 1989).

These theories provide feasible conceptual underpinnings suited to DT in rural healthcare contexts.

2.2.1 The Diffusion of Innovations Theory (DIT)

The Diffusion of Innovations Theory (DIT) theory has been extensively applied and validated through thousands of research studies. DIT addresses ways in which society adopts and spreads new innovations. DIT seeks to understand the rationale behind the acceptance of new concepts and behaviours that are embraced, and why their adoption can occur gradually over time (Halton, 2023). This theory is applicable in rural healthcare to comprehend the adoption and integration of DTs into healthcare systems. It describes a social process where individuals share and interpret information about a new idea based on their personal perceptions (Minishi-Majanja & Kiplang'at, 2005). DIT's primary aim is to explain how innovations are adopted by

focusing on the innovation, the passage time, communication channels, and the surrounding social systems (Kim & Crowston, 2011). Crofton (2024) identifies the key strengths of the model that can contribute to a deeper innovation adoption as follows:

- It offers insights into how innovation diffuses to understand the adoption of new concepts, technologies, or behaviours within a society,
- the model's classification into five adopter categories is widely recognised as valuable for segmenting populations and analysing their behaviour in embracing innovations,
- the theory outlines key factors that affect how quickly and easily an innovation is adopted,
- the model explores how the social environment, such as community norms, influential leaders, and individuals who drive change, affects the adoption of innovations,
- the theory emphasises how trusted individuals, often called opinion leaders, can significantly impact other choices and drive the adoption of innovations,
- the theory enables predictions about the speed at which a new idea or product will be embraced by analysing the influential elements, and
- the theory highlights how crucial communication pathways are in spreading new ideas.

This study employed certain concepts of DIT, including adoption and integration, as it does not fully capture all the concepts relevant to the study. Despite its widespread use in explaining the diffusion of innovations, this theory has a number of drawbacks in the context of rural healthcare. DIT overlooks the most common barriers in rural areas, such as unstable internet connectivity, limited funding, and inadequate infrastructure. Moreover, DIT does not fully account for cultural and social elements, like trust and community customs, which play a vital role in adopting technology in rural areas.

2.2.2 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) has become one of the most widely used models in Information systems, mainly because of its simplicity and ease of use (King & He, 2006). The primary idea behind TAM is that individuals are more likely to adopt a technology if they perceive it as beneficial and easy to use (Brezavšček et al., 2016). This means that healthcare professionals are more likely to use digital systems if those systems improve their tasks (Ajibade, 2018). In this study, TAM reviews how healthcare professionals may accept and embrace new technologies. It primarily addresses two key tenets: the *perceived usefulness* and *ease of use* of specific technological innovation. These factors have the potential to affect acceptance.

Despite its widespread use, TAM has been criticised for its inability to fully capture the

underlying motivations behind individuals adopting and using new technologies in a business environment (Ajibade, 2018). While TAM is a valuable framework, it should be incorporated into a more comprehensive model that encompasses factors related to both human and social transformation and the dynamics of innovation adoption (Legris et al., 2003). TAM overlooks external factors such as age, users' digital literacy level, which can significantly influence both their acceptance of technology and their willingness to engage with it (Zahid et al., 2013). TAM in this study helps HCPs improve their understanding of the digitalisation of healthcare systems in rural healthcare contexts. This study used certain concepts of TAM, such as acceptance and willingness; however, it is important to note that the model does not fully capture all the concepts relevant to this study.

2.2.3 The Social Cognitive Theory (SCT)

Social Cognitive Theory (SCT) explores the adoption of new behaviour patterns via observation and self-help mechanisms. SCT describes the role of personal, environmental, and cognitive factors in shaping human behaviour (Manjarres-Posada et al., 2020). Among various theoretical models, Bandura's Social Cognitive Theory is especially valuable for research promoting health through behaviour change (Islam et al., 2023). This theory is widely accepted in explaining individual behaviours (Zhou & Fan, 2019). In rural healthcare, SCT provides insight into how HCPs develop skills and become skilled at using DTs. SCT emphasises that learning occurs within a social context, where individuals both influence and are influenced by their environment (Nickerson, 2024). Learning techniques may include observation, training, and practice. Bandura (1986) highlights that individuals often learn new behaviours through observation. This study employed one concept of SCT, *new behaviour patterns*, as SCT is not sufficient on its own (Islam et al., 2023) for addressing the complexities of DT implementation in rural healthcare.

2.2.4 The Health Belief Model (HBM)

The Health Belief Model (HBM) links health-related choices to perceived seriousness of a health condition, perceived susceptibility, and the benefits of acting. This model was the first theory specifically designed to explain behaviour related to health (Orji et al., 2012). In rural healthcare contexts, HBM provides an understanding of the benefits of using DTs for their health. Over the years, HBM has been adopted in a wide range of public health settings (Orji et al., 2012; Hsieh & Tsai, 2013). The model has been adopted in developing various healthcare intervention programs (Hsieh & Tsai, 2013). It provides an understanding of the benefits of using DTs for their health. HBM has directed the attention of researchers and healthcare professionals toward key constructs that are essential for understanding and influencing health behaviour (Orji et al., 2012). Healthcare professionals may be required to

be the communication conduits of these benefits.

The key strength of the HBM lies in its practical and simplified constructs that make it easy to implement in health behaviour choices (Conner, 2010). This study employed two concepts of HBM: *perceived benefits* and *perceived barriers*. Perceived benefits refer to individuals' evaluation of the usefulness or advantage of adopting a health behaviour to reduce a perceived health risk (Orji et al., 2012). Additionally, the healthcare professionals must perceive that the intended health behaviour will lead to substantial positive outcomes. In particular, the target behaviour should be perceived as effective in preventing negative health outcomes (Orji et al., 2012).

Perceived barriers are the potential challenges that an individual believes might arise when taking action (Chuang et al., 2013). In the healthcare context, these might include internet connectivity, costs, digital infrastructure, and digital literacy, among others. HBM alone is insufficient to fully explain HCPs' behaviour in seeking digital health information (Ahadzadeh et al., 2015). Furthermore, this model seeks to explain technology use strictly from a health standpoint, but it does not capture the broader mechanisms driving such behaviour (Ahadzadeh et al., 2015).

2.2.5 The Ecological Systems Theory (EST)

Interactions have the potential to influence development. Bronfenbrenner's Ecological Systems Theory (EST) explains that various interconnected environmental systems, from immediate settings like family to larger societal structures like culture, actively shape an individual's development (Bronfenbrenner, 1977, 1994; Crawford, 2020; Guy-Evans, 2024, 2025).

Bronfenbrenner (1977) describes the individual's environment as a series of nested systems, where each level surrounds and influences the next, forming a layered structure of developmental contexts. These structures are:

- **Microsystem:** Encompasses healthcare environments (Guy-Evans, 2024).
- **Mesosystem:** Recognises that elements within the microsystem are interconnected and not isolated (Nolan & Owen, 2024).
- **Exosystem:** May include environmental procedures and policies across healthcare facilities (Nolan & Owen, 2024).
- **Macrosystem:** Encompasses external influences beyond the healthcare environment that influence the inner layers of the framework and the HCPs, like society, culture, and economy (Guy-Evans, 2024).

- **Chronosystem:** This level considers the changes and impacts that occur over time, and how these temporal transitions can influence the HCP's development (Nolan & Owen, 2024; Bronfenbrenner, 1977, 1994).

The structures have the potential to support an understanding of the integration of DTs into healthcare systems. Bronfenbrenner's theory can be used to understand how DTs can be integrated into the healthcare system, considering factors such as society, culture and economy. These factors affect healthcare delivery in rural areas. Although Bronfenbrenner's theory gained widespread acceptance among psychologists, teachers and sociologists for its comprehensive view of individual development, it lacks clear guidance for implementing interventions to improve healthcare outcomes (Guy-Evans, 2024).

The study used the *integration* concept of EST to explain the interaction between HCPs and their environment. Furthermore, EST is not sufficient on its own to address the multifaceted complexities of implementing DT in rural healthcare settings.

2.2.6 Justifications of the models and theories

Theories on technology adoption and utilisation state that various factors shape how organisations adopt and implement technologies. This study examines how digital technology affects healthcare facilities in rural areas. To explore how digital technology impacts healthcare facilities in rural areas, the study adopted the following models:

- **DIT –** focuses on adoption and integration (Rogers, 1983).
- **TAM –** highlights users' acceptance and adoption of new technologies (Davis,1985).
- **SCT –** considers the development of new behaviour patterns (Bandura, 1986).
- **HBM –** considers the perceived benefits and perceived barriers of DT (Rosenstock, 1974).
- **EST –** understands the integration of DT in a rural healthcare setting (Bronfenbrenner, 1989).

Each theory addresses different aspects of behaviour, technology adoption, and environmental influence. Existing theories do not fully capture the interplay between personal beliefs, social influences, technological factors, and environmental contexts. Developing a conceptual framework is essential for integrating multiple theoretical perspectives, such as TAM, DIT, SCT, EST, and HBM, into a cohesive structure that reflects the complex, context-specific factors influencing digital healthcare adoption in rural settings. Additionally, a conceptual framework helps bridge gaps between individual theories, guides data collection and analysis, and supports the design of practical interventions tailored to the unique challenges of rural healthcare environments.

2.2.7 The conceptual framework guiding the study

A conceptual framework is a structured set of assumptions, beliefs, concepts, expectations, and theoretical foundations that guide and inform research (Maxwell, 2005). It enables the researcher to illustrate connections between variables, which may or may not be grounded in a specific theoretical perspective used to explain a phenomenon (Yamauhi et al., 2017). The digital healthcare conceptual framework is built upon constructs derived from the theories outlined in this section, including TAM. Figure 2-1 illustrates different concepts derived from five theories. The conceptual framework is applied in Chapters 5 and 6.

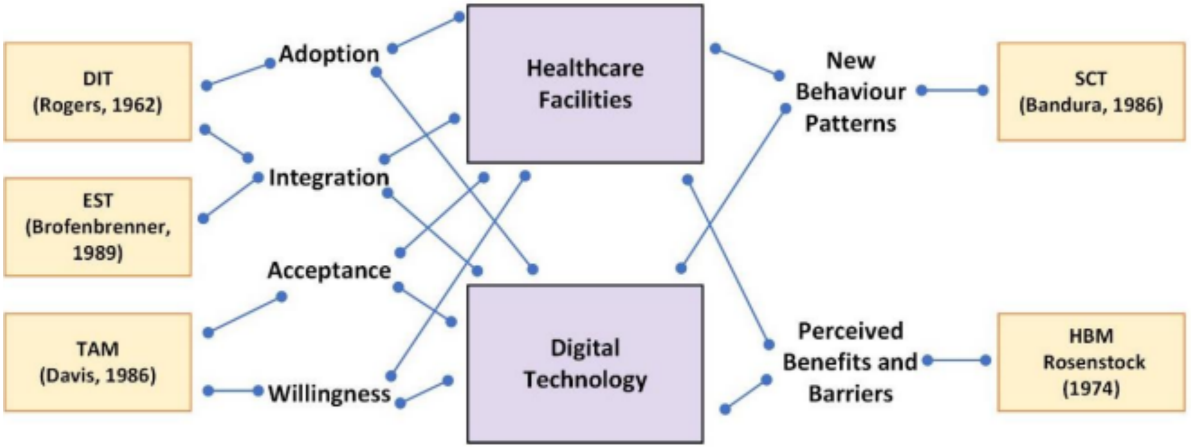


Figure 2-1: Conceptual underpinnings derived from existing theories

The conceptual model in Figure 2-1 illustrates a synthesised view of the concepts derived from theories explored for this study. The concepts that materialise in Figure 2-1, namely, adoption, integration, acceptance, willingness, new behaviour patterns and perceived benefits and barriers, will form the foundation of the SLR, which is Phase 1.

2.2.8 Constructs and their relevance to digital technology in rural healthcare

This section presents the main constructs derived from five theories that underpin this study, highlighted in section 2.2.1. Each construct has been selected based on its relevance to understanding the adoption, acceptance, integration, willingness, new behaviour patterns, perceived benefits, and challenges of DT in healthcare facilities in rural areas. Table 2-2 defines each construct, linking it to its theoretical origin and explaining its application in rural healthcare digitisation.

Table 2-1: Constructs and their relevance to digital technology in rural healthcare

Construct	Theoretical source	Definition in the rural healthcare context	Relevance to the study
Adoption and integration	Diffusion of Innovations Theory (Rogers, 1983); Ecological Systems Theory (Bronfenbrenner, 1989)	Infusion of DT in healthcare facilities in rural communities. How DT interacts with various systems in healthcare facilities in rural areas.	Explains how DT is adopted and becomes routine in healthcare facilities in rural communities. Illustrates systematic uptake of DTs in rural healthcare.
Acceptance and willingness	Technology Acceptance Model (Davis, 1985)	The willingness of the healthcare professionals (HCPs) to use DT is based on perceived ease use in rural areas.	Assesses attitudes and readiness for digital transformation in rural healthcare settings.
New behaviour patterns	Social Cognitive Theory (Bandura, 1986)	Changes in HCPs' learning, practices, and interactions due to DTs.	Explains how DT influences work practices in rural settings.
Perceived barriers	Health Belief Model (Rosenstock, 1974)	Perceived benefits such as internet connectivity issues, digital infrastructure gaps, data backlogs and data loss.	Captures the challenges experienced by HCPs in the adoption of DT in rural healthcare.
Perceived benefits	Health Belief Model (Rosenstock, 1974)	Perceived benefits include improved access to patient information, enhanced digital skills, efficiency, and improved healthcare delivery.	Captures the benefits experienced by HCPs on the adoption of DT in rural healthcare.

2.3 Key themes in the literature

The section highlights the rationale for the synthesis of an initial framework of guidelines informing decision-making in non-urban healthcare environments. Sub-sections associated with DTs in healthcare facilities provide the following themes: (i) Digital technology and transformation (section 2.2.1); (ii) Successes and challenges (section 2.2.2); (iii) Human factors (section 2.2.3); (iv) Processes and patterns (section 2.2.4). Table 2-2 sets out a summary of the initial articles included in the preliminary literature review. The authors have identified challenges related to DTs in different countries and have highlighted gaps for future research. This table represents a point of departure for the SLR. Its relevance lies in the penultimate column, where, as noted, emergent gaps are listed. The SLR will serve as a theoretical foundation for a synthesised framework of guidelines informing digitalisation in rural healthcare communities. The final column of Table 2-1 suggests the most pertinent themes (highlighted in bold) and concepts that emerge from each selected article.

Table 2-2: Summary of preliminary literature with noted gaps

#	Author	Title	Method	Source	Noted gap	Themes ad concepts
1.	Hassounah *et al.*(2020)	Digital response during Covid-19 pandemic in Saudi Arabia	Empirical Research	Journal of Medical Internet Research	Further investigate the successes and challenges of the digital experience.	**Human Factors**, Impact of Adoption
2.	Brown *et al.* (2020)	Issues affecting nurses ' capability to use digital technology at work – An integrative review	An integrative review	Journal of Clinical Nursing	Further research is needed to understand nurses 'attitudes and knowledge towards latest technologies.	**Human Factors**, Attitudes, Technological Changes, Environment
3.	Tortorella *et al.* (2021)	Impacts of digital 4.0 digital technologies on the resilience of hospitals	Empirical Research	Technological Forecasting and Social Change	There is a need to evaluate changes implied by new technologies in the work processes.	**Processes and Patterns,** Adjustments, Monitoring and Evaluation
4.	Abdolkhani *et al.* (2022)	The Impact of Digital Health Transformation Driven by COVID-19 on Nursing Practice: Systematic Literature Review	Systematic Literature Review	JMIR Nursing	Researchers may not have examined nurses' experiences and outcomes during COVID-19 across various regions.	**Processes and Patterns , Digital Technology and Transformation,** Adoption, Integration
5.	Aruleba and Jere, (2022)	Exploring digital transforming challenges in rural areas of South Africa through a systematic literature of empirical studies	Systematic Review	Scientific African	The digital divide in the rural areas.	**Processes and Patterns, Digital Technology and Transformation**. Adoption, Integration
6.	Sharma and Kshetri, (2020)	Digital healthcare: Historical development, applications, and future research directions.	Empirical Research	International Journal of Information Management	Authors recommend exploration of using DTs to assess their actual performance.	**Perceived Benefits and Challenges**, Adoption, Integration
7.	Rasa *et al.* (2021)	Using digital technologies in clinical trials: Current and future applications.	Empirical Research	Contemporary Clinical Trials	Rigorous examinations of limitations of using DTs to assess their actual performance.	**Perceived Benefits and Challenges**, Efficiencies
8.	Tlapa *et al.* (2022)	Effects of Lean Interventions Supported by Digital Technologies on Healthcare Services: A Systematic Review	Systematic Review	International Journal of Environmental Research and Public Health	Further research should focus on staff outcomes and patient outcomes on adaptation and implementation of the DTs	**Perceived benefits and Challenges**, Adoption, Integration
9.	Hélène *et al.* (2021)	Use of digital technologies in the time of COVID-19: opportunities and challenges for professionals in psychiatry and mental health care	Systematic Review	JMIR Human Factors	Further research to understand better variables in DT.	**Digital Technology and Transformation**, Technology Use Levels
10.	Mbunge *et al.* (2022)	Virtual healthcare services and digital health technologies deployed during coronavirus disease 2019 (COVID-19) pandemic in South Africa: a Systematic review.	Systematic Review	Global Health Journal	There is a lack of research in the low use of technologically supported medical care in rural areas.	**Digital Technology and Transformation**, Adoption, Integration, Technology Use Levels

2.3.1 Digital technology and transformation (DTT)

DTs are one of the focal points in the growth of the healthcare sector globally (Ter-Akopov et al., 2019). Digital technology (DT) involves the use of advanced information and communication technology (ICT) to collect, store, analyse, and distribute information (Yu et al., 2022). DT may use the latest generation of information technologies (ITs), including artificial intelligence (AI), big-data analytics, blockchain technology, cloud computing, deep learning, and Internet of Things (IoT), and can solve the major medical and clinical problems. This digital transformation in healthcare is changing the healthcare industry. Innovative DTs deployed in healthcare worldwide include:

- **Artificial Intelligence**: AI is described as a machine's ability to mimic intelligent human behaviour (Sharma & Kshetri, 2020).
- **Blockchain technology**: This technology in healthcare is being explored to address some of the very popular threats to data integrity and security (Sharma & Kshetri, 2020).
- **Drones**: Drones are flying robots that are revolutionising the pharmaceutical industry. They enable the efficient delivery of essential medicine to remote areas and rural communities worldwide (Bakibinga-Gaswaga et al., 2020).
- **Electronic health records (EHRs):** Storage of electronic records (Adler-Milstein & Jha, 2017).
- **IoT**: Involves a set of physical, electronic devices that connect with each other by exchanging data remotely over the Internet. With the aim of improving healthcare services (Sharma & Kshetri, 2020).
- **Mobile health (mHealth)**: Applications can be installed on mobile phones, which are ubiquitous in developing countries, facilitating communication (Mirkovic et al., 2014).
- **Remote monitoring devices:** Monitor and transmit patient data (Liao et al., 2019).
- **Robotics**: These tools have the potential to improve health delivery by reducing contact between people (Cohen et al., 2007).
- **Telemedicine:** Use of videoconferencing tools to reach remote healthcare sites (Olu et al., 2019).

2.3.2 Successes and challenges (SC)

Sharma and Kshetri (2020) point to a need for research that focuses on the quality of healthcare staff and patient outcomes, and resource utilisation would shed light on the adaptation, implementation, and integration of DTs (Tlapa et al., 2022). Rosa et al. (2021) note that the efficiencies, benefits, and limitations of using DTs should be thoroughly explored to assess their actual performance. There is a noted lack of preparedness in healthcare workers, hindering healthcare digitisation in developing countries (Tran Ngoc et al., 2018). In a South

African rural community study conducted at Mbizana and Ingquza Hill, Kraemer-Mbula et al. (2015) found that the performance of healthcare systems has led to challenges. These rural community challenges include a shortage of qualified healthcare workers. Geographic challenges such as large distance to large hospitals and limited access to specialised pharmacies and services. Financial barriers related to lower insurance coverage and lower income, as well as expensive transportation to access healthcare services. Additionally, rural areas are often faced with less effective emergency care services. Furthermore, poor infrastructure including limited equipment and under-resourced facilities worsen these challenges (Kraemer-Mbula et al., 2015).
The adoption of DTs brought some challenges, such as technological, cultural and organisational barriers, ethical issues, legal and regulatory barriers, and financial challenges (Mbunge et al., 2022). The authors posit that limitations are still evident, notwithstanding the evolutionary influence of coronavirus disease on the application of DTs in healthcare contexts.

In rural healthcare, DT is affected by challenges that may hinder its effectiveness (Mbunge et al., 2022). These challenges include network difficulties leading to intermittent internet connectivity, interrupted reporting, and privacy and security complexities. The problem of the digital divide has attracted the attention of modern-day society (Aruleba & Jere, 2022). Every digital divide delays the efforts to provide healthcare facilities to poor people. Sharma and Kshetri (2020) note a rapid spread of mobile health applications in the developing countries. According to Mbunge et al. (2022), there is poor use of Telemedicine and telecare in the rural areas in South Africa. Another challenge is that digital healthcare in African countries suffers from pilot projects that are not scaled beyond pilot stages (Bakibinga-Gaswaga et al., 2020). Furthermore, future research could investigate how issues around digital health are constructed, answered, regulated, and monitored in countries around the world, according to Sharma and Kshetri (2020).

2.3.3 Human factors (HF)

Studies have explored the adoption of digital health and the related challenges during the pandemic. However, there remains a gap in research on the impact of the adoption of digital health solutions (Hassounah et al., 2020). The authors indicate that workplace implications and the impact of a digital shift have yet to be known and studied in Saudi Arabia. Various studies have explored DT in South Africa. However, there is limited knowledge concerning using a set of guidelines for using DTs in the healthcare space in South Africa (Sharma & Kshetri, 2020; Aruleba & Jere, 2022; Mbunge et al., 2022). It is apparent that a digital divide skill exists (Aruleba & Jere, 2022). Hence, researchers need to consider the knowledge and attitudes of nursing staff towards the planning and implementation of technological changes in

the workplace, facilitating skills development and training (Brown et al., 2020).

2.3.4 Processes and patterns (PP)

Factors include adjusted work processes associated with complex digital transformation systems (Abdolkhani et al., 2022). Adjustments require evaluation (Tortorella et al., 2021). Resultant changes may lead to adjusted usage patterns and unplanned outcomes of implementation (Dekker, 2011).

2.4 Research gaps

This section summarises the gaps identified in the existing literature (see Table 2-1). These gaps serve as a foundation for a more comprehensive and structured analysis presented in Chapter 3, which employs a systematic literature review, allowing for a rigorous and transparent exploration of the literature. This structured approach not only validates the initial observations summarised in Table 2-1 but also directly informs and supports the empirical phase of the research by identifying specific areas where further investigation is needed.

2.5 Synthesis of the literature

This study employed an SLR to synthesise the literature for DT in rural areas, identifying the existing DT, examining recurring successes and challenges across studies, exploring human-related factors, and analysing the processes and patterns in the daily workflows. Conducting a systematic literature review is necessary to consolidate the existing body of knowledge and present an organised summary of the main themes. Through this approach, the study aims to contribute to a more cohesive and comprehensive understanding of the existing body of knowledge.

Figure 2-2 demonstrates the connection between Chapter 2 and Chapter 3, highlighting how the theoretical perspectives and the empirical perspectives are integrated.

Building upon the insights gained from the SLR, this study collected empirical data from four case studies in rural health facilities to explore the phenomena in real-world settings. This dual-method strategy allowed the researcher to examine how these themes can be applied in real-world settings.

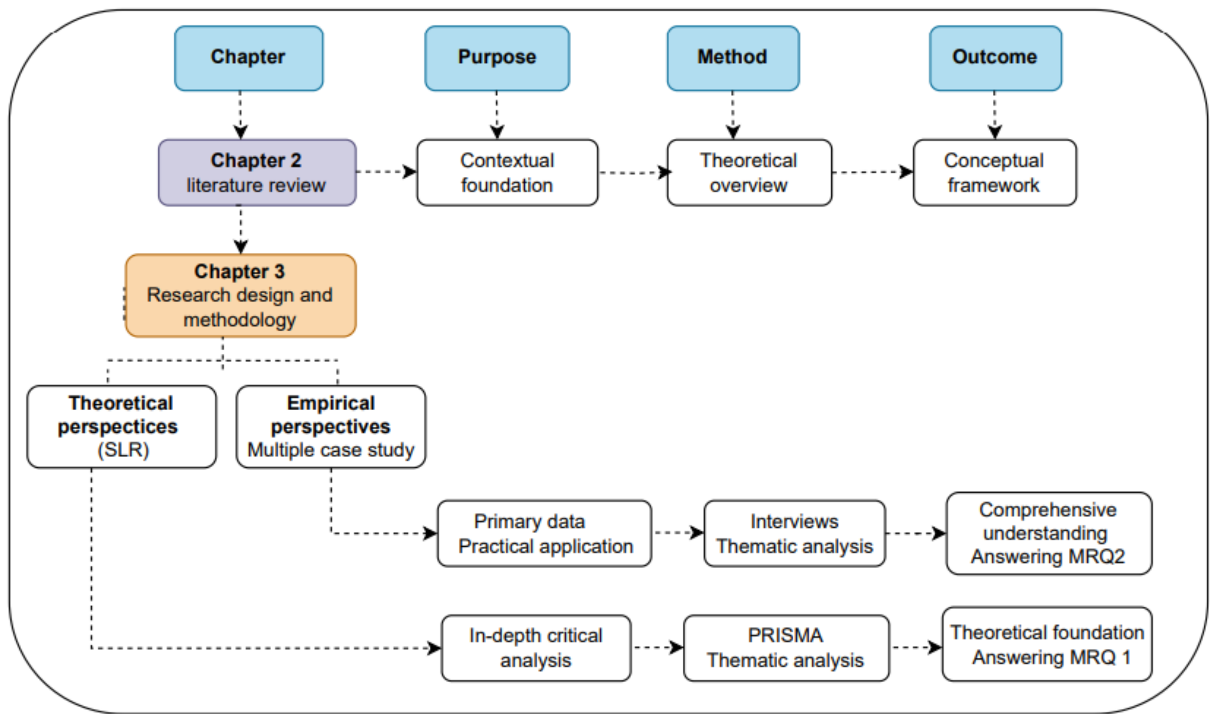


Figure 2-2: Connection between Chapter 2 and Chapter 3

2.6 Overall research strategy

The study involved four phases where theoretical underpinnings (Phase 1) and empirical exploration (Phase 2) iteratively evolve into an initial framework of guidelines for healthcare in rural communities. Phase 1 outlines a systematic literature review, while Phase 2 has a multiple-case study design. During Phase 3, a process of synthesis and evaluation is undertaken. Finally, Phase 4 leads to the framework of guidelines for digitalisation in rural healthcare communities (DHCF).

The outcomes of the systematic literature review (Phase 1) highlight themes and codes that are thematically analysed using ATLAS.ti. The themes and codes emerging from Phase 1 support the questions asked in the interviews in Phase 2. Thus, Phase 1 establishes the theoretical foundation and exploration of existing literature, and then the outcomes of the structure from Phase 1 inform Phase 2, which is the empirical data collection.

In Phase 2, all transcribed interviews from the participants are thematically analysed using ATLAS.ti to determine how the questions support the answering of the research questions. The outcomes of Phase 1 are a set of themes and codes, and this structure has helped the researcher to work out the details of the questions in Phase 2.

Figure 2-3 sets out the overall strategy of the study.

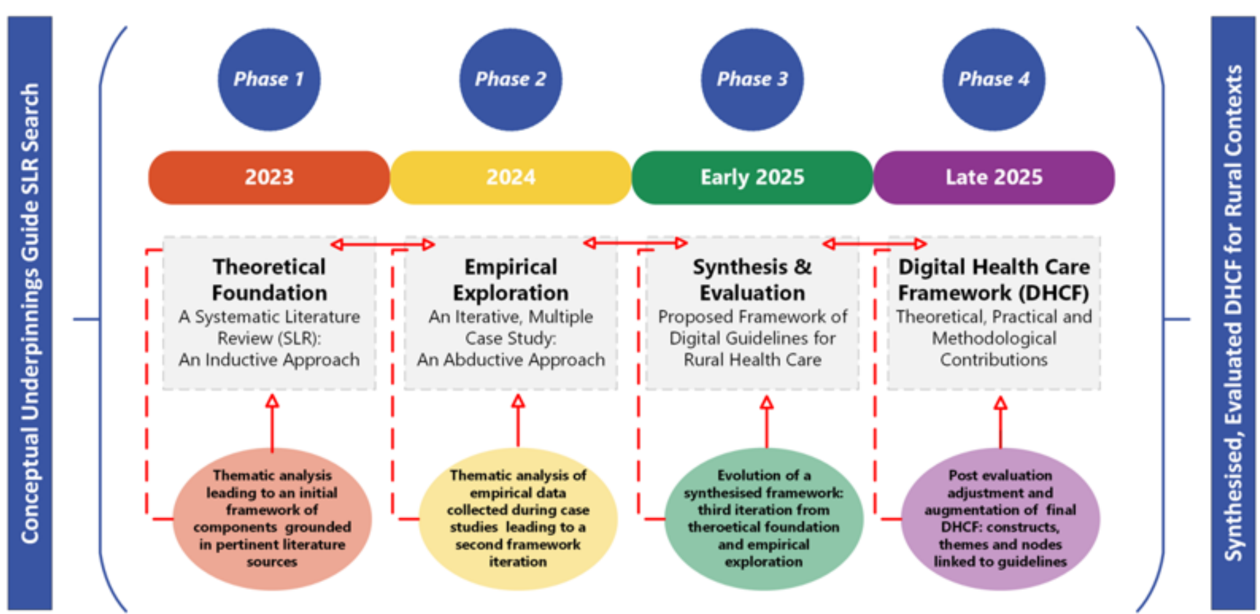


Figure 2-3: Overall research strategy

2.7 Chapter summary

This chapter discusses the overview of the key theories and models that underpin the conceptual framework of this study. The study highlights the pertinent key themes that emerged from the literature. The research gaps are identified and synthesised the literature. Furthermore, the overall research strategy is highlighted. The next chapter discusses the research design and methodology adopted for this study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The previous chapter outlined the literature review, including the theoretical frameworks, theories, and models that relate to this study. This chapter describes a dual-purpose research strategy employed to address the study's research questions and objectives. It introduces the dual research worlds reported respectively in Chapter 5, leading to a two-fold methodology. The first strategy is the theoretical collection of relevant literature sources through a systematic literature review (SLR). The second, empirically-based strategy applies the outcomes of an SLR and forms the foundation of an exploratory case study design (Harpur, 2018). Both the theoretical and empirical strategies explore the impact of DT in healthcare facilities in the rural areas of the Eastern Cape. Consequently, this study aims to explore the impact of DT on healthcare facilities in this area.

Section 3.2 revisits the research questions introduced in Chapter 1, followed by the research paradigm and philosophical underpinnings in section 3.3. In essence, this chapter focuses on the design and the methodology that support this study. Informed by the research onion (Saunders et al., 2019), this study employs the research onion illustrated in Figure 3-1.

3.2 Research questions revisited

This section revisits the research problem and the research aim, questions, and objectives initially outlined in Chapter 1. The researcher reviews various frameworks regarding DT in healthcare facilities in a rural community.

The researcher noted that the existing literature pays limited attention to consolidating a framework for DT in healthcare facilities in a rural community. This gap in the extant literature on the design and composition of a framework guiding healthcare facilities serves as a central focus of this study. The research therefore aims to explore the impact of DT on healthcare facilities in a South African Eastern Cape rural environment.

The study is guided by two main research questions introduced in Chapter 1: The first main research question is associated with the theoretical perspectives of the study (SLR). At the same time, MRQ2 is linked to the empirical perspectives. The second main research question is further clarified through five supporting research questions (SQ 2.1 – SQ 2.5). Addressing the secondary research questions supports the resolution of the main research question (MQ2).

Table 1-1: Research questions and objectives

Research Questions	Research Objectives
MRQ1: What is known about the role of digital technologies in healthcare contexts in rural communities?	
MRQ2: How does digital technology impact healthcare facilities in rural communities in South Africa?	
SQ 2.1: What digital technologies are currently in place in healthcare facilities?	**RO 2.1:** To explore digital technologies currently in place in healthcare facilities.
SQ 2.2: What is the significance of digital technology in healthcare facilities?	**RO 2.2:** To examine the significance of digital technology in healthcare facilities.
SQ 2.3: What challenges emerge when adopting digital technology?	**RO 2.3:** To investigate challenges that emerge when adopting digital technology.
SQ 2.4: What strategies contribute to the successful adoption of digital technology?	**RO 2.4:** To gain information about the success of the adoption of digital technology.
SQ 2.5: What is the nature of the impact of adopting digital technology in rural communities?	**RO 2.5:** To explore the nature of the impact of adopting digital technology in rural communities.

Note: MRQ = Main research question; SQ = Secondary question; RO = Research objective

3.3 Research paradigm and philosophical underpinnings

This section delves deeper into the research design of this study, which gives a clear view of the research structure. A research design is a plan that outlines how the researcher needs to fulfil the aim and answer the questions identified (Patton, 2015). It offers a framework for gathering and analysing data (Bryman & Bell, 2011). Yin (2018) states that a research design is a logical flow linking empirical data to the study's research questions and, eventually, to the study's conclusions. It is a detailed plan for collecting data in research (Bhattacherjee, 2012). It enables the researcher to outline the research structure, comprising the philosophy, research approach, and methodological choice, among others (Al Kilani & Kobziev, 2016). The purpose of the research design in this study is to give a clear view of the research structure. This study adopted Saunders et al.'s (2019) Research Onion design. Figure 3-1 illustrates the different layers of the Research Onion, discussed in detail in the following sections:

- Section 3.3.1 explains the research philosophy.
- Section 3.3.2 covers the approach to theory development.
- Section 3.3.3 provides a detailed explanation of the strategy.
- Section 3.3.4 focuses on the methodological choice.
- Section 3.3.5 delves into the research time horizon.
- Section 3.4 covers the SLR as data collection method.
- Section 3.5 covers the case study as data collection method.
- Section 3.6 discusses the data collection procedure.
- Section 3.7 explains the data analysis.

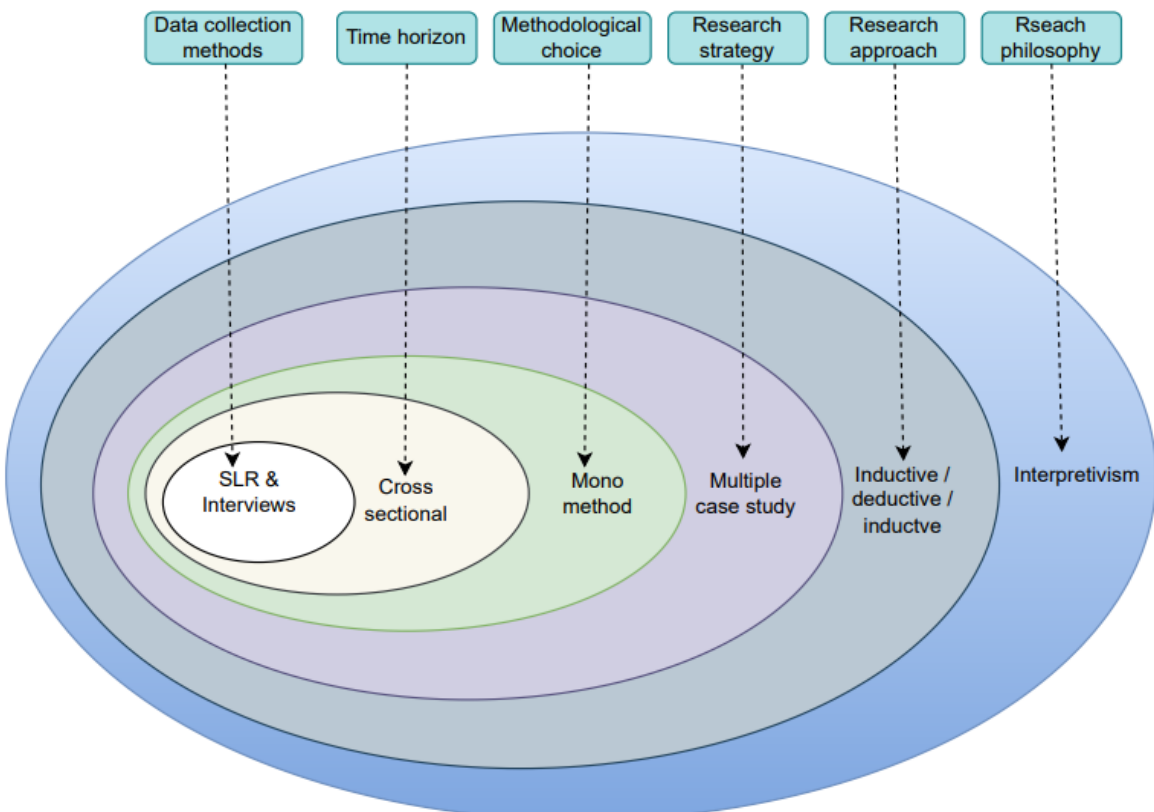


Figure 3-1: Research Onion (adapted from Saunders et al., 2019)

3.3.1 Research philosophy: A subjective, interpretivist stance

Researchers need to understand what reality is and how to study knowledge (Rehman & Alharthi, 2016; Saunders et al., 2019). Saunders et al. (2019) defines research philosophy as "a system of beliefs and assumptions" regarding knowledge development. At every point of the research, whether the researcher is consciously aware of them or not, they will make many assumptions (Burrell & Morgan, 2019). Philosophical assumptions regarding the nature of reality are important for understanding how the researcher makes meaning of the data they collect (Kivunja & Kuyini, 2017). Furthermore, how social science researchers perceive and study social phenomena is guided by three types of philosophical assumptions that distinguish research philosophies, namely, ontology, epistemology, and axiology (Burrell & Morgan, 2019; Saunders et al., 2019). Each paradigm has ontological and epistemological assumptions (Scotland, 2012).

3.3.1.1 Ontology

Ontological assumptions are concerned with what reality is (Scotland, 2012). Creswell (2009) defines ontology as a set of beliefs about the nature of reality. Ontology assumptions include:

- Examining the researcher's underlying belief system about the nature of being and existence,
- focusing on the assumptions that we make to believe something is true or logical,

- helps the researcher conceptualise the nature and form of reality and what the researcher believes can be known about reality,
- seeking to identify the fundamental concepts that make up themes which the researcher analyses to interpret the meaning contained in research data, and
- allowing the researcher to examine the underlying philosophical assumptions and belief systems, and the researcher's beliefs about nature's existence, being and reality (Kivunja & Kuyini, 2017).

The researcher's ontology gives rise to their epistemology (Otoo, 2020).

3.3.1.2 Epistemology

Crotty (1998) defines epistemology as "understanding and explaining how we know what we know". Thus, epistemology describes the assumptions regarding the best way to study the world, such as whether researchers should use a subjective or objective approach to study social reality (Bhattacherjee, 2012). Its emphasis is on the nature of human knowledge and understanding that the researcher may obtain to deepen, extend, and broaden understanding within their area of research (Kivunja & Kuyini, 2017). Furthermore, researchers engage with participants to comprehend phenomena within their contexts.

The two philosophical assumptions explained above assist in orienting the researcher's thinking regarding the research problem, the significance of the problem, and how the researcher might approach the problem (Kivunja & Kuyini, 2017). In this study, the researcher acquired knowledge about the impact of DT on healthcare facilities from qualitative data analysis and then synthesised findings during a systematic literature review. Therefore, the researcher aligns herself with a subjectivist epistemology as a qualitative researcher (Otoo, 2020). Furthermore, the researcher subjectively explored the impact of DT on healthcare facilities in a rural environment in the Eastern Cape of South Africa. The combination of the researcher's ontology and epistemology comes together to form a paradigm. Considering the above, the interpretivist paradigm is adopted as the philosophical stance of the researcher.

3.3.1.3 Paradigm

Choosing the appropriate research paradigm for a study is the most important step in every study's research design (Miskon et al., 2015). A paradigm is a "way of understanding the reality of the world and studying it" (Rehman & Alharthi, 2016). The researcher collected subjective knowledge based on people's personal experiences and their empirical understanding of DT in healthcare. This interpretivist study facilitates gathering people's opinions, views and experiences based on the outcome of interviews (Gray, 2021). With its focus on richness, complexity, various interpretations, and meaning-making, interpretivism is explicitly subjectivist

(Saunders et al., 2019). It seeks to comprehend people's perceptions of the social phenomena they engage with rather than seeking to uncover knowledge and truth that is universal, context-free, and value-free (Rehman & Alharthi, 2016). Here are seven principles of interpretivist research that this study follows:

- **The fundamental principle of the Hermeneutic Circle:** This principle forms the foundation of other principles. It states that all human comprehension is attained by repeatedly considering how the meaning of individual components and the whole they form are interdependent.
- **The principle of contextualisation:** This principle necessitates clear reflections on the historical and social background of the study setting to guarantee that the intended researcher can understand how the current situation under inquiry emerged.
- **The principle of interaction between the researchers and the subjects:** This principle necessitates clear reflections on how the research or data materials were developed via collaboration among researchers.
- **The principle of abstraction and generalisation:** This principle necessitates relating the idiographic details shown by the data interpretation by applying the principles of one and two to theoretical, general concepts that explain "the nature of human understanding and social action".
- **The principle of dialogical reasoning:** This principle necessitates understanding possible contradictions between the theoretical preconceptions driving the study design and actual results, with subsequent modification cycles.
- **The principle of multiple interpretations:** This principle necessitates understanding any possible differences among respondents' interpretations, which are usually expressed in multiple stories or narratives of the same sequence of events being studied.
- **The principle of suspicion:** This principle necessitates an understanding of possible systematic "distortions" and "biases" in the respondents' narratives that are collected (Miskon et al., 2015).

Thus, the interpretivism paradigm enables the adoption of the researcher's role in a social world (Žukauskas et al., 2018). This research philosophy guides the choice of research strategy, formulation of the problem, data collection, and analysis. Interpretivism was deemed suitable for this study as it enables the researcher to study the social order through the subjective interpretation of participants involved, such as: (i) interviewing various participants, and (ii) reconciling differences among their responses using their own subjective perspectives (Bhattacherjee, 2012). The focus of research undertaken within the interpretivism paradigm is the way humans attempt to make sense of the world around them (Saunders et al., 2019). The

researcher's view is that reality is subjective, shaped by society and is subject to change (Scotland, 2012). The constructivist-interpretivist paradigm has some characteristics of research located within, namely:

- The acknowledgement that there are multiple realities and that they are socially constructed,
- the acknowledgement that there is an unavoidable relationship between the researcher and her or his participants, and
- the acknowledgement that context is essential for knowledge and knowing (Morgan, 2007).

The research will be guided by these assumptions, beliefs, and values of the interpretivism paradigm employed for this study (Kivunja & Kuyini, 2017). The interpretative paradigm is suitable for a study that requires techniques such as case studies, observation, and textual analysis to be explored in detail (Walsham, 2006). Therefore, it can be concluded that the selected research philosophy encompasses the assumptions that underpin the research approach, methodological choice, research strategy, and the methods employed in this study (Creswell, 2009). The belief that findings form knowledge can be value-laden, and those values should be made explicit (Otoo, 2020). Thus, an axiological implication of this is that interpretivists understand that their interpretation of research data and materials, and thus their own beliefs and values, play a vital role in the research process (Saunders et al., 2019). Therefore, researchers cannot fully address their ontological and epistemological stance, which shapes the assumptions that they bring to this study and their position as researchers, without also addressing the ethics and values that they bring to the study (Otoo, 2020). This leads the researcher to the question of axiology.

3.3.1.4 Axiology

As a researcher, I cannot be completely separate from my own values and beliefs. The term "axiology" describes the ethical issues that need to be taken into consideration when planning research (Otoo, 2020). Axiology refers to the role of ethics and values (Saunders et al., 2019). Axiology is important in this research as it plays various roles, namely:

- Focusing on the ethical issues that should be considered when doing research,
- involving establishing, evaluating, and comprehending concepts of right and wrong behaviour about the research, and
- considering what value the researcher attributes to various aspects of the research, the data, the participants and the audience to whom the researcher will present the findings of the research (Kivunja & Kuyini, 2017).

The researcher is responsible for conducting herself ethically before, during, and after the study (Otoo, 2020).

3.3.2 Research strategy: Multiple case study

This section outlines the research strategy employed in this study in readiness for Section 2.6. Informed by Yin (2014), the study adopts an exploratory, multiple case study, directing the empirical component of the research design. This strategy is considered to be vigorous (Zainal, 2007). Moreover, a case study is one of the methods used by interpretivists to conduct their research (Weber, 2004). The chosen strategy permits the researcher to explore the phenomena in real-world contexts to collect rich and substantial data (Yin, 2014). Through the case study strategy, the researcher gained deep knowledge, which is two-fold:

- Firstly, a framework guiding DT in healthcare situations, and
- secondly, the meanings attached to this framework by the involved participants.

Case studies are commonly used in qualitative research methods (Yazan, 2015). The case study strategy provides an opportunity for the researcher to collect sufficiently substantial and rich data (Creswell, 2009). In this way, the presentation of the study's research questions becomes feasible.

3.3.3 Approach to theory development: Induction, deduction and induction reasoning

This section explains the concepts of induction and deduction used in this study. The study followed an iterative, phased approach (Saunders et al., 2019). During Phase 1, an **inductively** influenced systematic literature review (SLR) was conducted, which demarcated the theoretical part of the study. From the literature review, certain concepts emerged, and then the outcomes of the SLR informed the empirical data collection phase, forming the basis of a theoretical framework. After formulating codes, nodes, and themes from Phase 1, the researcher applied a coding scheme to the empirical data, which led to the possibility of creating new codes and themes. Phase 2 is both *deductive* and *inductive*, so the emergent framework may combine theoretical and empirical outcomes, yet some extension, agreement, and even disagreement may be noted.

Figure 3-2 illustrates the implemented approach.

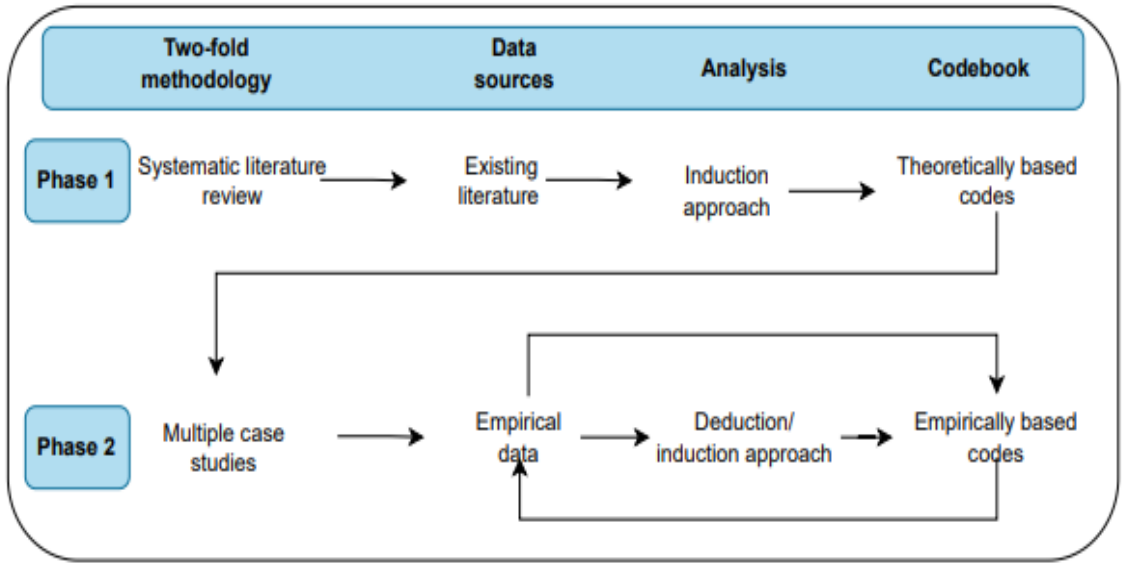


Figure 3-2: The adopted and implemented approach (Source: Harpur, 2018)

The empirical part of the study comprised a set of interviews. The SLR's theoretical outcomes influenced the interview protocol design. The results of the interviews with participants were used inductively to draw further conclusions. New information not contained in the literature emerged from the interview findings. In essence, Phase 1 (SLR) is inductive, as relevant literature sources provide concepts linked to the theoretical underpinnings of the study. This approach differs from deductive reasoning, where a study is based on a specific theory. However, Phase 2, involving the empirical exploration of multiple case study designs, adopted both deductive and inductive reasoning. Concepts emerging from Phase 1 were applied deductively in Phase 2. Additionally, new concepts emerged during interviews with case study participants, leading to further inductive outcomes.

3.3.4 Methodological choice: A mono-qualitative orientation

Qualitative research has been widely adopted by researchers to enhance the quality of their empirical studies (Liu, 2016). It enables the researcher to study phenomena in their natural setting. It is a strategy that uses words rather than numbers in gathering and analysing of data (Bryman & Bell, 2011). Qualitative research is exploratory with the purpose of discovering new insights, ideas or generating new theories (Creswell, 2009). This method is often associated with an interpretivist paradigm (Rolfe, 2006). The benefit of a qualitative method in an exploratory study lies in the use of open-ended questions that can evoke the following answers:

- Significant and usually prominent to the participant,
- unforeseen by the researcher, and
- investigative and rich in nature (Mack et al., 2005).

Hanson et al. (2011) explain that qualitative research methods aim to interpret observations relative to naturally occurring settings. Perceptions of people's feelings and thoughts are acquired, which could serve as the foundation for a future independent qualitative study (Sutton & Austin, 2015).

A qualitative researcher seeks to:

- Comprehend the participants' perspectives on DT in healthcare facilities and convey the meanings that participants construct regarding those phenomena,
- observe the real world where the phenomena occur, with as little interruption to the participants' daily routine as possible,
- consider the researcher's mind as an instrument of analysis and interpretation,
- extract data in the form of observations, words, and images (recorded as drawings, videotapes, written notes, audiotapes, or photographs) that lead to rich, detailed descriptions of processes, relationships, and settings, and
- seek to generate a better comprehension of phenomena from the specific details found in the data, rather than relying on theories and general models to anticipate what data will reveal to them (Hanson et al., 2011).

The researcher's goal as a qualitative researcher "is to know and understand" (Otoo, 2020). The qualitative method offers significant insights into the local viewpoints of the communities under study (Mack et al., 2005). The outstanding contribution of qualitative research is the contextually rich and culturally specific data it produces (Mack et al., 2005). A qualitative study may investigate topics that have not been thoroughly understood, which leads to future research (Hanson et al., 2011). It utilises open-ended questions and probing, allowing participants the chance to respond in their own words instead of forcing them to select from predetermined responses (Mack et al., 2005). The qualitative method provides the flexibility for the researcher to probe into participants' initial responses by posing questions such as how and why (Mack et al., 2005).

There are three noteworthy features for qualitative research:

- An inductive view of the link between research and theory,
- an epistemological stance described as interpretivism, and
- an ontological stance described as constructionist (Bryman & Bell, 2011).

In a qualitative study, the researcher is the primary research instrument (Creswell, 2009). A mono-qualitative method was chosen for this study to gain access to the participants' ideas and feelings, which might help the researcher to better comprehend the significance that

participants attach to their experiences (Sutton & Austin, 2015). Thus, to explore the nature of DT healthcare facilities in a rural environment, the researcher subjectively interpreted the data collected from the respondents. Therefore, a mono-qualitative strategy was most suitable for conducting this study.

3.3.5 Research time horizon: Cross-sectional

This study represents a snapshot of a certain period (Kesmodel, 2018). The researcher endeavoured to explore the current situation of DTs in healthcare facilities (Gray, 2013). Hemed (2015) identifies the benefits of cross-sectional studies as follows:

- It takes little time to conduct and is inexpensive.
- Risk factors and many outcomes can be assessed.
- It is valuable for public health planning.
- There is no loss to follow-up.

The data collected for this study captured feedback at a specific point in time in rural healthcare facilities in the South African Eastern Cape. Table 3-2 illustrates the research tools used in the study for data collection to achieve the research purpose.

Table 3-2: Research tools used for data collection

Research Tool	Purpose	Usage
ATLAS.ti V8.0 http://atlasti.com/	A qualitative data analysis tool used for coding and linking quotations to create networks.	Used for analysing literature sources.
EndNote http://endnote.com	An online reference management tool for searching, organising, writing, publishing and sharing of literature sources.	Used for managing references.
Google Drive https://www.google.com/drive/	A file storage that Google developed.	Allows users to store and back up files on Google servers.
Microsoft Office Suite: Word, PowerPoint and Excel https://www.office.com/	Programs are helpful in creating presentations and templates for the research.	Supported the diagram and wrote the report for the thesis.

3.4 Data collection

This section explains the study's theoretical and the empirical perspectives, and the data collection methods employed.

3.4.1 Theoretical perspectives: Systematic literature review

This systematic literature review (SLR) study adopted the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)* flowchart (Moher et al., 2009), a standard format for reporting SLR. The phases in the PRISMA flowchart guided the literature search in different databases to explore digital health in a community worldwide (Mbunge et al., 2022).

The SLR relates specifically to the first research question: *"What is known about the role of digital technologies in healthcare contexts in rural communities?"* The SLR is not only a methodological choice but is implemented as a standalone chapter to address MRQ1 directly. A systematic literature review was conducted to provide a robust, multi-dimensional and structured artefact that offers a solid theoretical platform for the study (Okoli, 2015; Okoli & Schabram, 2010). It included books, e-articles, journals, and peer-reviewed conference papers published between 2020 and 2024.

The SLR enabled the researcher to analyse, evaluate, and interpret research results on the impact of DT on healthcare facilities (Kitchenham, 2004). In addition, an SLR supported an unbiased search strategy to identify as many primary studies as possible that are pertinent to the research question (Kitchenham & Charters, 2007). Furthermore, the SLR ensured rigor in the search process.

The SLR method was used in this study to collect, analyse, and understand existing data. Informed by PRISMA flowchart guidelines (Moher et al., 2009), this study was based on a four-phase strategy. Section 3.4.1 sets out a distinction between a traditional review and a systematic literature review, followed by the features of a systematic literature review in section 3.4.2. Section 2.4.3 focuses on the guidelines from the experts that served as a guide to the implementation of the SLR in this study. Thereafter, section 2.4.4 explains the four-phase strategy employed in this study. Furthermore, section 2.4.5 focuses on the ethical considerations associated with conducting an SLR.

3.4.1.1 Traditional versus systematic literature review

Although this study adopted a systematic literature review, it is important to differentiate between an SLR and the traditional review to justify the chosen method (Okoli & Schabram, 2010; Okoli, 2015; Harpur, 2018; Ngesimani et al., 2022). The study employed an SLR to gather published data. A systematic literature review uses a well-defined approach to sift through the literature on a given topic, while traditional reviews sift and summarise a body of literature and draw conclusions on a specific topic (Cronin et al., 2008; Ngesimani et al., 2022). It is important to offer the reader an overall level of familiarity to perceive current knowledge and to emphasise the importance of the new research (Ngesimani et al., 2022). An SLR uses a clear-cut approach to reviewing literature (Ngesimani et al., 2022) within a specific research topic (Okoli & Schabram, 2010; Okoli, 2015; Ngesimani et al., 2022). Traditional reviews attempt to summarise multiple studies, whereas SLRs use a clear and precise approach to literature review within a specific topic. SLRs are interesting because they focus on the process of literature search (Boell & Cecez-Kecmanovic, 2010). In addition, an SLR helps in analysing, evaluating and interpretating results on a particular research topic (Kitchenham, 2004).

3.4.1.2 Features of a systematic literature review

An SLR is characterised by several features, firstly, it is systematic in that it follows clearly defined methodological approach. Secondly, the SLR is explicit in that it requires clear explanation of the methods used to undertake it. Thirdly, it is comprehensive, aiming to cover all pertinent information, and hence. Finally, it reproducible, meaning that other researchers would get similar results when following the same approach in studying the topic (Okoli, 2015).

3.4.1.3 Guidelines from the experts for a systematic literature review execution

The key guidelines scaffolding the systematic literature review process (Boell & Cecez-Kecmanovic, 2010) include a systematically phased approach (Okoli, 2015), inclusion and exclusion criteria (Harpur, 2018) and quality assessment criteria (Inayat et al., 2014).

3.4.1.4 A four-phase strategy

This section delves into a four-phase strategy process from the PRISMA flowchart (Moher et al., 2009) applied in Chapter 3:

- "Phase 1 – Identification",
- "Phase 2 – Screening",
- "Phase 3 – Eligibility", and
- "Phase 4 – Included".

i) Phase 1: Identification

The research questions determined the focus of the SLR planning, which consisted of the keywords and phrases used to search the literature. The researcher performed a systematic literature search for articles sourced from various countries published between 2020 and 2024.

Figure 3-3 reflects the planning of the collection of literature sources. The process stemmed from the topic associated with the context of the study, the research problem I identified, and the resultant research questions that I posed to address the problem. The process led to a narrowed selection of specific literature sources.

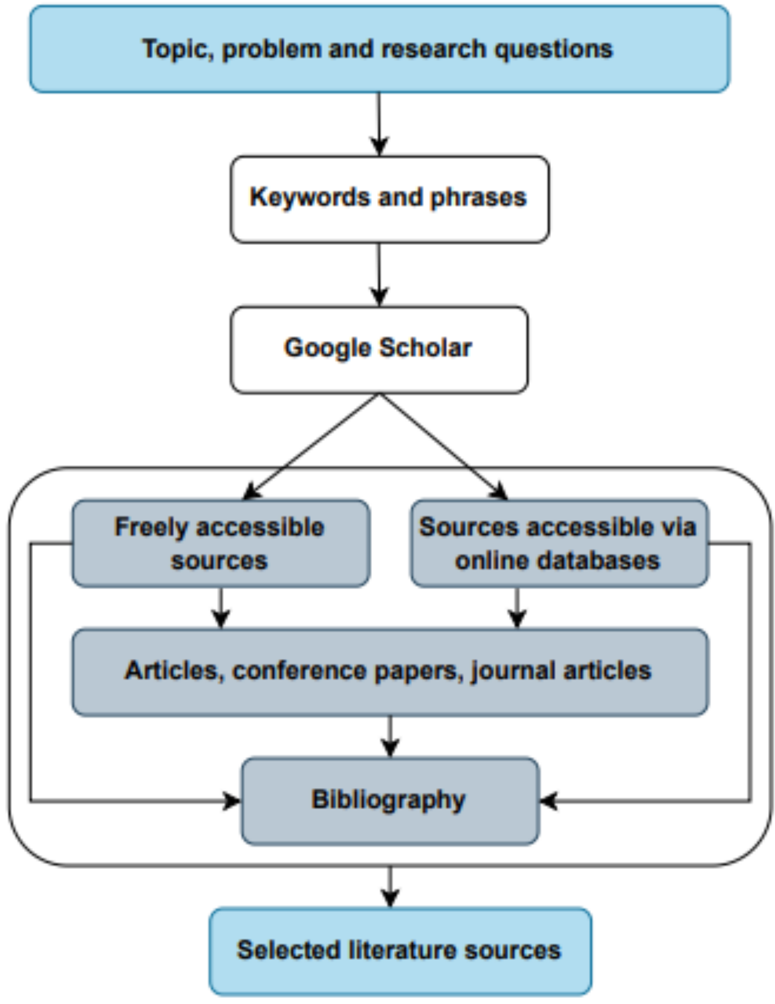


Figure 3-3: Organising the planning process of gathering literature sources

The initial search for literature sources via Google Scholar led to a wider search of electronic articles and books, all freely available. Thereafter, specific digital libraries were consulted to collect relevant articles. An initial search of literature sources was done via Google Scholar, with the focus on literature sources pertinent to digital technologies (DT) in healthcare facilities in rural communities. Table 3-3 show a list of search strings that were used to scan the literature.

Table 3-3: Search items used to scan the literature

Number	Search items
SS1	"Digital technology" AND ("rural healthcare" OR "sparsely populated")
SS2	eHealth AND ("rural healthcare" OR "sparsely populated")
SS3	(mHealth OR "mobile health") AND ("rural healthcare" OR "sparsely populated")
SS4	Telehealth AND ("rural healthcare" OR "sparsely populated")

Note: SS = Search string

The review was based solely on published conference papers and journal articles. Search items that focused specifically on DT in healthcare facilities within rural communities led to a deeper and more detailed exploration of specific digital library search engines, including Elsevier, ProQuest, Sage Publications, ScienceDirect, Scopus, Springer, and Wiley Online, using the search strings listed in Table 3-3. A total of 267 articles were identified from the digital databases. Thereafter, the researcher removed 59 duplicate articles, leaving 208 articles in total. Figure 3-4 below shows how the articles were stored in EndNote.

	Author	Year	Title
	Abdolkhani, Robab; Petersen, Sacha; Walter, Ruby; ...	2022	The impact of digital health
	Adler-Milstein, Julia; Jha, Ashish K	2017	HITECH Act drove large gain
	Agarwal, Naveen; Sharma, Himani	2024	Healthcare Functionaries' Per
	Ahlin, Eileen M	2019	Semi-structured interviews w
	Ahlin, Eileen M	2019	Semi-structured interviews w
	Airola, Ella	2021	Learning and use of eHealth
	Ajani, Oluwatoyin Ayodele	2024	Sustainable transformation in
	Ajani, V Olmvatoyin Ayodele; Maphalala, Mncedisi...	2023	The impact of the COVID-19
	Akbarı, Javad; Tabrızı, Hossein Heıdarı; Chalak, Azi...	2021	Effectiveness of virtual vs. no
	Al Kilani, Mohamed; Kobziev, Volodymyr	2016	An overview of research met

Figure 3-4: Articles stored in EndNote

Figure 3-4 shows how the articles used in this study were alphabetically stored and grouped according to author, year, and title.

ii) Phase 2: Screening

The goal of screening is to minimise the number of studies that need to be analysed so that the researcher can manage them practically (Okoli, 2015). In this phase, the researcher assessed the identified studies to determine their potential by reviewing their titles and abstracts. Therefore, A two-step process was used for screening and selecting articles. The first step involved the screening of titles and abstracts (Giebel et al., 2023) and the second step; the researcher assessed the full text of the included articles for deeper refinement (Giebel et al., 2023). Figure 3-5 illustrates the PRISMA flowchart (Moher et al., 2009) diagram of the systematic literature review on digital health in a rural community.

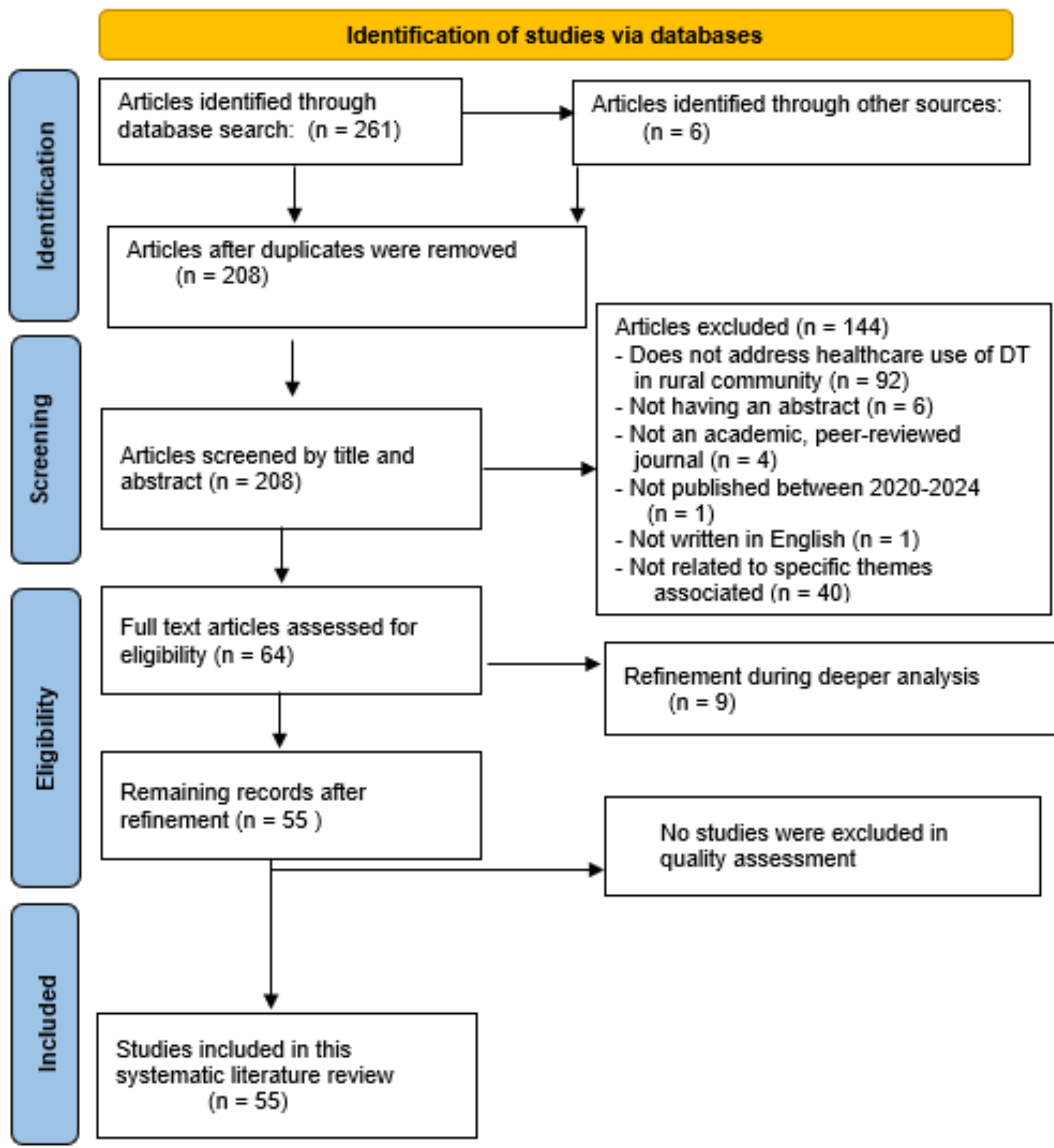


Figure 3-5: PRISMA flowchart diagram for the study selection process

Iteration 1 resulted in an initial set of 208 articles from “Phase 1 – Identification”. “Phase 2 – Screening” signifies the further refinement of the article identification process. The articles from “Phase 1 – Identification” act as input to “Phase 2 – Screening” (Harpur, 2018). The explicitly identified literature sources were evaluated for relevance, thereby narrowing the scope of the review. This led to a focused selection process with three iterations based on inclusion and exclusion criteria. The inclusion and exclusion criteria were applied to the 208 articles selected during this phase. Informed by Inayat et al. (2014) and Okoli (2015), 208 articles were judged to be included in the study using the following inclusion and exclusion criteria.

Inclusion criteria identified are:

- I1: Addressing the healthcare use of digital technology in rural communities,
- I2: Having an abstract available,
- I3: Including peer-reviewed journals and conference proceedings,
- I4: Incorporating articles published between 2020 and 2024,
- I5: Written in English, and
- I6: Relating to specified themes associated with the study.

This study explored healthcare facilities in a rural community. The exclusion criteria require that the reviewer must be clear about which studies they took into consideration for review and which ones they rejected (Okoli, 2015). The exclusion of studies was based on the following criteria:

- E1: Does not address healthcare use of digital technology in rural communities, urban areas are excluded, except in circumstances where a comparison study was done between rural and urban areas,
- E2: Does not have an abstract,
- E3: Is not a designated academic publication,
- E4: Is not published between 2020 and 2024,
- E5: Not written in English,
- E6: Does not relate to specified themes associated with the study, and
- E7: Refinement during deeper analysis.

Okoli (2015) points out that it is important to explain the practical reasons for excluding the studies as a reviewer. Iteration 1 included various scans of available literature sources. The study followed multiple processes,including snowballing. These processes are a foundation of the first selection defined in “Step 1 – Identification”, comprising 208 studies. In iteration 2, the applied exclusion criteria led to a reduction of 64 articles. During iteration 3, the exclusion criteria led to a reduced count of 55 articles. The steps from the initial to the final set of articles are presented in Table 3-4. During the preliminary review of the literature in Chapter 1, the approach led to four intuitive themes: (i) Digital technology and transformation (DTT); (ii) Successes and challenges (SC); (iii) Human factors (HF); and (iv) Processes (PP). The table summarises three iterations (1 to 3), detailing the exclusions and additions of articles. Iterations 1 and 3 comprise a single activity, whereas iteration 2 includes six exclusion criteria.

Table 3-4: Iterations for the SLR

Iteration	Description	DTT	SC	HF	PP	Total
1	**Result of iteration one: initial screen**	29	103	49	27	208
2	E1: Does not address healthcare use of digital technology in rural community	7	55	27	2	92
	E2: Does not have an abstract	2	2	0	2	6
	E3: Is not a designated academic publication	1	2	1	0	4
	E4: Is not published between 2020 and 2024	1	0	0	0	1
	E5: Is Not written in English	0	0	0	1	1
	E6: Does not relate to specified themes associated with the study	7	17	5	11	40
	Result of iteration one: reduction	12	27	16	11	64
3	E7: Refinement during deeper analysis	3	0	5	3	9
	Result of iteration three: reduction	9	27	11	8	55

(Adapted from Harpur, 2018; Ngesimani et al., 2022)

Note: HF = Human factors; PP = Processes and Pattens; SC = Successes and challenges; DTT = Digital technology and transformation; DT = Digital technology; E = Exclusion

All the literature sources included in the study were captured in EndNote, a bibliographic reference management tool (Hupe, 2019). Figure 3-4 shows how literature sources were stored in EndNote. The selected articles were screened based on titles, abstracts and occasionally the full text was examined to make a decision (Okoli, 2015). The researcher clearly explained the criteria used to judge which articles to reject due to poor quality (Okoli, 2015). The quality evaluation provided support for the researcher's scope and checks to see if the final search results are sufficient (Ngesimani et al., 2022). Apart from the inclusion and exclusion standard criteria, the researcher evaluated the quality of included studies:

- To provide even more thorough inclusion or exclusion criteria.
- to explore if quality variations offer an explanation for variations in study outcomes,
- as a strategy of weighting the worthiness of individual studies when outcomes are being synthesised,
- to direct the interpretation of results and assess the strength of inferences, and
- to guide recommendations for future research (Kitchenham & Charters, 2007).

Informed by Inayat et al. (2015), the study adhered to four quality assessment criteria (QAC) and customised these to suit this study (Harpur, 2018; Ngesimani et al., 2022):

- QAC1: Are the aims of the article in line with the study?
- QAC2: Does the article focus on DT in a healthcare context in a rural community?
- QAC3: Is there a clearly defined framework or set of criteria?
- QAC4: Do the findings indicate that the article is worthy of the synthesis of guidelines for DT?

The above questions were used to examine the eligibility of each study. The applied measure was Yes = 1; Partially = 0.5 and No = 0 (Kitchenham, 2004; Harpur, 2018; Ngesimani et al., 2022). Table 3-5 presents the quality assessment criteria used in the study.

Table 3-5: Quality assessment outcomes

ID	Author(s)	Article details - abbreviated title	QAC1	QAC2	QAC3	QAC4	Index
P01	Potts *et al*. (2021)	Chatbots to Support Mental Wellbeing in Rural Areas	1	1	0,5	1	3,5
P02	Sageena *et al.* (2021)	Evolution of Smart Healthcare - Telemedicine	1	1	0,5	1	3,5
P03	UDE-AKPEH & EZEGWU (2022	Integrating digital tech and innovations	1	1	0,5	1	3,5
P04	Mbunge *et al.* (2021)	m-health framework for improving malaria	1	1	1	1	4
P05	KINGSLIN (2023)	Mobile-enabled telemedicine system	1	1	0,5	1	3,5
P06	Jiménez-Díaz *et.al* (2024)	Neonatal jaundice detection - possibilities and barriers	1	0,5	1	0	2,5
P07	Maha *et a*l. (2024)	Revolutionizing community health literacy	1	1	0,5	1	3,5
P08	Woods *et al.* (2024)	Strengthening rural healthcare outcomes through dHealth	1	1	1	0,5	3,5
P09	PEH (2024)	Transforming healthcare systems in medically underserved rural	1	1	0,5	1	3,5
P10	Rutledge & Gustin (2021)	Preparing Nurses for Roles in Telehealth	1	1	1	1	4
P11	Lindberg *et a*l. (2021)	Older people and rural eHealth perceptions	1	1	0,5	0	2,5
P12	Rasi *et al.* (2020)	Older service users' experiences of learning to eHealth	1	1	0,5	1	3,5
P13	LeBlanc *et al.* (2020)	Patient and provider perspectives on eHealth intervention	1	1	0,5	1	3,5
P14	Holtz *et al.* (2024)	Perceptions of telehealth-based cancer support groups rural	1	1	0,5	1	3,5
P15	Shardha *et a*l. (2024)	Perceptions of telemedicine	1	1	0,5	1	3,5
P55	Svistova (2022)	Use of Telehealth Amid the COVID-19 pandemic	1	1	0,5	1	3,5
Overall aggregated indices			**1,0**	**1,0**	**0,6**	**0,8**	**3,4**
			100%	**98,2%**	**60,0%**	**80,0%**	**84,5%**

Note: QAC1 = Are the aims of the article in line with this study? QAC2 = Does the article focus on DT in a healthcare context in a rural community? QAC3 = Is there a clear framework or set of criteria? QAC4 = Are the findings clearly stated and worthy of the synthesis of guidelines for digital technology?

Informed by Kitchenham et al. (2009), the researcher used the reporting strategy and the evaluation method to calculate the total quality index for each criterion. Okoli (2015) suggests that researchers must provide a quality score to each included article based on the research methodology used. Thus, the last row in Table 3-5 shows how this calculation was done. All scores for each article were totalled, resulting in an index with minimum and maximum scores of 0 and 4 (Kitchenham et al., 2009; Harpur, 2018). The sum of the aggregated index for the final articles selected in the last row is 84,5% which shows that a conclusion based on these values indicates that the quality of an SLR was satisfactory (Harpur, 2018). The quality evaluation outcomes are grounded in the analysis included in Chapter 3.

Figure 3-6 visualises an analysis of search engines and databases used during the review process. The percentage contributions of ProQuest is 38%, Springer LINK 16%, ScienceDirect (13%) and Google Scholar (11%). In addition, it reflects the use of a broad spectrum of search engines and databases. The chart illustrates the results of “Phase 3 – Eligibility” as well as the entry point for “Phase 4 – Included”.

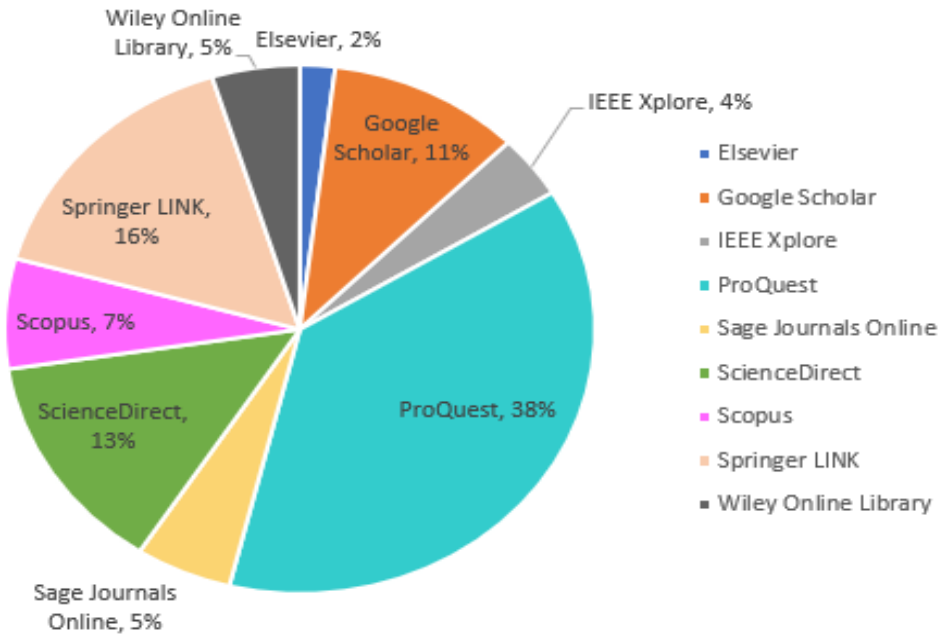


Figure 3-6: Analysis of search engines and databases

Table 3-6 presents a selection of 55 articles that serve as the foundation of the systematic literature review.

Table 3-6: A sample of the refined SLR articles

ID	Article details - abbreviated title	Author(s)	Origin	DTT	HF	PP	SC
P01	Chatbots to Support Mental Wellbeing in Rural Areas	Potts et al. (2021)	INT.	■	-	-	-
P02	Evolution of Smart Healthcare - Telemedicine	Sageena et al. (2021)	INT.	■	-	-	-
P03	Integrating digital tech and innovations	UDE-AKPEH & EZEGWU (2022)	INT.	■	-	-	-
P04	m-Health framework for improving malaria	Mbunge et al. (2021)	INT.	■	-	-	-
P05	Mobile-enabled telemedicine system	KINGSLIN (2023)	INT.	■	-	-	-
P06	Neonatal jaundice detection - possibilities and barriers	Jiménez-Díaz et al (2024)	INT.	■	-	-	-
P07	Revolutionizing community health literacy	Maha et al. (2024)	INT.	■	-	-	-
P08	Strengthening rural healthcare through digital health	Woods et al. (2024)	INT.	■	-	-	-
P09	Transforming healthcare rural systems via digital health	PEH, C.A (2024)	INT.	■	-	-	-
P10	Preparing Nurses for Roles in Telehealth	Rutledge & Gustin (2021)	INT.	-	■	-	-
P11	Older people and rural eHealth perceptions	Lindberg et al. (2021)	INT.	-	■	-	-
P12	Older service users' experiences of learning to eHealth	Rasi et al. (2021)	INT.	-	■	-	-
P13	Patient and provider perspectives on eHealth	LeBlanc et al. (2020)	INT.	-	■	-	-
P14	Perceptions of telehealth-based cancer support groups rural	Holtz et al. (2024)	INT.	-	■	-	-
P55	Telemedicine & mHealth apps for rural areas	Castillo (2023)	INT.	-	-	-	■

Note: INT = international

iii) Phase 3: Eligibility

No studies were excluded during the quality assessment criteria. Therefore, 55 studies were eligible for the systematic literature review. The researcher imported the final selection of SLR into ATLAS.ti V9 (Lewis, 2016), a Computer Assisted Qualitative Data Analysis Software (CAQDAS) tool in preparation for data analysis and report writing.

Following the refinement process, the researcher imported all 55 systematic literature review articles into ATLAS.ti v9. Figure 3-7 illustrates an excerpt from the systematic literature review articles in ATLAS.ti v9.The articles are categorised according to the four themes: **DTT:** Digital technology and transformation, **SC:** Successes and challenges, **HF:** Human factors, and **PP:** Processes and patterns. The prefix before each theme, for example SC, is an abbreviation for each article under the Successes and Challenges category. Thereafter, the articles were analysed in the next phase, "Included".

Figure 3-7: Systematic literature review articles in ATLAS.ti v9

iv) Phase 4: Included

The remaining 55 studies from "Phase 3 – Eligibility" were used as an entry into this phase. Creswell (2013) asserts that data analysis is a process that involves structuring the data, performing an initial review of the database, coding and categorising themes, presenting the data, and developing an interpretation. The data analysis process enabled the researcher to comprehend the data gathered from various studies – themes, categories and patterns (Cohen et al., 2007; Male, 2016). Informed by Braun and Clarke (2006), the study used thematic analysis to explore and understand the data from the included studies. The thematic analysis enabled the researcher to identify, interpret, and present themes found in the data. The six phases of thematic analysis directed the data analysis of this study, illustrated in Figure 3-8.

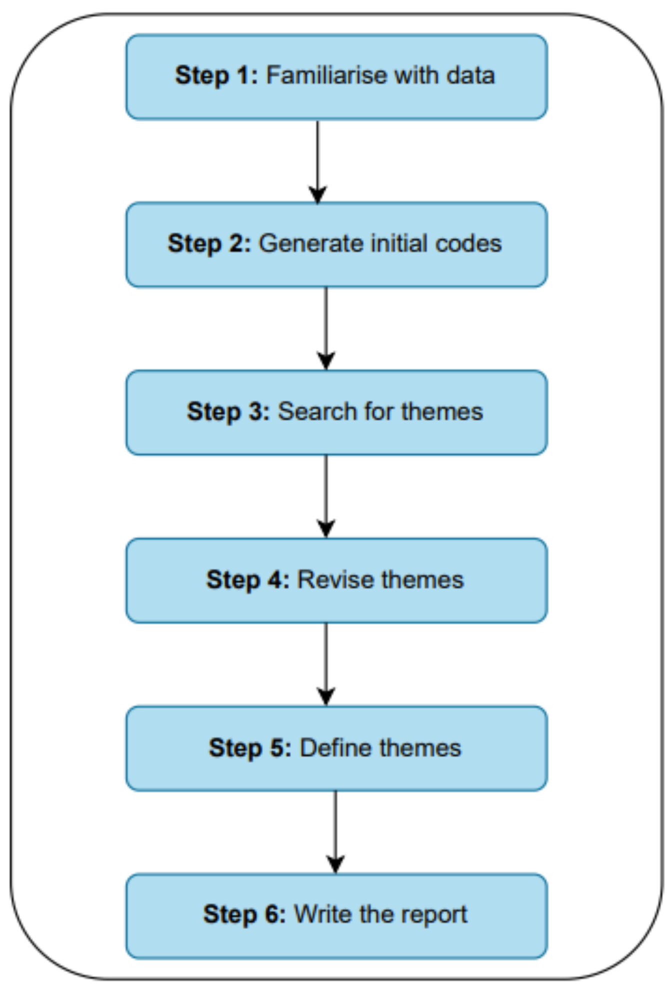


Figure 3-8: Six steps for thematic data analysis (adapted from Braun & Clarke, 2006)

***Step 1**: Familiarise yourself with the data:* The initial stage of any qualitative analysis involves carefully reading and re-reading the data (Braun & Clarke, 2006; Maguire & Delahunt, 2017). This step enabled the researcher to familiarise herself with the data included in ATLAS.ti v9 by understanding data and taking initial ideas. Initially, the documents were analysed individually; thereafter, all were uploaded simultaneously to ATLAS.ti v9 to compare the documents. Figure 3-7 illustrates that fifty-five documents were added to the ATLAS.ti v9 tool for data analysis. During this phase, the documents were organised in a structured and meaningful manner. I then carefully reviewed each document repeatedly to gain a deep and thorough understanding of the data. Gaining familiarity with the data facilitated the researchers' transition to the Step 2 of the analysis process.

***Step 2**: Generate initial codes:* In this stage, the researcher started to develop initial codes (Braun & Clarke, 2006; Maguire & Delahunt, 2017) using the 'Apply Codes' and 'Code In Vivo' features, which allowed the researcher to choose from a list of codes and apply them to the highlighted data segment. The 'Code In Vivo' feature enabled the researcher to select the

keywords in each article, whereby the selected textwas used as a code. The ‘Apply Code’ feature enabled the researcher to assign a new code label to the selected data segment. Figure 3-9 illustrates how the initial set of codes was developed from the data using ATLAS.ti v9. The researcher extracted phrases, words and quotations from included articles through open coding and In Vivo coding in preparation for the synthesis to be performed and reported in Chapter 3 (Okoli & Schabram, 2010).

Conclusion
The study was on the integration of digital technologies and innovations in rural health care delivery in communities in Anambra state. The essence was to identify the benefits, x-ray challenges and proffer solutions for better options. It was gathered that integrating digital technologies and innovations in rural health care has some benefits which include better treatment options and improved services. However there are factors that militate against its effective integration which include poor internet connectivity and adherence of rural dwellers to superstitions among others. In order to make the integration of digital technologies in rural health care more effective, it was gathered that training and employment of digital health experts and provision of internet connectivity are necessary among other options. Based on the findings from the study it was concluded that if digital technologies and innovations are integrated into rural health care delivery in Anambra communities, there would be a better health condition for rural dwellers.

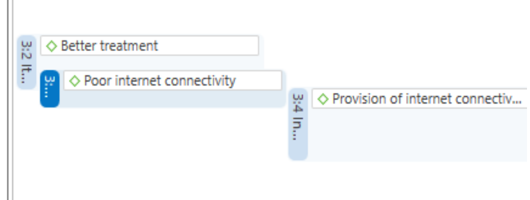


Figure 3-9: Coded segment of data focusing on poor Internet connectivity

Thereafter, the researcher merged similar codes, coding exciting points of the data and combining data applicable to each code. Figure 3-10 illustrates how similar codes were merged together. The codes highlighted in Figure 3-10 were merged because they reflect one underlying concept, ‘improved access to healthcare services’. The variation in phrasing presented differences across literature sources rather than showing substantial distinct processes. Therefore, merging these codes improved conceptual clarity. Additionally, the merging ensured that the development of themes was guided by underlying analytical processes.

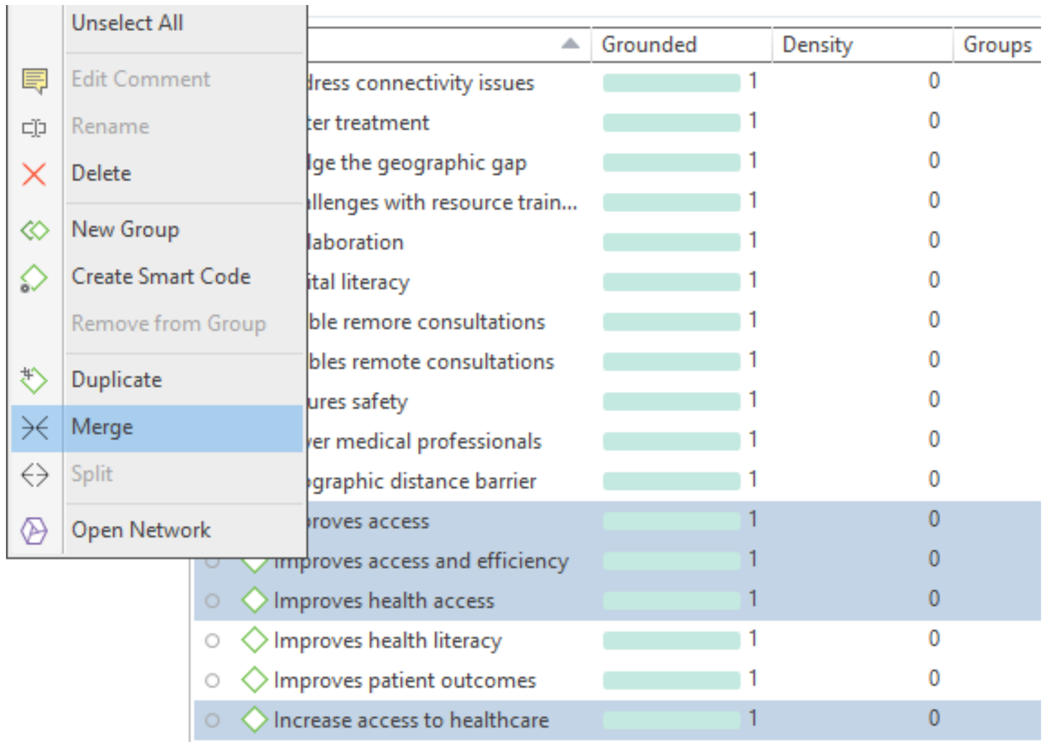


Figure 3-10: Merge similar codes on ATLAS.ti v9

As the coding progressed, the researcher noted an increase in the number of codes (Figure 3-11).

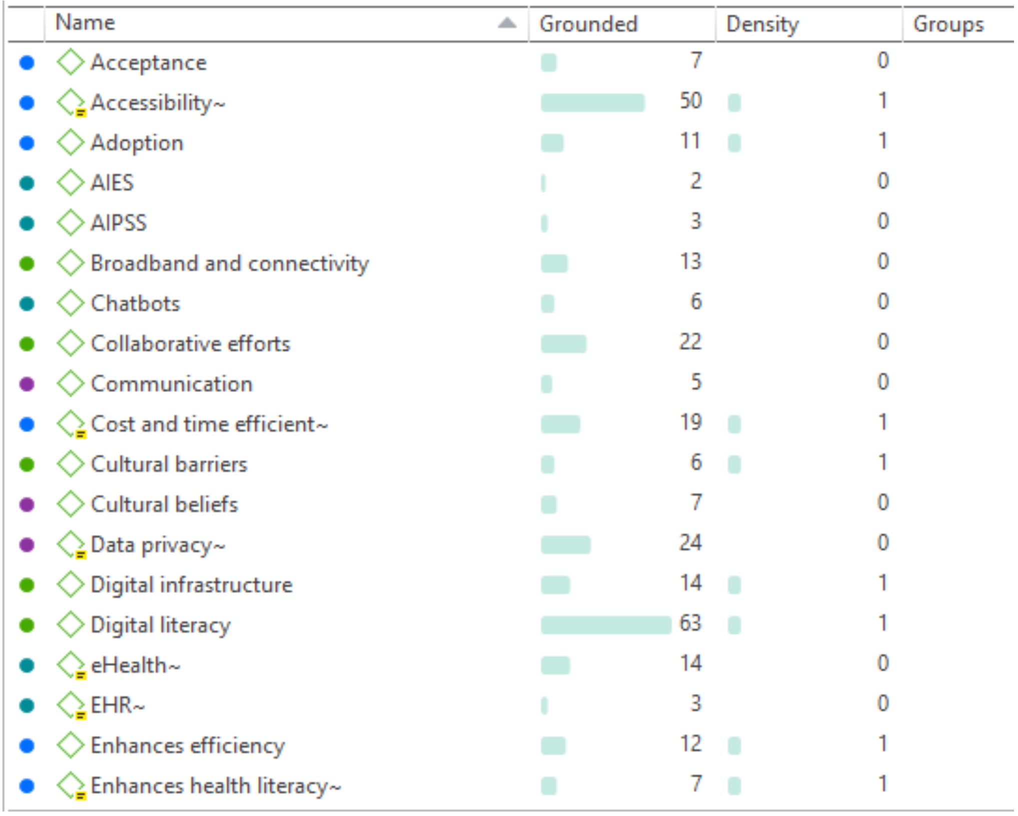


Figure 3-11: ATLAS.ti v9 excerpt on emerging codes from the SLR

Some codes, such as ‘AIES’, displayed low groundedness in the data, while others, like ‘Accessibility’, demonstrated higher groundedness. The degree of groundedness was determined by the number of quotations linked to each code. As a researcher, while leading the analysis process, I compared the codes along with their related quotations, exploring similarities and relationships among the codes (Miles et al., 2014).

During the process of ‘Apply Codes’ and ‘Code In Vivo’, the researcher generated free quotations to capture their initial reflections and general impressions of the data. For instance, in Figure 3-12, a prominent idea that began to surface from the free quotations was ‘Acceptance’, the acceptance of the adopted DTs. To illustrate this, Figure 3-12 presents a network featuring the ‘Apply Code’ node labelled ‘Acceptance’ representing the acceptance, which reflects healthcare professionals’ acceptance of the adopted DTs.

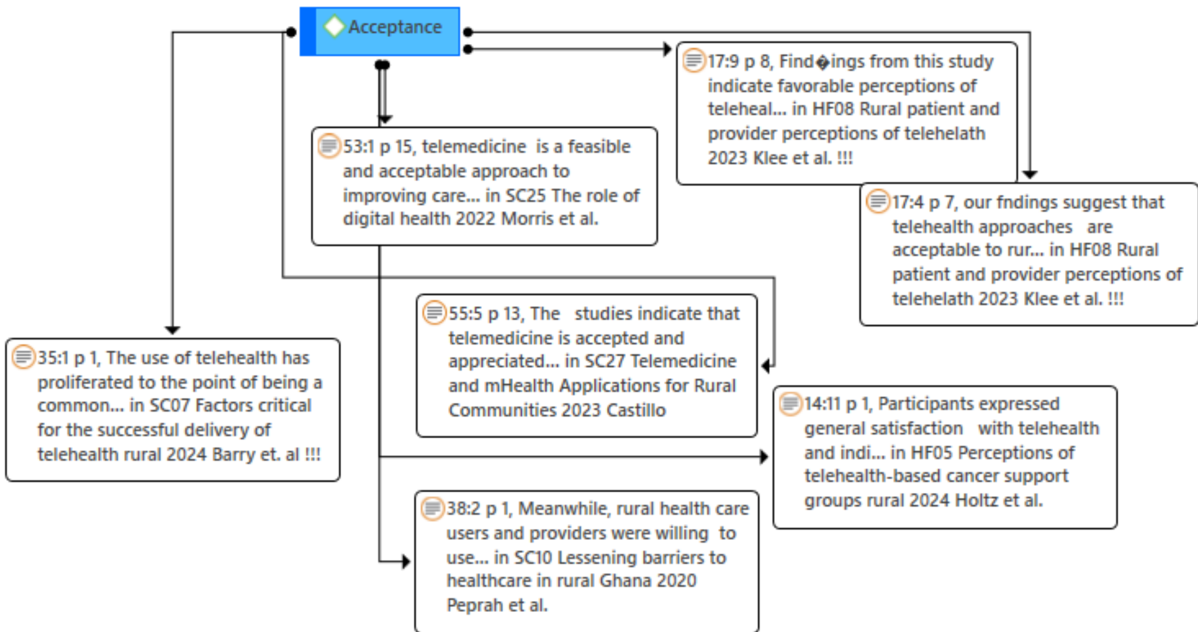


Figure 3-12: Network diagram of ‘Acceptance’ code with its associated quotations

<u>Step 3</u>*: *Search for themes: At this stage, the researcher moved from a detailed examination of codes (Naeem et al., 2023) to put codes into categories. Thus, I searched for the themes by combining codes and collecting data applicable to each possible theme. After the emergence of codes, as illustrated in Figure 3-12, the researcher constructed data categories to cluster related codes together. The data was divided into manageable pieces to support understanding and categorisation (Dey, 1993). Figure 3-13 shows that all related codes have been grouped into their relevant categories. Table 3-7 displays five distinct data categories along with their corresponding codes. The data corresponding to each theme was systematically colour-coded (Maguire & Delahunt, 2017).

Table 3-7: Theme development

CATEGORY A	CATEGORY B	CATEGORY C	CATEGORY D	CATEGORY E
• eHealth • AIPSS.. • Chatbots • HER • AIES • HIE • IoT • mHealth • RPM • SNPs • Telemedicine • Teleconsultation • Telehealth • Videoconferencing	• Improves quality • Enhances efficiency • Cost and time efficient • Enhances health literacy • Lessen HCWs burden • Reduces distance limitations • Reduces distance limitations	• Limited infrastructure • Data privacy • Financial considerations • Communication • Cultural beliefs • Geographical distance • Guidelines and licensing • Limited healthcare professionals • Low digital literacy • Technological limitations • Usage patterns	• Human behaviour • Willingness	• Collaborative efforts • Cultural barriers • Digital literacy • Broadband and connectivity • Digital infrastructure • Frameworks & policies • Funding • Improve practise change • Integration • Monitoring and evaluation • Recruitment processes • Tailor-made approaches

***Step 4**: Revise the themes:* In this phase, the researcher examined, refined, and further developed the initial themes identified in Step 3, ensuring their relevance and coherence with the coded extracts (Maguire & Delahunt, 2017).

***Step 5**: Define and name the themes:* In this step, I defined and named the themes, continuing the process of refining and analysing each theme to develop clear and distinct meanings (Braun & Clarke, 2006). Following this, I assigned names to the categories to establish coherent themes; for example, ‘CATEGORY A’ was named “THEME 1: Digital Technology and Transformation”. Additionally, I refined the codes by adding a prefix to each item to ensure consistency and traceability; for instance, ‘eHealth’ was renamed ‘TDTT04: eHealth’.

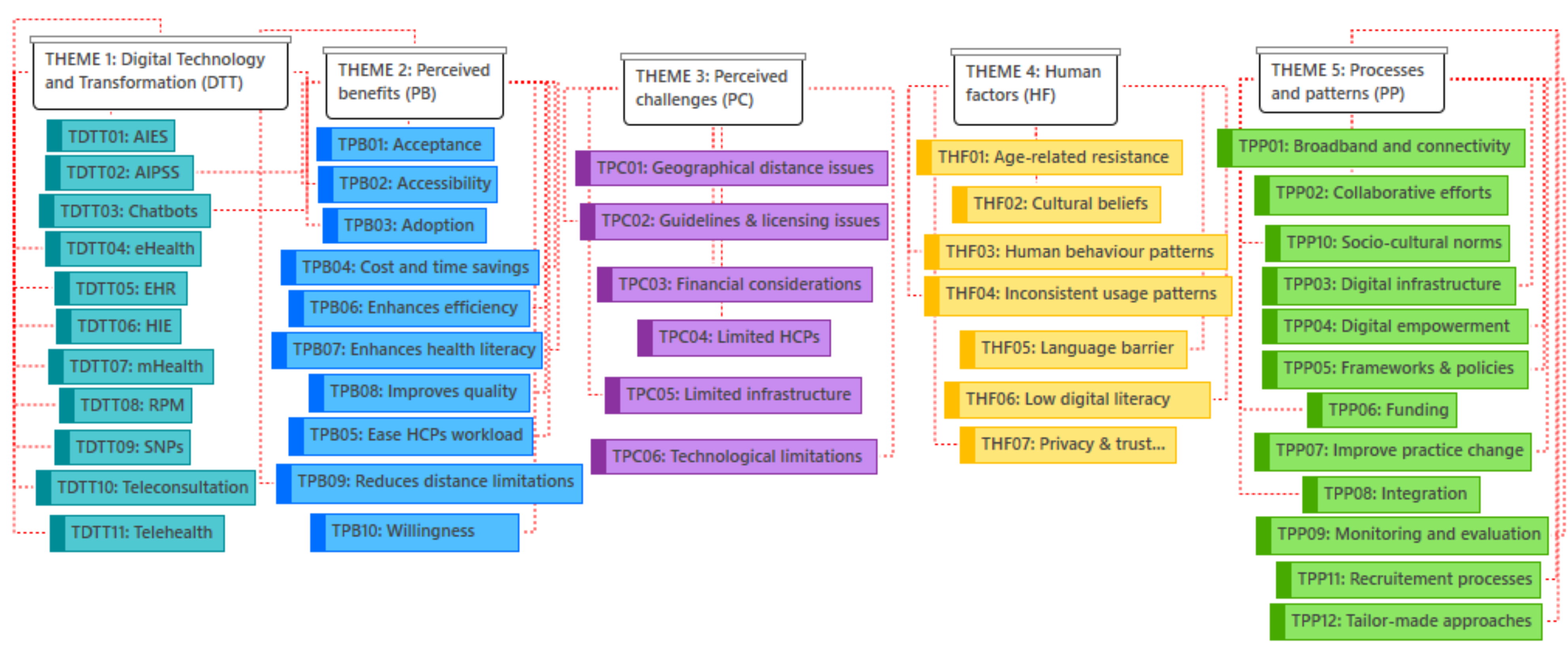


Figure 3-13: Thematic map of the identified themes and items in ATLAS.ti v9

Figure 3-14 presents the finalised overview of each theme, indicating the groundedness of each item which is determined by the number of quotations linked to it. The final column indicates the group to which each code has been allocated.

Code Groups
THEME 1: DIGITAL TECHNOLOGY... (14)
THEME 2: PERCEIVED BENEFITS (PB) (9)
THEME 3: PERCEIVED CHALLENG... (11)
THEME 4: HUMAN FACTORS (HF) (2)
THEME 5: PROCESSES and PATTE... (12)

Show codes in group **THEME 2: PERCEIVED BENEFITS (PB)**

Name	Grounded	Density	Groups
TPB01: Acceptance	7	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB02: Accessibility~	50	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB03: Adoption	11	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB04: Cost and time efficient~	19	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB05: Enhances efficiency	12	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB06: Enhances health liter...~	7	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB07: Improves quality~	11	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB08: Lessen HCWs burden	7	1	[THEME 2: PERCEIVED BENEFITS (PB)]
TPB09: Reduces distance limi...~	51	1	[THEME 2: PERCEIVED BENEFITS (PB)]

Figure 3-14: Final view of themes and their associated items in ATLAS.ti v9

In summary, the codes were first organised into categories and then further consolidated into themes, as Figure 3-14 illustrates. For instance, under “THEME 2: Perceived Benefits (PB)”, item ‘TPB01: Acceptance’ represents the first item within the theme. The prefix ‘T’ was used to distinguish theoretically-based items from empirically based ones.

<u>Step 6</u>: Write the report: The findings of the SLR are presented in Chapter 4, where the researcher links the findings back to the research question and relevant literature (Braun & Clarke, 2006). Through thematic analysis, the researcher could gain understanding, discover patterns, categorise codes, and create themes from the data. The use of ATLAS.ti v9 in this qualitative research improved rigor in several ways: By facilitating coding reliability and data triangulation of both primary and secondary data, the author then combined the themes that emerged into data. Further iterative development of a theoretically-based and customised codebook evolved.

In Table 3-8, the researcher shared a sample illustration of the evolution of the study’s codebook as synthesised from ATLAS.ti v9, the codebook is reported in Appendix D: A Synthesised Codebook. Further review of the extracted selection of 55 theoretical sources resulted in the synthesis of a theoretically-based framework for the impact of DT on healthcare facilities in a rural community, addressing aspects of the research questions. The findings of “Phase 3 – Included” are found in Chapter 3. Phase 4 reviewed literature sources identified and coded in preceding phases, highlighted the different areas of the selected frameworks and additional sources, and suggested categories, sub-categories and items associated with a framework for DT in healthcare facilities.

Table 3-8: Evolution of a theoretically-based codebook

Themes	Items
1. Digital technology and transformation (DTT	TDTT01: AIES
	TDTT02: AIPSS
	TDTT03: Chatbots
	TDTT05: eHealth
	TDTT05: EHR
	TDTT06: HIE
	TDTT07: IoT
	TDTT08: mHealth
	TDTT09: RPM
	TDTT10: SNPs
	TDTT11: Teleconsultation
	TDTT12: Telehealth
	TDTT13: Telemedicine
	TDTT14: Video conferencing
2. Perceived benefits (PB)	TPB01: Acceptance
	TPB02: Accessibility
	TPB03: Adoption
	TPB04: Cost and time efficient
	TPB05: Enhances efficiency
	TPB06: Enhances health literacy
	TPB07: Improves quality
	TPB08: Lessen HCWs burden
	TPB09: Reduces distance limitations
3. Perceived challenges (PC)	TPC01: Communication
	TPC02: Cultural beliefs
	TPC03: Data privacy
	TPC04: Guidelines and licensing
	TPC05: Geographical distance
	TPC06: Financial considerations
	TPC07: Limited healthcare professionals
	TPC08: Limited infrastructure
	TPC09: Low digital literacy
	TPC10: Technological limitations
	TPC11: Usage patterns

Note: DT = Digital technology and transformation, PC = Perceived Benefits, Perceived Challenges,; PP = Processes and patterns

3.4.1.5 Ethical considerations associated with conducting an SLR

As a researcher, it is my duty to adhere to ethics. This research explored a range of ethical considerations. Wager and Wiffen (2011) emphasise several ethical issues that researchers must consider when conducting a systematic literature review:

- **Refrain from duplicate publications:** Suppressing negative results and repeating positive results can have a negative impact.
- **Avoid plagiarism:** The study avoided using somebody else's data, words, and images withoutconsent and declaring them as the researcher's own.
- **Ensuring accuracy:** Ensured accurate extraction of data to avoid any attempt at biased results.

3.4.2 Empirical perspectives: An exploratory multiple case study strategy

This section explains the empirical perspectives of the dual-method strategy employed in this study. The empirical component of this study consists of four exploratory multiple case studies set in a healthcare context in rural communities in South Africa. The four cases encompassed the hospital directors, hospital and clinic managers, hospital and clinic nurses, and hospital administrators.

3.4.2.1 Introduction to the empirical section

The Cape Peninsula University of Technology ethical clearance granted the researcher permission to collect data from potential participants via gatekeepers. The gatekeepers gave permission for the research to collect qualitative data through face-to-face semi-structured interviews. Doctor 2 in one facility was unavailable due to commitments within the facility. This section covers the following items:

- Geographical location of the empirical study,
- population under study,
- justification of a case study as a choice in general,
- case study context and protocol, and
- the case study.

3.4.2.2 Geographical location of the empirical study revisited

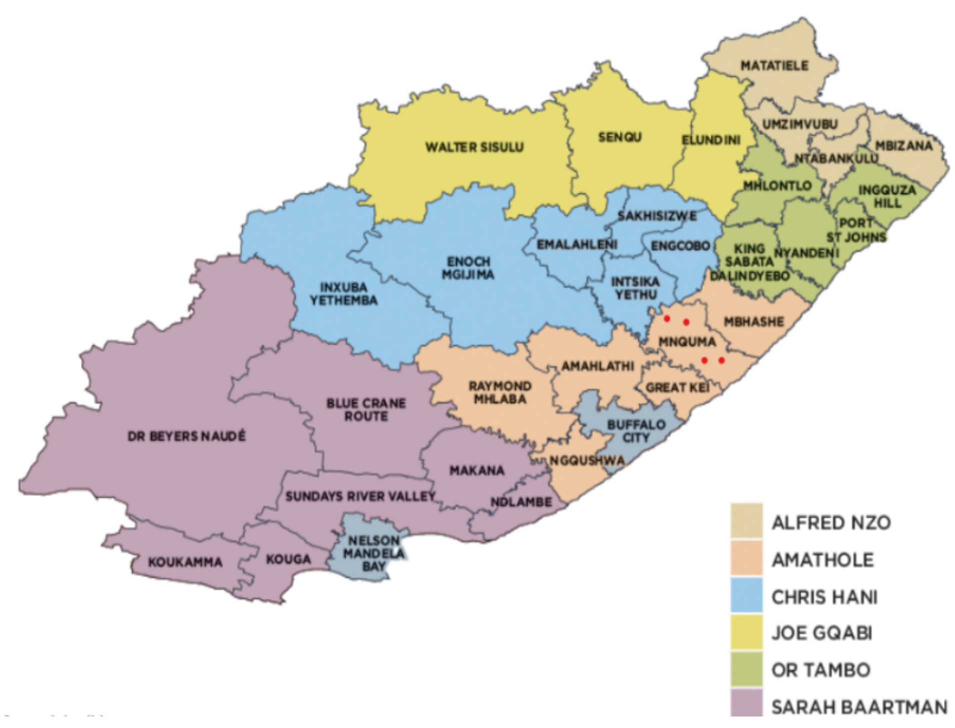


Figure 3-15: Geographical location of the four case studies in the Eastern Cape Province

This study was undertaken in the four healthcare facilities based at the Mnquma sub-district municipality in the Eastern Cape province. This section revisits the geographical location of the four case studies introduced in Chapter 1. Figure 3-15 illustrates the map and identifies the location of the four facilities where the study was conducted.

3.4.2.3 Population under study

Stockemer (2019) describes the population as the whole group of subjects about which the researcher wants information. The researcher has predetermined the population under study. To comply with the ethical code of conduct, the Cape Peninsula University of Technology (CPUT) granted ethical clearance permission to the researcher to collect data from participants via the site's gatekeepers (see Appendix B.1). Thereafter, the researcher obtained ethical approval to collect data from the Eastern Cape Department of Health (Appendix B.4.1, Appendix B.4.2, and Appendix B.4). Having received ethical clearance from the two institutions, the researcher approached the four cases explained in this study.

3.4.2.4 Justification of a case study as a choice in general

Case study research is a popular form of inquiry used in many social science fields as well as the practicing professions such as anthropology, business, community planning, education, nursing, sociology, political science, psychology and social work (Yin, 2018). It is one of the methods used by interpretivists to conduct their research (Weber, 2004). It is an empirical technique that explores a current phenomenon in depth in a real-world context (Yin, 2018). A case study was employed for this study as it:

- informed the design, data collection, and analysis by benefiting from "prior development of theoretical propositions" (Yin, 2018),
- facilitated the exploration of a "contemporary phenomenon in depth and its real-world context" (Yin, 2014),
- offered an opportunity to gather rich and substantial data directly from a healthcare real-world context (Yin, 2014; Harpur, 2018), and
- handled a wide range of evidence, including participant observation, direct observations, interviews, documents and artefacts (Yin, 2018).

The case study, as a chosen approach, offered the researcher an opportunity to collect rich and detailed data in a real healthcare context. The case study research process comprised:

- Design and preparation of data collection methods, instruments and protocols (section 3.5.5 and section 3.6),
- data analysis and interpretation of findings (section 3.7), and
- reporting (section 4.3 and section 5.5) (Runeson & Höst, 2009).

3.4.2.5 The case study

This section addresses the case study context, the associated protocol, case study sampling, and participant sampling.

3.4.2.5.1 The case study context

This section addresses an analysis of case study participants, which informs the content collected from the study. Table 3-9 details the secondary questions aligned with the respective phases, studies, data collection methods, and focus areas.

Table 3-9: Matrix linking each sub-question to the data sources and data collection methods

Phases	Studies and methods	SQ 2.1	SQ 2.2	SQ 2.3	SQ 2.5	SQ 2.5	Focus areas
1 Phase 2	1.1 Facility Director (CEO) Unstructured interviews	■	■	■	■	■	Rapport Investigation
	1.2 Doctor_1 Unstructured interviews	■	■	■	■	■	Enrichment
	1.3 Doctor_2 Unstructured interviews	■	■	■	■	■	Enrichment
	1.4 Nurse_1 Unstructured interviews	■	■	■	■	■	Exploration
	1.5 Nurse_2 Unstructured interviews	■	■	■	■	■	Exploration
	1.6 Administrator_1 Unstructured interviews	■	■	■	■	■	Innovation
	1.7 Administrator_2 Unstructured interviews	■	■	■	■	■	Innovation
2 Phase 2	2.1 Facility Manager_1 Unstructured interviews	■	■	■	■	■	Rapport Investigation
	2.2 Nurse_3 Unstructured interviews	■	■	■	■	■	Exploration
	2.3 Nurse_4 Unstructured interviews	■	■	■	■	■	Exploration
3 Phase 3	3.1 Facility Manager_2 Unstructured interviews	■	■	■	■	■	Rapport Investigation
	3.2 Doctor_3 Unstructured interviews	■	■	■	■	■	Enrichment
	3.3 Nurse_5 Unstructured interviews	■	■	■	■	■	Exploration
	3.4 Nurse_6 Unstructured interviews	■	■	■	■	■	Exploration
	3.5 Administrator_3 Unstructured interviews	■	■	■	■	■	Innovation
	3.6 Administrator_4 Unstructured interviews	■	■	■	■	■	Innovation
4 Phase 4	4.1 Facility Manager_3 Unstructured interviews	■	■	■	■	■	Rapport Investigation
	4.2 Nurse_7 Unstructured interviews	■	■	■	■	■	Exploration
	4.3 Nurse_8 Unstructured interviews	■	■	■	■	■	Exploration

Throughout the chapter, the following naming convention was used interchangeably to refer to the case respondents:

- Facility director [HFD]
- Facility managers [C1M1, CHCM2, and C2M3]

- Facility doctors [HDR1, HDR2, and CHCDR3]
- Facility nurses [HN1, HN2, HN2, C1N3, C1N4, CHCN5, CHCN6, C2N7, C2N8]
- Facility administrators [HA1, HA2, CHCA3, and CHCA4]

For example, HDR1 would refer to the first doctor working at the hospital, CHCDR3 would refer to the third doctor working at the community health centre, and C2N3 would relate to data collected from the third nurse working at the second clinic.

3.4.2.5.2 The case study protocol

A case study protocol is a guideline designed to organise and guide the conduct of the case study (Yin, 2018). It thus defines the processes and rules that researchers must follow before, during, and after carrying out a case research project (Maimbo & Pervan, 2005). A case study protocol outlined in Appendix B.6, Appendix B.6, Appendix B.7, and Appendix B.8 served the following purposes:

- Supported a case study checklist (Runeson & Höst, 2009),
- suggested research guidelines (Maimbo & Pervan, 2005),
- planning (Brereton et al., 2008), and
- defined data-collection procedures, definition of questions and quality measures (Yin, 2014).

3.4.2.5.3 The case study sampling

A sample is defined as a subset of the population that the researcher actually examines to collect data (Stockemer, 2019). Qualitative samples are typically purposive as opposed to random (Miles et al., 2014). In addition, samples in qualitative studies are usually not wholly prespecified but can evolve once fieldwork begins (Miles et al., 2014). The case selection for this study was non-probabilistic and convenient to the researcher (Etikan et al., 2016). The researcher has purposively selected case studies that are relevant to the research questions. Therefore, the study comprised four case studies that involved two hospitals and two clinics, as detailed below:

- **Case A – Hospital 1:** This mini-hospital (public health care centre [CHC]) serves the Mnquma Local Municipality in Eastern Cape, South Africa. Patients cannot stay overnight; it is more of a clinic-oriented mini-hospital.
- **Case B – Hospital 2**: This is a now a Community Health Centre (CHC) that serves the Mnquma Local Municipality in Eastern Cape, South Africa, and is supported by the district government. There are 350 beds available in the facility. It is more intensive care; any patient with a serious intensive issue from Case A is referred to Case B.

- **Case C – Clinic 1**: The clinic is situated in the Eastern Cape, South Africa.
- **Case D – Clinic 2**: The clinic is situated in the Eastern Cape, South Africa.

Thus, this study involved two hospitals (one mini-hospital and one Community Health Centre) and two clinics within South Africa's borders.

3.4.2.5.4 Participant sampling

Sampling is a technique of selecting research participants (Ahlin, 2019). Choosing participants is a key part of any research project to guarantee that data is gathered from the most knowledgeable participants (Ahlin, 2019). Sampling is the technique of choosing a suitable representative or sample portion of a population for the purpose of determining characteristics of the entire population (Mujere, 2016).

Purposive sampling, also known as judgment sampling, involves selecting participants on purpose based on personal characteristics (Tongco, 2007). It is a selection technique in which the researcher's knowledge about the population and the purpose of the study serves as a guiding process (Tansey, 2009). Tongco (2007) points out that this technique is a kind of non-probability sampling that works best when a researcher needs to study a particular community with experts. Qualitative research employs purposeful sampling rather than selecting a random sample to address the assumptions of statistical analysis techniques (Hanson et al., 2011).

Hanson et al. (2011) indicates that the researcher chooses a sample of participants or documents to accomplish a particular purpose and to gain the insight most applicable to the research question. Since the study involved interviewing a pre-defined and visible set of respondents, the researcher identified specific respondents of interest and sampled those deemed most suitable for the study's needs (Tansey, 2009). Thus, purposive sampling employed in this study enabled the researcher to select participants based on some predetermined characteristics before the study (Stockemer, 2019). The participants included hospital directors, doctors, nurses, administrators, clinic managers, and clinic staff.

In selecting the samples for this qualitative study, the key factor was not the number of participants, but their relevance to the topic, which guided the selection process. Participants were drawn from four cases, constituting a purposive sample of convenience. Qualitative research typically follows general guidelines regarding the number of interviews to be conducted to ensure the quality of data. Based on Creswell's (2009) work, Abdul Majid et al. (2018) suggest five to twenty-five interviews. Subedi (2021) argues that despite its methodological flexibility, qualitative inquiry does not impose rigid requirements on the number of participants to be selected in advance.

Qualitative studies often use purposive sampling when selecting participants for interviews, as the sample is intentionally chosen based on the aim of the study (Salmons, 2015). In this study, participating role-players in selected hospitals and clinical cases included:

- Hospital directors – managers in charge of healthcare departments.
- Hospital doctors – senior medical professionals experienced and certified to practice medicine to help patients.
- Hospital nurses – registered persons who provide medical and nursing care to patients in a hospital.
- Hospital administrators – persons in charge of planning and directing the hospital's daily operations and health services.
- Clinic managers – managers in charge of healthcare departments.
- Clinic nurses – registered persons who provide medical and nursing care to patients in clinics.

Sample size is one aspect of research design that researchers need to take into account as they plan their research (Burmeister & Aitken, 2012). In this study, participants drawn from four cases constitute a purposive sample of convenience. It was anticipated that the planned final sample of participants per level would include the following:

- Hospital directors (n = 2)
- Hospital doctors (n = 4)
- Hospital nurses (n = 4)
- Hospital administrators (n = 4)
- Clinic managers (n = 2)
- Clinic nurses (n = 4)

This sample above reflects a total of twenty (n = 20) participants related to the multiple case study. All participants were invited to partake in the study; 19 interviews were conducted. Table 3-10 illustrates the roles of the participants who took part in this study.

Table 3-10: Participants' roles

No.	Participants	Role	Years of service	Date
1	[HFD]	Director	1-3 years	29.10.2024
2	[HDR1]	Doctor	Above 10 years	29.10.2024
3	[HDR2]	Doctor	1-3 years	29.10.2024
4	[HN1]	Professional Nurse	7-10 years	29.10.2024
5	[HN2]	Professional Nurse	Above 10 years	29.10.2024
6	[HA1]	Administrator	Above 10 years	29.10.2024
7	[HA2]	Administrator	1-3 years	29.10.2024
8	[C1M1]	Manager	1-3 years	12.11.2024
9	[C1N3]	Professional Nurse	Above 10 years	12.11.2024
10	[C1N4]	Professional Nurse	7-10 years	12.11.2024
11	[CHCM2]	Manager	Less than a year	20.11.2024
12	[CHCDR3]	Doctor	Less than a year	20.11.2024
13	[CHCN5]	Professional Nurse	7-10 years	20.11.2024
14	[CHCN6]	Professional Nurse	4-6 years	20.11.2024
15	[CHCA3]	Administrator	4-6 years	20.11.2024
16	[CHCA4]	Administrator	7-10 years	20.11.2024
17	[C2M3]	Manager	7-10 years	26.11.2024
18	[C2N7]	Professional Nurse	Above 10 years	26.11.2024
19	[C2N8]	Enrolled Nursing Assistant	Above 10 years	26.11.2024

According to Patton (2015), the sample size depends on what the researcher wants to know, the intention of the inquiry, the information that will be valuable and credible and what can be accomplished with the available resources and time. The targeted sample excluded data collection from patients and technology suppliers. Instead, it focuses on individuals with expertise in healthcare facilities, allowing the researcher to collect informed insights. Aliff (2018, citing Morse, 1995) work, stresses that saturation is crucial for high-quality research, underscoring the need to demonstrate how data saturation was achieved and when the interviews were conducted. Creswell (2009) states that saturation occurs when the data collected no longer reveals any new insights. Hence, in this study, a total of 19 interviews were conducted to achieve the data saturation point (Guest et al., 2006; Chenail, 2011).

Section 3.6.1 presents respondent information linked to the four-phase method, encompassing 19 interviews, as shown in Tables 3-12, 3-13, 3-14, and 3-15.

3.4.2.5.5 Justification of sampling strategy

Given that the researcher is coming from the Eastern Cape, the sample is convenient for her. In addition, the rural community is of interest to the researcher. Thus, that gives the researcher access to context-specific expertise, information-rich participants, and representativeness of rural healthcare challenges. Furthermore, the researcher's personal experience with the loss of a family member in one of the rural hospitals in the area brought to the researcher's attention

the possibility that these facilities will provide the researcher with interesting feedback.

3.4.2.5.6 Inclusion and exclusion criteria for selected cases

The study collected data via four cases, including two hospitals and two clinics. This selection is based on a purposively selected set of cases convenient to the researcher's situation and the context of the study. This selection considered the rural area of the Eastern Cape. Furthermore, it indicates the exclusion of hospitals and clinics in urban areas of South Africa.

3.5 Data collection procedure

Data collection starts with the identification of participants (Young et al., 2018). The case outlined in Section 3.5.1 served as the vehicle for data-collection methods using interviews. This section discusses the methods used and defines the data collection instrument design. Thus, this section is outlined as follows: Section 3.5 explains the data collection procedure. Section 3.5.2 highlights the empirical methods, which comprises of four phases and 19 interviews.

3.5.1 Exploratory multiple case study

The empirical portion of this study consists of four exploratory multiple case study sets that set the healthcare context in South Africa.

***Instrument – semi-structured interviews*:** The interview protocol for this study was based on the work of Castillo-Montoya (2016), who posit that the interview protocol refinement framework is suitable for clarifying semi-structured interviews (refer to Appendix B.5, B.6, B.7, and B.8). Interviews are one of the most popular methods used in qualitative research for information gathering (Qu & Dumay, 2011; Englander, 2012; Gudkova, 2018; Mannan & Afni, 2020). Generally, the data collection method involves three stages, namely: preparing for interviews, conducting interviews, and transcribing interviews (Liu, 2016). Preparing for the interview is arguably the most important tip of advice on the interview process (Turner III, 2010). The research interview is one of the most important qualitative data collection methods and has been widely used in conducting field studies (Qu & Dumay, 2011).

The preparation phase of an interview involves the application of eight principles that comprise the following elements:

- Select a setting with little distraction,
- explain the purpose of the interview,
- address terms of confidentiality,
- describe the interview format,
- indicate the average duration of the interview,

- let the respondents know how to contact you later if they choose to,
- before the interview begins, ask the respondents if they have any questions, and
- don't rely on your memory to remember their responses (McNamara, 2009).

Interviews provide a useful tool for researchers to study the world of others, although real comprehension can occasionally be elusive (Qu & Dumay, 2011). Yin (2003) informs that conducting interviews is one of the main "important sources of case study information". The use of interviews as a method for gathering qualitative data has several advantages (Taylor, 2005), namely:

- It is possible to capture participants' own words,
- the interview might focus on issues important to the participants, rather than being led by the investigator's agenda,
- it is possible to seek clarification,
- allow opportunities for in-depth investigation, probe, and exploration,
- provides the possibility of recording and noting non-verbal behaviours,
- there is format flexibility in the interview,
- not much specialised equipment is needed, and
- The process makes use of existing skills of communication and conversation.

In this study, the researcher employed semi-structured interviews as a data collection method (Mack et al., 2005) and open-ended questions. The semi-structured interview involves prepared questioning guided by identified themes in a consistent and systematic manner, interposed with probes designed to elicit more elaborate responses (Qu & Dumay, 2011). Thus, both interviewer and interviewee participate in the interview, producing questions and answers through a discourse of complex interpersonal talk (Qu & Dumay, 2011). Semi-structured interviewing is a qualitative data collection approach (Ahlin, 2019). Conducting semi-structured interviews involves preparation and planning, including how questions are posed and interpreted before, during and after the interviews (Qu & Dumay, 2011). The semi-structured interview consists of prepared questions that are guided by predetermined themes in a systematic and consistent manner interposed with probes meant to elicit more in-depth responses (Qu & Dumay, 2011).

Figure 3-16 shows the best practices for a semi-structured interview.

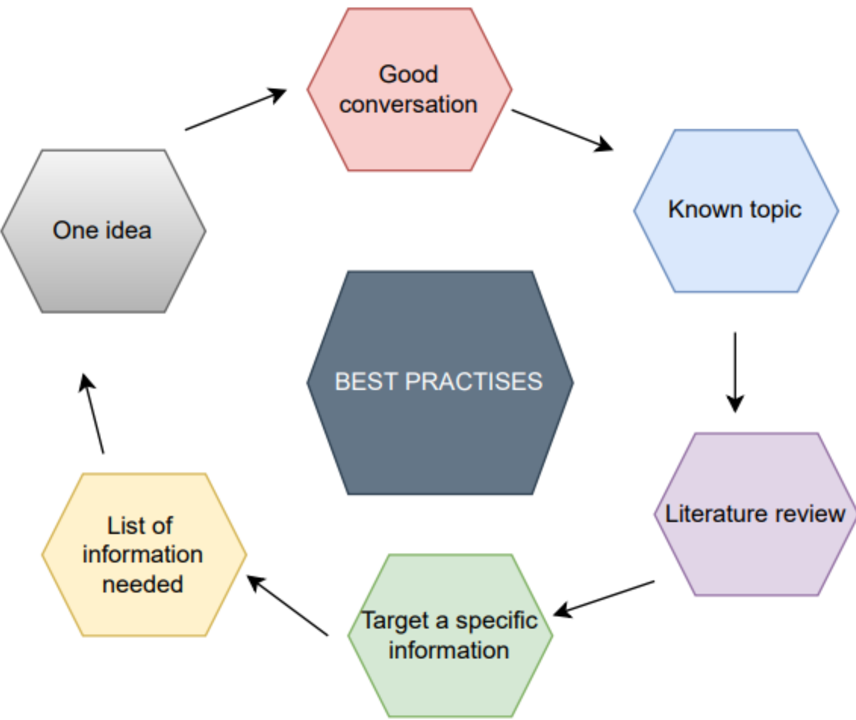


Figure 3-16: Best practices for semi-structured interviews (adapted from Mannan & Afni, 2020)

With reference to Figure 3-16, Mannan and Afni (2020) presents best practices for semi-structured interviews as follows:

- The interviewee needs to have a positive sense of conversation.
- Before the interview, the researcher should be conversant with the subject of the study.
- The researcher should always review the literature prior to creating the interview questions.
- After reviewing the literature, the interviewer must ask herself what information she needs to know from the semi-structured interview.
- It is necessary for the interviewer to prepare a list of all the questions they hope to ask during the semi-structured interview.
- Ensure that there is only one idea per item in the list.

Semi-structured interviews enable the researcher to probe for more information or refocus the questions, if something interesting or novel emerges (Baškarada, 2014; Young et al., 2018). The semi-structured interviewing is popular because of its flexibility, intelligibility and accessibility and, most importantly, its ability to reveal important and often concealed aspects of organisational and human behaviour (Qu & Dumay, 2011). Additionally, because it has its basis in human conversation, it:

- allows the skilful interviewer to modify the style, pace and ordering of questions to evoke the fullest responses from the interviewee (Qu & Dumay, 2011),

- enables interviewees to provide responses in their own terms and in the way that they think and use language (Qu & Dumay, 2011), and
- proves to be especially valuable if the researchers are to understand the way the interviewees perceive the social world under study (Qu & Dumay, 2011).

The research interview protocol was based on the four phases of the Interview Protocol Refinement (IPR) (Castillo-Montoya, 2016) as shown in the table below.

Table 3-11: Four phases of the Interview Protocol Refinement (IPR)

Phase	Purpose
Phase 1: Ensuring an alignment between interview and research questions (RQs)	To design an interview protocol (IP) matrix to link the interview questions to the RQs
Phase 2: Developing an inquiry-based conversation	To construct an IP that balances inquiry with conversation
Phase 3: Receiving feedback on IP	To get feedback on IP
Phase 4: Piloting the IP	To pilot the IP with a smaller sample

The interviews allow for face-to-face contact and will enable the interviewer to obtain detailed and in-depth information about participants' views and experiences of DT in healthcare (Dikko, 2016). The researcher used open-ended questions, as this permitted the researcher to maintain control over the flow of the conversation (Creswell, 2013). By doing so, the researcher obtains qualitative data. Open-ended questions, like *how* or *why*, were used.

Open-ended questions have the power to raise responses that are:

- Culturally salient and meaningful to the participant,
- unexpected by the researcher, and
- explanatory in nature and rich (Mack et al., 2005).

These interviews provided the researcher with rich, substantial data to better understand the participants' experiences. The use of semi-structured interviews enabled the researcher to follow up and trace explanations of the answers obtained during the interview (Kallio et al., 2016).

At the hospital level, the researcher purposively and conveniently selects three levels of participant role players from the cases mentioned above, A, B, C and D, as follows:

- Strategically (top-level managers),
- tactically (doctors), and
- operationally (nurses).

At the clinic level, the researcher interviewed professional nurses. At both hospital and clinic levels, the goal of the sample selection design is to collect sufficient data to achieve saturation (Saunders et al., 2019). Saturation describes the stage in an interpretative exploratory study where new data no longer adds new information or insights to the themes or research questions being explored (Guest et al., 2006; Chenail, 2011; Fusch & Ness, 2015).

Saturation is a key idea in qualitative research because it assists researchers in deciding whether they have gathered enough data to address their research questions or whether they still need to collect additional data to have a deeper knowledge of the phenomenon they are studying. Subsequent interviews may become necessary if the first round of interviews does not produce adequate levels of rich and substantial data. The researcher did not use questionnaires as they were irrelevant to the study.

Figure 3-17 shows the levels of hierarchy for the interview participants.

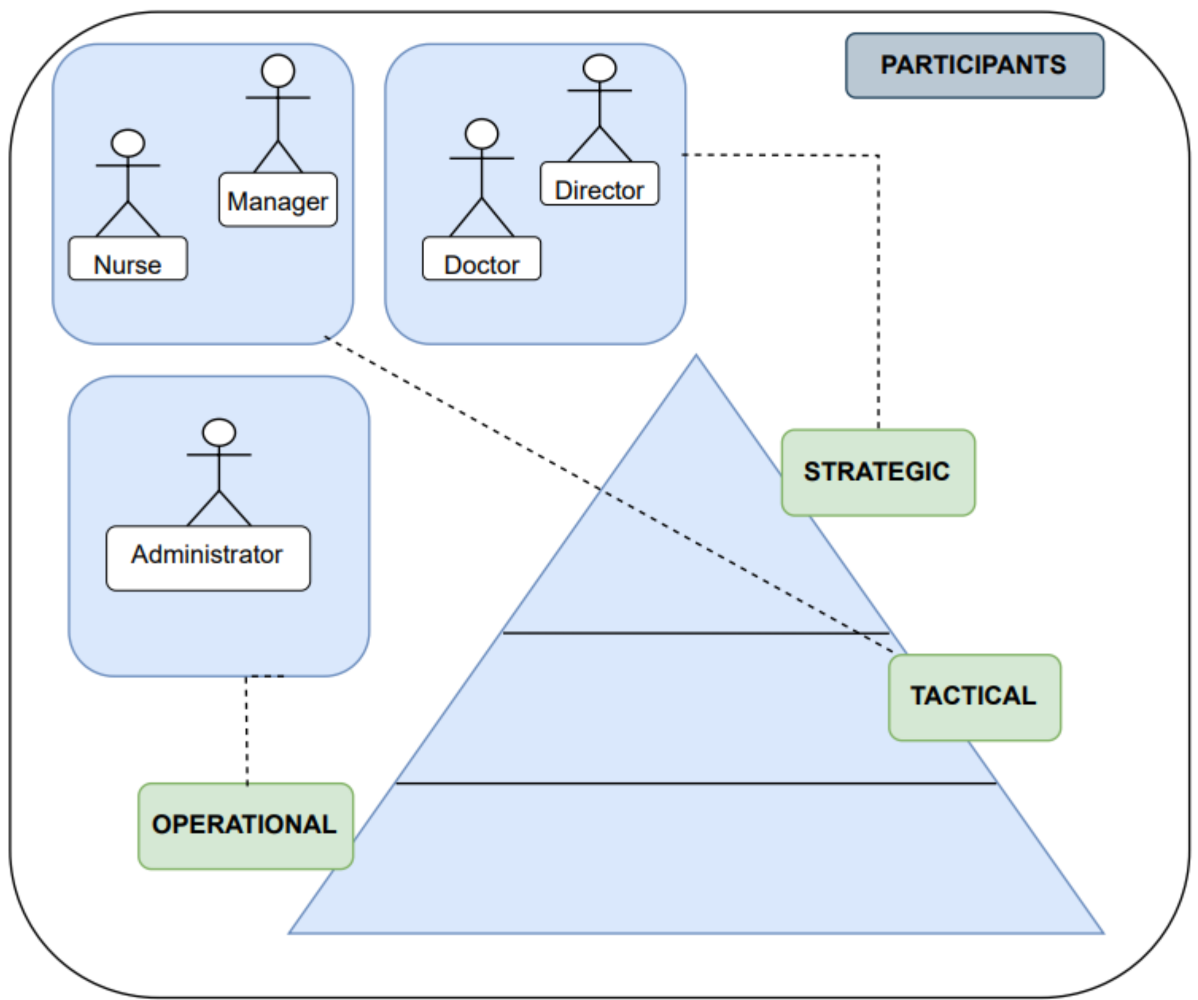


Figure 3-17: Interview participants (adapted from Theys et al., 2021)

It is necessary to transcribe the interview recordings (Whiting, 2008). Microsoft Teams, an integrated collaboration and communication tool, was employed to record participants' responses digitally, including taking notes.

Planned referral process: If emotional distress was observed during interviews under adverse circumstances, the following referral process was planned:

- Stop the interview, calm the participant down and allow a support person to be present,
- ask for support from a senior member of staff, and
- ensure that the emotional distress has been addressed satisfactorily by asking the participant if the interview can continue.

The interviews were conducted on different dates according to the participants' availability. At the beginning of each interview, the researcher thanked the participant for his/her availability. Then, the researcher assisted the participants in filling out the consent form. Thereafter, the researcher requested permission from the respondents to audio-record the interview. While the interview was in progress, the researcher took brief notes, which she used as memos during data analysis (Mncanca, 2022). Each interview lasted approximately 40 minutes. Semi-structured interviews assisted the researcher in interacting with the participants in an open and truthful conversation. Interviews were conducted for all four healthcare facilities chosen for this study at separate dates for the directors, managers, doctors, nurses, and administrators:

3.5.2 Empirical methods – four phases and nineteen studies

After completing the interviews, the interviewer transcribed the interview responses and imported the transcripts into ATLAS.ti for analysis (Mannan & Afni, 2020). The qualitative data collected were categorised into four phases of datasets as follows:

- Phase 1 – Seven studies
- Phase 2 – Three studies
- Phase 3 – Six studies
- Phase 4 – Three studies

3.5.2.1 Phase 1: Preamble – Seven studies

Table 3-12: Phase 1 with seven studies

Phase 1: Preamble				
	Study 1.1: Facility Director	**Studies 1.2 – 1.3: Facility Doctors (HDR1 – HDR2)**	**Studies 1.4 – 1.5: Facility Nurses (HN1 – HN2)**	**Studies 1.6 – 1.7: Facility Administrators (HA1 – HA2)**
Respondents	The Chief Executive Officer is the gatekeeper responsible for the entire facility. A purposive, non-probabilistic sample of convenience was selected from various departments in the same facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.
Instruments	Interview protocol	Interview protocol	Interview protocol	Interview protocol
Data collection methods	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview
Purpose	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection

Phase 1 involved the facility director (Study 1.1), two facility doctors (Studies 1.2 – 1.3), two professional nurses (Studies 1.4 – 1.5) and two facility administrators (Studies 1.6 – 1.7).

Study 1.1 Facility Director (HFD): Study 1.1 comprised an initial, semi-structured interview with the director, who is the CEO of the hospital facility. His responsibilities include:

- Leadership,
- developing and implementing long-term strategic plans,
- financial administration,
- effective use of resources,
- innovation,
- adaptability in the healthcare landscape, and
- the delivery of high-quality patient care while ensuring regulatory compliance.

Ultimately, the facility director holds the responsibility for the facility's overall performance, success, and compliance with regulations. The facility director served as gatekeeper to the research participants. This study aimed to establish rapport, gauge the feasibility of the planned data collection, and gather preliminary, in-depth information concerning the participants and the facility. The interview was conducted in the director's office and lasted around 40 minutes. Notes were taken and responses were recorded. The interview transcripts included those of the hospital Director serving as the Chief Executive Officer (CEO) of the facility, two doctors, two nurses, and two administrators.

Studies 1.2 – 1.3 Facility Doctors (HDR01): Studies 1.2 – 1.3 included two doctors from a hospital facility. The interviews were conducted in an office-based environment, and each respondent was interviewed separately. The semi-structured interviews took approximately 30 minutes. During the interviews, the researcher took notes while recording the responses from each participant.

Stud 1.4 – 1.5 Facility Nurses (HN1 – HN2): Studies 1.4 – 1.5 encompassed two hospital professional nurses for the facility, whose roles include evaluating patients, administering medications, keeping accurate records, tracking vital signs, offering education, and advocating for patients' well-being. Interviews were conducted in a professional manner in a safe and secure research environment. Each participant was interviewed separately, and the interview took approximately 20 minutes. The participants' responses were recorded.

Studies 1.6 – 1.7 Facility Administrators (HA1 – HA2): Studies 1.6 – 1.7 comprised two hospital facility administrators from different departments playing a vital role in ensuring the accuracy, security, and accessibility of the data. Each participant was interviewed separately

in an office-based environment. The semi-structured interviews took approximately 30 minutes for each participant. During the interviews, the researcher took notes while recording the participants' responses.

3.5.2.2 Phase 2 Preamble – Three studies

Table 3-13: Phase 2 with three studies

Phase 2: Preamble		
	Study 2.1: Facility Manager (C1M1)	**Studies 2.1 – 2.2: Facility Nurses (C1N3 – C1N4)**
Respondents	The facility manager is the gatekeeper responsible for the entire facility. A purposive, non-probabilistic sample of convenience was selected from various departments in the same facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.
Instruments	Interview protocol	Interview protocol
Data-collection methods	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview
Purpose	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection

Phase 1 involved the facility manager (Study 2.1) and two professional nurses (Studies 2.2 – 2.3).

Study 2.1 Facility Manager (C1M1): Study 2.1 comprised the clinic facility manager, whose responsibilities involve managing all facets of the facility operations, ensuring high-quality patient care, effective use of resources and adherence to regulatory standards. The facility manager served as a gatekeeper to the research participants. This study aimed to create a connection with the facility manager for the planned data collection and gather preliminary, in-depth information concerning the participants and the facility.

Studies 2.2 – 2.3 Facility Nurses (C1N3 – C1N4): Studies 2.2 – 2.3 encompassed two clinical professional nurses for the clinic facility who deliver a broad spectrum of patient care services within a clinic environment, such as conducting assessments, administering medications, educating patients, and working alongside medical staff.

3.5.2.3 *Phase 3 Preamble – Six studies*

Table 3-14: Phase 3 with six studies

Phase 3: Preamble				
	Study 3.1: Facility Manager (CHCM2)	**Study 3.2: Facility Doctor(s) (CHCD3)**	**Studies 3.3 – 3.4: Facility Nurses (CHCN5 – CHCN6)**	**Study 3.5 – 3.6: Facility Administrators (CHCA3 – CHCA4)**
Respondents	The facility manager is the gatekeeper responsible for the entire facility. A purposive, non-probabilistic sample of convenience was selected from various departments in the same facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.
Instruments	Interview protocol	Interview protocol	Interview protocol	Interview protocol
Data collection methods	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview
Purpose	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection

Phase 3 involved the facility manager (Study 3.1), one facility doctor (Study 3.2), two professional nurses (Studies 3.3 – 3.4), and two facility administrators (Studies 3.5 – 3.6).

Study 3.1 Facility Manager (CHCM2): Study 3.1 involved of the community health centre facility manager responsible for handling day-to-day operations, developing strategic plans, maintaining the facility's financial stability, ensuring effective use of resources and overseeing patient care and adherence to healthcare regulations. The facility manager also served as gatekeeper to the research participants. This study aimed to create a connection with the facility manager for the planned data collection and gather preliminary, in-depth information concerning the participants and the facility.

Study 3.2 Facility Doctor(s) (CHCD3): Study 3.2 consisted of one community health centre facility doctor responsible for a wide range of responsibilities primarily focused on diagnosing, treating, and managing patient care, collaborating with other stakeholders, maintaining accurate medical records and educating patients. The semi-structured interview was conducted in an office-based setting and took approximately 30 minutes. During the interview, the researcher took notes and recorded the responses from each participant.

Studies 3.3 – 3.4 Facility Nurses (CHCN5 – CHCN6): Studies 3.3 – 3.4 involved two professional nurses for the facility performing a wide variety of duties aimed at delivering primary care services and supporting overall community health and wellness. The semi-structured interviews were conducted in an office-based environment. Each participant was interviewed separately, and the interview took approximately 20 minutes. The participants' responses were recorded.

Studies 3.5 – 3.6 Facility Administrators (CHCA3 – CHCA4): Study 3.5 – 3.6 involved two community health centre facility administrators tasked with maintaining data accuracy, security, and availability of the facility's data, such as patient records and other important information. They are also actively involved in data analysis, reporting, and compliance with regulations. Each participant was interviewed separately in an office-based environment. The semi-structured interviews took approximately 30 minutes for each participant. During the interviews, the researcher was taking notes while recording the participants' responses.

3.5.2.4 *Phase 4 Preamble – Three studies*

Table 3-15: Phase 4 with four studies

Phase 4: Preamble		
	Study 4.1: Facility Manager (C2M3)	**Studies 4.1 – 4.2: Facility Nurses (C2N7 – C2N8)**
Respondents	The facility manager is the gatekeeper responsible for the entire facility. A purposive, non-probabilistic sample of convenience was selected from various departments in the same facility.	A purposive, non-probabilistic sample of convenience was selected from various departments in the facility.
Instruments	Interview protocol	Interview protocol
Data collection methods	Face-to-face, semi-structured interview	Face-to-face, semi-structured interview
Purpose	Determination of initial contextual information, feasibility of data collection	Determination of initial contextual information, feasibility of data collection

Phase 1 encompassed the clinic facility manager (Study 4.1) and two clinic professional nurses (Studies 4.2 – 4.3).

Study 4.1 Facility Manager (C2M3): Study 4.1 involved a clinic facility manager performing a vital and wide-ranging role, overseeing daily operations, managing staff, handling finances, and ensuring quality patient care. The facility manager served as a gatekeeper to the research participants. This study aimed to establish a connection with the facility manager for the planned data collection and gather preliminary, in-depth information concerning the participants and the facility.

Studies 4.2 – 4.3 Facility Nurses (C2N7 – C2N8): Studies 4.2 – 4.3 encompassed one clinic professional nurse and an assistant nurse for the facility. The professional nurse conducts patient evaluation, monitors vital signs, and delivers medical treatments. The role of the assistant nurse is to support basic nursing tasks, taking vital signs, assisting with hygiene, preparing patients for procedures, and managing medical records. The semi-structured interviews were conducted in an office-based environment. Each participant was interviewed separately, and the interviews took approximately 15–20 minutes. The participants were recorded. The next section presents the analysis of empirical data.

3.6 Data analysis

This section comprises the following sub-sections:

- Preparing and organising data,
- data analysis tool – ATLAS.ti v9,
- qualitative data analysis,
- reporting and dissemination of findings.

3.6.1 Preparing and organising the data – transcription

Preparing the data involves formatting it in a way that facilitates effective analysis (Cohen et al., 2018). Among other factors, preparing the data required assigning pseudonyms to the four healthcare facilities that participated in this research to hide their identities as well as those of the participants (Mncanca, 2022). Thus, the facilities were given names: Case A, Case B, Case C, and Case D. Likewise, the participants were given pseudonyms. The audio responses from the interviews were digitally recorded via a smartphone application. Thereafter, the recordings were transcribed using the transcription software. After transcribing all the audio responses from the interviews, the researcher checked each transcript for accuracy against the original audio recordings. Additionally, Microsoft Word (MS) was used to convert the recordings into a text file, and the MS documents were converted into a PDF file for analysis. Furthermore, the researcher imported the pdf files to ATLAS.ti v9 for data analysis.

3.6.2 Data analysis tool – ATLAS.ti v9

Data analysis was done in ATLAS.ti v9, a Computer Assisted Qualitative Data Analysis Software (CAQDAS) tool. ATLAS.ti v9 served for this study for several purposes, namely to:

- arrange files and data in an orderly manner,
- store data, notes and searches,
- explore and analyse data and text,
- create, revise, and refine them,
- Search and extract data from single files or across multiple files, including codes, notes, and memos,
- present data in various formats and generate visual data modelling and graphics,
- create connections among categories, such as chronological, hierarchical or relational relationships,
- assign codes to data and organise them into the hierarchical structure (trees) and key categories (nodes). This facilitates initial coding and allows text segments to be labelled for easier sorting and analysis later,
- proofread the data,
- facilitate the creation of memos, along with information about the context in which they were written,
- filter, organise and connect data according to themes, and

- cite data in the final report and export to different formats or software (Cohen et al., 2018).

The CAQDAS data analysis tools supported the researcher in importing the transcripts, conducting an iterative coding process to develop categories, and creating a report based on several themes that emerged from the data (Creswell, 2009). Figure 3-18 is an example of the imported transcripts.

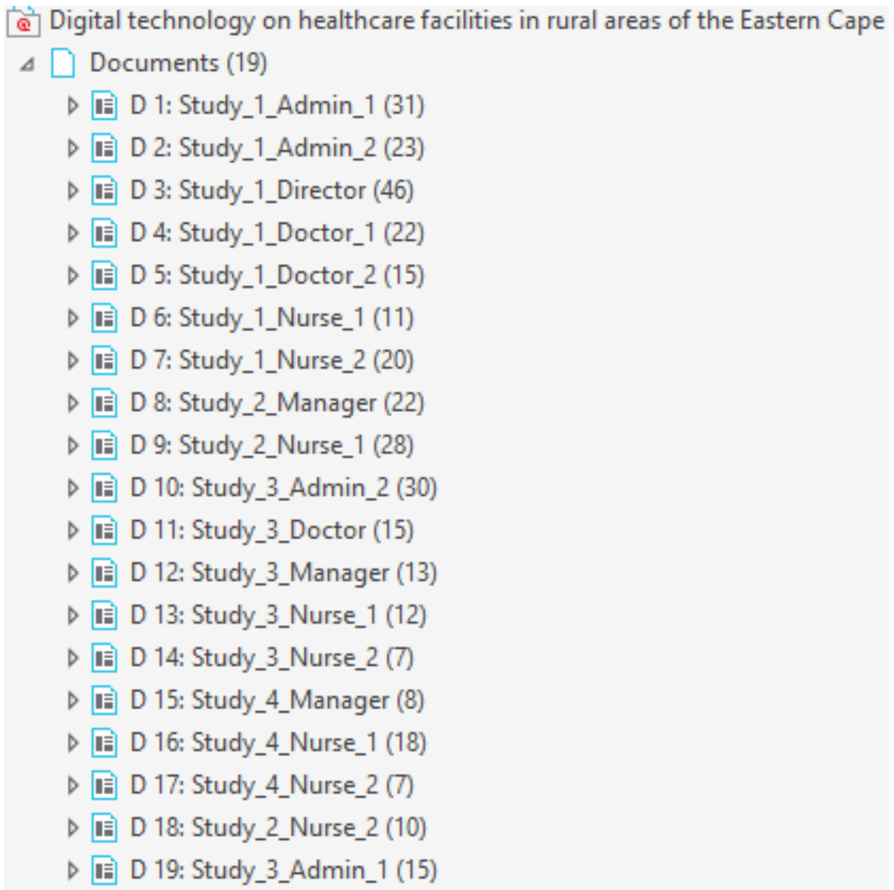


Figure 3-18: ATLAS.ti v9 except showing the imported transcripts

After importing the transcripts into ATLAS.ti v9, the thematic data analysis commenced.

3.6.3 Thematic aspects

In qualitative research data analysis is commonly known as interpretive analysis (Creswell, 2009). The researcher employed thematic analysis to explore and understand shared and collective meanings and experiences (Braun & Clarke, 2006). This study followed the interpretive analysis to gain an understanding of the impact of DT on healthcare facilities in a rural environment in the Eastern Cape province, South Africa.

With the use of ATLAS.ti v9 tool, the researcher managed, extracted, coded, compared and examined the data (Friese, 2011). Figure 3-19 illustrates how the researcher assigned the codes to the data using the 'Apply Code' feature in ATLAS.ti v9.

It is good impact, it will be bad because of connectivity challenges, network here is not good, connectivity is not good. That's why it makes it difficult. Now we are able to connect with this digital technology and then as you are saying, we don't need to come all of us in one place, meetings have been reduced to one-on-one or group meeting under one group as I am waiting for the meeting now from what they were all over, so you are able to discuss with different stakeholders that you have meeting with municipalities, meeting with the old education, meeting... you, you don't need to...So that impact is good because you can have a meeting, a fruitful meeting, but before we were not used and we thought that it's not going to work.

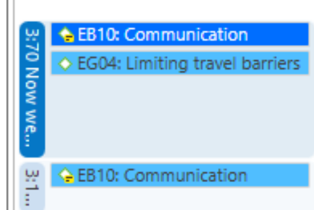


Figure 3-19: ATLAS.ti except showing assigning codes

The code manager helped the researcher to create new free codes, rename, duplicate, merge or split codes, and drag and drop codes. Figure 3-20 shows how I merged the theoretically-based codes in ATLAS.ti v9. Similar to the theoretically based codes, the empirically based codes in Figure 3-20 were merged because they reflect similar meaning. This difference in wording reflected variations across participants in how they expressed their lived experiences. Therefore, merging these codes enhanced conceptual clarity. Furthermore, merging ensured that theme development was informed by the underlying analytical processes rather than superficial differences in languages.

Name	Grounded	Density
EDTT18: IHSR	2	0
EDTT19: ISP	4	0
EDTT20: Lab Trak	9	0
EDTT21: LOGIS	4	0
EDTT22: Mobile apps~	10	0
EDTT23: Monitoring devices~	9	0
EDTT24: OHSC	1	0
EDTT25: PERSAL	4	0
EDTT26: RxSolution	4	0
EDTT27: TIER.Net	7	0
EPB09: Accessibility~	28	0
EPB10: Communication~	22	0
EPB11: Data storage	8	0
EPB12: Automation~	22	0
EPB13: Monitoring~	5	0

Figure 3-20: ATLAS.ti v9 excerpt showing the merging of empirically-based codes

The researcher categorised themes from the interview data (Braun & Clarke, 2006). Figure 3-21 presents an excerpt from ATLAS.ti, demonstrating the allocation of empirically based codes to their relevant themes.

Name	Grounded	Density	Groups
EDTT18: IHSR	2	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT19: ISP	4	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT20: Lab Trak	9	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT21: LOGIS	4	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT22: Mobile apps~	10	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT23: Monitoring devices~	9	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT24: OHSC	1	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT25: PERSAL	4	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT26: RxSolution	4	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EDTT27: TIER.Net	7	0	[CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT)]
EPB09: Accessibility~	28	0	[CATEGORY B: PERCEIVED BENEFITS (PB)]
EPB10: Communication~	22	0	[CATEGORY B: PERCEIVED BENEFITS (PB)]
EPB11: Data storage	8	0	[CATEGORY B: PERCEIVED BENEFITS (PB)]
EPB12: Automation~	22	0	[CATEGORY B: PERCEIVED BENEFITS (PB)]

Figure 3-21: Linking theoretically-based codes to the relevant themes in ATLAS.ti v9

Thereafter, the author connected citation codes to generate networks using ATLAS.ti v9 (Lewis, 2016). Finally, I created a codebook from the studies using the 'In Vivo' and 'Open Coding' (Friese, 2011).

In summary, ATLAS.ti v9 improves rigor in qualitative research in several ways by facilitating coding reliability and data triangulation of both primary and secondary data. Qualitative data analysis is a repetitive process of engaging oneself in the data and "making sense" of it (Hanson et al., 2011). It allows the researcher to comprehend the data gathered from participants, which includes participant definitions, themes, categories and regularities (Cohen et al., 2007; Male, 2016). Qualitative research employs purposeful sampling as opposed to a random sample, which addresses the assumptions of statistical analysis techniques (Hanson et al., 2011). In this study, the researcher seeks to generate a deeper understanding of phenomena from the specific details included within the data, instead of using general theories or models to anticipate what data will show (Hanson et al., 2011).

3.6.4 Reporting and dissemination of findings

The systematic literature review and the empirical studies are reported in Chapters 5, respectively, cohesively linking the outcomes of the SLR to the findings of the empirical perspectives. Analysed data were categorised, presented as sub-categories in tabular format, and interspersed between substantial descriptions. Figure 3-22 shows six categories of empirical data analysis.

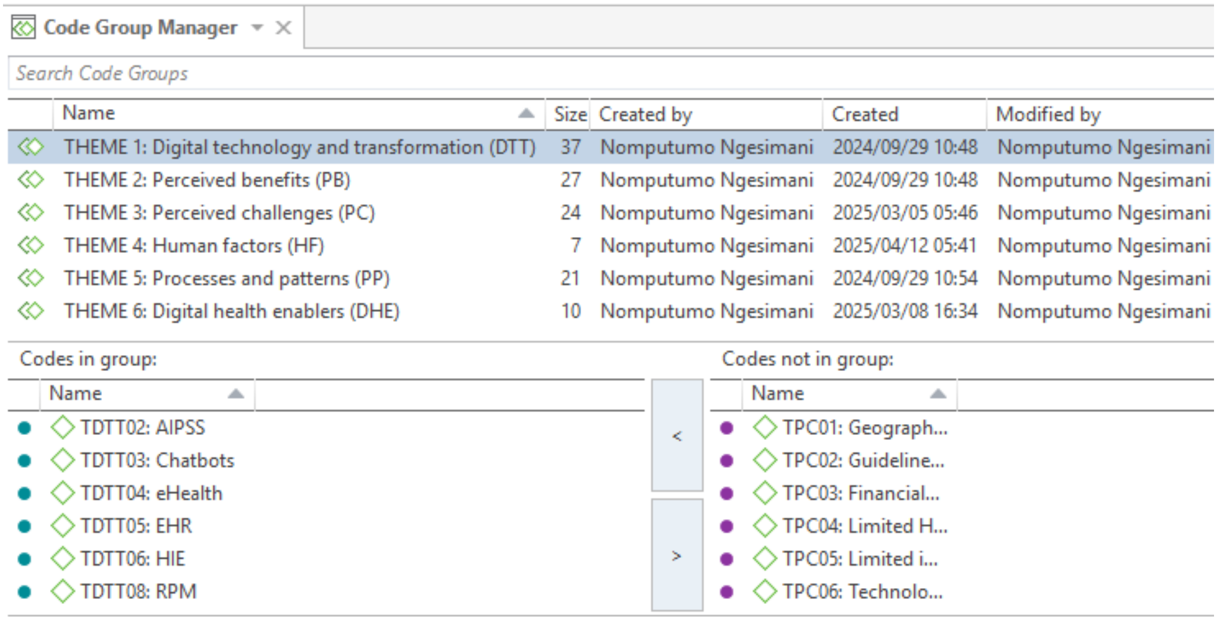


Figure 3-22: Six categories of empirical data analysis

The reporting strategy aimed to support the transferability of findings (Creswell, 2009).

3.6.5 The reflexivity role as a researcher

As a researcher with a background and interest in rural healthcare delivery, I acknowledge that my values and experiences have significantly influenced my interpretation of the existing literature. My familiarity with the challenges encountered by rural healthcare professionals and communities has notably shaped my focus on various issues, including digital divides, access barriers, and cultural resistance. While this familiarity equips me with a nuanced understanding of the local context, I recognise that it may also introduce potential bias in interpreting findings. To mitigate this, I have engaged in rigorous self-reflection and made concerted efforts to use diverse and credible sources to ensure a balanced perspective. Furthermore, I have exercised diligence in employing a systematic approach to coding and analysis, ensuring that my assumptions do not overshadow the voices and insights articulated within the literature.

3.7 Ethical considerations associated with conducting empirical data

Research ethics enhance the core values that are vital to effective collaboration, including trust, accountability, mutual respect, and fairness (Resnik, 2015). The data collection process in this study was guided by key principles, including gaining permission and access, voluntary participation, informed consent, privacy, anonymity, and confidentiality.

3.7.1 Gaining permission and access

This study received ethical approval for collecting the empirical data from the Cape Peninsula University of Technology Research Ethics Committee (Appendix B.1). Thereafter, the research

obtained permission letters from the Department of Health (Appendix B.4.1, Appendix B.4.2 and Appendix B.4.3). After obtaining approval from both institutions, the researcher approached four healthcare facilities to outline the purpose and nature of the study to the gatekeepers (director(s) and managers of the four healthcare facilities and requested permission to collect the data in their premises. The researcher also provided each facility gatekeeper with the information letter for the study (Appendix B.3). All four gatekeepers supported the study and permitted the researcher to conduct the study in their facilities. The gatekeepers played a big role in assisting the researcher in approaching other participants involved in the study. The appointed gatekeeper gave the researcher the names of suitable participants for the interview.

3.7.2 Voluntary participation

Participation of the respondents in this study was voluntary. Crow et al. (2006) stress that participants who receive the information consent must voluntarily agree to participate with the freedom to decline or withdraw from the study at any time without facing negative consequences. Therefore, all participants in this study took part in their own free will and were informed about the right to withdraw at any phase.

3.7.3 Informed consent

The principle of informed consent requires that potential research participants receive complete and understandable information about the study, enabling them to make a well-informed choice regarding participation (Crow et al., 2006). The researcher provided comprehensive information regarding participation to all participants before commencing the interviews. Then, during the face-to-face interview, the respondents were asked to complete informed consent agreements. Therefore, all participants gave informed consent before taking part in the study (Appendix B.4).

3.7.4 Protecting research participants from harm

To guarantee the protection of participants, the information letter contains the details of the principal supervisor as well as the details of the co-supervisor for reporting any discomfort or harm experienced during the study. The researcher kept the data collected from the participants on a password-protected computer.

3.7.5 Privacy, anonymity and confidentiality

Among other ethical measures that were taken to protect the participants and the purpose of the research, the participants were informed about guaranteed confidentiality. The researcher informed and reassured the participants that their names would not be mentioned in the report for confidentiality purposes (Appendix B.3). Furthermore, the researcher ensured that all

interview data and recordings are kept confidential and private in accordance with the Protection of Personal Information Act (POPIA) regulations (De Bruyn, 2014).

3.7.6 Trustworthiness

In this study, the researcher's goal was to establish credibility, dependability of the findings, confirmability of the data and analysis and transferability of the study to other settings (Hanson et al., 2011). According to Lincoln and Guba (1985), to explore trustworthiness, qualitative research can be measured in four ways, namely: credibility, transferability, dependability and confirmability and the techniques that the authors recommend. The researcher applied these techniques: triangulation, member checking, audit enquiry, substantial descriptions and reflexivity (Polit & Beck, 2010; Harpur, 2018) to support the enhancement of credibility, transferability, dependability and confirmability.

3.7.6.1 Credibility – triangulation and member checking

Credibility is a measure of the value of truth in a qualitative study. It checks whether the results are accurate and correct. It inquires, "How congruent are the findings with reality?" (Stahl & King, 2020). The study employed triangulation to ensure the credibility, reliability and validity of the data and findings (Fusch et al., 2018). Triangulating means using multiple sources of procedures or information from the field to generate identifiable patterns repeatedly (Stahl & King, 2020). The researcher incorporated participant triangulation to gain information from different sources to support each other.

Through triangulation, the researcher cross-examined the integrity of participants' responses and minimise systematic bias (Vicent, 2015). Lincoln and Guba (1985) inform that member verification is a vital technique for establishing credibility. It offers participants the opportunity to question and correct errors in what they perceive as incorrect interpretations.

3.7.6.2 Transferability – substantial descriptions

Transferability in this study refers to how well substantial and rich data is presented and how other researchers can apply it in similar contexts (Lincoln & Guba, 1985). In this study, substantial or detailed descriptions developed contextualised and explicit guidelines, leading to patterns for using DT in healthcare facilities (Harpur, 2018).

3.7.6.3 Dependability – external audit

Dependability is used to demonstrate the consistency and reliability of the study results. It refers to a decision made by a skilled external auditor that determines whether an audit trail exists (Lincoln & Guba, 1985). To establish dependability, the researcher used an audit trail and asked high-level academics as well as a community of fellow researchers to review the

content of the thesis (Harpur, 2018). Peer review is a solid communication habit that creates trust (Stahl & King, 2020).

Dependability is used to demonstrate the reliability and consistency of the study results. The purpose is to assess accuracy and whether or not the results, interpretations, and conclusions are in line with the data. Senior academics and researchers with expertise reviewed this study. To establish dependability, the researcher also used an external audit to review the thesis content (Harpur, 2018).

3.7.6.4 Confirmability – reflection

Confirmability is established when credibility, transferability and dependability are all achieved (Lincoln & Guba, 1985). It refers to the point when research results can be confirmed by other academics (Lincoln & Guba, 1985). The researcher engaged participants who contributed to this research by confirm the interpretation of the results. The researcher transcribed the recordings of the interviews and returned them to the participants to verify that the interpretations of the findings accurately reflected their responses. Reflexivity is an important aspect, which ensured that the researcher's perspectives did not bias the interpretation of the findings.

3.8 Chapter summary

This chapter demonstrated the synthesis of a structured framework for DT within healthcare contexts. The early phases of the systematic literature study (Section 2.3) resulted in a selection of 55 articles, which informed subsequent analysis and framework development.

CHAPTER 4: FINDINGS

4.1 Introduction

The preceding chapter detailed the research design and methodology, including the data collection methods employed, and the approach to data analysis. This chapter presents the findings of the study, framed within a constructivist ontological perspective and an interpretivist epistemology. The findings reflect the subjective experiences and interpretations of healthcare professionals. The analysis emphasises the identification of recurring themes and patterns that emerge from the data. This chapter presents the findings derived from a dual-method strategy, as described in section 3.4 and section 3.5 of Chapter 3, integrating both the theoretical perspectives (SLR) in section 4.2 and the empirical perspectives in section 4.3. A more detailed interpretation of these findings will be provided in the following chapter.

4.2 Findings – theoretical perspectives (SLR)

This section outlines the findings of the initial phase of the dual-method research strategy, the theoretical component of this study. The SLR noted many publications that addressed the components of digital technology and transformation, perceived benefits, perceived challenges, and processes and patterns in the rural healthcare context. Table 2-1 shows the four themes that emerged from the preliminary review of the literature from Chapter 2. In Chapter 2, the researcher's initial approach led to four intuitive four themes; however, after analysis using ATLAS.ti V9, two themes were larger; therefore, the researcher split the 'Perceived Benefits and Perceived Challenges' into two themes, namely, 'Perceived Benefits', and 'Perceived Challenges' (see Table 4-1, which is an adjusted version of the Table 2-1 in Chapter 2).

The study employed the conceptual framework in Chapter 2, Figure 2-1 that presents a synthesised view of the concepts derived from relevant theories, namely, adoption, integration, acceptance, willingness, new behaviour patterns, and perceived benefits and barriers, which formed the foundation of the SLR (Phase 1). The researcher also employed the process of immersion, an iterative, inductive process used to identify themes, patterns, and categories within data (Borkan, 2022).

Table 4-1: Adjusted summary of preliminary literature with noted gaps

#	Author	Title	Method	Source	Noted gap	Themes ad concepts
1.	Hassounah *et al.*(2020)	Digital response during Covid-19 pandemic in Saudi Arabia	Empirical Research	Journal of Medical Internet Research	Further investigate the successes and challenges of the digital experience.	**Human Factors**, Impact of Adoption
2.	Brown *et al.* (2020)	Issues affecting nurses ' capability to use digital technology at work – An integrative review	An integrative review	Journal of Clinical Nursing	Further research is needed to understand nurses 'attitudes and knowledge towards latest technologies.	**Human Factors**, Attitudes, Technological Changes, Environment
3.	Tortorella *et al.* (2021)	Impacts of digital 4.0 digital technologies on the resilience of hospitals	Empirical Research	Technological Forecasting and Social Change	There is a need to evaluate changes implied by new technologies in the work processes.	**Processes and Patterns,** Adjustments, Monitoring and Evaluation
4.	Abdolkhani *et al.* (2022)	The Impact of Digital Health Transformation Driven by COVID-19 on Nursing Practice: Systematic Literature Review	Systematic Literature Review	JMIR Nursing	Researchers may not have examined nurses' experiences and outcomes during COVID-19 across various regions.	**Processes and Patterns , Digital Technology and Transformation,** Adoption, Integration
5.	Aruleba and Jere, (2022)	Exploring digital transforming challenges in rural areas of South Africa through a systematic literature of empirical studies	Systematic Review	Scientific African	The digital divide in the rural areas.	**Processes and Patterns, Digital Technology and Transformation,** Adoption, Integration
6.	Sharma and Kshetri, (2020)	Digital healthcare: Historical development, applications, and future research directions.	Empirical Research	International Journal of Information Management	Authors recommend exploration of using DTs to assess their actual performance.	**Perceived Benefits, Perceived Challenges**, Adoption, Integration
7.	Rasa *et al.* (2021)	Using digital technologies in clinical trials: Current and future applications.	Empirical Research	Contemporary Clinical Trials	Rigorous examinations of limitations of using DTs to assess their actual performance.	**Perceived Benefits, Perceived Challenges**, Efficiencies
8.	Tlapa *et al.* (2022)	Effects of Lean Interventions Supported by Digital Technologies on Healthcare Services: A Systematic Review	Systematic Review	International Journal of Environmental Research and Public Health	Further research should focus on staff outcomes and patient outcomes on adaptation and implementation of the DTs	**Perceived Benefits, Perceived Challenges**, Adoption, Integration
9.	Hélène *et al.* (2021)	Use of digital technologies in the time of COVID-19: opportunities and challenges for professionals in psychiatry and mental health care	Systematic Review	JMIR Human Factors	Further research to understand better variables in DT.	**Digital Technology and Transformation**, Technology Use Levels
10.	Mbunge *et al.* (2022)	Virtual healthcare services and digital health technologies deployed during coronavirus disease 2019 (COVID-19) pandemic in South Africa: a Systematic review.	Systematic Review	Global Health Journal	There is a lack of research in the low use of technologically supported medical care in rural areas.	**Digital Technology and Transformation**, Adoption, Integration, Technology Use Levels

The qualitative analysis of coded text led to a consolidated hierarchy of 86 theoretically-based codes, organised within the five categories or themes:

- Digital technology and transformation,
- perceived benefits,
- perceived challenges,
- human factors, and
- processes and patterns.

Table 4-2 is an extract from Appendix A.1. It tabulates a portion of extracted themes, sub-themes and encoded items that emerged during qualitative data analysis of selected studies using ATLAS.ti v9.

Table 4-2: Categories, sub-categories and items

Theme	Sub-themes	Items
Digital technology and transformation	Digital health designs	TDTT01: AIES
		TDTT02: AIPS
		TDTT04: eHealth
		TDTT05: EHR
		TDTTT06: HIE
		TDTT08: mHealth
		TDTT10: SNPs
		TDT11: Teleconsultation
		TDTT12: Telehealth
		TDTT13: Telemedicine
		TDT14: Video conferencing
	Bots and monitoring devices	TDTT03: Chatbots
		TDTT07: IoT
		TDTT09: Remote patient monitoring

The qualitative analysis of coded text led to a consolidated hierarchy of 86 theoretically-based codes, organised within the five categories: ‘Digital technology and transformation’, ‘Perceived benefits’, ‘Perceived challenges’, ‘Human factors’, and ‘Processes and patterns’. Table 4-2 represents an illustrative sample of the five proposed categories, sub-categories, and the items associated with each category reported in Appendix D. Table 4-2 illustrates the link between the categories, sub-categories, and items. Appendix D displays the full list of categories, sub-categories, and items. The different colours distinguish the items for each category.

The five categories comprised 49 items, allocated as follows:

- THEME 1: Digital technology and transformation – 14 items (29%),
- THEME 2: Perceived benefits – 9 items (18%),
- THEME 3: Perceived challenges – 11 items (23%),
- THEME 4: Human factors – 3 items (6%), and
- THEME 5: Processes and patterns – 12 items (24%).

The items in each category were numbered to specify whether they were empirically determined (E) or theoretically-based (T). Figure 4-1 is a snippet from ATLAS.ti v9 that illustrates the categories and their associated codes.

CATEGORY A: DIGITAL TECHNOLOGY and TRANSFORMATION (DTT) (13)
TDTT01: AIES {2-3}
TDTT02: AIPSS {3-2}
TDTT03: Chatbots {6-2}
TDTT04: eHealth {14-5} ~
TDTT05: EHR {3-3} ~
TDTT06: HIE {1-2}
TDTT07: IoT {1-2}
TDTT08: mHealth {15-6} ~
TDTT09: RPM {20-2} ~
TDTT10: SNPs {2-3}
TDTT11: Teleconsultation {5-7}
TDTT12: Telehealth {28-6} ~
TDTT13: Telemedicine {30-4} ~

Figure 4-1: CATEGORY A: Digital technology and transformation (DTT) and items

The added prefix character showed category association, for example, TDTT08: mHealth refers to a theoretically-based code in 'Digital technology and transformation' category for item or code 08.

The study aimed to develop a comprehensive framework by integrating five major categories, each addressing unique aspects of the research focus. This strategy is theoretically and practically beneficial to healthcare technology experts. It provides a foundation for the future development of conceptual frameworks. Network diagrams resulted from data analysis, mapping items to five categories.

In section 2.2.7 of Chapter 2, the researcher proposed the conceptual framework based on five theories and concepts that emerged from the literature review. Thereafter, during the analysis of the SLR, the researcher used those concepts as a foundation for the SLR analysis

in ATLAS.ti. v9, which are:

- THEME 1: Digital technology and transformation (DTT),
- THEME 2: Perceived benefits (PB),
- THEME 3: Perceived challenges (PC),
- THEME 4: Human factors (HF), and
- THEME 5: Processes and patterns (PP).

The themes were then sub-divided into the sub-categories in preparation for writing.

4.2.1 THEME 1: Digital technology and transformation (DTT)

Digital technology and transformation in rural healthcare is redefining how services are delivered, accessed, and managed. This section highlights the diverse applications and evolving patterns that define the digital health landscape in rural areas worldwide. THEME 1 encompasses five sub-categories, namely:

- Artificial intelligence (AI) in healthcare,
- Electronic health (eHealth) infrastructure,
- Remote patient monitoring (RPM) and Telehealth,
- Mobile health (mHealth) and wearable devices, and
- Digital health records and information exchange.

4.2.1.1 Artificial Intelligence (AI) in healthcare

This section covers three items: 'AI-based emergency service', 'AI-based patient support system', and 'Chatbots'.

i) AI-based emergency service (AIES)

An AIES uses artificial intelligence (AI) to improve emergency response, ensure efficient use of resources and enhance outcomes during critical incidents on healthcare facilities (Selvaraj, 2024).

ii) AI-based patient support system (AIPS)

An AIPS uses AI to tackle the specific healthcare challenges faced in rural communities (Selvaraj, 2024).

iii) Chatbots

Chatbots, also known as conversational user interfaces, are a form of technology that can be used to respond to inquiries (Potts et al., 2021).

4.2.1.2 Electronic health (eHealth) infrastructure

This section covers eHealth, which represents a transformative approach to healthcare delivery, leveraging DTs to enhance access, efficiency, and quality of care. The incorporation of eHealth into healthcare delivery presents opportunities for improved efficiency in health systems, elevated quality of treatment, and expanded access to services for rural and isolated populations (LeBlanc et al., 2020). eHealth technologies are identified as a feasible way to enhance access to healthcare for remote and rural communities. The adoption of eHealth is offered as a solution to the demographic changes, rising costs, and quality problems in rural communities (Lindberg & Lundgren, 2022). eHealth is an emerging discipline within the intersection of medical informatics, public health, business, and clinical practices (Mwase et al., 2022). eHealth is viewed as a viable solution for bridging the distance gap (Valokivi et al., 2023).

4.2.1.3 Remote patient monitoring (RPM) and Telehealth

The section delves into 'RPM' (smart watches and wearable devices), 'Teleconsultation', and 'Telehealth – Videoconferencing' (VC).

i) RPM

Monitoring tools like remote patient-monitoring are employed for evaluating and transmitting patient data using electronic devices and wearables (Peh, 2024). The remote monitoring devices are used for remote patient home monitoring to gather clinical data for example, blood glucose levels and blood pressure (Rutledge & Gustin, 2021). The monitoring devices facilitate follow – up care, chronic disease management and real – time data collection for rural populations (Selvaraj, 2024). RPM provides continuous care and support for patients resulting in enhanced adherence and better clinical outcomes (Tolu-Akinnawo et al., 2024).

Telehealth involves using remote patient monitoring to evaluate patients from a distance (Rutledge & Gustin, 2021). The advent of mHealth applications and wearable devices has empowered patients to participate actively in their care, providing clinicians with real-time health data, including imaging and laboratory results (Tolu-Akinnawo et al., 2024). Monitoring devices enable individuals to manage chronic health conditions and track their health more effectively (Maha et al., 2024). There are various types of remote patient monitoring, such as smart watches, wearable devices goals (Maha et al., 2024) and Bluetooth stethoscope along with high-definition camera to capture and transmit data to healthcare professionals (Rutledge & Gustin, 2021). One component of the self-monitoring-system is a *smart watch*, worn continuously on the wrist, which is intended to be used continuously (Lindberg & Lundgren, 2022).

Wearable technology has significantly advanced, featuring high-tech devices that can continuously track vital signs like heart rate, blood pressure, and oxygen saturation (Tolu-Akinnawo et al., 2024). Monitoring devices like wearable devices and health tracking apps, enable people to monitor progress over time, track their health metrics and set health goals (Maha et al., 2024). Healthcare providers use remote home monitoring tools to gather clinical data like blood pressure and blood glucose levels (Rutledge & Gustin, 2021). Additionally, wearable devices may monitor health metrics and vital signs, giving significant data for both healthcare providers and patients (Maha et al., 2024). Furthermore, devices such as a Bluetooth stethoscope and high-definition camera are used to collect and transmit vital information to healthcare providers (Rutledge & Gustin, 2021).

ii) Teleconsultation – Video conferencing (VC)

Teleconsultations are essential for facilitating prompt medical advice between healthcare professionals and patients (Omaghomi et al., 2024). Teleconsultation Includes audio or video consultations between healthcare professionals and patients (Tolu-Akinnawo et al., 2024). The study findings reveal that video conferencing is among the most widely used audio and visual technologies for delivering Telehealth and Telemedicine services (Calleja et al., 2022). Telehealth, particularly through video conferencing, has been utilised to deliver care to COVID-19 patients, facilitate communication between these patients and their families, allow non-COVID patients to access care without risking exposure from travelling to healthcare facilities, and safeguard the healthcare workforce (Rutledge & Gustin, 2021). Through video conferencing, rural patients are able to connect with healthcare specialists, helping them overcome challenges posed by distance and limited travel options (Selvaraj, 2024). Furthermore, VC is increasingly being utilised in Telehealth, particularly for delivering education and training to healthcare professionals in rural areas (Calleja et al., 2022).

iii) Telehealth

The phrase "Telehealth nursing" has emerged to refer to nursing practitioners who provide audio or video modalities to patients who are geographically distant (Rutledge & Gustin, 2021). Telehealth involves the use of RPM to assess patients from a distance. In Telehealth practice, the healthcare professionals in remote and rural areas utilise various technologies, including:

- Videoconferencing to interact with patients (Anderson & Singh, 2021, Rutledge & Gustin, 2021),
- mobile health apps (Anderson & Singh, 2021),
- remote patient home monitoring to gather clinical data (Rutledge & Gustin, 2021), and
- devices like high-definition camera and Bluetooth stethoscope to collect and transmit data to healthcare providers (Rutledge & Gustin, 2021).

Telehealth has been promoted as a way to provide access to healthcare in remote and rural areas (Graham et al., 2023). It encompasses a wide range of services that facilitate patient education, medical consultations, health information services, and other associated services through the use of DT (Anderson & Singh, 2021). In the context of rural healthcare, Telehealth holds significant potential to address and improve the challenges associated with delivering healthcare in rural areas (Haque et al., 2023).

Telemedicine has proven viable in enhancing the detection and monitoring of chronic conditions like cardiovascular diseases and cognitive impairment (Sánchez Castillo et al., 2023).Telemedicine could help alleviate the shortage of healthcare professionals (Sheets et al., 2020). Collectively, these sub-categories on digital tools like RPM, teleconsultation, and VC-based Telehealth are bridging healthcare gaps in rural areas. Despite their benefits, these technologies face limitations due to poor connectivity, lack of private consultation spaces, restrictive policies, and communication barriers.

4.2.1.4 mHealth and socially-driven mobile healthcare

This section covers 'Mobile health' (mHealth) and 'Socially-driven mobile healthcare'.

i) mHealth

Health professionals use mobile technologies, such as tablets and smartphones, to share, retrieve, and input health data from satellite health facilities into the District Health Information System (Mbunge et al., 2021). Due to high prevalence of mobile phone possession and penetration in rural areas, mHealth has emerged as a valuable tool for reducing many healthcare obstacles in rural areas (Peprah et al., 2020). Through mHealth applications, patients can schedule appointments, receive real-time health information, track their health metrics, and participate in Telemedicine consultations with their healthcare professionals (Selvaraj, 2024).

Smartphone apps are now essential for collecting data, patient education, medication adherence, and empowering patients to engage in their treatment (Tolu-Akinnawo et al., 2024). mHealth empowers medical professionals by enabling immediate access to patient data, promoting communication among co-workers, and assisting with decision-making at the point of treatment (Selvaraj, 2024). Additionally, these mobile applications can serve as reminders for medications, monitor vital signs thus enhancing medication compliance, and provide educational material about managing cardiac conditions (Tolu-Akinnawo et al., 2024). Furthermore, in rural areas, mHealth can enable patients to communicate with medical professionals remotely, access educational resources, and monitor their health (Selvaraj, 2024).

ii) Socially-driven mobile healthcare (SNPs)

In healthcare context, SNPs such as Facebook, FaceTime, WeChat, WhatsApp, and Zoom provide a low-barrier communication tool for phone calls, video calls, voice messages, and the sharing of phone calls and images (Ye et al., 2023).

4.2.1.5 Digital health records and information exchange

This section focuses on 'Electronic health records' (EHRs) and 'Health information exchange' (HIE).

i) EHRs

The finding highlighted that the EHRs facilitate the transmission and reception of patient data in rural areas (Alfiyyah et al., 2022). Electronic health records make it feasible to ensure that patients, irrespective of their financial circumstances or location, receive appropriate and timely medical interventions (Peh, 2024).

ii) HIE

Healthcare facilities use HIE because it is a safe, digital method for transmitting patients' health information between various healthcare facilities, allowing healthcare providers to access and exchange data smoothly and efficiently (Selvaraj, 2024).

4.2.1.6 Digital technology and transformation – sub-categories and items from theoretical sources

This final section links to THEME 1, comprising five sub-categories and a total of eleven designated items. Table 4-3 summarises theoretically-based findings in THEME 1.

Table 4-3: THEME 1: Digital technology and transformation – sub-categories and items from theoretical sources

Theme	Sub-category	Item
Digital technology and transformation	AI in healthcare	TDTT01: AIES
		TDTT02: AIPS
		TDTT03: Chatbots
	eHealth infrastructure	TDTT04: eHealth
	Remote patient monitoring	TDTT08: Remote patient monitoring
		TDTT10: Teleconsultation
		TDTT11: Telehealth
	mHealth and socially-driven mobile healthcare	TDTT07: mHealth
		TDTT09: SNPs
	Digital health records and information exchange	TDTT05: EHRs
		TDTT06: HIE

Figure 4-2 shows a network diagram for THEME 1 from the theoretical perspectives. Additionally, Figure 4-2 provides an understanding of the DTs from the theoretical perspectives through a network diagram that links the theme to the items.

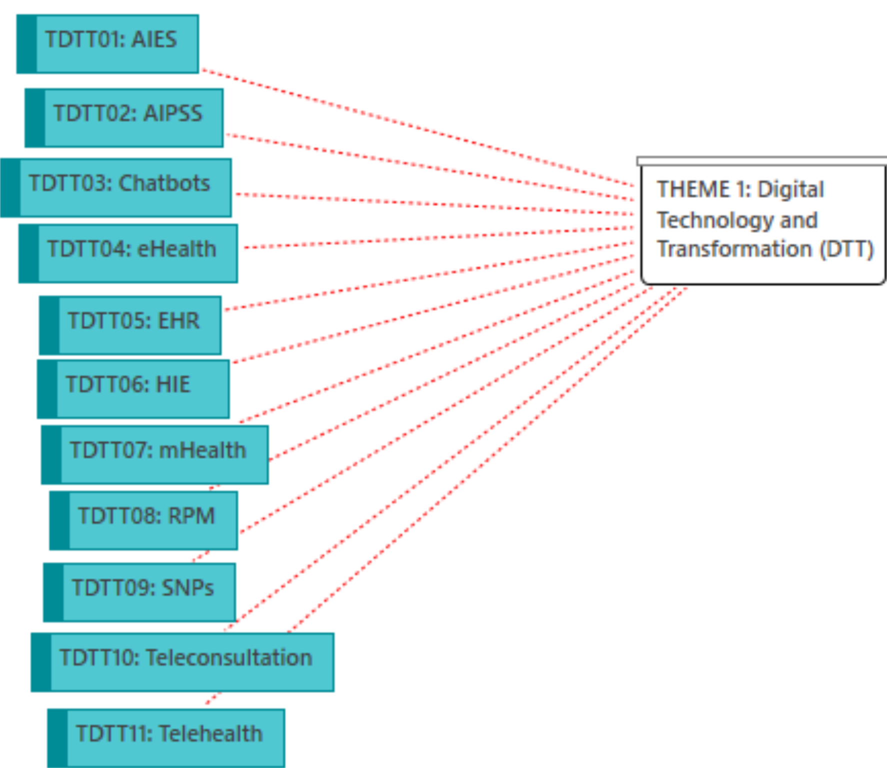


Figure 4-2: Network diagram for THEME 1: Digital technology and transformation and associated items for theoretically-based codes

In summary, the findings for THEME 1 express that DT is reshaping rural healthcare by improving access, efficiency, and service delivery. However, the adoption of these technologies must be supported by training, infrastructure investment, and community engagement.

4.2.2 THEME 2: Perceived benefits (PB)

Understanding the perceived benefits of DT in rural healthcare requires examining both the successes that encourage adoption and the preferences that shape healthcare choices. Participants noted that successful implementation often hinges on how well digital tools align with local needs, cultural expectations, and existing workflows. Technologies that are easy to use, improve access, and demonstrate clear value tend to be more readily adopted. Additionally, healthcare preferences, such as the desire for convenience, privacy, and continuity of care, play a significant role in shaping positive perceptions. These insights highlight that digital health solutions must not only be functional but also contextually relevant and user-centered to gain traction in rural communities. THEME 2 consists of two sub-categories: ‘Perceived successes to adoption’, and ‘Healthcare preferences’.

4.2.2.1 Perceived successes to adoption

The perceived successes to adoption cover ‘Acceptance’, ‘Accessibility’, ‘Adoption’, ‘Cost and time savings’.

i) Acceptance

Telehealth has become widely used as an accepted approach to delivering healthcare services (Barry et al., 2024). In rural communities, both healthcare providers and users expressed a willingness to utilise mHealth services that involve phone calls in the future, as they believed the technology could help to reduce healthcare barriers (Peprah et al., 2020). In fact, Telemedicine is already viewed as a practical and acceptable method for enhancing healthcare delivery (Morris et al., 2022). Supporting this view, the findings from Sánchez Castillo et al. (2023) reveal that Telemedicine is well appreciated and accepted by rural communities, and it can serve as an effective and convenient way to deliver medical care. However, Klee et al. (2023) point out that despite the DT acceptability, healthcare providers and patients in rural communities are encountering technology-related challenges.

ii) Accessibility

Healthcare delivery in rural areas enables doctors, nurses and other health and medical professionals to meet the health needs of individuals (Ude-Akpeh & Ezegwu, 2022). Kingslin (2023) highlights that one promising solution to close the healthcare gap and enhance access to diagnosis. Omaghomi et al. (2024) emphasise that the impact of DT in rural Africa is diverse,

encompassing enhanced healthcare access, more affordable interventions and improved diagnostic skills. Additionally, Kingslin (2023) found that Telemedicine in rural communities has yielded promising results in improving healthcare access and addressing challenges.

Maha et al. (2024) highlight that DTs such as Telemedicine, mobile applications, and educational platforms enable individuals to access important health information, engage with healthcare professionals remotely, and receive prompt assistance in managing their health. The utilisation of mHealth has shown several benefits, such as greater healthcare access in rural areas, enhanced patient engagement, improved management of chronic conditions, and more efficient healthcare delivery (Selvaraj, 2024). Additionally, by having access to self-care tools, symptom checkers, and health information, individuals can make well-informed decisions regarding their health. Furthermore, Telehealth is an important tool that can enhance access to treatment for remote and rural patients (Graham et al., 2023).

It is important to note that Telehealth enables individuals in rural communities to gain access to healthcare providers at larger medical facilities (Anderson & Singh, 2021). Telemedicine or Telehealth has the potential to greatly improve rural healthcare access such as in India; however, its effective implementation depends on addressing considerable obstacles and challenges (Arora et al., 2024). A key benefit of mHealth is enhanced access to qualified healthcare professionals (Begum & Nemshevich, 2021). Telehealth is likely to enhance patient outcomes, including access to quality of care, as well as provider outcomes like self-efficacy and knowledge (Totten et al., 2024). Furthermore, Telemedicine or Telehealth has great potential to enhance healthcare access and delivery, especially in rural areas where access to healthcare services is typically scarce (Molli, 2021; Sekhon et al., 2021; Sánchez Castillo et al., 2023; Tolu-Akinnawo et al., 2024).

iii) Adoption

Rogers (1983) talked about adoption, which falls under ‘Perceived benefits’. The study findings indicated that during COVID-19 pandemic, Telehealth experienced widespread growth as it was quickly adopted in various fields of practice in healthcare, enabling the continuation of medical services despite the need for physical distancing (Barry et al., 2024). The adoption of DTs on healthcare facilities in a rural community is not just advantageous but beneficial for enhancing health outcomes and addressing health disparities in these undeserved communities (Maha et al., 2024). Increasing public awareness of Telemedicine’s benefits is essential to promote its wider adoption (Kingslin, 2023). Moreover, the adoption of telemedicine will help lower overall costs of the healthcare system (Sageena et al., 2021).

iv) Cost and time savings

The adoption of Telemedicine can lower the cost of the healthcare system (Sageena et al., 2021). Telemedicine has the potential to transform the future of healthcare in rural and communities by improving access to healthcare treatment and providing a more cost-effective delivery method (Kingslin, 2023). The rise in health literacy can contribute to improved health outcomes and lower healthcare costs over time (Maha et al., 2024). Integrating eHealth into healthcare delivery creates opportunities for saving costs and time, expanded access to care, improved quality of care and to more efficient healthcare systems (LeBlanc et al., 2020). mHealth services lower travel costs, saves consultation time, simplify referrals and follow-up on patients, and facilitate remote consultation with groups of clients remotely instead of in-person meeting (Laar et al., 2022). Telemedicine offers the benefit of providing healthcare services in rural areas by reducing indirect patient costs such as travel costs and improving time efficiency (Peprah et al., 2020; Begum & Nemshevich, 2021; Alfiyyah et al., 2022; Totten et al., 2024). Additionally, Telemedicine is linked to cost savings for both healthcare professionals and patients (Molli, 2021; Tolu-Akinnawo et al., 2024). Together, acceptance, accessibility, adoption, and cost-and-time-effective sub-categories indicate that DT in rural health improves efficiency and reduces costs, making healthcare delivery more sustainable.

4.2.2.2 Healthcare preferences

Healthcare preferences explain the following items: enhances efficiency, enhances health literacy, improves quality, lessen healthcare workers (HCWs) burden, and reduces distance limitations.

i) Eases HCPs burden

In the healthcare context, DTs are utilised to enhance healthcare delivery by bridging the gap between technology and healthcare (Ude-Akpeh & Ezegwu, 2022). These digital health tools have the potential to reshape the healthcare landscape, especially in rural, by offering innovative solutions to tackle healthcare challenges (Maha et al., 2024). Healthcare professionals emphasised that DT enhanced clarity and the speed of communication and eliminated delays caused by waiting for reports (Graham et al., 2023). Furthermore, with the ability of online visits, healthcare professionals can care for their patients while also potentially supporting other impacted practices (Haleem et al., 2021).

ii) Enhances efficiency

In general, mHealth tools can enhance and facilitate the work of frontline healthcare workers (Jiménez-Díaz et al., 2024). Most rural providers indicated that Telehealth added value to healthcare practice, although fewer than half felt that it improved efficiency (Klee et al., 2023). Technological innovations in patient management are viewed as a chance to enhance the

sustainability and efficiency of 'continuity of care' by enabling longer treatment at home rather than in the hospital, ultimately reducing hospitalisation costs (Valokivi et al., 2023). Digital health provides the greatest opportunity for innovative, sustainable changes to tackle key challenges issues in healthcare in rural areas (Woods et al., 2024b).

iii) Enhances health literacy

DT has the potential to transform healthcare delivery in rural communities of Africa and the United States by enhancing health literacy (Maha et al., 2024). For instance, the evaluation of clinical skills after attending educational sessions could be conducted via videoconference, providing better support for remote and rural healthcare workers in their efforts to maintain clinical practices (Calleja et al., 2022). Moreover, the ongoing digitalisation of healthcare, characterised by and a rise in the use of digital devices for producing, surveilling, and tracking data, changes traditional modes of healthcare practice (Lindberg & Lundgren, 2022). Furthermore, DT is essential in improving health literacy and raising awareness of health-related issues (Maha et al., 2024).

iv) Improves quality

In the context of rural healthcare, digital health technologies are commonly presented as solutions to improve health system efficiency and to enhance quality of care (LeBlanc et al., 2020; Kobi et al., 2024). Minimising barriers for both providers and patients will enhance the overall quality of care during Telehealth visits and encourage wider adoption of Telehealth (Klee et al., 2023). The findings from a study conducted by Valokivi et al. (2023) reveal that eHealth is generally embraced with optimism, as it is thought to enhance the care quality and encourage older individuals to take responsibility for their own health. Telemedicine enhances the quality of services in healthcare (Alfiyyah et al., 2022). Customising Telehealth services for rural community residents is an emerging strategy for ensuring high-quality healthcare (Kolluri et al., 2022). For example, Telemedicine has proven to enhance the quality of healthcare facilities by enabling the exchange of information across remote areas (Haleem et al., 2021). Furthermore, the implementation of DTs has proven effective in enhancing the quality of healthcare, increasing access to specialised medical services, and minimising the feeling of isolation among healthcare professionals in rural areas (Sánchez Castillo et al., 2023).

v) Reduces distance limitations

DT assists individuals to interact in innovative ways, enabling users to maintain social engagements over distances and across time (Ude-Akpeh & Ezegwu, 2022). Telemedicine platforms allow patients to interact with specialists and doctors without having to travel (Maha et al., 2024). Digital health has the potential to overcome the challenges posed by distance (Woods et al., 2024a). Telemedicine has bridged geographical gaps, making healthcare

services accessible in rural areas (Sommer et al., 2023; Omaghomi et al., 2024; Peh, 2024; Selvaraj, 2024). Technological solutions are considered a way to ensure that all individuals in the communities have the opportunity to meet their healthcare needs, enabling communities to communicate electronically with healthcare providers regardless of their location (Valokivi et al., 2023). In China, Telehealth tools have played a key role in allowing patients to consult doctors beyond their physical reach (Ye et al., 2023). Furthermore, utilising Telehealth in rural areas to deliver and support health services can minimise challenges and burdens for patients, like transportation issues related to travelling for special care (Alfiyyah et al., 2022).

vi) Willingness

The success of Telemedicine initiatives largely depends on healthcare professionals' ability to effectively engage with Telemedicine technologies (Kobi et al., 2024). In rural communities, both healthcare professionals and users expressed willingness to use mHealth services, such as phone calls, in the future, as they saw the technology as a key tool in reducing healthcare barriers (Peprah et al., 2020). Additionally, Sánchez Castillo et al. (2023) revealed that Telemedicine is both accepted and appreciated by the rural communities, and that it offers an effective and convenient way to deliver medical care. Furthermore, LeBlanc et al. (2020) highlighted that rural healthcare practitioners' heavier workloads and lack of confidence in the benefits of eHealth diminish their willingness to adopt new technologies.

4.2.2.3 Perceived benefits – sub-categories and items from theoretical sources

This section links to THEME 2, which contains two sub-categories and ten items that were allocated properly. Table 4-4 summarises theoretically-based findings in THEME 2.

Table 4-4: THEME 2: Perceived benefits – sub-categories and items from theoretical sources

Theme	Sub-category	Item
Perceived benefits	Perceived successes to adoption	TPB01: Acceptance
		TPB02: Accessibility
		TPB03: Adoption
		TPB04: Cost and time savings
	Healthcare preferences	TPB05: Eases HCPs' burden
		TPB06: Enhances efficiency
		TPB07: Enhances health literacy
		TPB08: Improves quality
		TPB09: Reduces distance limitations
		TPB10: Willingness

Figure 4-3 shows a network diagram for the sub-categories and items from theoretical sources. The connections illustrate the relationship between THEME 2 and items.

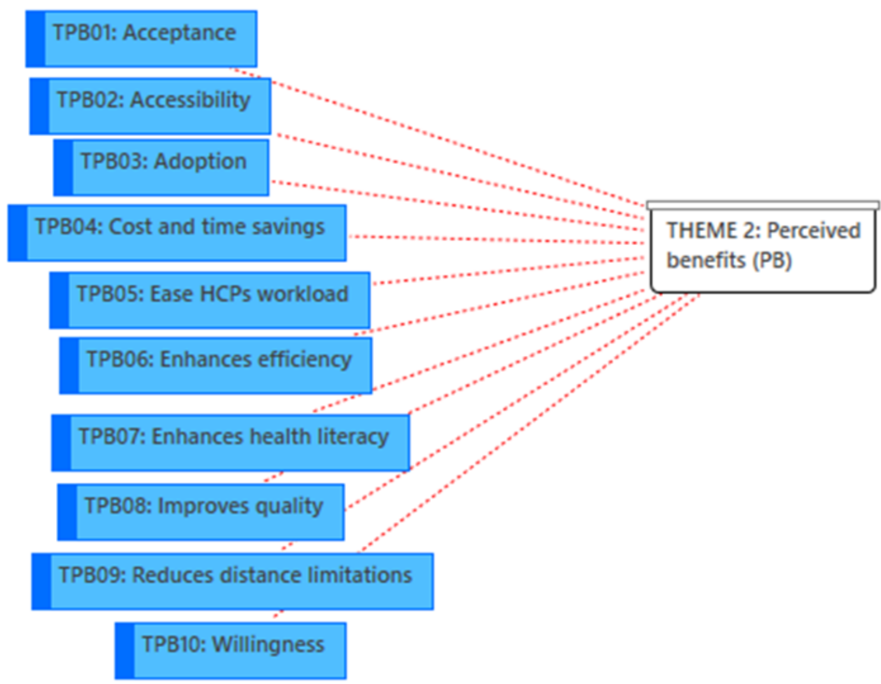


Figure 4-3: Network diagram for THEME 2: Perceived benefits and associated items

In summary, the findings from THEME 2 indicate that DT in rural health has the potential to significantly enhance service delivery by improving access, efficiency, and quality of care. However, its full potential is often limited by challenges such as low digital literacy, inconsistent usage, and concerns around privacy and trust.

4.2.3 THEME 3: Perceived challenges (PC)

Despite the growing presence of DTs in rural healthcare, their adoption is often met with hesitation and practical constraints. THEME 3 provides critical insight into the barriers that affect the successful implementation and sustainability of DTs in healthcare settings. Drawing from the sub-categories 'Response to technology adoption', and 'Technological requirements', this section outlines the technical factors that shape the digital transformation journey. Addressing these perceived barriers is essential for fostering trust, usability, and long-term sustainability in rural digital health initiatives.

4.2.3.1 Response to technology adoption

This section covers the three items: 'Geographical distance', 'Guidelines and policies', and 'Limited healthcare professionals'.

i) Geographical distance

Access to healthcare continues to be a significant challenge in rural Africa, where long distances and inadequate transportation infrastructure isolate many communities from healthcare services (Larson et al., 2022; Omaghomi et al., 2024). For example, in South Africa, the rural provinces of North West, Mpumalanga, Limpopo and Eastern Cape appear to experience the greatest challenges in health service delivery, primarily due to long distances and limited transportation, which prevent individuals from reaching healthcare facilities (Sumbana et al., 2024). Additionally, healthcare access in rural areas is often restricted due to geographic distance and the absence of healthcare facilities (Maha et al., 2024).

ii) Guidelines and policies

In the healthcare context, the absence of specific legislation addressing the unique challenges posed by the utilisation of the internet and technology is one of the biggest barriers to the adoption of digital health solutions (Kingslin, 2023). Jiménez-Díaz et al. (2024) indicated that there is a lengthy process required to obtain regulatory approval. The lack of proper guidelines for mHealth operations is hindering the effective use of mHealth in rural areas (Begum & Nemshevich, 2021; Kobi et al., 2024). Furthermore, licensing continues to be a significant obstacle in Telemedicine.

iii) Limited healthcare professionals (HCPs)

Rural healthcare facilities often lack specialised IT staff capable of managing and troubleshooting Telehealth technologies (Sommer et al., 2023). A major contributing factor is the migration of healthcare workers to urban areas and cities, likely due to higher remuneration, better working conditions and access to improved equipment (Ude-Akpeh & Ezegwu, 2022). As a result, clinics and hospitals in rural areas may have a shortage of healthcare

professionals, limited medical equipment, and fewer services available (Maha et al., 2024). Furthermore, the number of nurses, doctors, and medical technologists is often insufficient to meet the needs of the large population in rural areas (Begum & Nemshevich, 2021). These rural communities frequently encounter unique healthcare challenges because of their geographical isolation, limited availability of healthcare facilities, and a lack of healthcare professionals (Molli, 2021). Additionally, the scarcity of healthcare professionals, especially in rural areas, remains one of the major challenges (Sánchez Castillo et al., 2023; Sumbana et al., 2024).

4.2.3.2 Technological requirements

This sub-section covers 'Financial considerations', 'Limited infrastructure', and 'Technological limitations'.

i) Financial considerations

Some obstacles to the use of DTs in healthcare delivery in rural areas include a lack of funding (Ude-Akpeh & Ezegwu, 2022). Kingslin (2023) noted that Telemedicine may be financially inaccessible due to the high costs associated with communication and technology. In the healthcare context, a significant challenge is the high cost of Telemedicine equipment and software (Benjamin et al., 2024). Additionally, another barrier resistance to change (Arora et al., 2024).

ii) Limited infrastructure

A major challenge to adopting digital health tools in rural areas is the absence of reliable internet connectivity (Jiménez-Díaz et al., 2024). Rutledge and Gustin (2021) revealed that rural areas are affected by limited access to high-speed broadband internet, lack of technology for patients, or technology that lacks video or audio capabilities. Lack of access to high-speed internet, unreliable power supply, and insufficient technology infrastructure impede the smooth delivery of Telehealth services (Omaghomi et al., 2024). Additionally, developing and sustaining such infrastructure can also be costly and time-consuming (Ye et al., 2023). Furthermore, network quality and infrastructure are the key factors for transmitting data and conducting real-time consultations (Alfiyyah et al., 2022).

iii) Technological limitations

Despite positive responses to eHealth, its successful implementation is hindered by major drawbacks. Chief among these challenges is the absence of reliable, affordable technology and sufficient internet access (LeBlanc et al., 2020; Laar et al., 2022). For instance, in rural areas of Sindh, the slow progress of Telemedicine can be attributed to the unavailability of advanced communication devices, lack of advanced telecommunication services, servers and

software, as well as low levels of education, and awareness regarding modern Telemedicine tools (Shardha et al., 2024). This limited access to essential technology hinders individuals in rural areas from engaging with Telemedicine platforms and benefiting from remote healthcare services (Molli, 2021; Barry et al., 2024; Omaghomi et al., 2024). Rural areas are often technologically disadvantaged, facing issues such as poor internet connectivity, reliance on 3G mobile data, and low sound and picture quality (Graham et al., 2023). For example, Benjamin et al. (2024) found that in rural America, technological limitations pose a significant barrier to the effective implementation of Telemedicine. Furthermore, these limitations involve the availability and cost of essential technology, along with the need for sufficient training and technical support for both patients and healthcare providers.

Together, the items for THEME 3 indicate that DTs in rural areas hold great promise but are constrained by financial barriers that limit access and sustainability, infrastructure gaps, and technological limitations that affect usability and integration.

4.2.3.3 Perceived challenges – sub-categories and items from theoretical sources

This section links to THEME 3, which contains two sub-categories and six items that were appropriately allocated. Table 4-5 summarises theoretically-based findings in THEME 3.

Table 4-5: THEME 3: Perceived challenges – sub-categories and items from theoretical sources

Theme	Sub-category	Item
Perceived Challenges	Response to technology adoption	TPC01: Geographical distance
		TPC02: Guidelines and policies
		TPC03: Limited healthcare professionals
	Technological requirements	TPC04: Financial considerations
		TPC05: Limited infrastructure
		TPC06: Technological limitations

In addition, Figure 4-4 provides an understanding of the perceived challenges from the theoretical perspectives through a network diagram that links the constructs to the items.

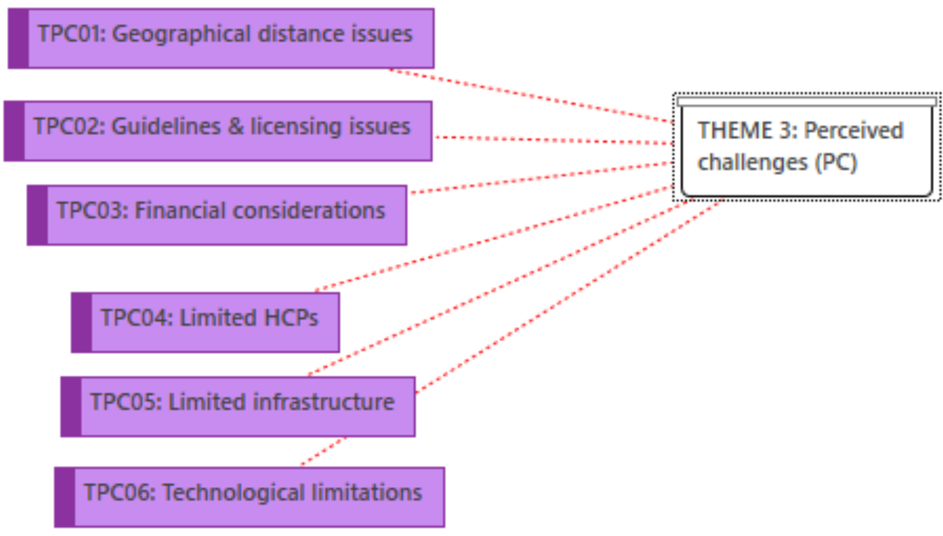


Figure 4-4: Network diagram for THEME 3: Perceived challenges and associated items

4.2.4 THEME 4: Human factors (HF)

The adoption and effectiveness of DTs in rural healthcare are deeply influenced by human factors, particularly the behavioral patterns, social barriers, and levels of digital engagement and health literacy among both healthcare providers and patients. These human-centered challenges highlight the need for inclusive design, community-based education, and supportive environments that empower users to confidently interact with digital health systems.

THEME 4 focuses on two sub-categories, namely: 'Behaviour patterns and social barriers', and 'Digital engagement and health literacy issues'.

4.2.4.1 Behavioral patterns and social barriers

This section covers four items: 'Age-related resistance', 'Cultural beliefs', 'Human behaviour patterns', and 'Language barrier'.

i) Age-related resistance

Older healthcare workers might struggle to use DTs (Jiménez-Díaz et al., 2024). Older users and their support networks vary in their ability to navigate and manage digital self-care (Rasi et al., 2021). Furthermore, health-related challenges frequently hinder older adults from integrating eHealth technologies into their daily lives (Airola, 2021). Collectively, items addressed under THEME 4 highlight that digital health in rural areas must navigate cultural and behavioural dynamics, language barrier, cultural beliefs, and age differences in technology acceptance. However, to succeed, digital health strategies should be culturally sensitive, environmentally adaptable, and user-centred and inclusive.

ii) Cultural beliefs

The challenges to adopting DT in Africa include linguistic and cultural diversity, limited infrastructure, the digital divide, health literacy, and regulatory hurdles (Omaghomi et al., 2024). Customs and cultural beliefs can also limit the adoption of DT in rural communities (Maha et al., 2024). Practices and cultural traditions influence healthcare-seeking behaviour (Kobi et al., 2024).

iii) Human behaviour patterns

Kobi et al. (2024) found that traditional practices and beliefs impact individuals' decisions and behaviour when seeking healthcare. To address this, healthcare professionals can incorporate digital tools in their practices and customise them to meet linguistic and cultural needs (Maha et al., 2024). Rasi et al. (2021) also highlighted that motives for using and learning DTs often reflected cultural identities, which, in turn, shaped such perceptions. Moreover, collaborating with healthcare professionals and community leaders can ensure that digital tools are culturally appropriate and acceptable to the intended population (Maha et al., 2024). It is also important that implementers and policymakers address socio-cultural and individual norms that act as obstacles (Laar et al., 2022). Furthermore, if rural health-seeking behaviours are not considered during DT adoption, healthcare access disparities are likely to worsen (Pullyblank, 2023).

iv) Language barrier

Rural communities face personal factors that impede the adoption of DT (Peng et al., 2024). The majority of users identified language as a potential barrier to using mHealth services (Peprah et al., 2020). Language barriers create issues with following the instructions through mobile phone (Begum & Nemshevich, 2021). Health information exchange (HIE) enhances effective communication among healthcare professionals, facilitates prompt decision-making, and ultimately elevates the quality of patient care (Selvaraj, 2024). However, in some countries such as rural Ghana, factors like language barrier, trust issues, quality of care, and mobile network connectivity were seen as obstacles to using mHealth (Peprah et al., 2020). Language barrier causes difficulties in understanding and following the instructions via mobile phone (Begum & Nemshevich, 2021). Furthermore, ineffective communication can also prevent the delivery of reliable care (Haleem et al., 2021).

4.2.4.2 Digital engagement and health literacy issues

This section focuses on 'Low digital health skills', 'Inconsistent usage patterns', and 'Privacy and trust concerns'.

i) Low digital skills

Technological literacy is an essential skill for assessing DT, and it plays a crucial role in the adoption of mHealth services (Laar et al., 2022). For instance, users often ignore or fail to respond to text messages because they either do not know how to use the phone's features or cannot comprehend the content of the message (Peprah et al., 2020). eHealth necessitates ongoing learning of diverse skills, encompassing not only digital but also administrative and medical capabilities (Rasi et al., 2021).

In rural areas, limited health literacy can hinder the successful implementation of Telemedicine (Omaghomi et al., 2024). A major challenge in rural areas is low digital literacy, due to individuals who may not be accustomed to using computers, tablets or smartphones, which makes it difficult for them to effectively navigate and utilise digital health tools (Maha et al., 2024). Rural families often have lower health literacy compared to their urban counterparts because they typically have lower levels of educational achievement (Laar et al., 2022; Peh, 2024). Additionally, numerous rural healthcare professionals lack the essential skills and knowledge to effectively use Telehealth technologies (Benjamin et al., 2024). At the individual-level, challenges include issues with digital and health literacy, while provider-level challenges revolve around training and concerns about the quality of care (Arora et al., 2024). For example, a study conducted in Ghana found that the lack of mHealth utilisation was primarily due to users' socio-demographic characteristics, especially literacy levels (Peprah et al., 2020). Similarly in Bangladesh, the lack of essential skills and knowledge regarding digital platforms are key barriers to delivering services via mHealth (Begum & Nemshevich, 2021).

ii) Inconsistent usage patterns

Poor infrastructure often creates challenges that hinder the successful implementation and adoption of DT intervention, despite the substantial potential benefits these digital interventions could offer rural communities (LeBlanc et al., 2020). Limited internet hinders the use Telehealth and remote patient monitoring, both of which are essential elements of digital health technology (Okobi et al., 2023). These challenges have contributed to the slow adoption of Telehealth services in rural areas (Omaghomi et al., 2024). However, compared to urban residents, rural residents were less likely to utilise digital health technologies to communicate with their doctors (Okobi et al., 2023). Internet access and cell phone reception are often limited in "dead zone" rural areas. The limited digital literacy and lack of awareness about existing digital health technology platforms among rural communities, particularly the low usage of health-related mobile apps among women, pose significant challenges (Begum & Nemshevich, 2021). Additionally, limited access to educational and information resources restricts rural residents' ability to adopt and use digital health technologies effectively (Okobi et al., 2023).

The findings from Peprah et al. (2020) pointed out that the use of mobile phone for healthcare was rare among healthcare users (Peprah et al., 2020). Most users are unable to use their mobile phones for healthcare purposes because they lack basic reading and writing skills (Bekyieriya et al., 2023). This has led mHealth system to encounter several challenges, including the willingness of rural communities to use digital platforms and women's access to mobile and internet-based healthcare services (Begum & Nemshevich, 2021). In Ghana, challenges like language barrier, illiteracy, quality of care, unreliable mobile network connectivity and trust issues were identified as challenges associated with utilising mHealth (Peprah et al., 2020). Furthermore, Svistova et al. (2022) pointed to a need for enhanced infrastructure to improve digital health services.

iii) Privacy and trust concerns

The risks linked to using mobile phones for creating and storing medical images involve issues of consent, privacy violations, insecure data storage, and potential liability for physicians as well as the potential of security breaches if electronic mobile devices are hacked, lost, or stolen (Graham et al., 2023). Patient privacy and data security remain a significant challenge to the widespread adoption of Telehealth (Sumbana et al., 2024; Tolu-Akinnawo et al., 2024). In developing countries, where digital literacy among patients is often lower, there is a greater risk of privacy issues when using Telehealth services (Ye et al., 2023). Furthermore, patients feel that their confidentiality is not preserved (Alfiyyah et al., 2022; Pullyblank, 2023; McCarthy et al., 2024).

The findings from Peng et al. (2024) highlight concerns such as privacy issues that could limit the benefits of Telehealth. The authors added that these concerns could reduce confidence in the adoption of Telehealth and hinder its ability to improve healthcare access in rural areas. A significant concern is the risk of hacking into patients' medical data, particularly when patients access Telemedicine from an unencrypted channel or through a public network (Haleem et al., 2021). Furthermore, some users reported a lack of trust in mHealth services, mainly because they were unable to see the person they are communicating with, leading to concerns that their calls may not be answered by a qualified medical professional (Peprah et al., 2020).

4.2.4.3 Human factors – sub-categories and items from theoretical sources

This section links to THEME 4, which contains two sub-categories and seven items that were appropriately allocated. Table 4-6 summarises theoretically-based findings in THEME 4.

Table 4-6: THEME 4. Human factors – sub-categories and items from theoretical sources

Theme	Sub-category	Item
Human factors	Behavioural and social barriers	THF01: Age-related resistance
		THF02: Cultural beliefs
		THF03: Human behaviour patterns
		THF05: Language barrier
	Digital engagement and health literacy issues	THF04: Inconsistent usage patterns
		THF06: Low digital skills
		THF07: Privacy and trust concerns

In addition, Figure 4-5 provides an understanding of the human factors from the theoretical perspectives through a network diagram that links the theme to the items. The connections illustrate the relationship between theme 4 and its associated items.

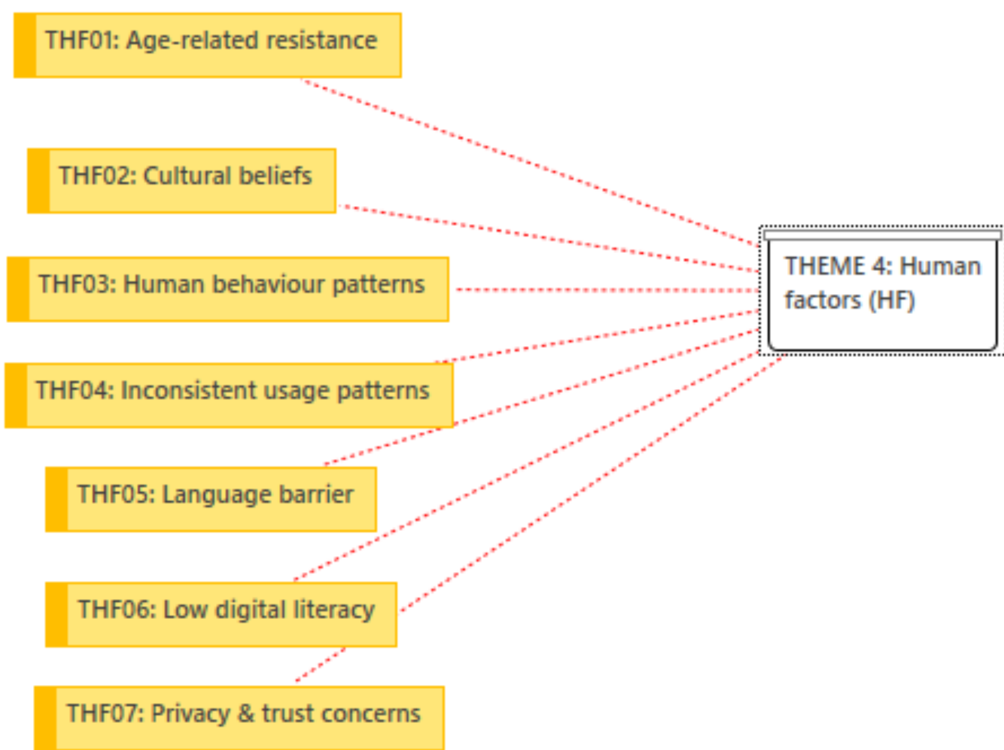


Figure 4-5: Network diagram for THEME 4: Processes and patterns and associated items

Collectively, the items from THEME 4 express that successful digital transformation is not only a matter of infrastructure and technology but also of empathy, inclusion, and empowerment. Recognising and responding to the diverse human factors at play ensures that digital solutions are not only accessible but also meaningful and impactful for all.

4.2.5 THEME 5: Processes and patterns (PP)

THEME 5: Processes and patterns in this study refers to consistent actions and practices that support the adoption of DT in healthcare facilities in a rural setting. Processes and patterns comprise three sub-categories: 'Access and infrastructure', 'Capacity and implementation', and 'Community engagement and governance'.

4.2.5.1 Access and infrastructure

This section focuses on 'Broadband and connectivity', 'Digital infrastructure', and 'Funding'.

i) Broadband and connectivity

Addressing these challenges involves a comprehensive approach that includes enhancing internet connectivity (Maha et al., 2024). For successful integration into the healthcare system, a framework for effective internet and electronic outreach should be established, along with a deeper understanding of the long-term financial impacts of these changes (LeBlanc et al., 2020). Important initiatives focus on enhancing broadband internet access and reliability of electrical power, both of which are crucial for the successful delivery of Telehealth services (Benjamin et al., 2024). Improvements in broadband access in rural areas will undoubtedly help reduce healthcare barriers for certain individuals (Hirko et al., 2020; Pullyblank, 2023). Additionally, stable electricity and high-speed internet are fundamental factors that allow healthcare professionals to deliver consistent and high-quality Telehealth services (Benjamin et al., 2024).

ii) Digital infrastructure

Ongoing investment in telecommunication infrastructure, the creation of supportive policy frameworks, and partnerships with the private sector will be crucial in fostering an environment that supports sustainable growth of Telehealth services in rural Africa (Omaghomi et al., 2024). Thus, healthcare practitioners and policymakers should leverage existing infrastructures to provide immediate Telehealth services and begin developing strategic plans for long-term infrastructure growth (Ye et al., 2023). Improving infrastructure is essential for overcoming the challenges to Telemedicine (Benjamin et al., 2024). Critical steps involve enhancing digital infrastructure, improving digital literacy, standardising protocols, and establishing clear regulatory frameworks (Arora et al., 2024). Furthermore, further advancement of ICT infrastructure and increased familiarity with digital tools among healthcare professionals are necessary to expand the reach of Telemedicine (Sánchez Castillo et al., 2023).

iii) Funding

Sommer et al. (2023) advised that coordination centres should be created, financial incentives for intersectoral collaboration and Telemedicine should be offered, and a diverse group of

healthcare service providers should be included. Availability of funds will also support capacity building, allowing the recruitment of qualified healthcare staff and ICT professionals, providing ICT training and introducing eHealth to the public (Mwase et al., 2022). Additionally, raising funding for rural healthcare facilities, enhancing strategies for recruiting and retaining healthcare workers, and establishing community-based health programs can contribute to better health outcomes in rural areas (Maha et al., 2024).

In summary, these items emphasise that digital health in rural areas is deeply influenced by connectivity gaps, infrastructure issues, and funding constraints.

4.2.5.2 Capacity and implementation

Capacity and implementation focus on 'Digital literacy', 'Improve practice change', 'Integration', 'Recruitment strategies', and 'Tailor-made approaches'.

i) Digital literacy

Among other things, Ude-Akpeh and Ezegwu (2022) highlighted the need to hire digital health experts to improve the diffusion of DTs in rural healthcare. Offering training on the use of digital health tools, as well as creating intuitive designs and user-friendly interfaces, can help accommodate individuals with different levels of digital literacy (Maha et al., 2024). For instance, in Africa and neighbouring countries, effective healthcare delivery in rural areas depends on training HCPs in providing IT and promoting IT solutions to individuals. Furthermore, HCPs must get ongoing education to prepare them for the potential and challenges presented by DTs (Holtz et al., 2024; Omaghomi et al., 2024; Shardha et al., 2024). Once the healthcare professionals are trained, they will be capable of developing, managing, and offering ongoing technical support for integrated eHealth systems (Mwase et al., 2022; Benjamin et al., 2024). Ultimately, the success of Telemedicine initiatives depends primarily on the ability of healthcare providers to effectively engage with Telemedicine technologies (Kobi et al., 2024).

ii) Improve practice change

Improved practice change involves modifications in healthcare professionals' practices as a direct outcome of participating in the provided education (Calleja et al., 2022). Thus, healthcare processes underwent significant changes and sometimes required daily adjustments (Anderson & Singh, 2021). For example, Telehealth proved to be valuable for addressing patients' issues promptly instead of waiting for their next scheduled visit (Barry et al., 2024). Additionally, mHealth applications enable patients to monitor their health data, access up-to-date health information, arrange appointments and connect with healthcare professionals through Telemedicine consultations (Selvaraj, 2024).

iii) Integration

Rogers (1983) on diffusion and innovation theory and (Guy-Evans, 2024) on Bronfenbrenner's Ecological Systems Theory talked about integration, which falls under 'Processes and patterns'. For example, Health information exchange systems enable the secure exchange of medical records, treatment plans, test plans, and other relevant health information among healthcare professionals involved in a patient's care (Selvaraj, 2024). This integration guarantees that physicians can access current information regardless of where care was provided, leading to better care coordination, reduced test duplication, and improved patient safety (Selvaraj, 2024).

iv) Recruitment strategies

Sumbana et al. (2024) highlighted that initiatives and innovative programs are essential to tackle the shortage of healthcare professionals in rural areas and guarantee that rural areas receive quality and comprehensive care. This can be done by raising funds for rural healthcare facilities, strengthening strategies for recruiting and retaining healthcare workers, and launching community-based health programs enhance health outcomes in rural areas (Maha et al., 2024).

v) Tailor-made approaches

By addressing access barriers and offering tailored health information and services, digital health tools can empower individuals to make informed decisions about their health, leading to enhanced health outcomes and well-being in rural communities (Maha et al., 2024). This empowerment is linked to users' perceptions, emphasising that consumer-centred care enhances both population health and patient experience (Woods et al., 2024a). To support this effectively, integrating DT by combining virtual and in-person interactions is key as it enhances healthcare delivery (Lindberg et al., 2021).

4.2.5.3 Community engagement and governance

This section covers the following items: 'Collaborative efforts', 'Framework and policies', 'Monitoring and evaluation', and 'Socio-cultural norms'.

i) Collaborative efforts

Technology companies can keep advancing and creating accessible digital health solutions, while local communities can adopt these tools and support their utilisation (Maha et al., 2024). Introducing innovative mHealth services could help bridge the access gap in rural areas (Laar et al., 2022). The continued commitment to overcoming barriers, utilising emerging technologies, and actively engaging local communities is crucial to a future where Telemedicine becomes a fundamental element of effective healthcare in rural Africa

(Omaghomi et al., 2024). China's experience indicates the potential of the collaboration among healthcare organisations, the government, non-governmental agencies, technology companies and financial support from philanthropic agencies (Ye et al., 2023).

Moreover, satellite internet technology offers a solution to the broadband connectivity challenges in rural areas (Benjamin et al., 2024). Arora et al. (2024) emphasised that collaborative efforts among healthcare institutions, the government, and technology providers can lead to the successful implementation of Telemedicine. Tolu-Akinnawo et al. (2024) further emphasised that global collaboration and technological advancements will strengthen Telemedicine's, ensuring more accessible, efficient, and personalised patient care both in the United States and globally.

ii) Frameworks and policies

Well-defined regulatory frameworks and policies that address medico-legal concerns and facilitate Telemedicine integration are essential for widespread adoption (Arora et al., 2024). Begum and Nemshevich (2021) highlight that the government can focus on several key areas to strengthen the health services through mHealth, namely:

- Establish clear guidelines,
- recruit and train healthcare professionals, and
- enhance the readiness of community engagement.

Furthermore, effective health systems are facilitated by clear guidelines, continuous training, and user-friendly Telehealth platforms (Arora et al., 2024).

iii) Monitoring and evaluation

Appropriate monitoring and evaluation strategies should be applied throughout the entire process to ensure both effectiveness and comprehensiveness (Mwase et al., 2022). Therefore, leaders should consistently monitor Telehealth usage rates to ensure continued engagement and determine if any adjustments are necessary (Anderson & Singh, 2021).

iv) Socio-cultural norms

Addressing cultural barriers involves collaborating with local communities, establishing trust, and adapting digital health interventions to suit cultural norms and preferences (Maha et al., 2024). Additionally, implementers and policy makers need to tackle individual and socio-cultural norms that serve as barriers, while also addressing infrastructural gaps. Furthermore, it is vital to take older adults' social and cultural practices into account when designing and implementing eHealth technologies (Airola, 2021).

In summary, the findings for THEME 5 highlight the importance of understanding the processes and patterns within each area, which is key to building systems that are not only technologically sound but also aligned with the workflow processes and patterns in rural healthcare.

4.2.5.4 Processes and patterns – sub-categories and items from theoretical sources

This section links to THEME 5, which contains three sub-categories and twelve items that were appropriately allocated. Table 4-7 outlines theoretically-based findings in THEME 5.

Table 4-7: THEME 5: Processes and patterns – sub-categories and items from theoretical sources

Theme	Sub-category	Item
Processes and patterns	Access and infrastructure	TPP01: Broadband and connectivity
		TPP03: Digital infrastructure
		TPP06: Funding
	Capacity and implementation	TPP04: Digital literacy
		TPP07: Improve practice change
		TPP08: Integration
		TPP11: Recruitment processes
		TPP12: Tailor-made approaches
	Community engagement and governance	TPP02: Collaborative efforts
		TPP05: Frameworks and policies
		TPP09: Monitoring and evaluation
		TPP10: Socio-cultural norms

Figure 4-6 displays a network diagram for THEME 5 with sub-categories and items from theoretical sources. In addition, Figure 4-6 presents an understanding of the processes and patterns from the theoretical perspectives through a network diagram that links the theme to the items.

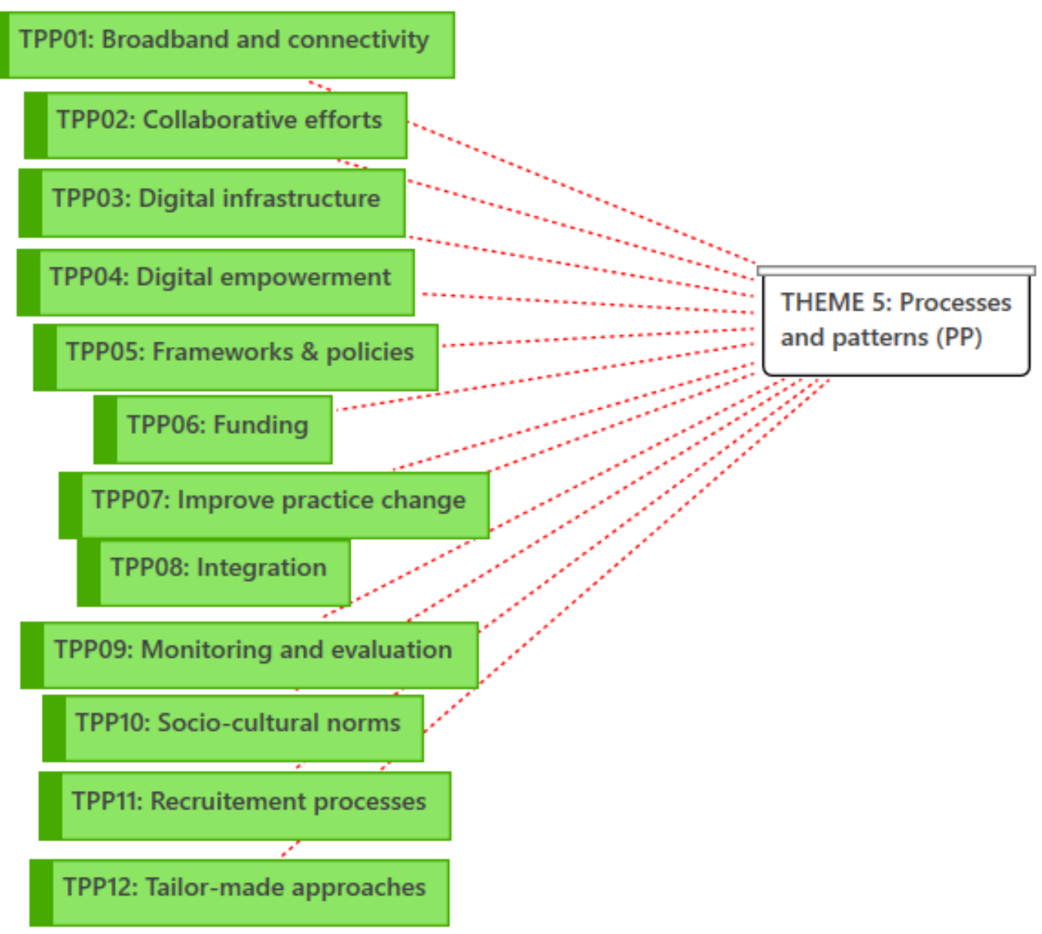


Figure 4-6: Network diagram for THEME 5: Processes and patterns

4.2.6 Synthesis of the five themes

To summarise, the findings of the systematic literature review form an initial set of theoretically-based themes for DT in healthcare facilities in rural areas. The findings of the SLR provide the foundation for an initial set of theoretical insights. Figure 4-8 provides a summary of the results discussed in detail in Table 4-4 (Digital technology and transformation), Table 4-5 (Perceived benefits), Table 4-6 (Perceived challenges), Table 4-7 (Human factors), and Table 4-8 (Processes and patterns). The items outlined in the findings constitute a visual summary of the items identified in the findings, presented in a network diagram.

Figure 4-8 portrays a consolidated view of the five themes and their associated items using a network diagram.

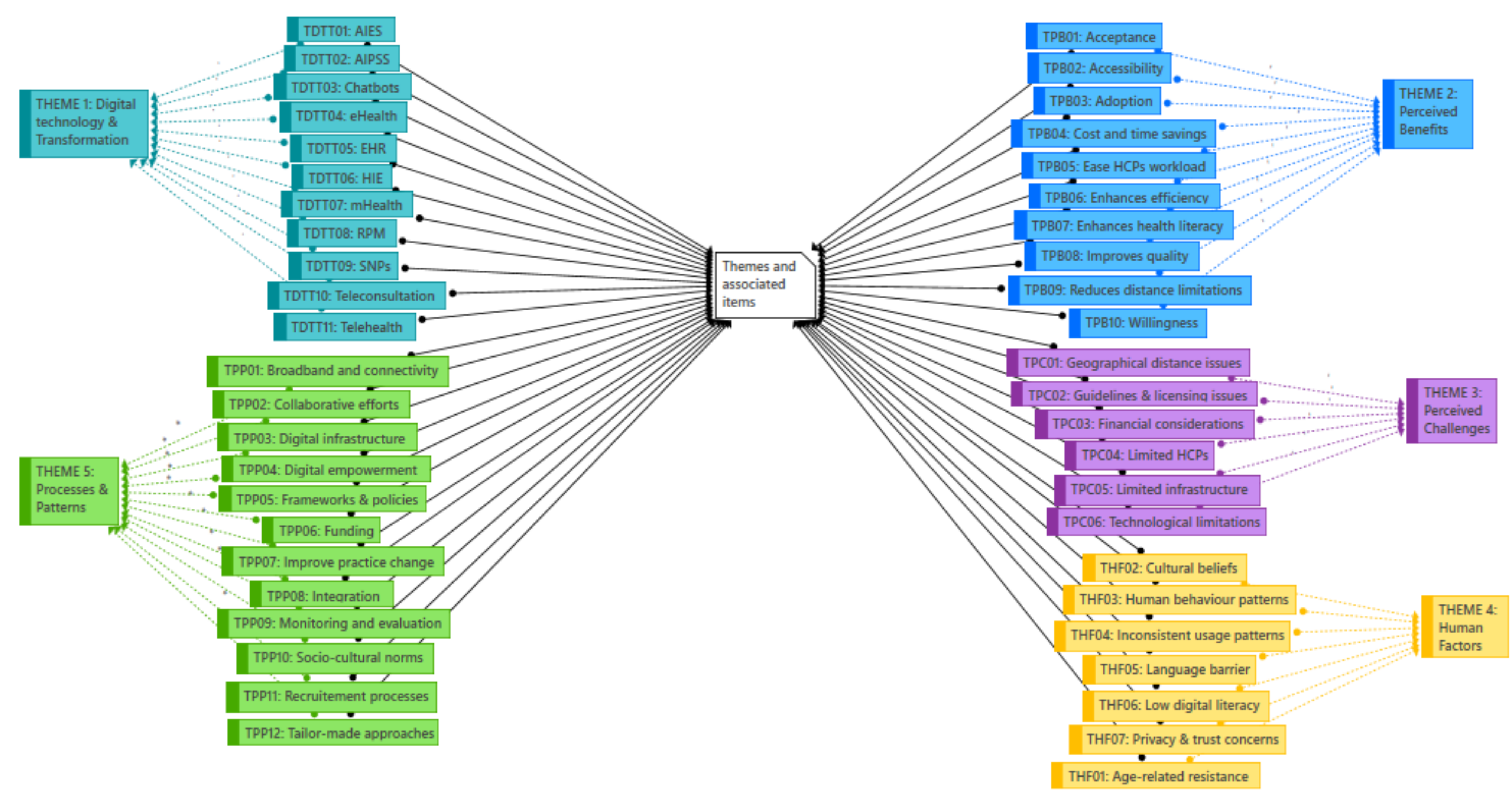


Figure 4-8: Network diagram for the five themes and their associated items

4.3 Findings – empirical perspectives

Section 4.2 forms the preliminary part of the dual strategy underpinning the study. Some aspects reported in section 4.2 are not part of section 4.3, but section 4.3 extends the framework from the themes reported in the SLR. It augments a set of theoretically-based items to integrate empirically determined themes, sub-categories and items. To enhance clarity, participant roles are briefly restated. Additionally, a summary table of participant roles and identifiers is included in Appendix C for reference.

Table 4-8: Participants' roles revisited

No.	Participants	Role	Years of service	Date
1	[HFD]	Director	1-3 years	29.10.2024
2	[HDR1]	Doctor	Above 10 years	29.10.2024
3	[HDR2]	Doctor	1-3 years	29.10.2024
4	[HN1]	Professional Nurse	7-10 years	29.10.2024
5	[HN2]	Professional Nurse	Above 10 years	29.10.2024
6	[HA1]	Administrator	Above 10 years	29.10.2024
7	[HA2]	Administrator	1-3 years	29.10.2024
8	[C1M1]	Manager	1-3 years	12.11.2024
9	[C1N3]	Professional Nurse	Above 10 years	12.11.2024
10	[C1N4]	Professional Nurse	7-10 years	12.11.2024
11	[CHCM2]	Manager	Less than a year	20.11.2024
12	[CHCDR3]	Doctor	Less than a year	20.11.2024
13	[CHCN5]	Professional Nurse	7-10 years	20.11.2024
14	[CHCN6]	Professional Nurse	4-6 years	20.11.2024
15	[CHCA3]	Administrator	4-6 years	20.11.2024
16	[CHCA4]	Administrator	7-10 years	20.11.2024
17	[C2M3]	Manager	7-10 years	26.11.2024
18	[C2N7]	Professional Nurse	Above 10 years	26.11.2024
19	[C2N8]	Enrolled Nursing Assistant	Above 10 years	26.11.2024

This section presents the findings of the empirical data collection as a second dual-method strategy identified in section 3.5, Chapter 3.

4.3.1 THEME 1: Digital technology and transformation (DTT)

THEME 1 reflects the comprehensive shift in healthcare systems toward integrated, data-driven, and user-centered digital solutions. Through the analysis of six sub-categories, this section highlights the diverse technological components that contribute to improved service delivery, operational efficiency, and patient outcomes. THEME 1 encompasses the following sub-sections:

- Electronic health records and patient information systems,
- data management and monitoring systems,
- laboratory and medical systems,

- digital communication tools,
- compliance and diagnostic tools,
- human resource and payroll systems.

4.3.1.1 Electronic health records (EHRs) and patient information systems

This sub-category forms part of THEME 1 and incorporates four items:

- Electronic health records (EHRs),
- Health Patient Registration System (HPRS),
- Institute for Health Systems Research (IHSR), and
- Three Interlinked Electronic Registers.Net (TIER.Net).

i) EHRs

Participants noted that the transition from paper-based records to digital health systems has reduced the risk of missing or lost data [C1M1].

> *It is very important because our files are usually taken by or get lost, let me put it that way, but the information in the system remain[s] there, but in the file, someone can take the file and take it out and it also protect[s] us because it is our legal document* [HN1].

> *Like, like everything is almost digitalised, like the Lab reports, X-rays and then…so that when you refer a patient to [a] tertiary institution, they can get from the system the investigations that you've done, like the Lab and X-rays and then they will give you advice or they can get it when the patient is on the other side* [HDR2].

ii) HPRS

The Health Patient Registration System is a central system at the frontline or in the reception area of the facility to register all the patients in the facility [C1N3].

> *Firstly, in the reception area, we do have computers to register clients to do the registration for our clients, so we have HPRS where the clients are being registered to, to keep the information so that when the client is coming back at the time it is going [to] be easy to retrieve the information* [C1N4].

> *For example, let's say, there's a new client coming in, you use their file, the first step, they go to the frontline/desk, alright, to the first system which is HPRS, they open their file for them, then they put them in an HPRS system* [CHCA4].

The HPRS system is primarily used by the data capturers and administrators within the facility. [C1N4]. The HPRS system is interconnected with other systems, allowing the administrators to retrieve patients' information [CHCM2].

iii) IHSR

IHSR – Ideal Health System Realisation seeks to align healthcare facilities to the National Health Insurance (NHI):

> *So another system that I can put here with that… we also have… there's a system that we called Ideal Health…Ideal Hospital…System Realisation, so that one is preparing for implementation of National Health Insurance.*
>
> *Our hospital must comply with the package of ideal system, so we look at the system, are we complying? Do we have all the things that hospital realisation requires?* [HFD].

iv) TIER.Net

> *TIER.Net is a software created mainly to…for a specific or lets' say a chronic specific type of disease. For instance, TB and HIV, they are both, they are bot…OK, TIER.Net mainly operates on TB and HIV, it is an integrated system that only consists of... TB and HIV* [CHCA3].
>
> *So, TIER.Net is there to make sure that everything about the client is there, including a relative of the client* [CHCA4].

4.3.1.2 Data management and monitoring systems

Data management and monitoring systems as a sub-category focuses on the systems for reporting data at the facility level as well as on systems for tracking health indicators, namely:

- Basic accounting system (BAS),
- District Health Information System (DHIS),
- Electronic Tick register (e-Tick register), and
- Health Management System version 2 (HMS2).

i) BAS

The HFD, who plays the role of a Chief Executive Officer (CEO), indicated that the facility is using BAS for tracking financial transactions, managing assets and liabilities, and preparing financial statements. This system is integrated into the facility operations, for example, paying the Hospital Board and other service providers.

> *Then we use Finance Management (BAS), they call it Basic Accounting System. So, all our procurement processes when we buying and when must pay, we pay with BAS. There are for instance, Hospital Board is paid via BAS and other areas are paid via BAS, so that is the system that manages the finance and payments of suppliers* [FHD].

ii) DHIS

> *District Health Information System (DHIS) is a web-based platform for managing and analysing health data [CHCA3].*
>
> *The system is used by the data capturers to collect health data [C2N7].*

Participants defined DHIS as a data collection, stating:

> *There are few information technology systems that we are using, district health information systems where we collect the data* [HFD].

DHIS serves as a monitoring tool, specifically for hospital data [HA1], TB capturing [C1N3], performance monitoring [CHCM2], and data capturing by the administrators [C2N7]. One participant associated DHIS with the Department of Health:

> *And then we also have DHIS that one I'm not sure if my colleague has actually explained to you, it's actually for DOH, department of Health, it's the Department of Health that actually works so much about* it [CHCA4].

iii) e-Tick register

This is a digital system designed to replace the manual tick registers traditionally used by professional nurses for recording patient data. The professionals register all their clients in the facility when they are in the consulting rooms with the patients [C1N3, C2M2]. Thus, HN2 pointed out that:

> *We used to write, we write lot and lot, we used to have the big book called the…what is it again… Tick register, we used to have a Tick register, so now we no longer have the manual, we have the system there* [HN2].
>
> *And then now in each and every consulting room the nurses are no longer using a register. They're no longer using the register as a tick register, they are using the e-Tick register. Yes, I think we forgot that one, they are using an e-Tick register, that's where they actually register every visit* [CHCA4].

The e-Tick register ensures data accuracy and supports statistical reporting, as indicated:

> *The purpose of the e-Tick register is to count the number of client[s] that visit in the facility daily so that to know our data…and to keep the data correct in everything the stats need to go up and not go down* [C2N8].

iv) HMS2

HMS2, a Human Management System version 2, is an integrated, newly digital patient management system, a new system that has been adopted in phases. HMS2 improves access

to patient data and efficiency, as stated below:

> *…the HMS2, I'm talking about, patient administration, it's an integrated system which you can easily tell how many patients by the click of a button, how many patients are there in the hospital are admitted in a specific ward* [HDR1].
>
> *We are now on Phase 2, but our hospital is one of the hospitals that were in the first phase of the pilot stages. It starts from the patient registration, when the patient comes in, they are registered on the system when they go through the patient path* [HA1].

One participant [HDR1], who is a medical doctor, noted that the system is used by the admitting clerks to admit patients and record patients visits in the systems. HSM2 facilitates the billing process for external entities such as, correctional and police services while tracking whether patients have been billed or not [HFD].

HA2 stated that the HMS2 system is linked with other systems, such as the Department of Home Affairs.

> *And then that system is also linked into the wards where those people who were registered in OPD, registered and care wards when they are re being admitted, the professional nurses in the ward, they will also use the system to admit that patient and monitor and put all the details of the patient in that system. It's for patient registration where there's an OPD taking all the information about the patient just the demographic information of the patient and everything by the admin clerks* [HA1].
>
> *We also use the other system HMS2 to monitor billing of patients whether you're private or just an ordinary patient, being patients that are under RAF - Road Accident Fund, bill other stakeholders like police, correctional services, so if you have not billed that particular client, it will see on why you have not billed this particular client that, is HMS2.*

Collectively, these digital health systems strengthen rural health services by improving medication access and management, enhancing diagnostic efficiency, and optimising supply chains and inventory control.

4.3.1.3 Laboratory and medical systems

This sub-category covers four items:

- Central Chronic Medicine Dispensing and Distribution (CCMDD),
- National Health Laboratory Services – Lab Trak (NHLS – Lab Trak),
- Logistical Information Systems (LOGIS), and
- RxSolution.

i) CCMDD

The facility adopted CCMDD [CHCA3, C1M1, C1N3, CHCN5, C2N7] to enhance access for stable patients with chronic medication by allowing them to get their treatment from external contact points, for example, pharmacies and outreach clinics, as indicated:

> *By the use of CCMDD – this is the distribution of medication to external contact points. All clients that are stable on treatment we register them there to collect their treatment. We do have five external pickup points outside the clinic. No, they take treatment inside the facility for about twelve months, then after that twelve months, we see that the patient is stable now* [C1N3].

> *So it helps to the issue of waiting times because many of clients that they are outside taking their treatment on their separate external pick up points, so in the facility we are dealing with the patients that are not stable and those that are new on treatment* [CHCN5].

One participant pointed out that CCMDD is integrated with other systems, like TIER.Net, to ensure the traceability and continuity of patient care:

> *...this system is for those clients that are decanted because we are trying by all means to actually reduce the number of the clients that are coming on a daily basis. So we are trying to reduce the number so to decant them we are actually putting them in the system so that they can actually come once in six months. So actually we decant every client more especially the HIV positive clients, so this system actually helps us in that case…So the information of that client you will find it on CCMDD as well as on TIER.Net* [CHCA4].

ii) Lab Trak

The Lab Trak system emerged as an important digital health tool to facilitate and track patient laboratory results. Participants from various roles like doctors, managers, and professional nurses, highlighted its use in ensuring continuity of care, especially in patients with chronical medical issues like HI. One of the participants highlighted:

> *Yes, for instance, we have the Lab Trak system, we have the Lab Trak system so – in in the Lab Trak system if we take the blood of the client or the client was taking the treatment at Cape Town or in Joburg then we will be able to Lab Trak the client, then we will see that oh client so and so was taking blood at Cape Town, etc., so we will be able to see now. … we have the Lab Trak system so – in in the Lab Trak system if we take the blood of the client or the client was taking the treatment at Cape Town or in Joburg then we will be able to Lab Trak the client, then we will see that oh client so and so was taking blood at Cape Town* [C1M1].

One professional nurse emphasised that, in many cases, patients tend to claim that it is their first time to visit a facility:

Lab Trak is one of the important digital technologies we use because if a patient came in our facility, the patients have a habit when they came to the facility stating that it is my first…Then Lab Trak helps us that this patient is not new, he/she is an HIV this patient, this patient was taking treatment at another facility, so Lab Trak is very, very important to us [C2N8].

From the management point of view, the manager from another facility shared his experience regarding the Lab Trak:

And also with the Lab Trak as I have already said, we are tracking our blood results. It's useful because even before we receive the blood results for the blood that we have taken, if the client happens to come earlier, we are able to Lab Trak his or her results and act urgently [CHCM2].

iii) LOGIS

The LOGIS system emerged in healthcare as a central digital tool for logistical and financial operations. It is responsible for asset management and supply chain functions, facilitating provisioning, procurement, and inventory. The facility director stated:

The LOGIS system is responsible for capturing information, finance related information, making payments, the inventory management and the preparing orders, that is the LOGIS system. LOGIS system is also for procurement processes and monitoring how you utilise budget [HFD].

i) RxSolution

The findings from the study highlight that RxSolution is an electronic pharmaceutical management system. It improves the management of medicine, for example, stock management:

There is a pharmacy system, the dispensary, whereby they keep their recording and manage their stock, it's called RxSolution, it's specifically for the dispensary [HDR1].

One participant who performs the role of an administrator pointed that:

RxSolution I would say, it also assists the pharmacy department in terms of managing stock and making orders of pharmaceuticals, which means of medicine. It can tell them the maximum and what so that they know when to order [HA1].

Together, digital health technologies like CCMDD, NHLS Lab Trak, LOGIS, and RxSolution are transforming rural health by improving access, efficiency, and accountability.

4.3.1.4 Digital communication channels

Participants highlighted different communication channels they utilise across various

platforms, such as emails, SMS, MS Teams, Zoom and WhatsApp.

> *We are using SMS's, we are using WhatsApp. WhatsApp is the only one which is good for us because we have to WhatsApp if we are in need of anything, we have a WhatsApp group for all facilities, so we communicate through WhatsApp* [C2N8].

> *So that is how these digital technologies help us, even we see less deaths now as I said that we are using WhatsApp, so the patients get assistance quickly through the ambulance system via our WhatsApp group* [CHCN5].

> *We are using the mobile phones for making calls let's say a client is coming from another facility to this facility, then we make a phone call to inquire about that to the other facility, another one wants us to call an ambulance depending on the condition that the client is facing by the time he visits the facility* [HN2].

> *Yes, we do use the phones, we use messages to remind the clients of the appointment dates before we do now and then provide them with information that they need from us. E-mail, WhatsApp, Messaging, phone calls we do use them to assist patients and also for us to communicate as the staff, like here in this facility we use it* [CHCA3].

> *We are logged to Teams, yes, we are using MS Teams. So we discuss all these practices of these hospitals through telephone, through Teams. So we discuss all these practices of these hospitals through telephone, through Teams* [HFD].

The participants highlighted that they are using WhatsApp as a method of communication for emergency responses, group communication and inter-facility support [HDR1, HDR2, C2M2, C2N7]. One participant noted that:

> *Yes, we have the WhatsApp group, it's for the Mnquma Municipality because even the Idutywa area is there, so if we are unable to get through via the phone call, we just text in the WhatsApp group and then those that are working in the ambulance will respond and say that we have picked up the patients and the patient is now on the way to the facility* [CHCN6].

Another participant [HN1] noted that they are using SMS when they experience network issues. Collectively, the participants expressed that these digital communication tools (emails, SMS, MS Teams, Zoom and WhatsApp) enhance connectivity, coordination, and patient engagement in rural healthcare.

4.3.1.5 Compliance and diagnostic tools

The compliance and diagnostic tools sub-category comprises three items: 'Digital diagnostics', 'IntelliSpace Perinatal' (ISP), and 'Office of Health Standards Compliance' (OHSC).

i) Digital diagnostics

Participants revealed the use of digital diagnostic tools like X-ray equipment, ultrasound machines and automated blood pressure monitors [CHCDR3, HN2, C2N7].

> *So we are no longer using those old manual BP machines that make a noise* [C2N7].

> *And the BP monitors for the vital signs. But it's not the manual one, the one we use in the old days, this one you plug the cuff and then you just start and then it gives the reading [HN2].*

> *And then it's the X-ray machine – with the X-ray machine, we use it in many circumstances. It's very useful when we want to check in wide range of things, so for example if someone fell, we need to know how the bones as much as in the examination…well, OK there's…we have deformities here, there's swelling, there's decreased like range of movement of the limb, I need to know what's the situation with the bones so that I can see the fracture, what type of it, how is it, so well…the X-ray then takes a picture and then we see the bone so we can see how the bone is fractured and how we'll manage each and every different fracture. And then we have some cases where maybe someone is like… has a step-chest or a step-abdomen, so we need to know, did they bleed into the chest? Is there air that's going into the chest, like you can be able to differentiate and see* [CHCDR3].

ii) ISP

The IntelliSpace Perinatal (ISP) is a Philips system used by professional nurses that track the well-being of a foetus during pregnancy.

> *The ISP what it does…so our second system is called ISP, as I said, it's a Philips introduced system which helps mostly with CTGs. I am not a professional nurse, so I might not know how to explain it properly, but this is basically a CTG. It helps align with the progress and factuality of a child while the mother is still pregnant, so basically it outlines and checks everything if the BP is still beating well* [HA2].

The ISP digital system enables nurses to track vital health indicators, thereby improving quality, and responsiveness for mothers and children.

iii) OHSC

The digital tools serve to monitor and enforce healthcare safety and quality standards in health settings ranging from major hospitals to clinics to independent practises of doctors and other health professionals providing safe and quality healthcare services. The facility director explained that, from time to time, they had to check if they comply with the national health standards, saying:

So another system that is being monitored here also stays here and nationally and provincially, the Occupational Health System Compliance (OHSC), yes, so from time to time they will look at the system, see if we are complying so that when they come and monitor so that we all complying with the requirements of that particular system [HFD].

Altogether, digital diagnostics, ISP, and OHSC support effective healthcare delivery in rural healthcare settings.

4.3.1.6 Human resource and payroll system

Two participants noted the PERSAL system, which is a payroll system mainly used by the Human Resource (HR) department for HR related information.

PERSAL monitors who is appointed, who is employed, whenever employees are going on leave use PERSAL, benefits that you must get, we use PERSAL, payments, retiring employees, and so on, we use PERSAL. If you're going to monitor disciplinary actions taken, they will also reflect on PERSAL, so that is another system [HA1].

…another system that [is] called PERSAL, the one that monitors the availability of employees in each and every institution [HFD].

4.3.1.7 Digital technology and transformation – sub-categories and items from empirical data

Table 4-9 outlines empirically based findings under THEME 1. Six sub-categories were identified, incorporating seventeen items on DT and transformation in rural communities. Each item is linked to the corresponding study.

Table 4-9: THEME 1: Digital technology and transformation – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCDR3	CHCN5	CHCN6	CHCA3	CHCA4	C2M3	C2N7	C2N8
Electronic health records and patient information systems	EDTT16: EHRs	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	-
	EDTT19: HPRS	■	-	-	-	■	■	■	■	■	■	■	■	■	■	-	■	-	-	-
	EDTT20: IHSR	■	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	EDTT28: TIER.Net	-	■	■	-	-	-	-	-	■	-	-	-	-	-	■	■	-	-	-
Data management and monitoring systems	EDTT12: BAS	■	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	EDTT14 DHIS	■	-	-	-	-	■	-	-	■	-	■	-	-	-	■	■	■	■	-
	EDTT17: e-Tick register	-	-	-	■	■	-	-	-	■	■	■	■	■	-	-	-	■	■	■
	EDTT18: HMS2	■	■	■	-	-	■	■	-	■	-	-	-	-	-	-	-	-	-	-
Laboratory and medical systems	EDTT 13: CCMDD	■	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-
	EDTT22: Lab Trak	-	■	■	■	■	-	-	■	■	-	■	-	-	-	-	■	■	■	-
	EDTT23: LOGIS	■	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-
	EDTT26: RxSolution	■	■	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-
Digital communication channels	EDTT27: Tele-communication tools	■	■	-	-	■	-	-	-	-	-	■	■	-	-	-	-	■	■	-
Compliance and diagnostic tools	EDTT15: Digital diagnostics	■	■	■	-	■	-	-	-	-	-	-	■		■	-	-	-	■	-
	EDTT21: ISP	-	-	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-
	EDTT24: OHSC	■	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-
HR and Payroll system	EDTT25: PERSAL	■	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-

Figure 4-7 presents a network diagram illustrating THEME 1 from an empirical perspective. The diagram visually maps the relationship between the theme and its associated items, offering insight into the adopted DTs in rural healthcare settings in the Eastern Cape province. For instance, the item 'EDTT13: CCMDD' is included in the network diagram, where the prefix 'E' indicates that the item originates from the empirical data. This coding system distinguishes between theoretical (T codes) and empirical (E codes) perspectives, helping to clarify the source and nature of each item.

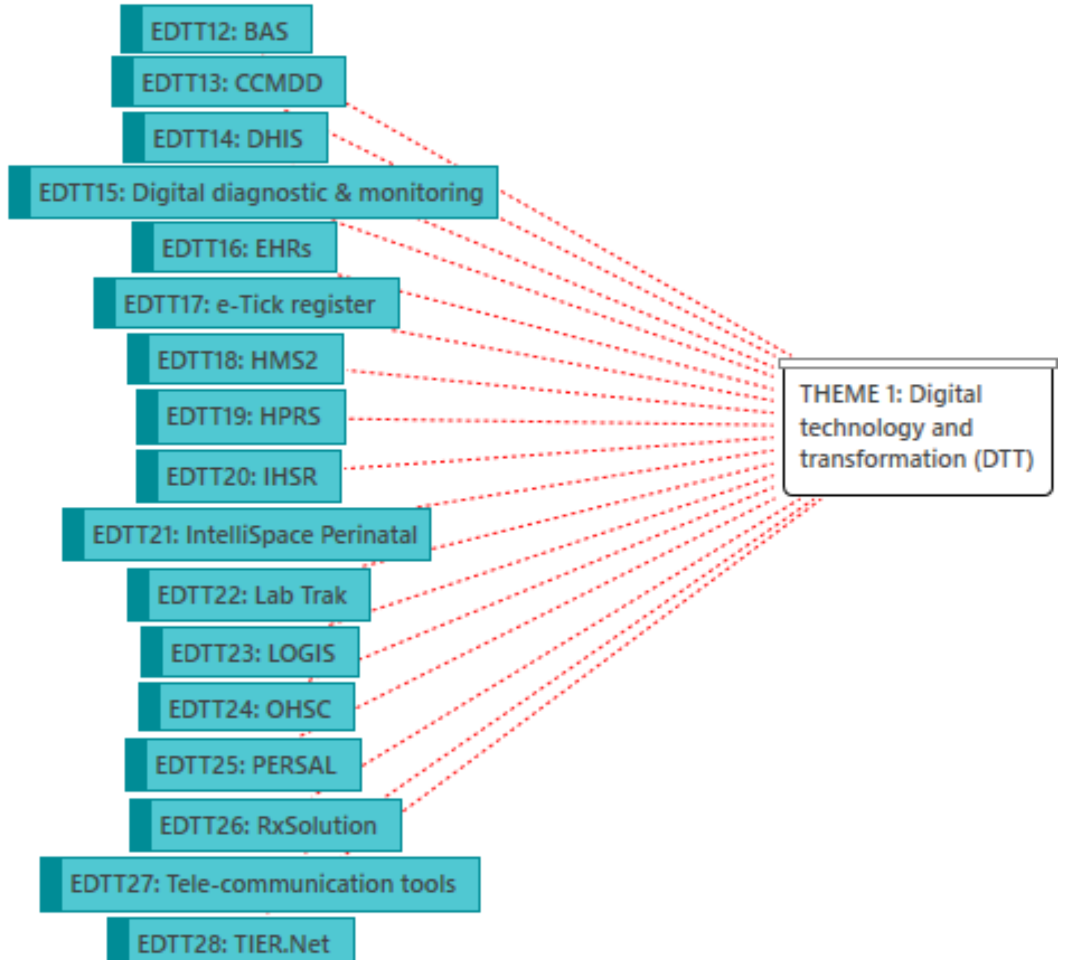


Figure 4-7: THEME 1: Digital technology and transformation (DTT) and associated items for empirically based codes

Collectively, THEME 1 presents the types of DTs adopted in healthcare facilities in rural areas. The following section provides the perceived benefits associated with the adoption of DTs in rural healthcare settings.

4.3.2 THEME 2: Perceived benefits (PB)

THEME 2 highlights the positive impacts of digital transformation in healthcare, as experienced by stakeholders across various levels of the system. Through the analysis of three sub-

categories, this section outlines how DTs contribute to enhanced performance, better service delivery, and improved patient outcomes. The success of digital transformation in rural healthcare is not solely determined by technical capabilities; it is equally shaped by how stakeholders perceive these technologies. Perceived benefits such as improved access, efficiency, and data-driven care can drive enthusiasm and adoption. THEME 2 covers three sub-categories: ‘Data management and system efficiency’, ‘Improved operational efficiency’, and ‘Patient-centred outcomes’.

4.3.2.1 Data management

This sub-category incorporates three items: ‘Improved data management’, ‘Facilitates data transmission’ and ‘System integration’.

i) Data management

One participant pointed out that the role of DT in healthcare facilities is to manage information [HFD]. Most participants emphasised the importance of DT in their daily activities within the facilities:

> *I’ll say it’s important because you can store the patient information as we are in the rural areas, you’ve got old people, sometimes you’ll come to the hospital, they’ll leave their ID’s behind, so you’ll have that information in the computer in case of that or they don’t, they don’t come with the information from their local clinics. So if you are using computers then you will be able to access that information* [HN2].

The participants highlighted the security and reliability of digital data, praising the easy retrieval of patient data in comparison to the paper-based system.

> *I would say beneficial because it is taking the institution away from relying on manual documents which at times are misfiled, or they get stolen, or they are damaged because of the duration they have been there for a long time. It makes life easy whenever there’s someone looking for an answer- what happened to your certain transaction in terms of payment, you made an order, they can be able to go into the system and see who made it, who made the payment* [HA1].

> *OK, this technology or these computers help us, now that you have said that we registered all the clients in the… in the health facilities, so if somebody lost his file or his lost his card, his or her card will be able to find the patient through these computers* [C1M1].

> *Yes, as I am saying, with the filing system, sometimes, these files they get misplaced. Alright, and then you will come to the digital technology, then it’s easy for you to access, it makes it easy for one to access the information of that particular client because it has been, it has been recorded, captured and* stored [CHCN5].

Digital records support longitudinal tracking of patient medical history, which is very important for managing patients with chronic diseases. One medical doctor indicated that:

> *If a patient is telling you that I was admitted maybe in 2023. Then you are able to get…you can get the results of the patient like if you are not sure when the patient has started in a certain treatment, for example let's give HIV, when you go to the system, you see that this patient was done the Lab results, and received this medication or started on treatment and defaulted on treatment, like you can see why patient has been doing the default or yes* [HDR2].

ii) Data transmission

DT facilitates patient transfers by maintaining continuity of care even if the documentation is missing, enhancing rural healthcare delivery. One professional nurse indicated:

> *I was saying another thing that is assisting us with the digital systems, now that we are in the rural areas, let's say sometimes you want to…you want the views of the senior doctors from the special hospitals, so you can send the information on the digital systems. Like if…you've got X-rays, you can send the pictures, you can send the blood results via the digital system. Then the doctors on the tertiary system can assist you if you've got that patient that you need without the patient going to the tertiary* level [HN2].

Digital health systems facilitate real-time transmission of data at various levels, such as district, provincial and national level.

> *It's good because it makes the communication much more easier because we just transfer information to another facility… Yes, like there are those clients that came transferred themselves without the transfer letters, but we can see we can get information through these digital systems* [C1N3].

> *By capturing the patient information in these digital systems by the data capturers it helps a lot, I think this is how these digital systems are helping us. Even now we can easily collect and distribute the information. And the information now moves faster, I mean to say that all the information that we collect from the patients it reaches the national level faster or quicker* [CHCN6].

The quick transmission of data among facilities enhances data integration in rural healthcare.

iii) System integration

One participant revealed that the digital systems are integrated, for example, HMS2 is integrated with other systems within the Eastern Cape province, starting with Home Affairs and extending to various additional platforms.

Also, from the HMS2, I'm talking about, patient administration it's an integrated system which you can easily tell how many patients by the click of a button, how many patients are there in the hospital, are admitted in a specific ward [HA1].

HMS2… connects … other systems to other systems, first one being Home Affairs and then the second one being all other, I don't know if I should put it as regional or provincial hospitals, everything around in the Eastern...every hospital or clinic around in the Eastern Cape is put here [HA2].

One participant highlighted that the digital tools improve accuracy and informed decision making at the national level:

So… information that we capture we store it in the digital system so that those that [are] working at the national level they can see that OK, now there is an increase on patients with HIV, there is an increase on patients with hypertension, so they come back to us with the feedback maybe saying that now you need to educate them because we see an increase in patients with HIV [CHCN6].

The adopted digital systems enhance coordination and streamline communication across various institutions of the health system, as noted:

…this digitisation of information is linked to Treasury, so the treasury does support us with a few things that we don't have, for instance, they give backup of a modem for this project. You see that kind of thing, but now this system tells you where you were at once admitted in Cape Town, you were once admitted in Pretoria, you been to another facility, you've been to Frere, and so on, so it tells you your history.

So we monitor all those indicators, imagine this system here, the District Health System, it links with Primary Health Care, so if something is not right at the Primary Health Care, you got lots of teenage pregnancy, it's going to be coming to maternity, then we will have lots of children giving birth, then that increase we can see on the system and we have meetings to say, why are so many teenage pregnancies are happening and giving death… birth to the hospital – which is a problem for the health of a child who's going to be pregnant early so that we devise strategies so that we reduce those children coming from there with still births [HFD].

4.3.2.2 Improved operational efficiency

This section focuses on two items: 'Minimises expenses and time', and 'Improved healthcare delivery'.

i) Cost and time efficient

The participants indicated that the use of DT in healthcare facilities is to save time as they also save money for transportation.

For example, if we are to have a Teams meeting, as the technology has forced us to go to that direction that we don't have to go to meetings [HA1].

It saves a lot of time for us to do the work quickly, it reduces workload, for example I am not going to write a lot now in the book as we used to write the patients information on books. Yes, I think these systems work for a good purpose It saves time, you can do all things in one time whilst sitting in one place and not moving up and down [CHCN6].

It improves the lives of people because people are unemployed this side, they struggle financially, it's very difficult for them to move around to seek healthcare. It makes things easier for them that they travel all the way to here and then they can get all the services here, then they go back without having to go to the referral hospital or to East London and spend money they don't have, so at least they get all the things here [CHCDR3].

ii) Healthcare delivery

Participants noted that the use of DT makes communication much easier because now they can just transfer information to another facility [C1N3]. Professional nurses can send pictures, blood results via the digital system, then the doctors on the tertiary system can help to attend to the patient without the patient going to the tertiary level [HN2]. For example:

Now we can say that this patient was seen in Cape Town by the time like in August, but we can see that she takes the blood in Cape Town in August and the results are this. So it makes life easy. Yes, like there are those clients that came transferred themselves without the transfer letters, but we can see we can get information through these digital systems. So it makes life easier for the patients, because then we used to tell them that she must go back to Cape Town and collect the transfer letter here because we don't know when she started treatment, what was the CD4 Count there but now because of Lab Trak we can see all of that [C1N3].

Now it is easy to transfer information between the facility and the sub-district level [CHCM2]. These systems enable the managers to get quick responses at the district level [C2M3]. The senior management team is able to monitor various operations within the facility:

So that system is able to monitor, so nurses are able to monitor, nursing service manager is able to monitor, clinical manager is also helping to monitor this system and when I want more information, I look at the system or I ask clinical manager to use it and give me information about that system, carefully recording what is happening, death that is happening in the institution, in the wards and how many patients are there in the wards, so monitoring what is called the bad utilisation rate for each unit. So, it's that kind of a system [HFD].

Other participants reported that:

Even now we can easily collect and distribute the information, imagine how are we going

to send the information to the national level if we store that patient data in the book? It will take a very long time, but if we capture the data today, by tomorrow, it will be reflecting at the national level [HN2].

It is it is managing information, getting connected to managers, senior managers from getting connected with the district management, getting connected with the provincial management, getting connected with the national management, also getting connected with the Centre of Disease Control, the CDC internationally. There's national level, which reflects provincial level, reflecting in Geneva if it's Geneva, where World Health Organisation (WHO) monitors us. So that impact is good because you can have a meeting, a fruitful meeting, but before we were not used and we thought that it's not going to work.

So that is how the impact is, it helps us to be alert so that we would not be running short of things that we're not supposed to run short, if we do, we are able to contact other stakeholders. Therefore, if also you see there's a problem in the community you go and meet the community, community – why are your children so malnourished, then why are your children dying [HFD].

DT plays a vital role in healthcare facilities as it enables the shift from manual processes to automated processes [C1N3, C2N7, C2N8]. For example:

It helps us a lot because it takes like for example, if I have a client we used to use the registers where we write the client, the treatment, all those things, but with the systems that we are using now, it only takes maybe like about five minutes instead of twenty-five minutes [C1N3].

Digital systems facilitate continuity of care, as pointed out by one of the facility administrators:

You can still retrieve the information of the client and then once it appears, you can click to the client, it shows the entire information, the treatment that the client is taking, the period the client has taken the treatment, if the client has defaulted for this long, it shows you that the client has defaulted [CHCA4].

These systems help the facility such that the professional nurses can identify that the patient visited the facility at a specific time and also shows the kind of problem that the patient has so that they can assist the patient quicker and better [C1M1].

The digital systems enhance transparency to mitigate fraud, for example, HA1 stated that:

On the patient registration, you are able to see who was the first person to register that client and even in the patient flow you can see that doctor so and so is the one, so it makes it easy when there is something that has to be investigated. In the system, it will tell that this one had or has a medical aid, so it makes life easy, which means mitigating against fraudulent activities, maximising the revenue collection in one way or the other.

4.3.2.3 ***Patient-centred outcomes***

This sub-category covers two items: 'Continuity of care' and 'Value-added outcome'.

i) Continuity of care

The participants indicated that the systems ensure a coordinated and seamless flow of patient care through the healthcare journey:

> *I am talking about here, in South Africa, because if a patient was attending a clinic, for example, here we are working in the maternity, If a patient was attending clinic in… like we had a patient that was from Saint Elizabeth. When they typed the name of the patient on the computer using the ID, the information came out that she is…in fact in the system, she has been registered under Saint Elizabeth, so we are just going to add on the Saint Elizabeth information what we did and what happened to the patient, the transfers and everything. So there is continuity of care of the patient. You know what they did, what treatment they gave, you know whether to augment or reduce* [HDR2].

> *Yes, even…it helps us in things like for instance, if the patients was in Cape Town before and visited a health facility on that side, now through the use of digital technology we can see the patient was diagnosed before in Cape Town, for instance if the patient is trying to hide that she was diagnosed with HIV we can see that she was diagnosed with HIV before in Cape Town whereas the patient says that she is new in this facility, so we can see that the patient was taking the HIV treatment long ago in Cape Town by checking their details that is stored in the computers* [C1M1].

ii) Value-added outcome

Various roles reported on how DT adds value to the healthcare services:

> *The impact of digital technology on…rural community, I can say it is working for the good impact because the information it doesn't get lost, it makes it easy for us to refer back to the information that we need for that particular…for that particular purpose. And yes, we are able to retrieve it back anytime we want it or anytime we need to use that information. So it is working for the good impact* [CHCN5].

> *… we all know these papers and the community it's a mission in the environment.... So it's kind of green if you use digitalisation and technology* [HDR1].

> *I think digital technology improves the quality of the care of our patients. It reduces workload, for example I am not going to write a lot in the book now as we used to write the patients information data in books. Yes, I think these systems work for a good purpose* [CHCN6].

> *The digital technology is very important because it takes us from the manual ways of doing things in the past so the job now becomes easy* [C2N7].

So these are the things that the systems of nowadays in terms of managing information, improving health outcomes, improving life of people. They are quite valuable [HFD].

Table 4-10 presents a summary of the empirically based findings under THEME 2: Perceived benefits grouped into three sub-categories containing seven items. Each item is explicitly linked to the corresponding study from which it emerged, allowing for clearer traceability of evidence and reinforcing the thematic structure through grounded empirical support.

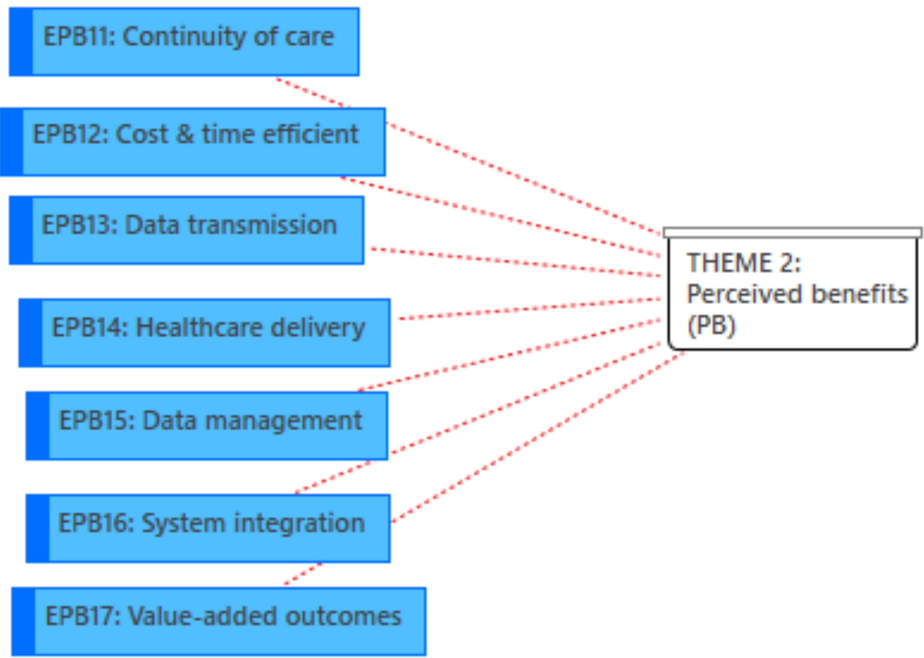


Figure 4-8: THEME 2: Perceived benefits (PB) and associated items for empirically based codes

THEME 2 offers the benefits associated with the adoption of DT in healthcare facilities in rural areas. The following section provides the challenges associated with the adoption of DTs in rural healthcare communities.

Table 4-10: THEME 2: Perceived benefits – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCDR3	CHCN5	CHCN6	CHCA3	CHCA4	C2M3	C2N7	C2N8
Data management and system efficiency	EPB13: Data transmission	■	■	■	■	■	■	■	■	■	-	■	■	■	■-	■	■	■	■	-
	EPB15: Data management	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	EPB16: System integration	■	■	■	-	-	■	■	■	■	■	■	-	■	■	■	■	■	■	-
Improved operational efficiency	EPB12: Cost and time efficient	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	EPB14: Healthcare delivery	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Patient-centred outcomes	EPB11: Continuity of care	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	EPB17: Value-added outcome	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Additionally, Figure 4-8 presents a network diagram illustrating THEME 2. The diagram visually maps the relationship between the theme and its associated items, offering insight into the perceived benefits associated with the adopted DTs in rural healthcare settings in the Eastern Cape province.

4.3.3 THEME 3: Perceived challenges (PC)

In this section, SQ 2.3, *"What challenges emerge when adopting digital technology?"* is answered by THEME 3 and THEME 5. While DTs offer promising solutions for rural healthcare, their implementation is often met with significant challenges, both real and perceived. These include concerns about infrastructure limitations, digital literacy gaps, system reliability, and data security. Such perceptions can influence the willingness of healthcare workers and patients to adopt and trust digital tools. Understanding and addressing these perceived challenges is essential for designing resilient, inclusive, and sustainable digital health systems that truly meet the needs of rural communities.

THEME 3 highlights the practical and systemic barriers that hinder the effective implementation and sustainability of digital transformation in healthcare settings. Drawing from empirical observations, this section outlines the key challenges related to technological infrastructure and operational dynamics. This section covers two sub-categories: 'IT infrastructure and technical issues', and 'Operational issues'.

4.3.3.1 IT infrastructure and technical issues

This section covers two items: 'Connectivity issues' and 'Lack of IT personnel'.

i) Connectivity issues

Many participants expressed the issue of connectivity in terms of electricity and internet signal problems because of power cuts [HA2; HDR1; HDR2; CHCDR3; C1M1; C2M3; HN1; C1N3].

> *And we do struggle sometimes with the network of the Internet, yes, because say because of the area that we are in, because it's more rural, sometimes the network is not always available* [HN2].
>
> *So basically it's that connectivity issue which needs to be taken care of, to ensure that it is there, there is a backup system in terms of or whatever failure. The only glitch that I'm talking about is about the connectivity…the challenges these are the ones I said that mainly around the connectivity issues, which is the downtime* [HA1].
>
> *…just network and the electricity that was the biggest challenges* [HA2].
>
> *There are challenges such as electricity* [HA2].
>
> *What I can quickly remember is that because of our landscape and what not… we have Internet signal problems. Sometimes we don't have the connectivity, maybe it's a Telkom problem* [HDR1].
>
> *The challenges that we've got now is the as I said, sometimes there's no network* [HN2].

The digital systems that are implemented depend on the availability of the internet [C1N3]. Other healthcare facilities are unable to use the digital health systems when there is no electricity, for example, another participant noted that:

> *The only problem is when there is no electricity because we don't have backup, for those that are on CCMDD, we have to use Internet so, if there is no electricity, it will be a problem for us to renew those scripts* [CHCA3].

ii) Lack of IT personnel

The participants indicated that there is a shortage of qualified resources in terms of healthcare and IT professionals:

> *So those are the challenges around the adoption of the system. Well for the support, we have to wait to get support, we are in the rural area. Therefore somebody who is going to come and assist you with more skills than the one that we have must it's either must come from East London to our facility here and we have to wait even that one is also servicing and all other areas so you might wait longer and you wish because these are busy helping somewhere* [HFD].

> *The technology needs people who have expertise, which means technicians who can deal with technical glitches on the spot* [HA1].

> *Also, we have a challenge of personnel, we don't have IT people. We don't have in this facility a permanent ICT manager, we depend on interns* [HFD].

> *…there is an IT person that is here already there is a plan that has been done, there are interns, IT interns that have been deployed, although we would like a professionally permanent* [HA1].

> *The digital health systems need people who are experts, which means technicians who can troubleshoot on the spot* [HA1].

The participants further highlighted that:

> *No IT people to work on the on, on the system that is broken over some time. Also we have a challenge of personnel we don't have IT people. We don't have in this facility the permanent ICT manager. We depend on interns, but we…don't have post, when they leave, we wait for another intern, we don't have a post to say we have our own ICT manager* [HFD].

> *We've had to procure everything that goes with that, the speed was not what we would have liked it to be, as I've said earlier on. It was probably the roll out, it was not as fast as we had hoped it would uh…because of resources we've had to procure computers* [HDR1].

The challenge, the challenge is that sometimes they crash, sometimes the computer crash, you lose information if you have forgotten to back up. So hence we say we have to back up every end of the day before you knock off, you have to back up. So you come across a challenge that once the computer that you're using crashes and it's the only computer that is the depending on the size of the facility, and then that means you have lost the entire information [CHCA4].

The challenge is the computer you find that there's only one computer for the whole ward is used by the nurses and the doctors [HN2].

And me too, I'm using the manual, only the manager is now using e-Tick because my computer having a problem [C2N7].

4.3.3.2 Operational issues

This sub-category covers 'Backlog issues' and 'Data duplication and loss'.

i) Backlog issues

Backlog challenges are a result of power failures [HA2]. During power cut-off, the admin staff capture patient information in a paper-based system then when the power is back, the admin staff capture all the patient details in the system [HA2, HN1, HN2] and this results in duplication of work [HN1]. The participants indicated that:

We have to write down the patience and after the power is back one will have to go back to the e-Tick and rewrite those patients data. We just write down the patients on paper based we go back to paper based then after electricity came, we write all those patients, we go back to the digital system to capture all those patients that were on paper based [HN1].

We just write down the patients on paper based, we go back to paper based then after electricity came, we write all those patients…we go back to the digital system to capture all those patients that were on paper based [C1N3].

I think I have mentioned earlier on during power outage when you still had low shedding, it affected us so much that we had to go back to the paper based and then we needed…when the electricity is back-capture again [HDR1].

Yes, we are using the old ways so that there are no delays for the clients. Then after we got…when the electricity is electricity is back then we register again, again, all those clients in the system [C1M1].

Other participants pointed out that the paper-based system in the facility is used as a backup system when the power is off, for instance in case of load-shedding to keep the facility in a working condition:

When there's a power failure we've got only to use our manual documents and then when the power is back, it's then that now we are able now to use our digital technologies to capture the information [CHCN5].

So I think we will have it back up now because we do have a problem by the time of load shedding, we have to write down the patience and after the power is back one will have to go back to the e-Tick and rewrite those patients data [C1N3].

One participant noted that the digital systems need backup generators for electricity [HFD]. For example:

For those that are on CCMDD, we have to use Internet so, if there is no electricity, it will be a problem for us to renew those scripts. Even HPRS depends on electricity, Internet [C1N3].

ii) Data duplication and loss

The participants indicated that in case of power failure or sometimes the data gets lost or duplicated:

I think based on estimation, the challenges that were met before digital technologies were introduced, I think is the duplication of…duplication of…duplication of papers, like this is like the information was incorrect based on the duplication, so we were over reporting and under reporting back then, so when it when it comes to the hard copies, so now it's easier because the, the registers are electronic now instead of the hard copies which are…for example the registers get old, and get torn, and the information gets lost somewhere or somehow [CHCA3].

Sometimes, the patients… the patient things detailed, somebody will upload them, but then maybe miss the storing part, the saving and then they may not be saved so somebody else has to look again and check if all the patients… like you would say we had 11 deliveries only to find that maybe only seven are saved. There's four that are missing. So you have or somebody has to recheck that [HDR2].

We are encountering many problems now, especially when the network is gone, because the information now…if you don't save the information now, it quickly goes [HN1].

Table 4-11 presents a summary of the empirically based findings under THEME 3, grouped into two sub-categories containing four items. Each item is explicitly linked to the corresponding study from which it emerged, allowing for clearer traceability of evidence and reinforcing the thematic structure through grounded empirical support.

Table 4-11: THEME 3: Perceived challenges – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCDR3	CHCN5	CHCN6	CHCA3	CHCA4	C2M3	C2N7	C2N8
IT infrastructure and technical issues	EPC08: Connectivity issues	■	■	■	■	■	■	■	■	■	■	-	-	-	■	-	■	■	■	-
	EPC11: Lack of IT personnel	■	-	-	-	-	■	-	-	-	-	-	-	-	-	-	-	-	-	-
Operational issues	EPC09: Data duplication and loss	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	EPC10: Backlog issues	-	-	■	■	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Additionally, Figure 4-9 presents a network diagram illustrating THEME 3. The diagram visually maps the relationship between the theme and its associated items, offering insight into the perceived challenges associated with the adopted DTs in healthcare facilities in rural areas. Furthermore, the empirical data items support all theoretically-based items associated with THEME 3.

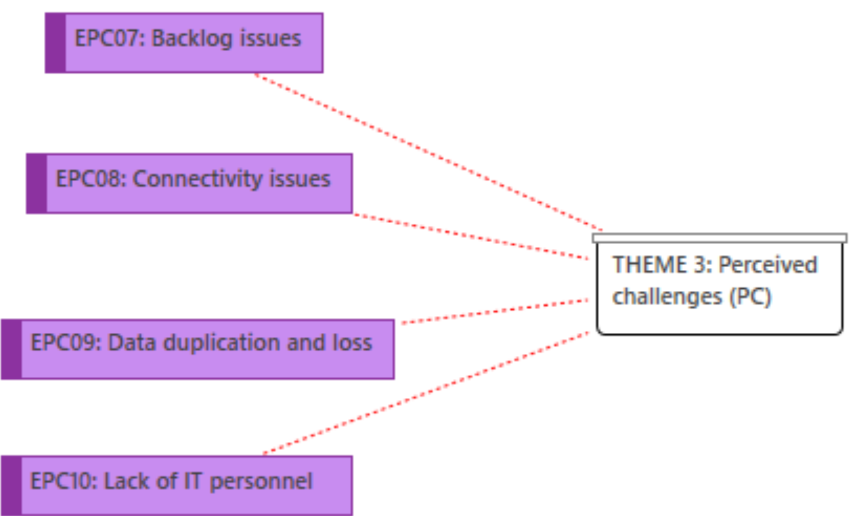


Figure 4-9: THEME 3: Perceived challenges (PC) and associated items for empirically based codes

THEME 3 outlines the perceived challenges associated with the implementation of DTs in healthcare facilities in rural areas. The following section provides the human-related factors associated with the adoption of DTs in rural healthcare settings.

4.3.4 THEME 4: Human factors (HF)

The section covers four items: ‘Adoption resistance’, ‘Age-related barriers’, ‘Digital literacy’, and ‘User perceptions’.

4.3.4.1 Adoption resistance

The participants indicated that during the initial stage of the adoption of DT within the facility, it was not easy for them to adjust to the changes although over time, they got used to the digital systems.

> *There is a little bit of resistance to change, being afraid of computers, you click you think that all the information you have lost, you don’t know how to retrieve it back. If I were to talk about challenge with this new system, let’s put aside the resistance to change, nurses want to be nurses, they don’t want to sit next to computers, doctors want to be doctors, they don’t want to sit next with the computers* [HFD].

No, we were relented, for it's too much because we have a book that we are writing and then we have to write another book in the computer [HDR2].

4.3.4.2 Age-related barriers

The participants mentioned the age-related issues:

We didn't accept this technology first, especially those who are older just like me, but the young ones were so happy, but now we as times goes on, we find that you know it's, it's, it's, , it's, it's easy to use this technology and they save time [C1M1].

It was too difficult because we are old we do not know these technologies but we are trying [HN1].

Although there is a challenge because not of all of us are young, there are old nurses, they always experience the challenges also because sometimes we are busy with clients and you hear that someone is calling you, can you please come help me [C1N4].

4.3.4.3 Digital literacy

The participants highlighted that computer literacy is a major challenge in the facility as most of them were not trained on computers and they said:

Yes, they are making things easier but we are not… we are… not all of us are computer trained. [HDR2].

Well, firstly, the staff was…most of the staff were not computer literate [HN2].

The challenge were…most of us were not trained on computer [C1N3].

The challenge I would say it was just an unfamiliarity with the system since we have long been using our manual way of documenting information. So it was unfamiliarity with the system, but as we had trainings, people got along and they adopted to the new system as well, the new system, which is the digital technology [C2N7].

The unfamiliarity of how to use the technology like for example, the use of computer, it's not that we did not learn about how to use the computer but it's just that when you are not using the skill that you learned for a longer time, you end up forgetting about that skill, but when we get training again, we end up remembering what we were thought. So there is a challenge…then us as nurses we only know the medicine side, you know, there is nothing to do with IT, we don't have anything to do with IT [C1N4].

4.3.4.4 User perceptions

Folders they get missing, so if the if the information is in the computer then it will be much better.…but some people did not have the willingness to learn so that also was a challenge, because now you see, but we don't have all hands on deck because it's this

new thing you understand and it's like me no, you see... slowly but surely came to a point where everyone is easily getting to it [HA2].

We were relented, for it's too much because we have a book that we are writing and then we have to write another book in the computer [HDR2].

Yes, so I say it is difficult to change, our subordinates are saying that, no we are not adjusted to these things [HN1].

The respondents showed eagerness to adapt to the new ways of working:

…so it's good for the fact that everyone gets to learn new things so everyone is learning new things [HA2].

Another participant pointed out that as healthcare professionals in the facility, they have moved past the stage of resistance [HFD]. All the items in THEME 4 are central to the success or failure of digital health initiatives in rural settings.

Table 4-12 summarises empirically-based findings in THEME 4, incorporating four items that were properly allocated.

Table 4-12: THEME 4: Human factors – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCDR3	CHCN5	CHCN6	CHCA3	CHCA4	C2M3	C2N7	C2N8
Human factors	EHF08: Adoption resistance	■	-	-	-	-	-	-	-	■	-	■	■		■	-	-	■	-	■
	EHF09: Age-related barriers	-	■	-	■	■	-	■	■	■	-	-	■		■	■	-	■	-	
	EHF10 Digital literacy	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	EHF11: User perceptions	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Additionally, Figure 4-10 presents a network diagram illustrating THEME 4. The diagram visually maps the relationship between the theme and its associated items, offering insight into the human-related associated with the adoption of DT in healthcare facilities in rural communities. The next section provides the processes and patterns associated with the adoption of DTs in rural healthcare settings.

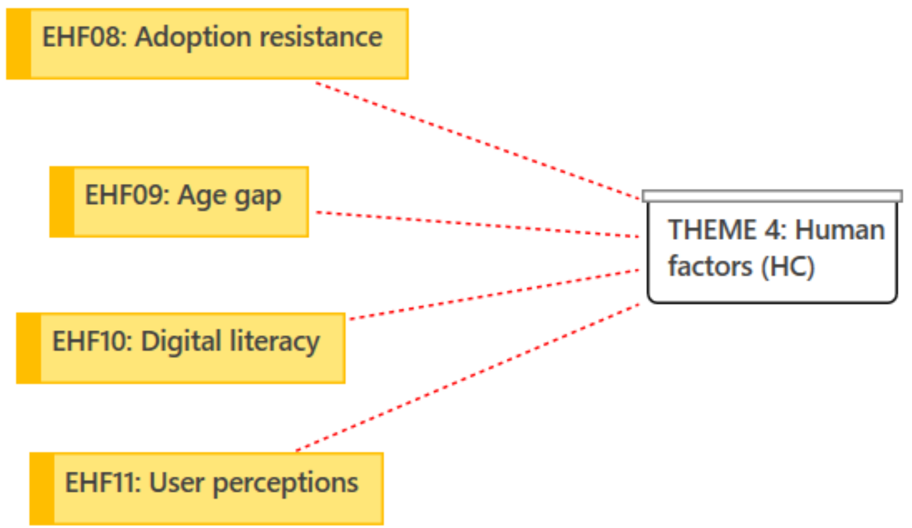


Figure 4-10: THEME 4: Human factors (HF) and associated items for empirically based codes

Addressing the human factors is essential for ensuring that digital health initiatives are embraced, effective, and sustainable.

4.3.5 THEME 5: Processes and patterns (PP)

Theme 5 from the empirical data provides valuable insights into how digital transformation unfolds in practice, based on observed behaviours, systems, and institutional responses. By examining workflow processes and capacity-building efforts, this theme highlights the operational realities and developmental needs within digital health environments. This theme encapsulates two sub-categories: 'Workflow process', and 'Capability development'.

4.3.5.1 Workflow process

This section covers five items: 'Adoption process', 'Data entry process', 'Decision-making process', 'Referral patterns', and 'Workflow integration'.

i) Adoption process

The participants indicated that the adoption process for the Human Management System version 2 (HMS2) – the patient registration system, occurred in phases.

> *And lastly, I think it's newly introduced system called HMS2. The HMS2 is a patient administration system. We are now on Phase 2, but our hospital is one of the hospitals that were in the first phase of the pilot stages. It starts from the patient registration, when the patient comes in, they are registered on the system when they go through the patient path* [HA1].

> *That one, it's still in the developing stages, we are hoping to build up on that to a point where by we do all our recording digitally and electronically, so HMS2, that's one* [HDR1].

We're still on the building up phase, but it's looking better, we're going to towards a good direction [HDR1].

One participant pointed out that some urban facilities in the cities of the Eastern Cape province had already adopted the patient administration system, allowing them to receive support from those more experienced facilities.

So when it came, it also came with a lot of support from the other places that we work with which is that we mainly work with Frere and Cecilia Makiwane in East London, so we also came with a lot of support from there because some people will come and show us how to do certain things as even how things were there [HA2].

ii) Data entry process

The participants described the process through which patient data is entered into the system, starting from the registration point at the reception area.

…in this hospital we have currently we have two digital systems that we use, which are HMS2, the… that's the main one we use for recording of systems. We also use it to attain new data. ...we record the data for all clients that comes into our facility in the sense of the patients. So we use it in the sense that when the patient arrives their first starting point is here which is here [HA2].

And then the patient is admitted, when they get to the ward where they admitted, they are entered into the system as a patient that has been admitted and then they are entered into another system, as a patient that has delivered and then they are entered…like there is a ward for the ones that have not…that are still awaiting delivery and then there are those that are delivered so they have to be counted. They should appear in the computer and then when they are discharged, they have to be discharged from the computer [HDR2].

iii) Decision-making process

The data administrators indicated that the decision-making process within the facility is informed by the data collected from the administrators. A data administrator described the data collection process from the professional nurses through the e-Tick register and then the analysis in preparation for reporting.

The e-Tick is the exact register, what's in the exact words or what's in the manual register is exactly what is there, you just use the computer this time around, so it's on Excel. So that register, that's where they actually work in and then at the end of the month, we as the data capturers, we go there to collect every e-Tick register from every consultant room and consolidate them to one register. So that's the register that will actually represent the entire facility [CHCA4].

Similarly, the information officer, who also played the role of an administrator, pointed out that:

> *…this is one of our co-workers – this is our system. So here, she collects all the data that we use on a daily, weekly and monthly basis, everything now, this is where we also collect our data. As an information officer here, I collect the data and stats on a monthly basis because we have to check how many people we had that… in that specific month... Because I also do stats, monthly stats for our purpose for work* [HA2].

The participants noted that data inform certain decisions from the district level to the national level and as well from the national level back to the district level.

> *Then information like I'm saying, if something is not going right, it will reflect on the information, then we gather all these people relevant and discuss and look at the strategies to make that particular decline of information…we discussed certain strategies then we improve from there, we develop improvement plan for whatever is not going right, we find the root cause, how we can deal with it and manage it [HFD].*

> *So at the national level is whereby they see that something is not going right in a particular department and they send the feedback with the strategy that that particular problem needs to be fixed using the strategy that they supply and they also give a positive feedback as well to the departments where things go well [CHCN6].*

iv) Referral patterns

An administrative participant indicated that the facility adopted the Three Interlinked Electronic Registers.Net (TIER.Net) system, an integrated electronic system that facilitates seamless patient transfers by connecting with other systems.

> *Like, we actually have the systems that we are working with, to name a few, it's TIER.Net which contains more than one system within, so it actually helps to capture TB, HIV, prep. TIER.Net that's where we actually capture the data of the clients with TB and HIV, prep as well. TIER.Net also helps to actually grant a transfer letter, and we actually create a transfer letter through the TIER.Net* [CHCA4].

The integration of TIER.Net with other systems plays a big role in ensuring continuity of care especially when patients relocate. [HDR2]

For example, "… the information of that client you will find it on CCMDD as well as on TIER.Net " [CHCA4].

> *It is, is a great impact actually, because it actually helps us to manage every client coming in as well, because we're also… it's also easy for the client when they are when they are moving to another town, they come to us for a transfer letter, so TIER.Net also helps to actually grant a transfer letter, and we actually create a transfer letter through the TIER.Net* [CHCA3].

…like if a patient was once in Cape Town, or went to East London like all the hospitals, we will see all that information that it's uploaded there [HDR2].

The integration of the digital systems in the facility enables healthcare professionals to issue transfer letters without any issues [C1N3].

v) Workflow integration

The integration of DT into healthcare processes has replaced manual processes with automation and enabled smooth data transfer from registration through to discharge.

And then the patient is admitted, when they get to the ward where they admitted, they are entered into the system as a patient that has been admitted and then they are entered into another system, as a patient that has delivered and then they are entered…like there is a ward for the ones that have not…that are still awaiting delivery and then there are those that are delivered so they have to be counted. They should appear in the computer and then when they are discharged, they have to be discharged from the computer [HDR1].

4.3.5.2 Capability development process

This sub-category focuses on 'Skills and training'.

i) Skills and training

The participants noted that, once the new system is adopted, the facility takes the responsibility to train the users of the system.

…so the training is mainly making sure that people know how to use the system, thoroughly [HA2].

Basically…for every project that is being implemented…what you call the people that are coming to install the product, they first have to do what – training - physical training, they don't just come and install and move, they have to train all personnel, relevant personnel that are going to be engaged in the system itself [HA1].

The participants indicated that there is a peer-to-peer or in-service training for the new employee that fosters collaboration and knowledge sharing among healthcare professionals.

All the nurses that are trained has a responsibility to train, to train other nurses so that the work will move on. OK, in-service education - for the facility to move, move, we have to do in service educations like training other staff [C1N3].

Since we've got an information system here in the facility, so the employees that they are taking for workshops, write and then when they come for a workshop, they come and do the trainings on us [C2N7].

> *And the new employee will come without knowing these systems so he or she will get help when he/she receives the in-service training or education within the facility so that she can move on and do the work* [C1N3].

One participant noted that the healthcare facilities are using webinars as a strategy to enhance their skills.

> *There is communication like via webinars and stuff so that we know how to deal with patient illnesses whilst maybe you are waiting for the ambulance* [HDR2].

The staff members are "encouraged to enrol for advanced computer courses" [HA1] and to attend workshops [C2N7]. One participant noted that they outsource the service providers within the facility:

> *So, we outsource this as the department, so the service provider would come and train us in groups according to the functions that you are going to be using. For instance, they can't train a clerk and the nurse at the same time because their functions are not the same. So they came and then they broke us into different groups according to what you will be using* [HDR1].

Together, the items in THEME 5 show that digital transformation is not only a technical shift but also a process of organisational learning and adaptation.

Table 4-13 summarises empirically based findings in THEME 5. Two sub-categories emerged, incorporating five items that were allocated properly.

Table 4-13: THEME 5: Processes and patterns – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCDR3	CHCN5	CHCN6	CHCA3	CHCA4	C2M3	C2N7	C2N8
Workflow process	EPP13: Adoption process	■	■	-	-	-	■	-	-	■	-	-	■	■	-	-	■	-	-	-
	EPP14: Data entry process	■	■	■	■	■	■	■	■	■	-	-	-	-	■	-	■	■	■	-
	EPP15: Decision-making process	■	-	■	-	-	■	■	■	-	-	■	■	-	■	■	■	■	-	-
	EPP16: Referral process	■	-	-	■	■	-	-	■	■	■	■	-	■	■	-	-	■	■	■
	EPP18: Workflow integration																			
Capability development process	EPP17: Skills and training	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Additionally, Figure 4-11 presents a network diagram illustrating THEME 5 from an empirical perspective. The diagram visually maps the relationship between the theme and its associated items, offering insight into the processes and patterns that are associated with the adopted DTs in rural healthcare settings.

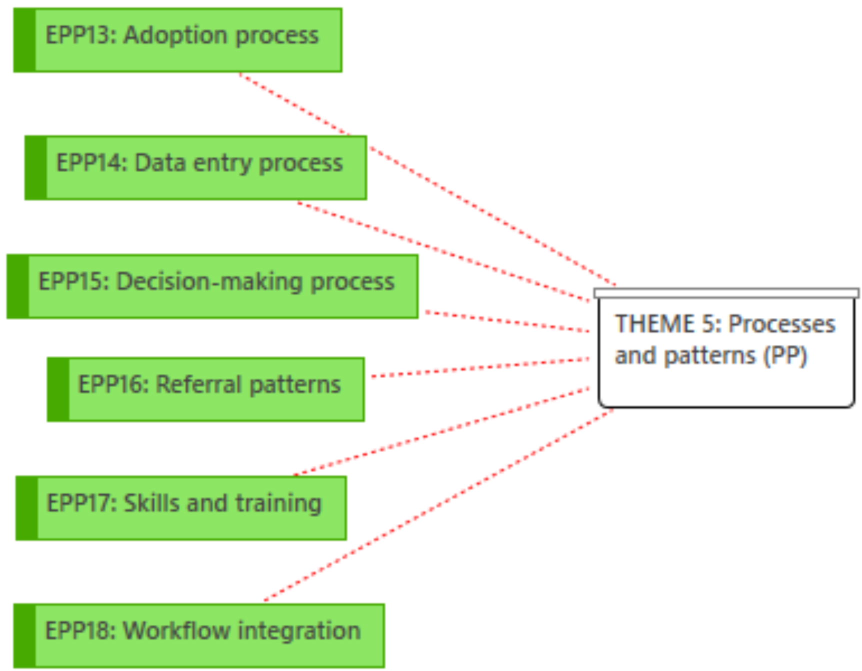


Figure 4-11: THEME 5: Processes and patterns (PP) and associated items for empirically based codes

Collectively, THEME 5 highlights the various processes and patterns within healthcare facilities that shape the adoption and use of DTs. The following section provides the strategies that contributed to the successful adoption of DTs in rural healthcare settings.

4.3.6 THEME 6: Digital health enablers (DHE)

This section presents THEME 6 that inductively emerged from the empirical findings and was not identified among the themes derived from the SLR. The participants indicated that these foundational strategies ensure that they have access to the adopted DTs in the rural facilities, The importance of strategies such as 'Backup generators', 'Facility fibre and Wi-Fi', 'Solar power supply', and 'Uninterruptible Power Supply' (UPS) was a common theme among participants.

4.3.6.1 Backup generators

One respondent noted that the digitalised systems require uninterruptible electricity [HFD]. The facilities have implemented strategies like backup generators to make sure that all their digital systems in the facility are running effectively [HA1; HA2].

> *I think the challenge…part goes hand in hand with the strategies part if I'm not mistaken because those challenges are what led to the* strategies [HA2].

The participants pointed out that they are privileged to have a backup system within the facility:

> *That's an ISP server, so it works as a backup generator for the computer network* [HA2].

> *…they have all the backup systems to make sure that if something fails, we have the backup for it. So in terms of the strategies being implemented, I'll say that they've implemented them successfully* [HA2].

> *We do have generators, I think we have maybe four generators in the event that we have electricity issues, I don't know the name, but we have generators that take over as soon as Eskom has taken off electricity* [HDR2].

> *The fuel-operated generators are helping the healthcare professionals a lot when they have power outages* [CHCDR3].

One participant in another facility noted that "*…* we don't have the generators" [C1M1].

4.3.6.2 Facility fibre and Wi-Fi

The participants noted that there is a department installing fibre that is available in terms of power failure.

> *So with the department installing fibre, that has been a very good strategy for us so that when the electricity goes off, it doesn't affect us* [HDR1].

> *…the Wi-Fi is connected, the router, the government have supplied us with your routers, so that we must be connected all the time* [C2N7].

> *Yes, there is a hospital, there is the department Wi-Fi, the Wi-Fi is available in the institution* [HN2].

> *The Wi-Fi is connected, here* [C2M3].

4.3.6.3 Solar power supply

In case of a power outage, there is solar power in place and it serves as a backup system [C2M3].

> *We do…we do have solar system for backing for backup of the Wi-Fi, but we were using the solar system some time ago, but it is vandalised by the community, so we don't have batteries. That solar system was helping us when we are having a load shedding* [C2N7].

4.3.6.4 UPS

The facility was given an UPS for uninterrupted power supply so that the place is always up and running [CHCA3].

> *We have got the UPS which we are going to use it when we have got interrupted power supply* [CHCM2].

> *The facility was given an UPS. So, in the case of the power cut, power cut-outs, we normally use backup generators, and the UPS…yes, so that the information is not lost* [CHCA3].

Collectively, these enablers form the backbone of a resilient digital health ecosystem. Their strategic implementation supports uninterrupted service delivery, enhances infrastructure reliability, and contributes to the long-term sustainability of digital transformation efforts in healthcare.

Table 4-14 summarises empirically based findings in THEME 6 that emerged from the empirical data and extending five themes identified through the SLR.

Table 4-14: THEME 6. Digital health enabler – sub-categories and items from empirical data

Sub-category	Items	Study 1.1	Study 1.2	Study 1.3	Study 1.4	Study 1.5	Study 1.6	Study 1.7	Study 2.1	Study 2.2	Study 2.3	Study 3.1	Study 3.2	Study 3.3	Study 3.4	Study 3.5	Study 3.6	Study 4.1	Study 4.2	Study 4.3
		HFD	HDR1	HDR2	HN1	HN2	HA1	HA2	C1M1	C1N3	C1N4	CHCM2	CHCN5	CHCN6	CHCDR3	CHCA3	CHCA4	C2M3	C2N7	C2N8
Digital health enabler	EDHE01: Backup generators	■	■	■	■	■	■	■	-	-	-	■	■	■	■	■	■	■	■	■
	EDHE02: Facility Fibre and Wi-Fi	■	■	■	■	■	■	■	■	■	-	-	■	-	-	-	■	■	■	-
	EDHE03: Solar power supply	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	■	■	-
	EDHE04: UPS	-	-	-	-	-	-	-	-	-	-	■	-	-	-	■	-	-	-	-

The strategies that contributed to DTs success in healthcare facilities in rural areas are summarised in Table 4-15.

Table 4-15: Summary of the findings for the strategies that have contributed to digital technology success

Digital health enabler: Items	Summary
EDHE01: Backup generators	Implemented backup generators to ensure reliability, contributing to the successful adoption of digital technology.
EDHE02: Facility Fibre and Wi-Fi	Installed facility fibre and Wi-Fi on hospitals to ensure stable connection.
EDHE03: Solar power supply	Installed facility Solar Power Supply on clinics as a backup during power cutoffs.
EDHE04: UPS	In one hospit has a UPS for uninterrupted power supply.

Additionally, Figure 4-12 presents a network diagram illustrating THEME 6 from an empirical perspective. The diagram visually maps the relationship between the theme and its associated items, offering insight into digital enablers that are associated with the adopted DTs in rural healthcare settings.

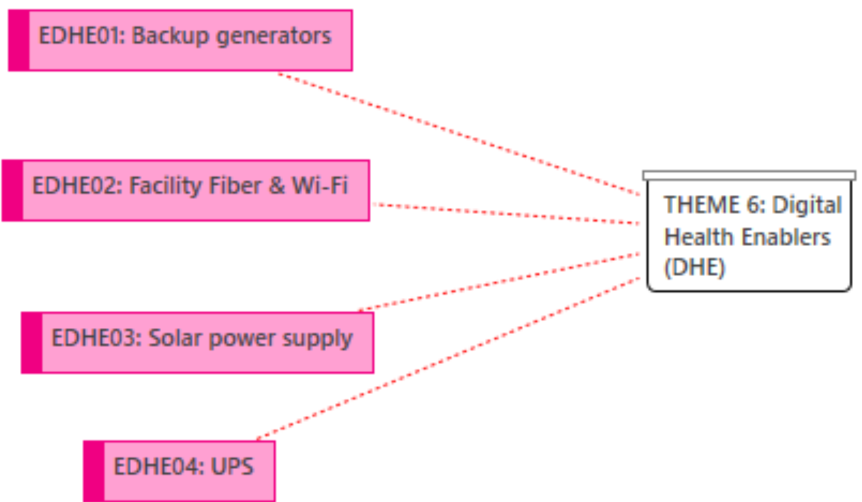


Figure 4-12: Network diagram for THEME 6: Digital health enablers (DHE) and associated items

4.3.7 Reflexivity – role as a researcher

As a researcher possessing a background and personal interest in rural healthcare delivery, I acknowledge that my values and experiences have significantly influenced my interpretation of the existing literature. My familiarity with the challenges encountered by rural healthcare professionals and communities has notably shaped my focus on various issues, including digital divides, access barriers, and cultural resistance. While this familiarity equips me with a nuanced understanding of the local context, I recognise that it may also introduce potential bias in the interpretation of findings. In order to mitigate this, I have engaged in rigorous self-

reflection and made concerted efforts to utilise diverse and credible sources to ensure a balanced perspective. Furthermore, I have exercised diligence in employing a systematic approach to coding and analysis, thereby ensuring that my personal assumptions do not overshadow the voices and insights articulated within the literature.

4.3.8 Critical reflection

While this systematic literature review has presented a comprehensive and varied overview of digital health technologies within rural healthcare contexts, several critical gaps and inconsistencies persist. Firstly, there is a scarcity of empirical research specifically focused on rural communities in South Africa, rendering it difficult to contextualise global findings within the local healthcare landscape. Furthermore, while studies generally highlight the potential of Telehealth and mHealth in addressing geographical barriers, they frequently understate the ongoing challenges related to cultural resistance, digital literacy, and infrastructural deficiencies. Certain contradictions also arise; for instance, while some studies report enthusiastic adoption of mobile health applications, others underscore low digital literacy and deeply entrenched cultural norms as significant obstacles. This emphasises the necessity of context-sensitive strategies that recognise both the technological potential and local realities. Ultimately, very few studies critically examine the sustainability of digital health interventions in resource-constrained environments. These observations reinforce the significance of grounding the empirical research phase in the lived experiences of rural healthcare settings in South Africa.

4.4 Chapter summary

This chapter has presented the main findings from the SLR, including both the adopted DTs, associated perceived benefits and challenges, as well as the influence of human factors, and processes and patterns. A comprehensive analysis of these findings will follow in the next chapter.

CHAPTER 5: DISCUSSION

5.1 Introduction

Chapter 4 presented the findings from both the theoretical (SLR) and empirical perspectives. This chapter discusses the findings presented in Chapter 4 from both the SLR and the empirical data on the impact of DT on healthcare facilities in a rural community, and, specifically, on the adoption of DT on healthcare facilities in rural areas.

This chapter presents an interpretation of the findings by drawing on the conceptual framework outlined in Chapter 2, which integrates five theoretical perspectives: the Diffusion of Innovations Theory, Technology Acceptance Model, Social Cognitive Theory, Health Belief Model, and Ecological Systems Theory. These theories collectively informed the understanding of DT adoption, acceptance, system integration, behavioural change, and perceived benefits and challenges.

The interpretation is structured around five core themes that emerged from the systematic literature review (SLR). These themes serve as a foundation for aligning the findings with existing literature, exploring their theoretical and practical implications, and addressing the second main research question (MRQ2).

In addition to the five SLR-derived themes, an additional theme emerged inductively from the empirical data, reflecting a context-specific insight that was not identified in the literature. The sixth theme enriches the interpretation by offering grounded perspective that complements and extends the initial conceptual framework. The SLR thus not only informed the empirical data collection but also provided a scaffold for interpreting the broader significance of the findings. Additionally, the chapter highlights the study's key contributions and offers recommendations for future work.

Furthermore, the discussion also addresses the research questions initially presented in Chapter 1 and revisited in Section 5.2.

5.2 Research questions revisited

The study was guided by two main research questions that were first introduced in Chapter 1 and informed both the theoretical (SLR) and the empirical investigations:

Table 1-1 Research questions and objectives revisited

Research Questions	Research Objectives
MRQ1: What is known about the role of digital technologies in healthcare contexts in rural communities?	
MRQ2: How does digital technology impact healthcare facilities in rural communities in South Africa?	
SQ 2.1: What digital technologies are currently in place in healthcare facilities?	**RO 2.1:** To explore digital technologies currently in place in healthcare facilities.
SQ 2.2: What is the significance of digital technology in healthcare facilities?	**RO 2.2:** To examine the significance of digital technology in healthcare facilities.
SQ 2.3: What challenges emerge when adopting digital technology?	**RO 2.3:** To investigate challenges that emerge when adopting digital technology.
SQ 2.4: What strategies contribute to the successful adoption of digital technology?	**RO 2.4:** To gain information about the success of the adoption of digital technology.
SQ 2.5: What is the nature of the impact of adopting digital technology in rural communities?	**RO 2.5:** To explore the nature of the impact of adopting digital technology in rural communities.

Note: MRQ = Main research question; SQ = Secondary question; RO = Research objective

5.3 Constructs revisited for the interpretation of findings

This section revisits the main constructs defined in Section 2.2.2 of Chapter 2,which form the basis for interpreting the findings of this study. These constructs, derived from the established theoretical models, provide a structured lens through which the findings are analysed in relation to the adoption, acceptance, and integration of DT in healthcare facilities in rural communities.

Table 2-2 is presented again to ensure continuity between the conceptual framework and the interpretation of findings (see Table 5-2).

Table 5-2: Constructs and their relevance to digital technology in rural healthcare

Construct	Theoretical source	Definition in rural healthcare context	Relevance to the study
Adoption and integration	Diffusion of Innovations Theory (Rogers, 1962); Ecological Systems Theory (Bronfenbrenner, 1989)	Infusion of digital technology (DT) in healthcare facilities in rural communities. How DT interacts with various systems on healthcare facilities in rural areas.	Explains how DT is adopted and becomes routine in healthcare facilities in rural communities. Explains systematic uptake of DTs in rural healthcare.
Acceptance and willingness	Technology Acceptance Model (Davis, 1985)	The willingness of healthcare professionals (HCPs) to use DT based on perceived ease of use in rural areas.	Assesses attitudes and readiness for digital transformation in rural healthcare settings.
New behavior patterns	Social Cognitive Theory (Bandura, 1986)	Changes in HCPs learning, practices, and interactions due to DTs.	Explains how DT influences work practices in rural settings.
Perceived barriers	Health Belief Model (Rosenstock, 1974)	Perceived barriers such as internet connectivity issues, digital infrastructure gaps, and data backlogs and data loss.	Captures the challenges experienced by HCPs with the adoption of DT in rural healthcare.
Perceived benefits	Health Belief Model (Rosenstock, 1974)	Perceived benefits such as improved access to patient information, enhanced digital skills, efficiency, and improved healthcare delivery.	Captures the benefits experienced from HCPs on the adoption of DT in rural healthcare.

5.4 Interpretation of findings – SLR (MRQ1)

This section presents the interpretation of the findings derived from the SLR, which sought to address the first main research question (*MRQ1): "What is known about the role of digital technologies in healthcare contexts in rural communities?"* The analysis is guided by the conceptual framework presented in Figure 2-1 in Chapter 2.

The five themes that emerged from Chapter 4 are:

- Digital technology and transformation (DTT),
- Perceived benefits (PB),
- Perceived challenges (PC),
- Human factors (HF), and
- Processes and patterns (PP).

Each theme is analysed through the lens of a conceptual framework derived from five theories:

- The Diffusion of Innovations Theory (DIT) – adoption and integration (Rogers, 1962).
- The Technology Acceptance Model (TAM) – acceptance and willingness (Davis, 1985).
- Social Cognitive Theory (SCT) – new behaviour patterns (Bandura, 1986).
- Health Belief Model (HBM) – benefits of digitalisation (Rosenstock, 1974).
- Ecological Systems Theory (EST) – integration (Bronfenbrenner, 1989).

5.4.1 THEME 1: Digital technology and transformation (DTT)

This section explores the DTs that are currently implemented in rural healthcare facilities. The findings revealed a range of DTs, that include:

- Artificial Intelligence (AI) in healthcare,
- digital (electronic) health records and Health information exchange (HIE),
- mHealth,
- socially-driven mobile healthcare,
- eHealth,
- remote patient monitoring,
- Teleconsultation, and
- Telehealth.

5.4.1.1 Artificial intelligence (AI) in healthcare

The AI-based emergency service (AIES), AI-based Patient Support Systems (AIPS), and chatbots were adopted in some countries. The findings highlighted that these AI tools improve emergency response in rural healthcare (Selvaraj, 2024). Davis's (1985) TAM suggests that technological innovations are more likely to be adopted and accepted where healthcare

providers (HCPs) recognise their value, such as in improving emergency response times. These factors may influence the level of acceptance of a technological innovation by the HCPs across facilities in rural communities.

Similar to AIPS, these AI tools enhance patient outcomes and improve communication among HCPs in rural areas (Selvaraj, 2024). The literature shows that AIES is valued for its potential to reduce mortality, improve coordination, and enhance patient safety, benefits that drive interest in its adoption. Theory suggests that new technologies lead to new behaviour patterns. These findings are supported by Thacharodi et al. (2024) who pointed out that technological innovations such as AI and Telehealth offer promising solutions for addressing some of the most pressing challenges in the healthcare sector. Furthermore, another study concluded that the convergence of Artificial Intelligence (AI) and Information Technology (IT) in community medicine represents a powerful shift towards data-driven, proactive, and personalised healthcare (Panahi, 2025).

Chatbots, also known as conversational user interfaces, are AI-driven tools designed to simulate human conversation and respond to user enquiries (Potts et al., 2021). In rural healthcare, chatbots are increasingly used to provide information and facilitate administrative tasks. This adoption and integration is further supported by Rogers's (1983) DIT, which explains that innovations are gradually spread into healthcare workflows, especially when supported by infrastructure and leadership.

Collectively, the findings indicate that technological innovations such as AIES, AIPS, and chatbots are increasingly adopted in rural healthcare settings. Although the literature suggests that the adoption of AI-driven DTs can enhance healthcare emergency responses, tackle specific challenges; however, their implementation requires investment in funding, digital infrastructure fit for rural areas, and training of healthcare providers.

5.4.1.2 Digital (electronic) health records and Health information exchange (HIE)

The findings highlighted that EHRs and the HIE DTs play a vital role in improving healthcare delivery. Another study revealed that DTs facilitate the sharing of data across rural healthcare facilities (Alfiyyah et al., 2022). EHRs ensure access to prompt medical interventions regardless of geographical location (Peh, 2024). Additionally, HIE facilitates seamless data exchange. This enhances continuity of care and coordination (Selvaraj, 2024). This is consistent with Rogers's (1983) DIT, which highlights that innovations are gradually adopted into rural healthcare when supported by digital infrastructure. These DTs enhance data accessibility and ultimately improve service delivery.

5.4.1.3 mHealth and socially-driven mobile healthcare (SNPs)

The findings uncovered that mobile applications (apps) facilitate data exchange across rural healthcare facilities (Mbunge et al., 2021). According to Rogers's (1983) DIT, innovations are embraced more frequently if supported by infrastructure. mHealth has become a useful tool for addressing several barriers in rural settings (Peprah et al., 2020). These findings align with another study that emphasised the importance of smartphone apps for collecting patient data (Tolu-Akinnawo et al., 2024). This aligns with Selvaraj's (2024) research, which highlighted that mHealth apps enable patients to schedule appointments. These findings highlight how mHealth has the potential to revolutionise healthcare delivery in rural communities.

5.4.1.4 Electronic health (eHealth) infrastructure

The findings indicated that eHealth adoption is promising for addressing quality issues and increasing access to healthcare in rural areas. Rogers's (1983) DIT states that eHealth is a technological advancement progressively being embraced in rural communities, particularly when infrastructure is in place to enable it. Additionally, Lindberg and Lundgren (2022) pointed out that eHealth adoption could help bridge the distance between patients and HCPs in rural healthcare (Valokivi et al., 2023). Rosenstock's (1974) HBM supports this by stating that the perceived benefits of utilising digital health systems enable the HCP to interact more with the adopted systems.

5.4.1.5 Remote patient monitoring (RPM), teleconsultation, and Telehealth

The findings revealed that RPM tools facilitate the collection and exchange of patient data, including blood glucose, via Telehealth and wearables devices (Rutledge & Gustin, 2021). This is consistent with Rogers's (1983) DIT, which describes how DTs are progressively embraced as innovations, especially when they demonstrate the perceived benefits. The findings further revealed that RPM tools enable real-time follow-up care, support chronic disease management, and promote continuous support in rural communities (Selvaraj, 2024).

In addition to RPM, the study showed that teleconsultation has emerged as a component of digital healthcare delivery, facilitating timely medical consultations between patients and healthcare providers. This digital interaction incorporates audio and video communications, facilitating remote access to healthcare services and bridging the geographical barriers that limit access in rural communities. These findings align with Thacharodi et al. (2024), who emphasised the potential to create a more equitable and accessible healthcare system by eliminating structural and geographical barriers.

DTs are revolutionising healthcare through the use of Telehealth. The findings collectively highlighted that digital transformation is a global trend in rural healthcare, driven by innovations

such as Telemedicine, electronic health records, and mobile health applications. However, the pace and depth of transformation vary, often constrained by infrastructure and policy limitations. These DTs play various roles in rural healthcare, as reflected in the thematic areas of perceived benefits, associated challenges, human factors, and operational patterns. Nonetheless, the effectiveness of these technologies depends on key factors such as investment in infrastructure, adequate training and support for both HCPs and patients, and coherent policies regarding data security, and licensing.

THEME 1 directly addresses the first primary research question (MRQ1), which focuses on understanding the adopted DTs in rural areas worldwide. Figure 5-1 shows a network diagram for THEME 1 that is used to support the visual interpretation of the findings. The connections illustrate how themes, constructs, and their associated items are interrelated, highlighting the specific research question each theme seeks to address. The visual representation in Figure 5-1 highlights the DTs adopted in rural healthcare settings worldwide. All items presented in the diagram are linked with the construct 'CO02: Adoption', which illustrates the adoption of DTs as innovative solutions within rural healthcare settings. Moreover, the coding system was used to organise and label data, for instance, item 'TDTT01: AEIS' is explained as follows:

- 'T' indicates a theoretically-based code.
- 'DTT' is the acronym for theme Digital Technology and Transformation.
- '01' is the first item identified under this theme.
- 'AIES' is the label for an AI-based emergency service.

Additionally, for 'CO02: Adoption', the code 'CO' is the prefix for the construct and '02' represents the second item identified in this construct. To ensure consistency and clarity in data analysis, the same coding method introduced in Chapter 4 was applied throughout the study. With this approach items can be systematically categorised under each theme, combining thematic identifiers (e.g. TDTT) and item numbers (e.g. 01) followed by the code. In order to ensure consistency, ease of interpretation and traceability when connecting empirical findings to theoretical perspectives, the study applied this coding system for all themes.

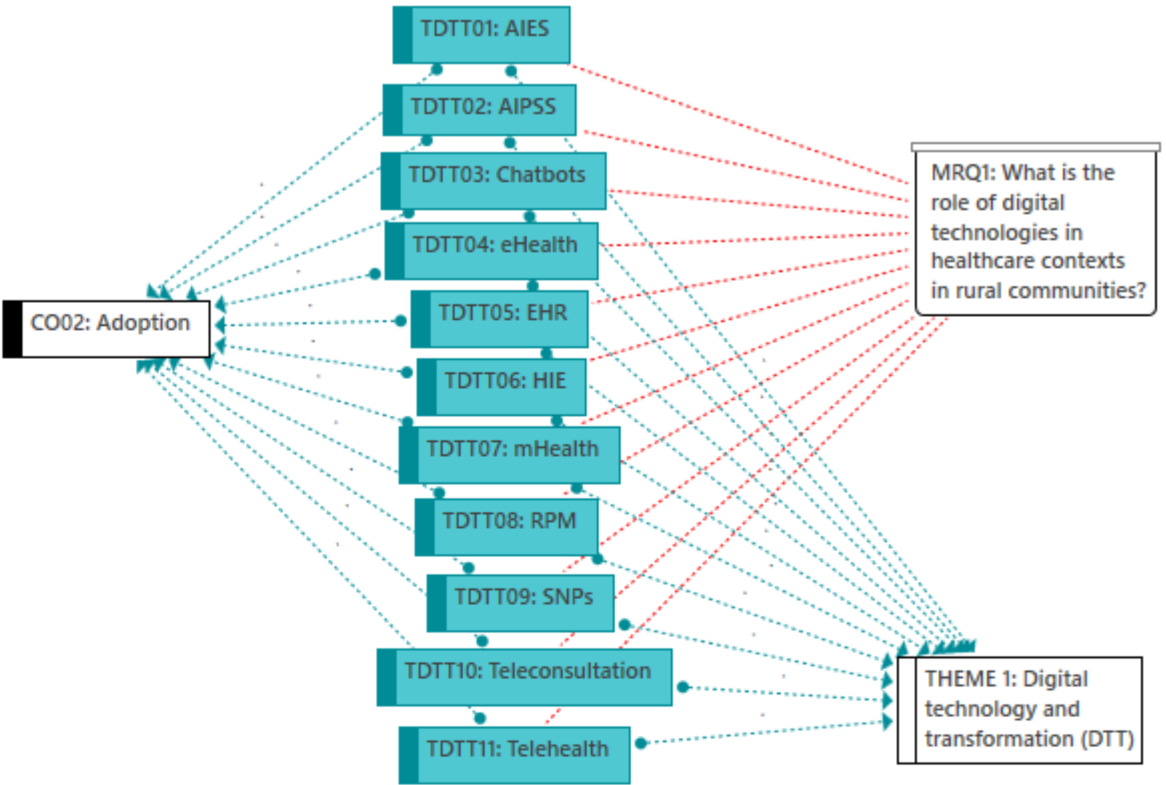


Figure 5-1: Network diagram for THEME 1: Digital technology and transformation, constructs, and associated items

In summary, DTs are increasingly being recognised as transformative tools in healthcare, particularly for bridging gaps in access, efficiency, and service delivery in underserved areas. The next section explores the perceived benefits associated with the adoption of DT in rural healthcare facilities.

5.4.2 THEME 2: Perceived benefits (PB)

This section explores the perceived benefits associated with DT adoption in rural healthcare, which include:

- Data management, adoption, acceptance, accessibility, and willingness,
- cost and time efficient,
- eases HCPs workload,
- enhances health literacy,
- enhances efficiency and quality, and
- reduces distance limitations.

5.4.2.1 Data management, adoption, acceptance, accessibility, and willingness

The findings revealed that Telehealth, Telemedicine, and mHealth are utilised worldwide in delivering health services in rural areas. Telemedicine, for instance, is an acceptable and

feasible digital health solution for improving access to care in rural areas (Morris et al., 2022; Castillo et al., 2023). This means that HCPs can easily retrieve patient data and attend patients remotely. This demonstrates the widespread adoption of DT in rural healthcare (Rogers, 1983). Additionally, according to Rogers's (1983) DIT, this reflects the diffusion of innovation in rural settings. The findings further revealed that healthcare users were willing to utilise mHealth services such as phone calls (Peprah et al., 2020). This shows the perceived benefit of digital technology to improve healthcare access in rural communities. This also aligns with TAM, which explains the willingness of users to utilise innovations when they perceive their usefulness and ease of use (Davis, 1989).

5.4.2.2 Cost and time efficient

The study uncovered that the adoption of DT such as Telemedicine has the potential to minimise travelling costs and time in rural areas (Sageena et al., 2021). This enables HCPs to easily treat and monitor patients online. This aligns with the findings by Kingslin (2023) and Graham et al. (2023), which highlight that digital health tools, such as Telemedicine, have the potential to improve access to treat patients remotely. Moreover, the findings revealed that the eHealth interventions in rural settings enhance efficiency and improve quality of care (LeBlanc et al., 2020). These findings are consistent with Rosenstock's (1974) HBM, which emphasises that the potential benefits of innovation motivates its adoption. These findings show how DT has the potential to improve healthcare delivery and patient outcomes in rural healthcare.

5.4.2.3 Eases HCPs workload

The findings uncovered that DTs such as Telehealth enhance communication speed and clarity during consultations (Graham et al., 2023). Additionally, Telehealth has the potential to prevent delays brought on by waiting for reports in rural healthcare. With virtual consultations, HCPs may provide care to their patients and potentially support other impacted (Haleem et al., 2021). The study showed that Telemedicine minimises the time of patient check-in, ultimately enabling the HCPs to focus on more valuable tasks. This directly eases the healthcare professional's workload in rural healthcare.

5.4.2.4 Enhances health literacy

The findings indicated that DTs have the potential to revolutionise healthcare delivery in rural communities by improving health literacy. According to Rogers's (1983) DIT , the adoption of an innovation starts with awareness and understanding. DTs that promote health literacy help to bridge the knowledge gap in technology use. This ultimately supports the users in progressing through the early stages of technology adoption. Subsequently, this leads to the increased diffusion and adoption of innovations across healthcare facilities in rural areas. These findings are supported by Maha et al. (2024), who indicated that DT is essential in

enhancing health literacy and raising awareness of health-related issues in rural areas. For example, Calleja et al. (2022) points out that the evaluation of clinical skills for HCPs after attending educational sessions could be conducted via the videoconference digital platform. This fosters collaboration and active engagement among HCPs. Additionally, it empowers HCPs to make informed decisions, ultimately contributing to more effective healthcare delivery in rural areas.

5.4.2.5 Enhances efficiency and quality

The study found that technological innovations in patient management are regarded as valuable tools for improving the sustainability and efficiency of continuous care delivery in rural areas. For example, the adoption of mHealth technologies has the potential to facilitate and improve the operational efficiency of HCPs in rural healthcare (Jiménez-Díaz et al., 2024). As a result, this improves quality of service delivery in healthcare facilities in rural areas. Efficiency and quality improvements reflect how DTs in rural healthcare positively influence interactions across facility systems, from HCPs to the entire facility. Guy-Evans (2025) on Bronfenbrenner's Ecological Systems Theory, confirms that these improvements support the integration of technology into broader healthcare environments. The findings further revealed that the adoption of DTs in rural healthcare offers a promising solution for implementing transformative improvements to overcome key challenges in rural areas (Woods et al., 2024b). For example, to overcome quality-related challenges, the findings uncovered that DHTs are often presented as solutions to enhance quality and improve health system efficiency (LeBlanc et al., 2020). Additionally, Haleem et al. (2021) identified that Telemedicine enables patient data to be shared across remote areas. This means that DT does not only eases HCPs' workload but also improves efficiency and quality in rural settings. Furthermore, Rosenstock's (1974) HBM explains that individuals are more inclined to embrace technology when they see the perceived benefits.

5.4.2.6 Reduced distance limitations

The study showed that digital platforms such as Telemedicine can overcome geographic barriers by enabling patients to consult medical doctors virtually (Maha et al., 2024). This limits the need for travel in rural healthcare. This is supported by Thacharodi et al. (2024), who indicated that Telemedicine and RPM have effectively overcome distance limitations in rural areas. This implies that access to healthcare services is now simpler for rural communities. These findings are further supported by Alfiyyah et al. (2022), who stated that EHR and Telemedicine are examples of digital tools that minimise indirect patient costs regarding time and travel costs.

These findings also align with Bronfenbrenner's Ecological Systems Theory as discussed by Guy-Evans (2025), which describes how individuals interact with their environment. In rural communities, Telehealth helps provide patient-centered and more-accessible healthcare. Furthermore, technology adoption tends to increase when users perceive benefits for their organisations (Maduku et al., 2016). This further aligns with the perceived benefit component of Rosenstock's Health Belief Model (Rosenstock, 1974). Furthermore, the study findings point out that healthcare delivery in rural areas enables medical professionals, including doctors, nurses, and other healthcare workers, to effectively respond to the health needs of individuals (Ude-Akpeh & Ezegwu, 2022). For example, another finding revealed that Telemedicine has shown promising outcomes in rural communities by enhancing healthcare access and addressing existing challenges (Kingslin, 2023).

To visually support the interpretation of the findings, a network diagram was used to represent the perceived benefits associated with the DTs adopted in rural healthcare. The constructs related to the perceived benefits indicate that the DTs adopted were not only accepted but also integrated successfully into healthcare workflows. This integration reflected in the emergence of new behavioural patterns and recognition of the perceived benefits brought by digitisation in rural settings. Figure 5-2 demonstrates THEME 2 through a network diagram illustrating various items related to perceived benefits, identified in section 4.2.2, Chapter 4.

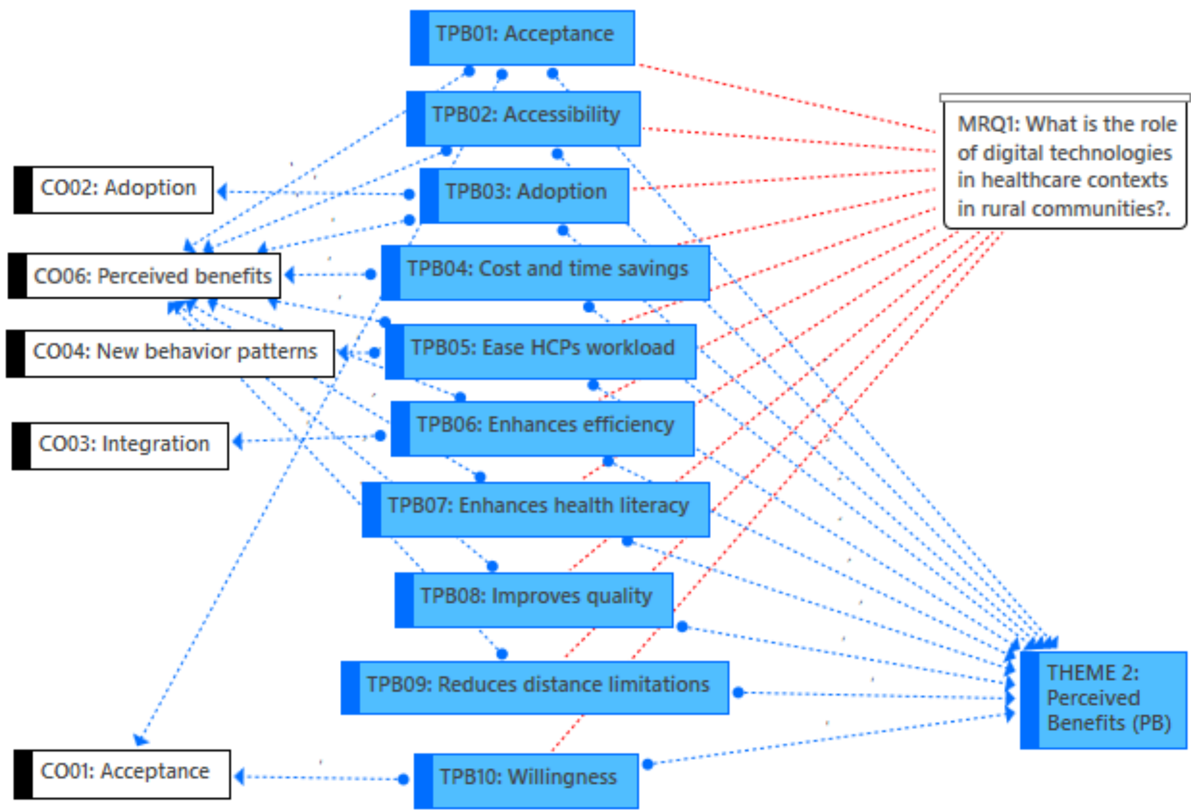


Figure 5-2: Network diagram for THEME 2: Perceived benefits, constructs, and associated items

In summary, THEME 2 suggests that while the findings clearly demonstrate growing acceptance and integration of DHTs in rural healthcare, it is equally important to consider the challenges that may hinder their effective adoption and long-term sustainability.

5.4.3 THEME 3: Perceived challenges (PC)

This section discusses the perceived challenges associated with the adopted DTs identified in Section 4.2.3 of Chapter 4. The SLR identified several challenges that limit the adoption and integration of DTs on healthcare facilities in rural communities. These challenges associated with the adopted DHTs include geographical distance, guidelines and policies, limited healthcare professionals, financial constraints, limited infrastructure, and technological limitations.

5.4.3.1 Geographical distance

The study found that access to healthcare remains a key challenge in rural areas due to poor transportation networks that hinder individuals from getting medical services (Larson et al., 2022). This reflects Bronfenbrenner's (1989) EST, which explains that broader environments such as transport and infrastructure indirectly shape access to DHTs in rural areas. Sumbana et al. (2024) and Maha et al. (2024) support this by pointing out that poor transportation and

geographical distance are significant obstacles to healthcare delivery in rural settings. This highlights the necessity of enhanced transportation networks to bridge the gap between patients and HCPs in rural areas.

5.4.3.2 Guidelines and policies

The study revealed a lack of tailored regulations and policies for digital health in rural healthcare. This leads to risks and uncertainty regarding data protection and internet use to retain and attract HCPs in rural healthcare settings (Kingslin, 2023). This aligns with Rosenstock's (1974) HBM, which highlights that perceived barriers may hinder individuals from engaging with innovation. Jiménez-Díaz et al. (2024) emphasised that obtaining regulatory approval is a lengthy process that discourages innovation in rural areas. The study recommends that policymakers develop context-specific and clear regulations that are tailored to the specific requirements of rural settings.

5.4.3.3 Limited healthcare professionals

The study revealed that a lack HCPs is one of the challenges that rural healthcare face (Castillo et al., 2023; Sumbana et al., 2024). Consequently, digital platforms are utilised by fewer HCPs. The shortage of HCPs in rural healthcare is directly caused by the migration to urban areas (Ude-Akpeh & Ezegwu, 2022). This migration is consistent with Bronfenbrenner's (1989) EST, which shows how environmental contexts affect individual behaviour. The key drivers of this migration include access to advanced medical equipment, improved working conditions, and higher remuneration in the urban areas. This study proposed strategic incentives to retain and attract HCPs in rural settings such as improved rural working environments, competitive salaries, and professional development opportunities.

5.4.3.4 Financial constraints

This study revealed that a lack of funding is a key challenge to the successful adoption of DTs in rural healthcare (Ude-Akpeh & Ezegwu, 2022). This aligns with Rosenstock's (1974) HBM, which highlights that a perceived barrier can discourage the adoption of innovation. Additionally, the study found that high costs linked to DT may hinder users from affording services from digital platforms (Kingslin, 2023). This could limit DT use and widen the digital access divide between rural and urban areas.

5.4.3.5 Limited digital infrastructure

The study found that poor digital infrastructure, including poor internet connectivity, limits the adoption of DT in rural areas (Jiménez-Díaz et al., 2024). Thus, without stable internet connection, DT may not function successfully in rural healthcare. Rural healthcare facilities have limited access to high-speed broadband internet (Rutledge & Gustin, 2021), which

hinders the ability of HCPs to engage with DT. Consequently, this prevents the smooth provision of digital health services in rural settings (Omaghomi et al., 2024). Rosenstock’s (1974)HBM highlights that poor digital infrastructure represents a perceived barrier that could prevent adoption in rural healthcare. This is supported by Alfiyyah et al. (2022), who noted that network quality and infrastructure are essential for efficient adoption of DT in rural areas. The findings emphasise the need for developing infrastructure, including increased broadband, affordable technologies, and funding for reliable power sources.

5.4.3.6 Technological limitations

Several studies pointed out the challenge of technological limitations (LeBlanc et al., 2020; Molli, 2021; Barry et al., 2024; Omaghomi et al., 2024).This means users will be hindered from fully engaging with digital platforms. According to Graham et al. (2023), rural communities are disadvantaged in terms of often only having 3G mobile data connections. The 3G networks result in poor pictures and sound quality which hinder the effectiveness of DT such as Telehealth in rural healthcare. These technological limitations are consistent with Rogers’s (1983) DIT, which explains that these challenges may slow down the diffusion of DT in rural areas. To address technological challenges, it is essential to invest in affordable, context-appropriate, and accessible technologies. Without overcoming these technological gaps, digital health initiatives run the risk of being unsustainable in rural settings. While the identified perceived challenges are significant, the integration of DTs in healthcare facilities in rural communities also hinges on addressing critical human factors that influence adoption, usage, and sustainability.

Figure 5-3 illustrates THEME 3 through a network diagram that links the items to their corresponding construct, and the research question the theme addresses. The connections highlight the relationships between the theme and its associated items, offering a structured view of how theoretical insights inform the findings.

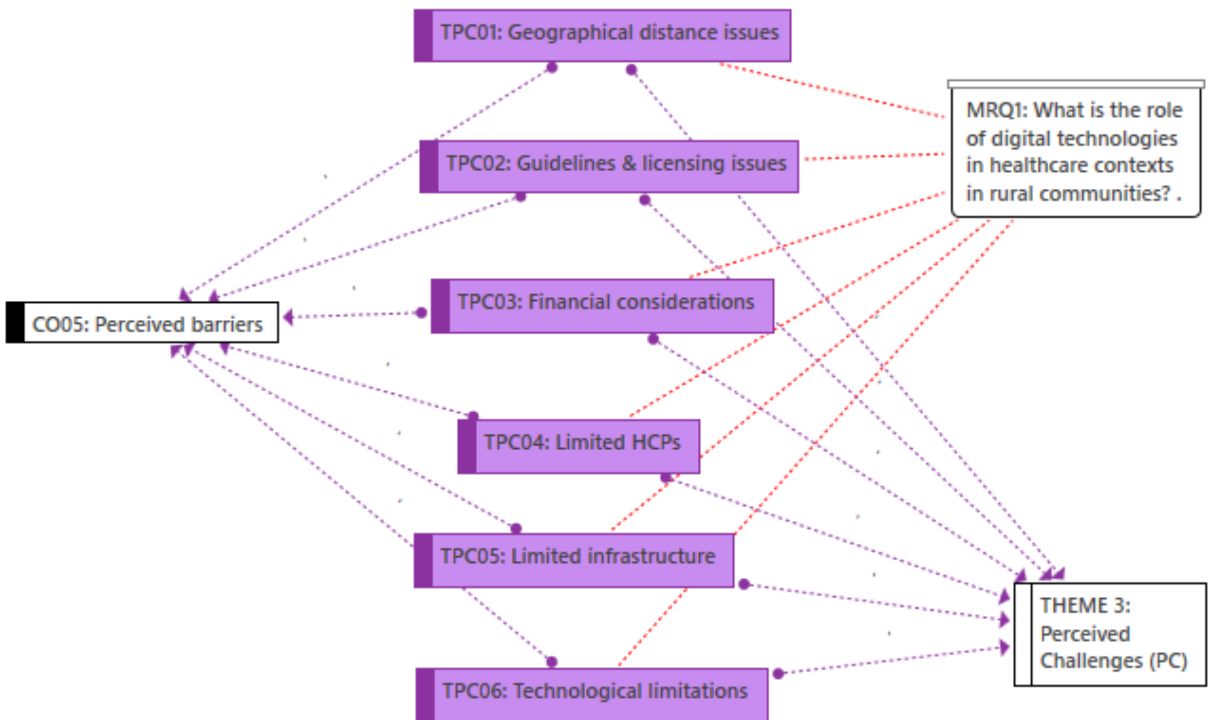


Figure 5-3: Network diagram for THEME 3: Perceived Challenges, constructs, and associated items

THEME 3 highlighted the main challenges to DT adoption in rural healthcare. The next section focuses on the human factors associated with the adoption of DT in healthcare facilities in rural areas.

5.4.4 THEME 4: Human factors (HF)

This section discusses the findings on THEME 4. These include cultural beliefs, human behaviour patterns, and resistance. The section further highlights low digital skills as part of human factors.

5.4.4.1 Cultural beliefs, human behaviour patterns, and resistance

The study revealed that cultural beliefs can be a barrier to DT adoption in rural communities (Maha et al., 2024). This means that engaging the community leaders in rural healthcare is vital for the successful development and adoption of DT. The participation of the community leaders could ensure that DTs are appropriate for the rural healthcare contexts that they are meant to serve (Maha et al., 2024). The findings further uncovered that generational age differences could pose a significant barrier to the effective adoption of DT in rural healthcare. Younger users, for example, welcome the technology, whereas older ones may find it challenging to utilise the digital systems (Jiménez-Díaz et al., 2024). This generational gap in the use of technology may affect the healthcare quality and consistency in rural systems. This

study suggests the importance of creating user-centric digital platforms tailored for rural healthcare.

5.4.4.2 Low digital skills

The findings showed that poor digital literacy may hinder the ability of HCPs to effectively engage with DTs (Maha et al., 2024). This is supported by Benjamin et al. (2024) and Begum and Nemshevich (2021), who highlighted that some HCPs lack the digital skills and knowledge to effectively use digital platforms. Rosenstock's (1974) HBM highlights that low digital skills act as a perceived barrier. This underscores a need to invest in training to empower HCPs to utilise digital platforms effectively.

Figure 5-4 displays a network diagram for THEME 4. The lines show the link between the items and the constructs. Construct 'CO05: Perceived barriers, for instance, is linked to item 'THF06: Low digital skills'.

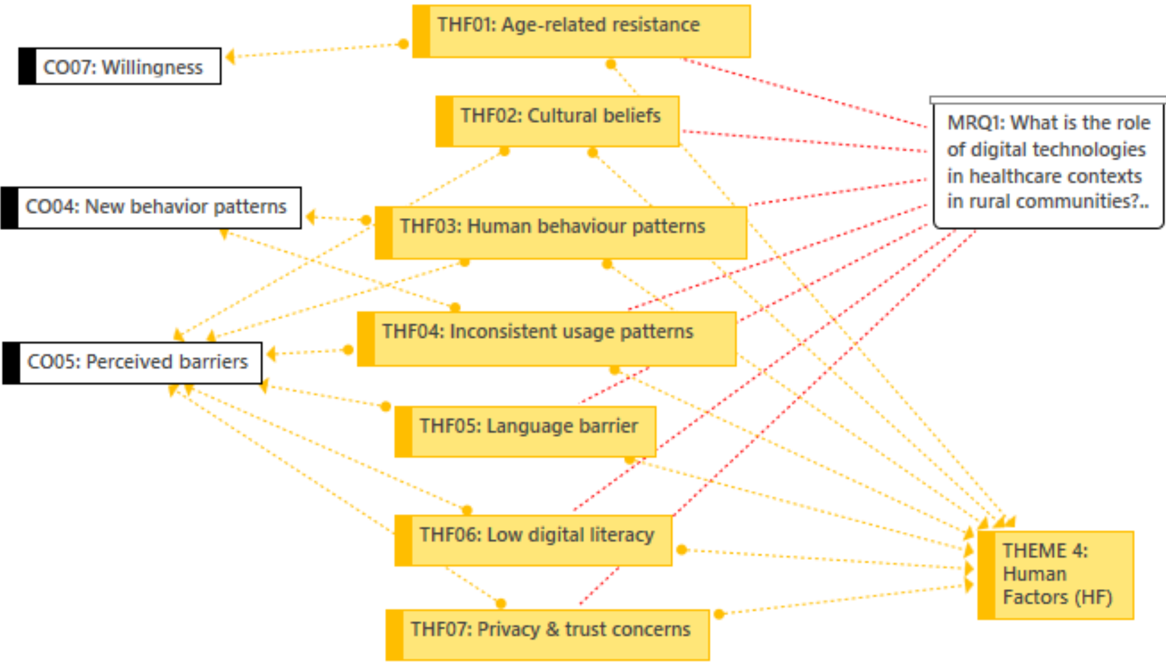


Figure 5-4: Network diagram for THEME 4: Human factors, constructs and associated items

In summary, THEME 4 focused on the factors associated with humans that may hinder the adoption of DTs in rural settings. The next section delves into the processes and patterns associated with the adoption of DT in rural healthcare.

5.4.5 THEME 5: Processes and patterns (PP)

This section discusses the findings of THEME 5. These include:

- Broadband and connectivity, and digital infrastructure,
- collaborative efforts, and
- digital literacy.

5.4.5.1 Broadband, connectivity, and digital infrastructure

The study found that the key initiatives for the effective delivery of DT are to focus on enhancing broadband internet connectivity and stable electrical power (Benjamin et al., 2024). Several studies support this, pointing out that addressing infrastructure challenges requires a strategy that involves improving internet connectivity in rural areas (Hirko et al., 2020; LeBlanc et al., 2020; Maha et al., 2024). This implies that DT may not be aligned with healthcare requirements in rural areas without a clear framework. Furthermore, the study found that satellite internet technology presents a solution to the broadband connectivity challenges in rural settings (Benjamin et al., 2024).

5.4.5.2 Collaborative efforts and policies

The study found that successful implementation of DT in rural healthcare is driven by collaborative efforts (Arora et al., 2024). This includes healthcare institutions, government stakeholders, and technology providers. This is supported by Tolu-Akinnawo et al. (2024), who pointed out that collaboration among various stakeholders could strengthen Telemedicine. This can result in more effective and efficient patient care.

5.4.5.3 Digital literacy

The study found that digital literacy supports the use of digital systems among HCPs (Holtz et al., 2024). Investment in continuous training for HCPs can improve digital skills. This will lead to improved workflows and better data management. The findings identified the necessity of developing user-centric digital solutions, tailored to the specific contexts and needs of rural healthcare communities. Such contextual design is essential for fostering user acceptance and supporting the long-term adoption and use of digital systems. According to Rosenstock's (1974) HBM, the perceived benefits of digitalisation are hindered by poor connectivity and inadequate digital infrastructure. The findings suggest that improving the strategies in Figure 5-5, the network diagram for THEME 5 could facilitate the integration of DTs in rural healthcare. Ultimately, this may foster the emergence of new behaviour patterns.

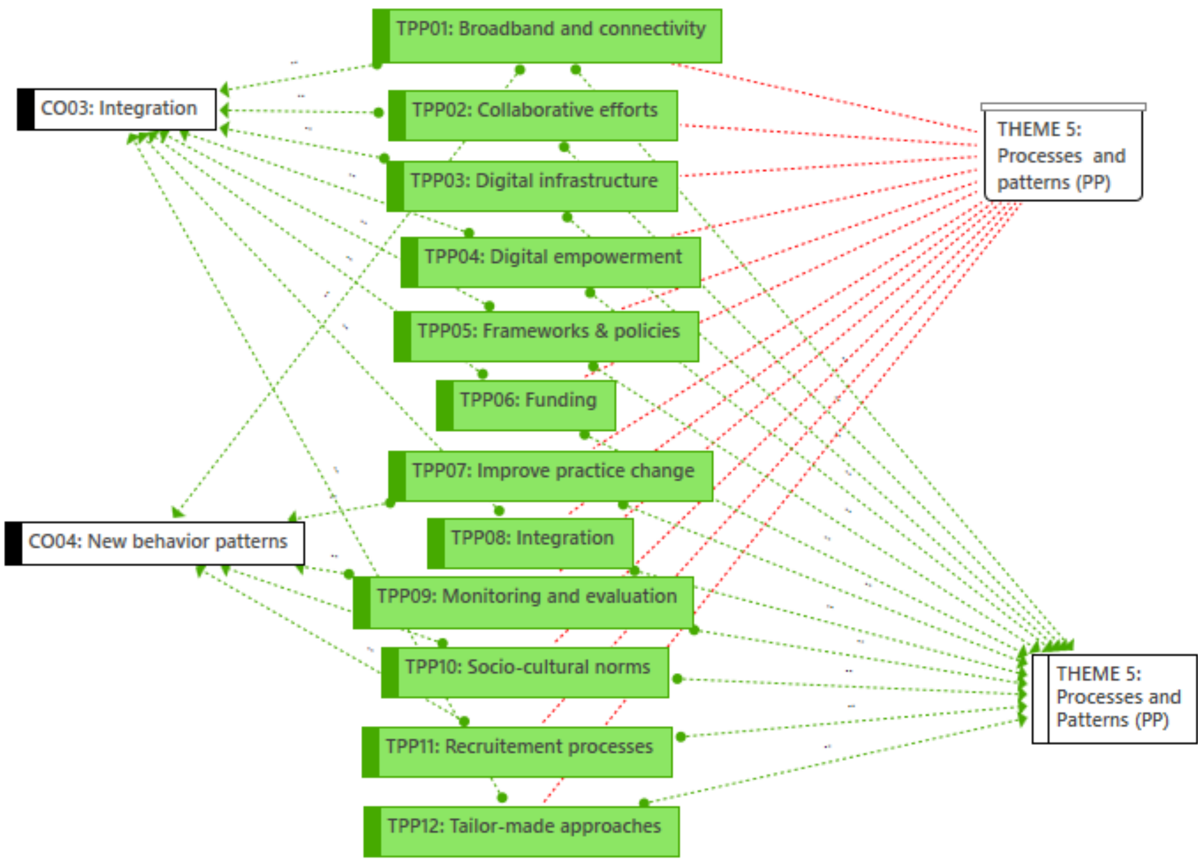


Figure 5-5: Network diagram for Theme 5: Processes and patterns, constructs, and associated items

Collectively, the findings on processes and patterns highlight that successful digital transformation in rural healthcare depends on improving broadband, connectivity, and digital infrastructure. Additionally, successful digital transformation also relies on collaboration among stakeholders, technological innovation, ongoing digital literacy initiatives, and structured implementation processes. While the findings identified DTs, the perceived benefits and challenges, human factors, and processes and patterns as the main themes, exploring how these themes operate in real-world practice remains essential. In conclusion, the discussion addressed the first main research question (MRQ1) by exploring the role of DTs in the healthcare context in rural communities through the five themes identified in the SLR.

5.4.6 Guidelines for the theoretically-based items

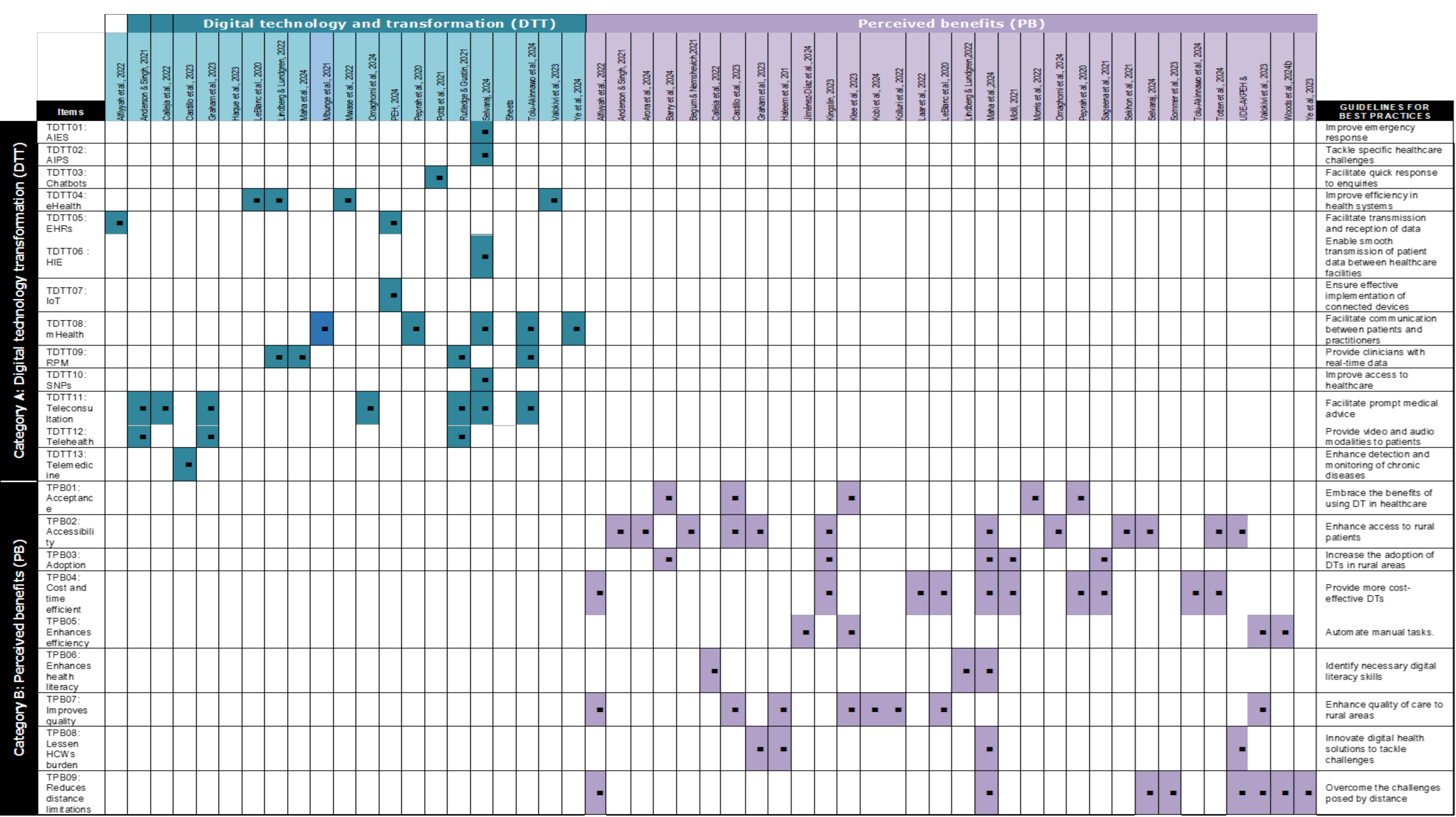
Section 4.3 focuses on the theoretical aspect (SLR) of the research, presenting a structured review of existing DTs, perceived benefits, human factors, and workflow processes and patterns. The findings of the SLR suggest that the issues presented in Chapter 1 and examined in Chapter 4 continue to be relevant, distinctive, and valuable areas for further investigation. The results of the analysis confirm that the themes reflected in the preliminary review of the literature in Chapter 1, and further explored in this chapter, remain relevant.

This chapter confirms the continued relevance of the research question initially presented in Chapter 1. The researcher gleaned five concepts from the literature sources that led to the proposal of themes:

- Digital technology and transformation,
- perceived benefits,
- perceived challenges,
- human factors, and
- processes and patterns.

Table 5-3 to Table 5-5 present the guidelines from the theoretical perspectives associated with DT on healthcare facilities. These tables highlight the kept themes, which are: Digital technology and transformation (DTT), Perceived benefits (PP), Perceived challenges (PC), Human factors (HF), and Processes and patterns (PP).

Table 5-3: Guidelines for improving digital technology on healthcare facilities for: Digital technology and transformation and perceived benefits



Digital technology and transformation (DTT)

Category	Items	Alfiyyah et al., 2022	Anderson & Singh, 2021	Calleja et al., 2022	Castillo et al., 2023	Graham et al., 2023	Haque et al., 2023	LeBlanc et al., 2020	Lindberg & Lundgren, 2022	Maha et al., 2024	Mbunge et al., 2021	Mwase et al., 2022	Omaghomi et al., 2024	PEH, 2024	Peprah et al., 2020	Potts et al., 2021	Rutledge & Gustin, 2021	Selvaraj, 2024	Sheets	Tolu-Akinnawo et al., 2024	Valokivi et al., 2023	Ye et al., 2024
Category A: Digital technology transformation (DTT)	TDTT01: AIES																	■				
	TDTT02: AIPS																	■				
	TDTT03: Chatbots															■						
	TDTT04: eHealth							■	■			■									■	
	TDTT05: EHRs	■												■								
	TDTT06 : HIE																	■				
	TDTT07: IoT													■								
	TDTT08: mHealth										■				■			■		■		■
	TDTT09: RPM								■	■							■			■		
	TDTT10: SNPs																	■				
	TDTT11: Teleconsultation		■	■		■							■				■	■		■		
	TDTT12: Telehealth		■			■											■					
	TDTT13: Telemedicine				■																	
Category B: Perceived benefits (PB)	TPB01: Acceptance																					
	TPB02: Accessibility																					
	TPB03: Adoption																					
	TPB04: Cost and time efficient																					
	TPB05: Enhances efficiency																					
	TPB06: Enhances health literacy																					
	TPB07: Improves quality																					
	TPB08: Lessen HCWs burden																					
	TPB09: Reduces distance limitations																					

Perceived benefits (PB)

Items	Alfiyyah et al., 2022	Anderson & Singh, 2021	Arora et al., 2024	Barry et al., 2024	Begum & Nemshevich,2021	Calleja et al., 2022	Castillo et al., 2023	Graham et al., 2023	Haleem et al., 201	Jiménez-Díaz et al., 2024	Kingslin, 2023	Klee et al., 2023	Kobi et al., 2024	Kolluri et al., 2022	Laar et al., 2022	LeBlanc et al., 2020	Lindberg & Lundgren,2022	Maha et al.,2024	Molli, 2021	Morris et al., 2022	Omaghomi et al., 2024	Peprah et al., 2020	Sageena et al., 2021	Sekhon et al., 2021	Selvaraj, 2024	Sommer et al., 2023	Tolu-Akinnawo et al., 2024	Totten et al., 2024	UDE-AKPEH &	Valokivi et al., 2023	Woods et al., 2024b	Ye et al., 2023	GUIDELINES FOR BEST PRACTICES
TDTT01: AIES																																	Improve emergency response
TDTT02: AIPS																																	Tackle specific healthcare challenges
TDTT03: Chatbots																																	Facilitate quick response to enquiries
TDTT04: eHealth																																	Improve efficiency in health systems
TDTT05: EHRs																																	Facilitate transmission and reception of data
TDTT06 : HIE																																	Enable smooth transmission of patient data between healthcare facilities
TDTT07: IoT																																	Ensure effective implementation of connected devices
TDTT08: mHealth																																	Facilitate communication between patients and practitioners
TDTT09: RPM																																	Provide clinicians with real-time data
TDTT10: SNPs																																	Improve access to healthcare
TDTT11: Teleconsultation																																	Facilitate prompt medical advice
TDTT12: Telehealth																																	Provide video and audio modalities to patients
TDTT13: Telemedicine																																	Enhance detection and monitoring of chronic diseases
TPB01: Acceptance				■			■					■								■		■											Embrace the benefits of using DT in healthcare
TPB02: Accessibility		■	■		■		■	■			■							■			■			■	■			■	■				Enhance access to rural patients
TPB03: Adoption				■							■							■	■				■										Increase the adoption of DTs in rural areas
TPB04: Cost and time efficient	■										■				■	■		■	■			■	■				■	■					Provide more cost-effective DTs
TPB05: Enhances efficiency										■		■																		■	■		Automate manual tasks.
TPB06: Enhances health literacy						■											■	■															Identify necessary digital literacy skills
TPB07: Improves quality	■						■		■			■	■	■		■														■			Enhance quality of care to rural areas
TPB08: Lessen HCWs burden								■	■									■											■				Innovate digital health solutions to tackle challenges
TPB09: Reduces distance limitations	■																	■							■	■			■	■	■	■	Overcome the challenges posed by distance

Table 5-4: Guidelines informing the improvement of digital technology for: Perceived challenges and human factors

		Perceived challenges (PC)																																		Human factors (HF)								
	ITEMS	Afifyyah et al., 2022	Airola, 2021	Arora et al., 2024	Barry et al., 2024	Begum & Nemshevich, 2021	Bekyiya et al., 2023	Benjamin et al., 2024	Castillo et al., 2023	Graham et al., 2023	Haleem et al., 2021	Jiménez-Diaz et al., 2024	Kingslin, 2023	Kobi et al., 2024	Laar et al., 2022	Larson et al., 2022	Le Blanc et al., 2020	Maha et al., 2024	McCarthy et al., 2024	Molli, 2021	Okobi et al., 2023	Omaghomi et al., 2024	PEH, 2024	Peng et al., 2024	Peprah et al., 2020	Pullyblank, 2023	Rutledge & Gustin, 2021	Selvaraj, 2024	Shardha et al., 2024	Sommer et al., 2023	Sumbana et al., 2024	Svistova et al., 2022	Tolu-Akinnawo et al., 2024	UDE-AKPEH & EZEGWU, 2022	Ye et al., 2023	Castillo et al., 2024	Kobi et al., 2024	Laar et al., 2022	Le Blanc et al., 2020	Maha et al., 2024	Peng et al., 2024	Peprah et al., 2020	Rasi et al., 2021	GUIDELINES FOR BEST PRACTICES
Category C: Perceived challenges (PC)	TPC01: Communication					■					■														■			■																Facilitates information sharing
	TPC02: Cultural and traditional beliefs						■															■																						Tackle socio- cultural and individual norms
	TPC03: Data privacy	■								■	■								■					■	■	■					■				■									Enhance data security and privacy measures
	TPC04: Geographical distance															■		■				■									■													Utilise mobile application for information access
	TPC05: Guidelines and policies					■						■	■	■																														Define proper guidelines and policies
	TPC06: Financial considerations			■				■					■																					■										Utilise DT to optimise financial issues
	TPC07: Limited healthcare professionals					■			■									■		■										■	■			■										Improve recruitment strategies
	TPC08: Limited infrastructure	■										■										■	■				■								■									Improve digital infrastructure
	TPC09: Low digital literacy			■		■		■							■			■				■	■		■																			Enhance digital literacy
	TPC10: Technological limitations							■		■					■		■			■									■															Design digital atmosphere that enhances performance
	TPC11: Usage patterns		■			■											■				■	■			■							■												Define teaching patterns for DT
Category D: Human factors (HF)	THF01: Human behaviour patterns																																				■	■		■			■	Effectively address human behaviour patterns
	THF02: Environmental & personal factors																																								■			Address environmental and personal factors
	THF03: Willingness																																			■	■		■			■		Motivate users to engage with DT

Table 5-5: Guidelines which inform the improvement of digital technology for: Processes and patterns

Category	ITEMS	Processes and patterns																									GUIDELINES FOR BEST PRACTICES
		Airola, 2021	Anderson & Singh, 2021	Arora et al., 2024	Barry et al., 2024	Begum & Nemshevich, 2021	Benjamin et al., 2024	Calleja et al., 2022	E-AKPEH & EZEGWU, 2022	Holtz et al., 2024	Kobi et al., 2024	Laar et al., 2022	LeBlanc et al., 2020	Lindberg et al., 2021	Maha et al., 2024	Mwase et al., 2022	Omaghomi et al., 2024	Pullyblank, 2023	Selvaraj, 2024	Shardha et al., 2024	Sommer et al., 2023	Sumbana et al., 2024	UDE-AKPEH & EZEGWU, 2022	Tolu-Akinnawo et al., 2024	Woods et al., 2024a	Ye et al., 2023	
Category E: Processes and patterns (PPp	TPP01: Broadband and connectivity					■	■						■		■			■									Increase broadband and connectivity
	TPP02: Collaborative efforts			■			■					■			■		■							■		■	Enable collaborative efforts
	TPP03: Cultural barriers	■													■												Bridge cultural barriers
	TPP04: Digital infrastructure			■			■	■									■									■	Improve digital literacy
	TPP05: Digital literacy						■			■	■				■	■	■						■				Establish frameworks and policies
	TPP06: Frameworks & policies			■		■																					Increase funding
	TPP07: Funding														■	■					■						Improve practice change
	TPP08: Improve practice change		■		■			■											■								Increase funding
	TPP09: Integration																		■								Leverage the full potential of interoperability
	TPP10: Monitoring and evaluation		■													■											Implement digital dashboards
	TPP11: Recruitment processes														■							■					Enhance recruitment processes
	TPP12: Tailor-made approaches														■												Design tailor-made approaches

Additionally, Figure 5-6 presents a network diagram that illustrates the preliminary framework from a theoretical perspective. It consolidates five core themes derived from the SLR, along with their respective constructs and associated items. The five identified themes contribute to addressing the first main research question (MRQ1), "*What is known about the role of digital technologies in healthcare contexts in rural communities?* The DTs explored, along with their perceived benefits and challenges, human related factors, and the underlying processes and patterns, offer a comprehensive explanation of the role of DT in healthcare facilities in rural communities.

5.4.7 Framework for the theoretical perspectives

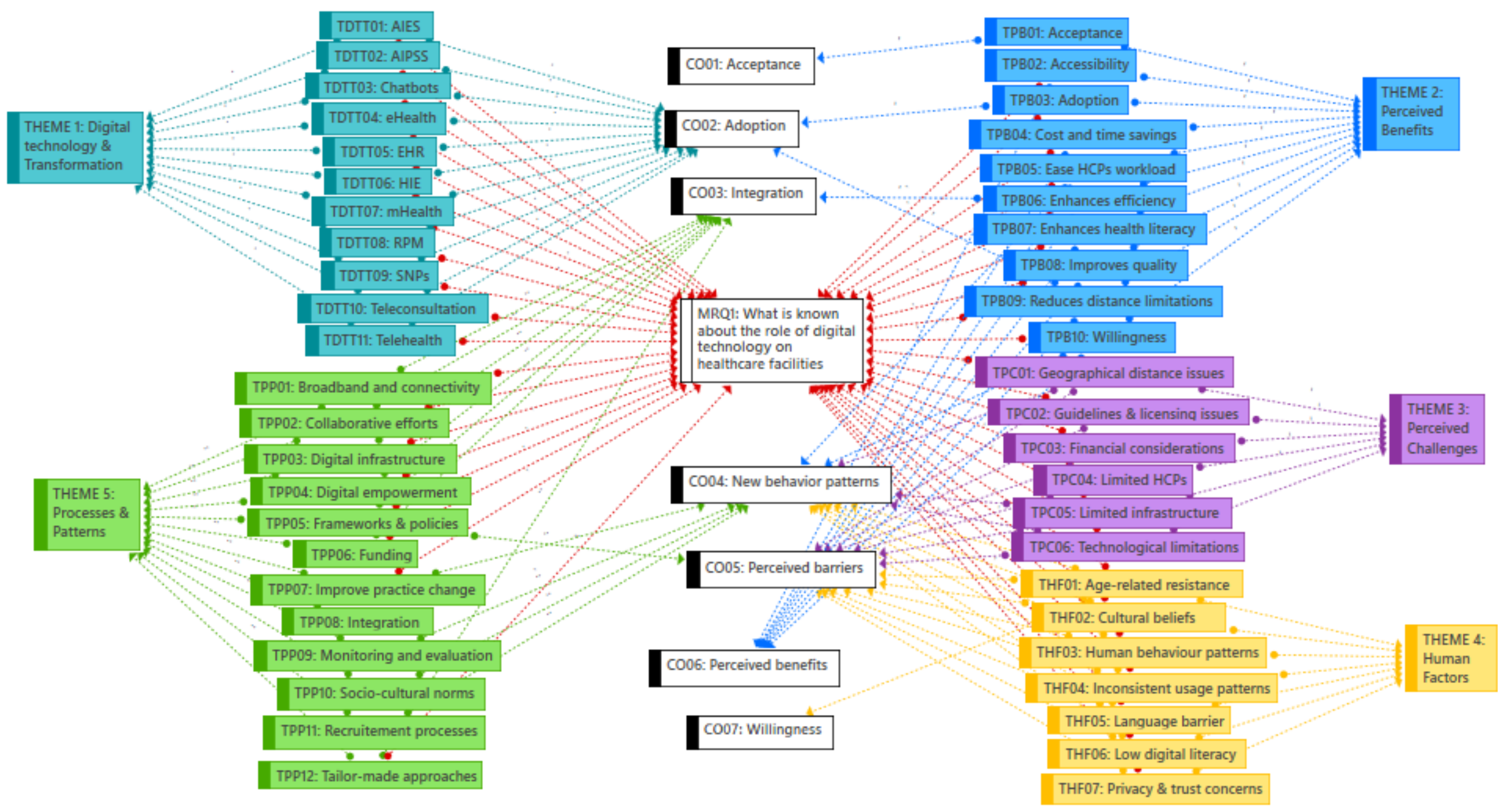


Figure 5-6: Preliminary framework for the role of digital technology of healthcare facilities in rural areas

5.5 Interpretation of findings – empirical (MRQ2)

This section interprets the key findings presented in Chapter 4 by integrating insights from both the SLR and the empirical investigation. The discussion is organised around the five secondary questions, each linked to specific themes identified in the SLR. These themes – Digital technology and transformation (DTT), Perceived benefits (PB), Perceived challenges (PC), Human factors (HF), and Processes and patterns (PP) – along with an additional theme, Digital health enablers (DHE), which emerged from the empirical data, provide the lens through which the findings are interpreted. Additionally, the analysis of each theme is informed by the conceptual framework, which integrates five theories:

- **The Diffusion of Innovations Theory (DIT)**: Adoption and integration – to understand ways in which healthcare facilities adopt and diffuse new technologies.
- **The Technology Acceptance Model (TAM)**: Acceptance and willingness – to explore the manner in which HCPs may accept and embrace new technologies.
- **Social Cognitive Theory (SCT)**: New behaviour patterns – to examine the adoption of new behaviour patterns via observation and self-help mechanisms.
- **Health Belief Model (HBM)**: Benefits and challenges of digitalisation – to investigate of the benefits of using digital technologies for their health.
- **Ecological Systems Theory (EST)**: Integration – to understand the interaction between HCPs and their environment.

The main research question (MRQ2) addressed in this section is: *"How does digital technology impact healthcare facilities in rural communities in South Africa?"*

5.5.1 SQ 2.1: What digital technologies are currently in place in healthcare facilities?

This section explores digital technologies in place in healthcare facilities through THEME 1.

5.5.1.1 THEME 1: Digital technologies and transformation (DTT)

This section explores the implemented DTs in healthcare facilities to address SQ 2.1. The sub-headings include:

- Electronic health records and patient information systems,
- Data management and monitoring systems,
- Laboratory and medical systems,
- Digital communication channels,
- Compliance and diagnostic tools, and
- Human resource and payroll system.

i) Electronic health records and patient information systems

Participants reported the adoption of several digital technology (DT) tools within rural healthcare facilities. These digital systems include:

- Electronic health records (EHRs),
- Health Patient Registration System (HPRS),
- Institute for Health Systems Research (IHSR), and
- Three Interlinked Electronic Registers.Net (TIER.Net).

EHRs: The study found that rural healthcare facilities have transitioned from paper-based files to digital records. This transition in rural healthcare facilities demonstrates a significant change toward digitisation. One professional nurse emphasised the benefit of EHRs in that the patient-date is securely stored compared to the paper-based files. This digital storage minimises the risk of misplacing or losing patient data. The perceived benefits of DT motivated the HCPs to utilise the digital systems. This aligns with Rosenstock's (1974) HBM, which highlights that the perceived benefits of DT motivate users to embrace innovation. Additionally, this reflects a behaviour change in HCPs. This is consistent with Bandura's (1986) SCT, which explores the new behaviour patterns via observation. The study further revealed perceived benefits such as protection of patient data against file loss and sharing digital records. This is consistent with Rogers's (1983) DIT, which explains that diffusion of innovation is driven by the perceived benefits. This study recommends tailored training that suits the needs of healthcare facilities in rural communities to ensure the sustainability of DT.

HPRS: Participants identified a central HPRS system. This digital system is used mainly to register all new patients at the facility's reception. One participant highlighted that the digital transformation of patient data at the reception has enhanced the registration process. This shows that DT has the potential to facilitate data management in rural healthcare systems. According to Rogers's (1983) DIT, HPRS is an example of a technology advancement that is used in rural clinics, hospitals, and community health centres to enhance data management. Another participant indicated that the HPRS system empowers various roles such as administrators and data capturers with reliable access to essential information for reporting.

The integration of HPRS with other digital systems allows seamless data sharing across healthcare facilities. Another participant further revealed that the HPRS system is interconnected with other systems. Additionally, the interconnectedness of the HPRS system with other systems facilitates information sharing across hospitals and clinics. This aligns with Bronfenbrenner's (1989) Ecological Systems Theory, which explains the importance of the integration of digital systems to improve healthcare delivery in rural areas. However, while the

DT offers clear perceived benefits, there is a consideration for perceived challenges such as connectivity issues, system downtime, and the need for ongoing training for HCPs.

IHSR: The data revealed that the Ideal Health System Realisation (IHSR) is a digital system designed to align healthcare facilities with the National Health Insurance (NHI). This reflects a strategic shift in rural areas, where digital systems are not only used for operational efficiency but for accountability and standardisation. One participant explained that the IHSR system facilitates compliance of the rural healthcare facilities to a set of standards that define an 'ideal' healthcare environment. This reflects Bandura's (1986) Social Cognitive Theory (SCT), which explains behavioral changes, where senior managers such as the facility directors and managers adapt to new standards in rural communities. The alignment promotes data-driven decision-making, strategic oversight, and integrated service delivery by equipping senior management with digital tools. While this alignment is key for achieving efficient and high-quality care in rural communities, the findings highlight a need for robust digital infrastructure, internet connectivity, and workforce development for the success of IHSR in rural healthcare facilities.

TIER.Net: The findings revealed that TIER.Net is a disease-specific digital system designed to manage chronic conditions such as HIV and tuberculosis (TB). This system improves data integration and patient tracking across rural clinics and hospitals, even across different provinces in South Africa. One participant emphasised the usefulness of TIER.Net in tracking chronic conditions such as HIV/TB across rural clinics and hospitals. This aligns with Davis's (1989) TAM, where perceived usefulness of TIER.Net influences acceptance and willingness of the HCPs to adopt the system. This further reflects behavioral changes among HCPs, who are increasingly adapting to digital workflows in response to the demands of chronic disease management in rural healthcare settings. Although the system offers some perceived benefits such as improved continuity of care in rural areas, its success depends on reliable internet connectivity, and continuity of training for HCPs. Consequently, the study suggests strategic investments in both digital infrastructure and digital literacy within rural healthcare facilities.

Collectively, digital systems such as EHRs, HPRS, IHSR, and TIER.Net are designed to digitise and streamline rural healthcare, ultimately improving access, efficiency, and outcomes. However, the successful implementation and use of these digital systems depend on robust digital infrastructure and the digital literacy of the HCPs in rural healthcare settings.

ii) Data management and monitoring systems

The findings revealed several digital tools used for data management and monitoring, such as the Basic accounting system (BAS), District Health Information System (DHIS), Electronic Tick

(e-Tick) register, and Health Management System version 2 (HMS2) as helpful in transforming healthcare services in rural areas.

BAS: One participant identified the Basic Accounting System (BAS),a foundational digital system that supports senior management for budgeting, procurement, and reporting. The integration of the BAS into payments and procurement processes, such as paying the Hospital Board and service providers, demonstrates the facility's adoption of innovation to improve operational efficiency. This aligns with Rogers's (1983) DIT, which explains how BAS as an innovation is adopted and accepted within rural healthcare practices to modernise financial workflows and enhance transparency. The transition from manual accounting systems to digital accounting systems illustrates a new behavioral pattern, consistent with Bandura's (1986) SCT, where HCPs adapt to technology-driven processes.

DHIS: Several participants across facilities identified the DHIS, used for collecting patient data across facilities. The findings showed that the participants' interpretations of the DHIS varied based on their professional experiences. One professional nurse, for instance, pointed out that DHIS assists in collecting TB data, while an administrator emphasised that DHIS helps in monitoring facility performance. This variation in interpretation is consistent with Rogers's (1983) DIT, which describes how innovation has been adopted and accepted across institutions. This further reflects Badura's (1986) SCT, which explains the behavioural changes among HCPs adapting to the new innovation across clinics and hospitals in rural healthcare. Furthermore, one participant associated the DHIS with the Department of Health (DoH), noting its integration into broader governmental structures. This integration illustrates Bronfenbrenner's (1994) EST, which emphasises the role of DHIS in linking facility-level data to the national health system.

These interpretations suggest that DHIS empowers various roles across facilities by enhancing data management in rural areas. However, the effectiveness of DHIS in rural healthcare facilities hinges upon reliable digital infrastructure, particularly internet connectivity. To maximise its impact, the study recommends targeted capacity building along with sustained investments in infrastructure to support the successful adoption and use of DHIS in rural healthcare.

e-Tick: The study uncovered the e-Tick register as a digital replacement for the manual register previously used by professional nurses to record patients visits in consulting rooms. This transition signifies a notable technological advancement in rural healthcare facilities in the Eastern Cape, enhancing data access, data accuracy, and efficiency. From the perspective of Rogers's (1983) DIT, the adoption of the e-Tick register illustrates how innovations are slowly

embraced within healthcare communities to enhance existing practices. The acceptance of the e-Tick register by the HCPs reflects a shits in behaviour attitudes toward DT, demonstrating willingness and acceptance to integrate technology into healthcare workflows. However, the study revealed the challenges that may hinder the adoption of the e-Tick register, such as system failures, digital literacy, and infrastructure limitations. Therefore, this study suggests collaboration among stakeholders to invest in digital infrastructure and digital training for HCPs to support the long-term sustainability of DT in rural healthcare.

HMS2: The participants highlighted that rural healthcare facilities adopted HMS2, an integrated, digital patient management system. The participants stated that HMS2 was adopted in phases, starting with the pilot hospitals and progressively spreading to other healthcare facilities. This phased implementation reflects a systematic approach that enables time for testing and refinement of the system prior to complete adoption. Participants pointed out that HMS2 facilitates patient administration, monitors admissions, and offers real-time access to patient data. One medical doctor, for instance, stated that HMS2 enables data administrators to register patients and record their visits. Another participant highlighted the role of HMS2 in billing external entities like correctional services and police departments. These varied interpretations reflect a constructivist view that reality is experienced differently depending on one's role within the rural healthcare facilities. This aligns with Rogers's (1983) DIT, as HMS2 reflects a technological innovation that is being slowly adopted across rural healthcare. Additionally, Bronfenbrenner's (1989) EST is reflection through HMS2 integration with external systems such as the Department of Home Affairs.

Overall, HMS2 empowers HCPs across various roles to improve patient care, data management, and operational efficiency in rural health settings. However, its success in rural healthcare depends on reliable digital infrastructure gaps, internet connectivity, and ongoing capacity building. To ensure sustainable adoption, the study recommends targeted investments in infrastructure and training tailored to the needs of rural HCPs.

Together, BAS, DHIS, e-Tick, and HMS2 strengthen rural health services by improving medication access and management and monitoring. While data and monitoring systems provide essential insights into health service performance, the next category of DTs focus on the operation aspects of healthcare and logistics.

iii) Laboratory and medical systems

The study uncovered the use of several digital tools including the Central Chronic Medicine Dispensing and Distribution (CCMDD), Lab Trak, Logistical Information Systems (LOGIS), and RxSolution.

CCMDD: Participants indicated that the CCMDD system involves the distribution of medication to the external pickup points. The adoption of CCMDD in rural healthcare facilities demonstrates the use of DT to improve access to chronic medication for stable patients. CCMDD enables patients to collect their treatment from external pick-up points such as outreach clinics and pharmacies. This reduces the congestion and waiting times in the facilities. Davis's (1985) TAM is evident in the positive acceptance of CCMDD by the HCPs, who emphasised its usefulness in managing patient flow and improving operational efficiency. This shift in the healthcare practice where patients are decanted and monitored remotely illustrated a new behavioural pattern, aligning with Bandura's (1986) SCT as HCPs adapt to new digital health systems and workflows. This is further supported by the Rosenstock's (1974) HBM, which explains that the perceived benefits of CCMDD such as reduced waiting time, improved continuity of care, and efficiency, motivated the HCPs to engage with CCMDD. Moreover, the integration of CCMDD with other systems like TIER.Net highlights its role within a broader infrastructure, aligning with Bronfenbrenner's (1989) EST, which emphasises the interconnectedness of systems at multiple levels. The adoption of CCMDD emerged in response to the issue of long waiting times across healthcare facilities in rural areas and to enhance access to chronic medication. Its effectiveness heavily depends on the availability of stable internet in rural healthcare facilities.

Lab Trak: Several participants highlighted the role of the Lab Trak system in facilitating and tracking patient laboratory results. This system significantly enhances the system of tracking patients across geographic locations, helping to address the issues of fragmented healthcare services in rural areas. This adoption aligns with Rogers's (1983) DIT, which explains how new innovations diffuse within rural healthcare communities. The findings revealed that the Lab Trak system enables access to patient laboratory histories, even when the tests are conducted in distant provinces. Furthermore, the integration of the Lab Trak system with other systems reflects the Bronfenbrenner's (1989) EST, which highlights the importance of integrated systems in enhancing improved healthcare delivery. However, the effectiveness of the Lab Trak system depends on the availability of stable internet in rural areas.

LOGIS: One participant identified the Logistical Information Systems (LOGIS) as a key digital system used to manage financial and logistical operations in healthcare facilities in rural areas. In particular, the LOGIS system supports data capturing, budget monitoring and inventory control. This reflects Davis's (1989) TAM, which highlights the perceived usefulness in capturing financial data and preparing orders. This transition from manual financial tracking to digital financial tracking systems demonstrates a new behaviour pattern, consistent with SCT in healthcare delivery in rural areas (Bandura, 1986). However, the success of LOGIS in rural

healthcare depends on addressing unstable internet connectivity. Therefore, while LOGIS improves financial management in rural healthcare, its sustainability requires ongoing support in digital infrastructure to improve internet connectivity.

RxSolution: The study revealed that RxSolution is an electronic pharmaceutical management system within the healthcare facility. This system is used in dispensaries to manage medicine stock and ordering processes. The transition from manual stock take to the digital system shows a new behavioural pattern, consistent with SCT (Bandura, 1986). This also aligns with Rogers's (1983) DIT, which reflects the adoption of a new innovation in the facility's response to the need for more reliable and efficient pharmaceutical systems. Overall, RxSolution improves efficiency and reliability of the management of medicine in healthcare facilities in rural areas. However, its effectiveness heavily depends on the availability of a robust digital infrastructure. Therefore, the study recommends investment in digital infrastructure to improve internet connectivity in rural healthcare.

Collectively, the laboratory and medical systems demonstrate significant potential to transform healthcare delivery in rural settings. The next section explores how digital communication platforms facilitate information collaboration and sharing among HCPs across healthcare facilities in rural areas.

iv) Digital communication channels

Participants identified a range of digital communication platforms such as emails, SMS, MS Teams, WhatsApp and Zoom that are adopted in healthcare facilities in rural areas. These digital platforms are actively used in rural healthcare. For example, participants emphasised the use of WhatsApp, in particular, for rapid response to improve coordination and responsiveness. Additionally, these digital tools have become essential for real-time communication, especially in emergencies. The participants emphasised that they used WhatsApp frequently for its ease of use in dispatching ambulances across facilities for patient referrals.

This adoption aligns with Davis's (1985) TAM as HCPs integrate these digital tools into their daily tasks to enhance healthcare delivery in rural healthcare. One participant mentioned that being part of management, he uses MS Teams for virtual meetings: "*So, we discuss all these practices of these hospitals through telephone, through Teams".* An administrator pointed out that they use phones in their facilities to send short message services (SMSs) to the patients reminding them of their next appointments. One professional nurse mentioned that they use mobile phones for communication purposes through direct phone calls. For instance, she said that when a patient is referred from another facility, the HCPs use mobile phones to contact

the facility and get relevant information. Additionally, depending on the patient's condition upon arrival, they may use the mobile phone to request an ambulance. Furthermore, the diffusion of digital communication platforms across rural healthcare facilities reflects Bronfenbrenner's (1989) EST, showing how digital communication is integrated among the HCPs and clinics and hospitals.

The transition from traditional communication methods to digital communication channels illustrates a new behaviour pattern, consistent with SCT (Bandura, 1989). While hospital management benefit from more structured platforms like MS Teams and Zoom, clinic managers rely heavily on mobile phones and tools like WhatsApp and SMSs. This gap underscores the need to unpack the disparity between policy promises and the lived experiences of rural HCPs. Although these digital platforms offer promising benefits, without addressing infrastructural barriers such as unstable internet connectivity in rural areas, their effectiveness in rural healthcare remains hindered.

v) Compliance and diagnostic tools

Participants indicated the integration of modern digital diagnostic technologies in their facilities in rural healthcare. Diagnostic tools such as automated blood pressure monitors, ultrasound machines, X- ray machines, IntelliSpace Perinatal (ISP), and Office of Health Standards Compliance (OHSC) are transforming rural healthcare.

Diagnostic tools: Several participants highlighted a range of diagnostic tools such as automated blood pressures, ultrasound machines, and X- ray machines in their practices as HCPs adopted in rural areas. The adoption of these diagnostic tools in rural healthcare facilities reflects a significant transformation in clinical practice. This transition aligns with Rogers's (1983) DIT, as HCPs move away from manual equipment such as outdated BP monitors to more accurate and efficient DTs. The HCPs are appreciating the adoption of digital tools for their reliability and simplicity. For example, one professional nurse pointed out that "*we are no longer using those old manual BP machines that make a noise".*

Another professional nurse from another facility supported this by saying that *"it's not the manual one, the one we use in the old days, this one you plug the cuff and then you just start and then it gives the reading".* This is supported by the Davis's (1985) TAM, which indicates the acceptance and willingness of the HCPs to use digital tools in clinical practice in rural healthcare settings.

This change in their routine work of manual pumping BP machines to simply pressing a button demonstrates a new behavioural pattern consistent with Social Cognitive Theory (Bandura,

1986), where HCPs adapt to new practices through learning and experience. One medical doctor emphasised the use of X-ray machines for diagnosing fractures. Moreover, the use of X-ray machines for diagnosing fractures, swelling, movement of the limbs, internal bleeding, and other conditions. This highlights the benefits of digitisation, supporting the Health Belief Model (Rosenstock, 1974). The adopted digital health tools not only enhance diagnostic accuracy but also improve patient outcomes in rural healthcare settings.

Participants mentioned that diagnostic tools such as X-rays were exclusively available in hospital facilities, with no mention of their use in clinic facilities. Finally, the use of these DTs in clinics and hospitals in rural areas shows their integration into the broader healthcare system, as described by the Ecological Systems Theory (Bronfenbrenner, 1989). Although these diagnostic tools offer promising benefits, power outages may hinder their effectiveness in rural healthcare. The study recommends robust digital infrastructure for the sustainability of digital diagnostic tools in rural healthcare settings.

ISP: One administrator described ISP as a valuable digital tool used in tracking the well-being of a foetal during pregnancy, particularly through Cardiotocography (CTG). Although this role primarily falls under professional nurses, the administrator acknowledged its significance in rural healthcare. This indicates cross-role awareness of the benefits of ISP. This aligns with Davis's (1989) TAM, which highlights the system's perceived usefulness in monitoring maternal blood pressure and tracking the foetal heart. Additionally, this reflects the ease of use of the ISP system in automated monitoring of the pregnancy. Furthermore, guided by Rosenstock's (1974) HBM, the HCPs embrace the ISP system because of its benefits in improving responsiveness to maternal and child health needs. The participant further highlighted that the ISP system is only available in hospital facilities and not in clinic facilities. This disparity indicates the resource gaps that limit the diffusion of DT in rural healthcare. Addressing these disparities is necessary to ensure that DTs like ISP contribute to comprehensive maternal care across all facility levels in rural healthcare settings.

OHSC: The study uncovered that the adoption of OHSC illustrates how digital systems are embedded within multiple layers of the healthcare environment. One participant noted that OHSC facilitates alignment with national standards. This reflects Bronfenbrenner's (1989) EST, which explains the interaction between individuals and their broader institutional environments. Additionally, the use of OHSC demonstrates how rural healthcare facilities are connected to national structures, thus promoting transparency and accountability. The participant further highlighted that the OHSC system enables senior management to monitor and ensure compliance, and to maintain readiness for audits. This reflects the alignment between the local rural healthcare facilities and the broader institutional structures to comply

with national health standards. While the OHSC system is intended to support transparency and uniform compliance, barriers such as unstable internet connectivity may hinder its effectiveness in rural healthcare. For example, facilities with limited internet access may struggle to meet the audit requirements despite policy mandates. This gap between the envisioned role of DT and their actual implementation highlights a need for context-sensitive support to ensure that rural healthcare facilities can fully participate in national health governance.

vi) Human resource and payroll system

Some participants indicated that the Personnel and Salary System (PERSAL) is used by the Human Resource Department. This adoption highlights the role of DT in transforming human resource management. Additionally, the participants highlighted that PERSAL plays a key role in managing employee appointments, employee benefits, disciplinary actions, leave administration, and retirement processes. This aligns with Davis's (1989) TAM, which emphasises the perceived ease of use as a key factor in the adoption of new innovations. Furthermore, the participants highlighted that the PERSAL system enables senior management to facilitate staff transfers across facilities and monitor leave schedules. The findings further uncovered that the PERSAL system also supports the processing of staff salaries and benefits. This reflects a gradual shift from paper-based systems to digital platforms. Overall, the PERSAL system plays a vital role in supporting human resource management, contributing to more efficient and transparent operations in rural healthcare. However, the effectiveness of the PERSAL system depends on the availability of internet connectivity in rural healthcare facilities. This study recommends investment in robust digital infrastructure to ensure sustainability of the PERSAL system.

Table 5-6 presents a summary of the findings identified in section 4.3.1, Chapter 4, detailing the purpose and the benefits of each DT adopted in rural healthcare facilities within the Eastern Cape province of South Africa.

Table 5-6: Summary of findings for THEME 1: Digital technology and transformation (DTT)

Digital technologies: Items	Purpose	Benefits	Role
EDTT12: BAS	Tracks financial transactions	Assists in budgeting and resource allocation	Seni
EDTT13: CCMDD	Distribution of patients with chronic diseases to external contact points	Reduces long ques within the facility	Facil
EDTT14: DHIS	Capturing, collecting, managing and analysing health data	Facilitates data management	Facil
EDTT15: Digital diagnostic & monitoring	Diagnosing and monitoring vital signs	Facilitates remote monitoring	Doct
EDTT16: EHRs	Automates manual health records	Enhance accountability and minimise operational risks	Seni admi
EDTT17: e-Tick register	Automates manual tick registers	Facilitates quick retrieval of patient data. Reduces manual errors	Profe
EDTT18: HMS2	Monitors billing for the patients	Improves access and efficiency	Admi
EDTT19: HPRS	Patient registration system	Centralised patient record for operational efficiency	Admi
EDTT20: IHSR	Aligns healthcare facilities to the NHI	promotes data-driven decision, strategic oversight, and integrated service deliver	Seni
EDTT21: IntelliSpace Perinatal	Manages fetal monitoring and perinatal care	Improves quality, and responsiveness for mothers and children	Profe
EDTT22: Lab Trak	Manages blood samples and results	Enhances the system of tracking patients across geographic location	Doct
EDTT23: LOGIS	Manages procurement and inventory	Empowers senior management to maintain operational efficiency	Seni
EDTT24: OHSC	Enforces and monitors health standards	enables facility senior management to ensure compliance, manage risks, and maintain readiness for audits	Seni
EDTT25: PERSAL	Manages human resource and payroll	Informs senior management decisions across clinics and hospitals	Seni
EDTT26: RxSolution	Tracks and manages medicine in the Pharmacy department	Ensures availability of medicine and supports informed clinical decisions	Doct
EDTT27: Tele-communication tools	Health updates and alerts	Reduces missed appointment. Helps in sending reminders and organising meeting	Direc
EDTT28: TIER.Net	Tracks and monitors HIV/ TB patients	Improved patient tracking	Profe

Additionally, the network diagram in Figure 5-7 displays a synthesised visual presentation of THEME 1 from an empirical perspective. This diagram enhances the understanding of the DTs currently adopted in rural healthcare facilities by linking specific constructs to their corresponding items. Furthermore, one construct identified through empirical data analysis is associated with THEME 1 items. For instance, item 'EDTT16: EHR' is logically connected to the construct 'CO02: Adoption', indicating how electronic records align with broader digital innovations. The coding system used, where 'E' denotes empirical items, helps differentiate between theoretical and empirical data sources.

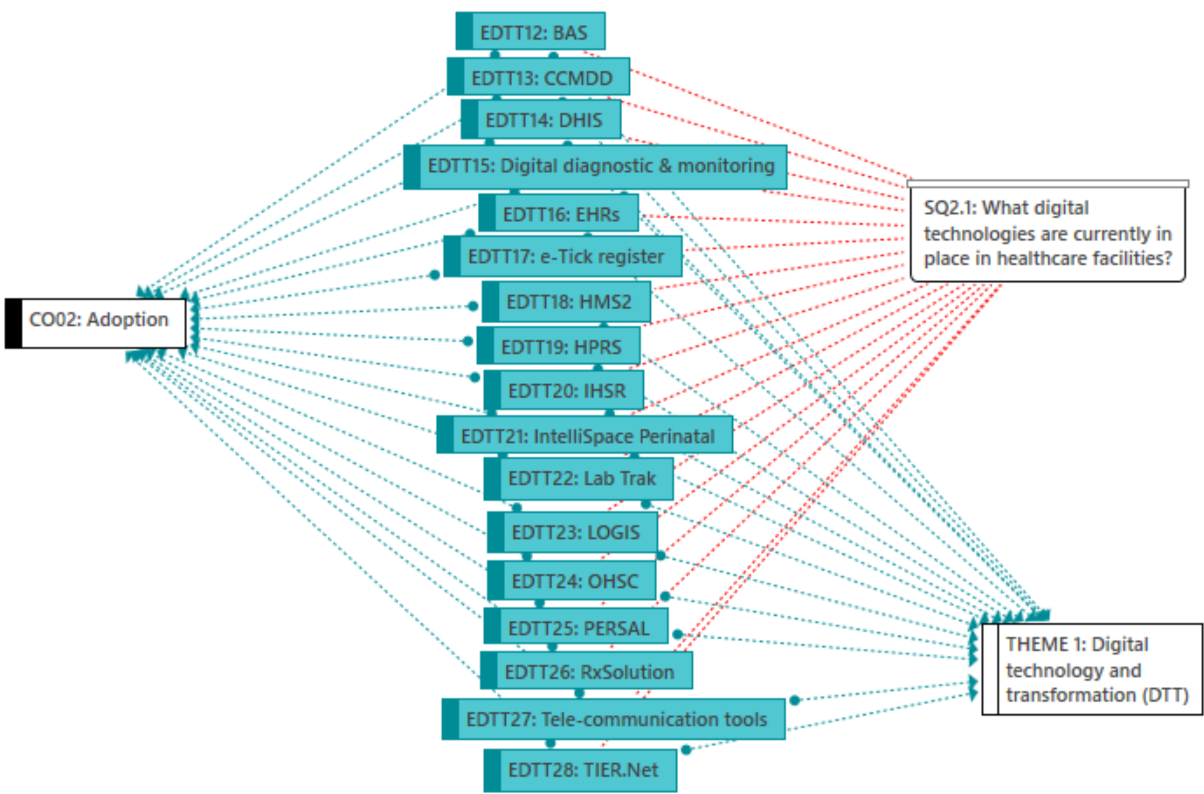


Figure 5-7: Network diagram for THEME 1: Digital technology and transformation, constructs, items, and associated secondary question

Figure 5-7 lists a range of DTs adopted in healthcare facilities in rural areas. The findings under THEME 1 address SQ 2.1: "*What digital technologies are currently in place in healthcare facilities?"*

The literature findings focused on high-level categorisation of digital technologies, such as eHealth, mHealth, and RPM. The digital technologies are often discussed in the context of global health trends and national strategies. While this type of classification is useful for framing digital health policy, it lacks detail regarding the practical implementation and lived experiences in healthcare facilities in rural areas. The findings of this study offer a context-specific account

of digital technology implementation and lived experiences in healthcare facilities in the rural areas of the Eastern Cape province in South Africa. Participants referenced concrete systems such as CCMDD for chronic medication, TIER.Net for managing HIV/TB patients, Lab Trak for tracking laboratory blood samples, HMS2 for data management, and the e-Tick register for daily patient data collection. These digital systems are not only operational but deeply embedded in the daily workflows of the facilities in rural healthcare. This uncovers a significant gap in the literature, which tends to generalise digital health innovations. Therefore, these findings suggest that future research and policy must move beyond abstract classifications and engage with the specific technologies that define healthcare delivery in rural contexts.

Collectively, these findings on THEME 1 uncovered that the key role of the adopted DTs is to improve operational efficiency and healthcare delivery in healthcare facilities in rural communities. While literature presents DTs as a promising avenue for improving healthcare delivery, the lived experiences of HCPs reveal that infrastructural limitations continue to hinder progress in rural healthcare. For example, poor internet connectivity compromises the utilisation of the DTs as highlighted in Davis's (1989) TAM, which emphasises ease of use as a main factor in technology adoption. Furthermore, beyond understanding the adoption of DTs, it is also vital to examine their significance in rural healthcare. The following section addresses SQ 2.2, which investigates the practical outcomes and significance associated with the adoption of DTs in rural settings.

5.5.2 SQ 2.2: What is the significance of digital technology in healthcare facilities?

This section examines the significance of digital technology in healthcare facilities. To address this, THEME 2 and THEME 5 collectively respond to SQ 2.2.

5.5.2.1 THEME 2: Perceived benefits (PB)

Participants highlighted several perceived benefits associated with the adoption of DT. These include: 'Improved data management'; 'Facilitates data transmission'; 'Improved system integration'; 'Minimises expenses and time', 'Continuity of care', and 'Value-added outcomes'.

i) Improved data management

Participants emphasised the role of DTs in enhancing data across facilities in rural healthcare. Several HCPs praised the adoption of DTs, for example, one administrator noted that "*I would say beneficial because it is taking the institution away from relying on manual documents which at times are misfiled, or they get stolen".* This insight implies that DT enhances data management and data security. Additionally, the participants indicated that the digital systems enable them to retrieve patient records easily and quickly.

This indicates that HCPs can access accurate patient records promptly, consequently improving healthcare delivery. This transition from the paper-based filing system to the digital system has led to the reduction of time and operational costs in rural healthcare. These findings align with Rosenstock's (1974) HBM, which highlights that the recognition of perceived benefits, such as improved access to patient data, and efficiency, drive the adoption of DT in rural healthcare. This transition from manual systems to digital systems aligns with Badura's (1986) SCT, which highlights the new behavioural pattern. Furthermore, DT ensures continuity of care and minimises the risks associated with missing records in manual systems.

ii) Facilitates data transmission

The study found that DT can assist with real-time data sharing in rural healthcare. For instance, one professional nurse pointed out that "*It's good because it makes the communication much more easier because we just transfer information to another facility*". This indicates that in rural healthcare settings, DTs are enhancing collaborative care in addition to data management. The findings further revealed that HCPs can share blood results and X-ray images quickly, making it possible for senior doctors to provide advice from a distance. This capability demonstrates how DTs enables prompt access to specialised medical doctors. The experience aligns with Rogers's (1983) DIT, which highlights how innovations are adopted through communications channels over time within rural healthcare. This allows healthcare providers in rural areas to consult with their specialists at tertiary hospitals remotely, enabling timely support or patients without requiring them to travel long distances.

In this context, DTs serve as vital communication channels that accelerate the diffusion of medical expertise across geographically dispersed healthcare facilities in rural settings. Another participant further noted that "*there are those clients that came transferred themselves without the transfer letters, but we can see we can get information through these digital systems*". The transition from manual transfers and writing physical letters to digital communication shows the new behaviour pattern, aligning with SCT (Bandura, 1986), which highlights the adoption of new behaviour patterns through observation and self-help mechanisms. Furthermore, the findings revealed that DTs support longitudinal tracking of patient history, which is very important for managing patients with chronic diseases. These insights underscore the transformative impact of DT in facilitating data transmission in rural healthcare settings. However, without stable internet connectivity and consistent technical support, the perceived benefits of DTs in rural healthcare may not be fully realised. Therefore, this study recommends a need for strategic investment in infrastructure development and training capacity for HCPs to ensure that rural healthcare settings can leverage DTs effectively.

iii) Improved system integration

Participants highlighted that the adoption of DT has improved system integration across clinics and hospitals in rural areas. For instance, digital systems now enable seamless coordination between local facilities and national departments such as the Treasury for logistical support. Additionally, the digital system is linked to the Department of Health at the national level to provide feedback such as identifying trends, like a rise in HIV cases, and recommending targeted interventions such as community education.

The participants further revealed that, one of the notable benefits of DT in rural health systems is the ability to track and consolidate patient history across multiple facilities. For example, the participants emphasised that the system could identify if a patient was previously admitted in Cape Town, Pretoria or Frere Hospital, providing a comprehensive review of the patient's medical journey. This level of integration aligns with EST (Bronfenbrenner,1989), which emphasises the integration of HCPs and healthcare facilities with broader systemic structures. This facilitates continuity of care, reduces duplication of services and enables healthcare professionals to make more informed decisions based on a patient's complete clinical background.

The participants also indicated that the DT links Primary Health Care to the District Health system and the National Health system. This enables real-time monitoring of key health indicators. For instance, a rise in teenage pregnancies at the primary care level can be detected early through the digital system, as it is reflected in increased maternity admissions. This data-driven insight allows healthcare professionals to hold targeted discussions, identify root causes and develop strategies, such as community education, to address the issue and reduce negative outcomes of stillbirths. It demonstrates how DT not only supports but also strengthens rural healthcare planning and response.

iv) Minimises expenses and time

The participants emphasised that they no longer need to write patient information in manual files, which was time-consuming and prone to errors or loss. Instead, digital systems allow for faster data capturing, access, and processing. This minimises the physical movement of healthcare providers, reduces workload, and enables multiple tasks to be completed simultaneously. These improvements align with Rosenstock's (1974) HBM, as perceived benefits such as cost and time savings are recognised by HCPs. The improvements not only save time but also contribute to a more organised and responsive healthcare environment, allowing HCPs to focus more on patient care.

v) Continuity of care and value-added outcome

Several participants emphasised the role of digital health systems in ensuring continuity of care. This is essential for patients in rural areas where they often move across facilities. For example, one medical doctor described how a patient's medical history from another clinic could be instantly retrieved using their identity number. The continuity of care capability ensures that treatment decisions are informed by a complete and accurate patient history, ultimately reducing medical errors. This allows HCPs to seamlessly update and build upon existing patient records. Such integration aligns with EST, which highlights the importance of integrated systems in supporting patient care. Additionally, DTs support improved data management, transmission, and data integration, which are the cornerstones of rural health transformation. Ultimately, DT strengthens the overall quality of healthcare delivery in rural healthcare facilities.

Collectively, the identified perceived benefits in the empirical data closely mirror those found in the SLR. This indicates a strong alignment between theoretical insights and lived experiences. However, the empirical findings offer more content-specific insights, particularly tailored to the realities of rural healthcare facilities in the Eastern Cape province. These include detailed examples of how digital systems improve data transmission, patient tracking, and inter-facility communication, elements that are often generalised in the literature but are vividly illustrated through firsthand accounts in the field. These perceived benefits lead to improved operational efficiency, as healthcare providers are now able to capture, access, and transmit patient data quicker and accurately.

Figure 5.7 illustrates a network diagram for THEME 2, showing the relationships between constructs and associated items. Two of the constructs identified through empirical findings are linked to items under THEME 2. For example, the item 'EBB11: Continuity of care' is logically associated with the construct 'CO06: Perceived benefits'.

The findings illustrated in Figure 5-7 under THEME 2 highlights the practical benefits of DTs in healthcare facilities in rural communities of the Eastern Cape province. The benefits include improved data transmission, continuity of care, improved communication, and value-added care. To further understand the significance of DTs, it is also vital to explore how the adopted DTs align with the existing workflow processes and patterns in healthcare facilities in rural areas.

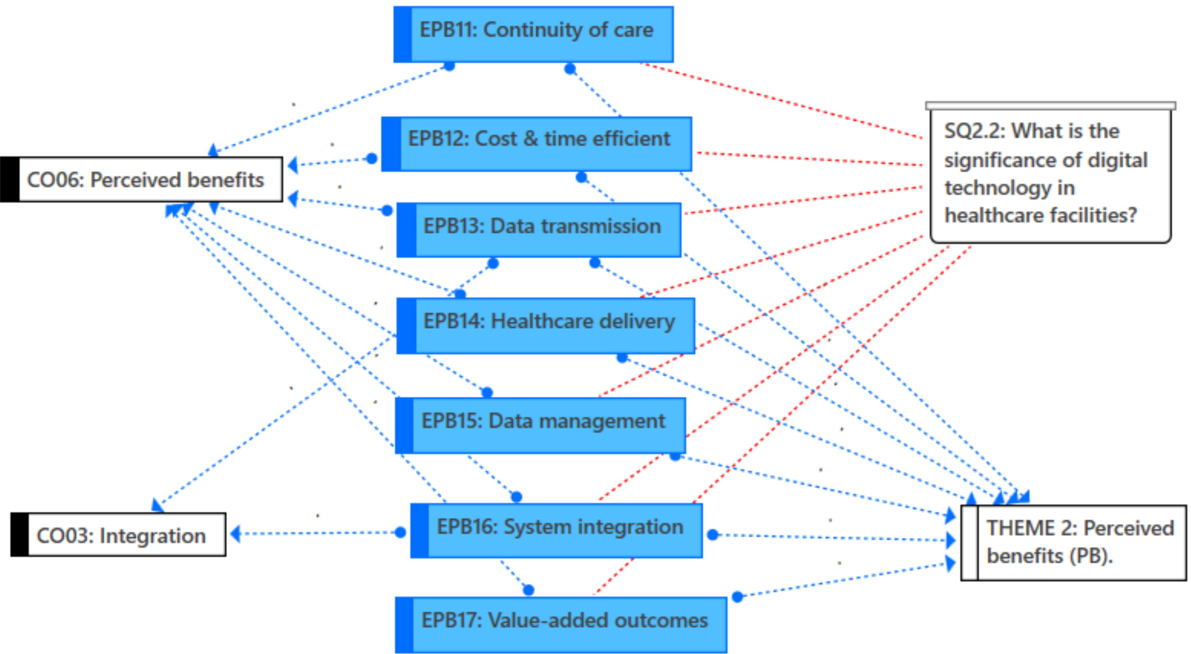


Figure 5-8: Network diagram for THEME 2: Perceived benefits, constructs, and associated items

5.5.2.2 THEME 5: Processes and patterns (PP)

Beyond the perceived benefits, the participants emphasised that DTs also reflected in the processes and patterns through which they are adopted, implemented, and integrated into daily operations. This includes the adoption phase, data entry processes, decision-making processes, referral systems, and incorporation of digital tools into routine workflows. Additionally, the participants highlighted the importance of skills development as a key factor in ensuring successful integration and effectiveness of these digital tools.

i) Adoption and data entry process

The study revealed that HMS2 was adopted through a phased approach, demonstrating the operational realities of the adoption of DTs in healthcare facilities that were not considered in the literature. This shows a gap between literature and practical perspectives on the adoption of DT in rural healthcare. Additionally, it underscores the necessity for implementation models to reflect the lived experiences of rural HCPs. This gradual adoption of HMS2 in rural healthcare shows that digital transformation is not a one-size-fits-all strategy. This phased adoption is consistent with Rogers's (1983) DIT, which explains a multi-phase adoption process. The findings suggest that tailored support at each adoption phase is necessary to enhance the adoption of DTs in rural healthcare communities.

ii) Decision-making process

The findings of this study uncovered a structured, data-driven decision-making process within

rural healthcare communities, an aspect notably absent from the literature. The findings showed that professional nurses capture patient data through the e-Tick register. This data is compiled by the administrators to monitor patient numbers and service delivery trends. Once consolidated, it is submitted to the national level for analysis to identify any issues or areas needing improvement. If a problem is detected, relevant HCPs are brought together to discuss the findings, determine the root cause and develop improvement plans. On the other hand, the facilities receive feedback with corrective measures from the national level. These findings are supported by Bandura's (1986) SCT, which highlights how feedback can influence organisational behaviour. However, the literature has ignored the operational realities of facility level decision-making and focused primarily on broad sustainability strategies. This gap draws attention to a limitation in the body of existing literature, which frequently assumes that decisions are top-down without taking into account the bottom-up information flow that underpins responsive healthcare management. This process shows how the decision-making process is intricately integrated into the facility's operations and extends to the national level. Furthermore, this process encourages planning grounded on reliable data and promotes transparency, both of which enhance better healthcare delivery.

iii) Referral process and workflow integration

The findings revealed the TIER.Net system's transformative benefit in improving workflow integration and facilitating the patient referral process across rural healthcare facilities. This illustrates that DT has a higher chance of being adopted when it meets facility needs and tackles real-world problems (Rogers, 1983). According to the participants, the TIER.Net system consolidates patient data for TB and HIV, enabling HCPs to access complete patient records from any geographical location. This is supported by Davis (1989), who explains that HCPs engage with the technology when they perceive it as useful and easy to use. Participants emphasised that TIER.Net system streamlines the transfer letter process, ensuring that the patient treatment history is easily available. It relieves the HCPs and patients from the burden of manually following up on records from other facilities. Furthermore, the findings highlighted that TIER.Net's integration with CCMDD improves the facility's capacity to manage and monitor patient care across provinces.

The integration illustrates how digital health systems can bridge the gaps between rural healthcare facilities and provincial healthcare facilities, improving system coordination (Bronfenbrenner, 1989). Additionally, this means there is improved care coordination among facilities that enables healthcare providers to collaborate effectively across facilities, ensuring that patients receive the right care at the right time. Moreover, digital systems help ensure patients are patients transferred to appropriate facilities and services. Overall, this supports

smoother workflow integration in rural healthcare facilities. However, this operational dimension of digital health systems was not captured in the literature that focused on infrastructural aspects. The literature failed to account for how digital heath systems function in practice to support workflow integration and referral processes, which highlights a significant gap. Therefore, the findings in section 4.2.5 recommend that future digital health solutions should include both operational and strategic realities to ensure context-specific and effective implementation in rural healthcare facilities.

iv) Skills and training

Skills development and digital literacy emerged in both the literature and the empirical findings of this study. Participants highlighted that formal training is offered when new technologies are adopted, followed by a peer-to-peer knowledge transfer to ensure continuity of skills. This aligns with Davis (1989), who highlights that training enhances perceived ease of use and perceived usefulness of the innovation. Additionally, the participants indicated that in-service training is offered to new staff, which limits perceived barriers and increases perceived benefits (Rosenstock, 1974). Moreover, webinars are used to guide healthcare providers on how to manage patient conditions, especially in situations where immediate medical support, such as an ambulance, is delayed. This supports the idea that digital platforms can improve both social and cognitive skills (Bandura, 1986). Although each role demands role-specific digital skills, rural HCPs often lack access to structured and continuous training, resulting in the underutilisation of available technologies. Importantly, the study highlights that digital skills and training are foundational to the successful digital health implementation in rural areas. While hospitals are generally better equipped, clinics often face significant challenges. Therefore, addressing these gaps through role-specific, accessible, and context-sensitive training programs is essential to ensure that DTs truly enhance healthcare delivery, efficiency, and equity in rural areas.

Collectively, the findings on THEME 5 demonstrate that DTs are transforming rural health by improving data integrity, process efficiency, and continuity of care in rural areas. Furthermore, the findings revealed that the digital tools support improved adoption, data entry process, decision-making, staff capability, and referral systems across hospitals and clinics in rural communities. Figure 5-9 illustrates a graphical view of the items on processes and patterns, with each item linked to the relevant constructs. For example, item ‘EPP13: Adoption process’ is linked to construct ‘CO02: Adoption’.

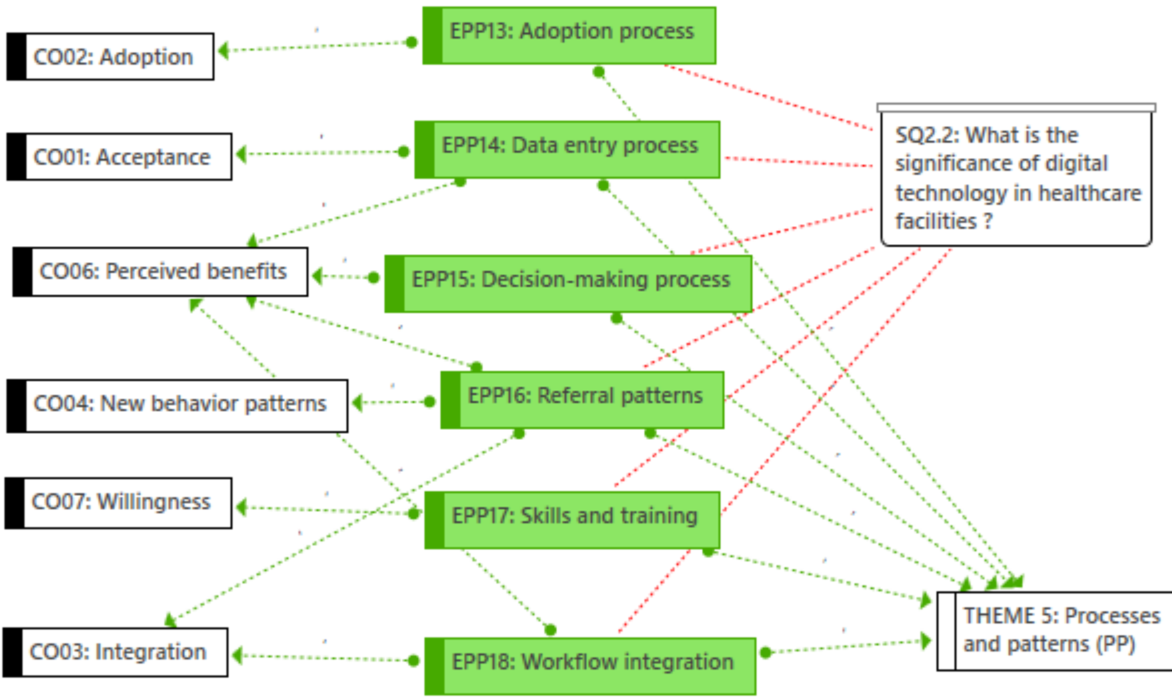


Figure 5-9 Network diagram for THEME 5: Processes and patterns, constructs, and associated items

Table 5-7 presents the summary of the findings related to SQ 2.2: *"What is the significance of digital technology in healthcare facilities?"* The table highlights a summary of the perceived benefits of DT in rural healthcare under THEME 2 and THEME 5.

Table 5-7 Summary of findings for SQ 2.2: What is the significance of digital technology in healthcare facilities?

Perceived benefits: Items	Summary
THEME 2 - Perceived benefits	
EPB10: Continuity of care	Patient information from various healthcare facilites in South Africa, can be accessed and updated to ensure continuity of care across facilities.
EPB11: Minimises expenses and time	Assists unemployed patients to save money and avoid costly travel to distant healthcare facilities, thus making care more accessible and easier for them
EPB12: Facilitates data transmission	Digital health systems enable faster collection, distribution, and transmission of patient information, improving communication up to the national level.
EPB13: Improves healthcare delivery	Digital technology on healthcare facilities improves healthcare delivery by making patient information accessible, so patients no longer need to travel far for transfer letters or treatment details.
EPB14: Improves data management	Facilitates secure data storage and retrieval. Reduces reliance on manual documents, preventing loss or damage and making information easier to access.
EPB15: Improves system integration	Enhances interoparaility among healtchare systems for reporting. For example, HMS2 enhances system integration by connecting with Home Affairs and linking hospitals and clinics across the Eastern Cape.
THEME 5: Processes and patterns	
EPP13: Adoption process	The digital health systems are adopted in phases, for example, HMS2, a patient administration system, was piloted in the first phase at one of the facilities and manages workflow starting from patient registration through their care process
EPP14: Data entry process	After admission, patient details are entered into the system for both admission and delivery records, this results to a faster and more accurate data entry.
EPP15: Decision-making process	Digital technology on healthcare facilities assist in more reliable data for senior management. For instance, Data highlights issues, prompting relevant teams to discuss, develop strategies, identify root causes, and create improvement plans to address problems.
EPP16: Referral process	Improves tracking of patient referrals among healthcare facilities, for example, TIER.Net assists in generating patient transfer letters as part of the referral process
EPP17: Skills and training	Training is provided before adopting any new digital system to support capacity and digital literacy among HPCs.
EPP18: Workflow integration	Supports uninterrupted flow of information. The workflow integrates patient admission, delivery status, and discharge into the system to ensure accurate tracking throughout their hospital stay.

In summary, THEME 2 and THEME 5 collectively provide a comprehensive response to SQ 2.2: *"What is the significance of digital technology in healthcare facilities?"* The objective of SQ 2.2 to explore the significance of DT in rural healthcare facilities has been effectively addressed through insights captured under THEME 2 and THEME 5. The findings uncovered that DTs play a transformative significance in improving healthcare delivery in rural communities. SQ 2.3 is covered in the next section.

5.5.3 SQ 2.3: What challenges emerge when adopting digital technology?

The section discusses the challenges that have been explored in adopting DT in rural healthcare. SQ 2.3 is addressed by THEME 3 and THEME 4.

5.5.3.1 THEME 3: Perceived challenges (PC)

The findings revealed that the adoption of DT is hindered by several challenges in rural healthcare. These include:

- Connectivity issues,
- backlog issues, data loss and duplication, and
- lack of HCPs and IT personnel.

i) Connectivity issues

The findings uncovered that connectivity issues hinder the adoption of DT in rural areas. This reflects the barriers to adoption and integration of DT (Rogers, 1983). These include electricity outages, which disrupt the internet access and the functionality of the digital systems. The disruptions lead to frequent network downtime, affecting productivity and access to the functionality of the digital systems. These challenges affect the perceptions of some of the HCPs regarding use DT in rural areas (Rosenstock, 1974). The participants further indicated that other facilities like the hospitals have power generators, whereas other facilities like the clinics do not have power generators as a backup during power outages. When there is no internet connection or electricity, HCPs experience difficulties as they must revert to manually recording patient information on a paper-based system. Additionally, the findings revealed that once the internet connection is restored, the HCPs are then required to spend additional time to transfer the same information into the digital system, resulting in duplicated efforts and inefficiencies.

The connectivity issues in healthcare facilities in rural areas has significant implications across various roles. For example, for management, unstable internet disrupts their ability to coordinate services and monitor performance effectively due to delays or gaps in data. This disruption extends to the medical doctors and nurses who often face interruptions in accessing patient information and lab results, which can affect the quality of healthcare delivery in rural

areas. In addition, data administrators face challenges in capturing data, analysing data, updating systems, and submitting reports to the national health offices. These findings underscore that connectivity issues not only disrupt digital operations but also create duplication of work in rural healthcare for HCPs. The findings suggest a need for improved internet infrastructure and reliable power solutions to support efficiency and to ensure stable internet connectivity in healthcare facilities in rural areas.

ii) Backlog issues, data duplication and loss

Participants highlighted that connectivity issues in rural healthcare facilities result in significant backlog, data duplication or loss of patient data. One professional nurse explained, "…*we have to write down the patience and after the power is back one will have to go back to the e-Tick and rewrite those patients' data".* It highlights the need for HCPs to perform the same task twice, initially recording patient information manually during power outages, and later re-enter it digitally when the power is restored. This repetitive process slows down the smooth adoption and integration of DT as described by (Rogers, 1983).

Moreover, reverting to manual systems during power outages reduces the perceived ease and usefulness of DT, contributing to user frustration (Davis, 1985). This process not only increases the workload but also raises the risk of data entry errors, duplication, or potential loss. Also, the reliance on manual processes during power outages can lead to inaccurate reporting, including underreporting and overreporting of patient data. Another participant indicated that *"...the registers get old, and get torn, and the information gets lost somewhere or somehow*", further emphasising the vulnerability of manual systems. These challenges highlight the need for stable power infrastructure, offline capable digital systems, and streamlined data management processes to limit duplication and to prevent data loss.

iii) Lack of HCPs and IT personnel

Participants expressed a concern about the shortage of HCPs and qualified information technology (IT) personnel in rural areas. This creates a challenge to the effective adoption and support of the digital systems. Without qualified IT personnel in various rural healthcare facilities, troubleshooting becomes slower and effective, disrupting the seamless operation of the digital systems. One participant described the delays in receiving technical support, noting that assistance often has to come from external support teams based in the urban centre like East London, which further prolongs response times. The participant further emphasised the absence of a permanent Information and Communication Technology (ICT) manager, noting that they rely on interns who have limited experience. The reliance on interns implies a lack of IT technicians who are responsible for managing digital systems. This reflects Rosenstock's (1974) HBM, which highlights that although benefits of digitisation are acknowledged,

perceived barriers such as long waiting times for assistance reduce motivation to adopt the digital systems. The findings suggest a need for human resources to ensure reliable technical support and seamless operation of the DTs in rural healthcare.

Overall, DT has the potential to transform rural healthcare, but its success is deeply dependent on resolving connectivity, human resource, and IT infrastructure challenges. Figure 5-10 shows a network diagram of the items on THEME 3with each item linked to the relevant constructs. For example, Item 'EPC08: Connectivity issues' is linked to construct 'CO05: Perceived challenges (barriers)'.

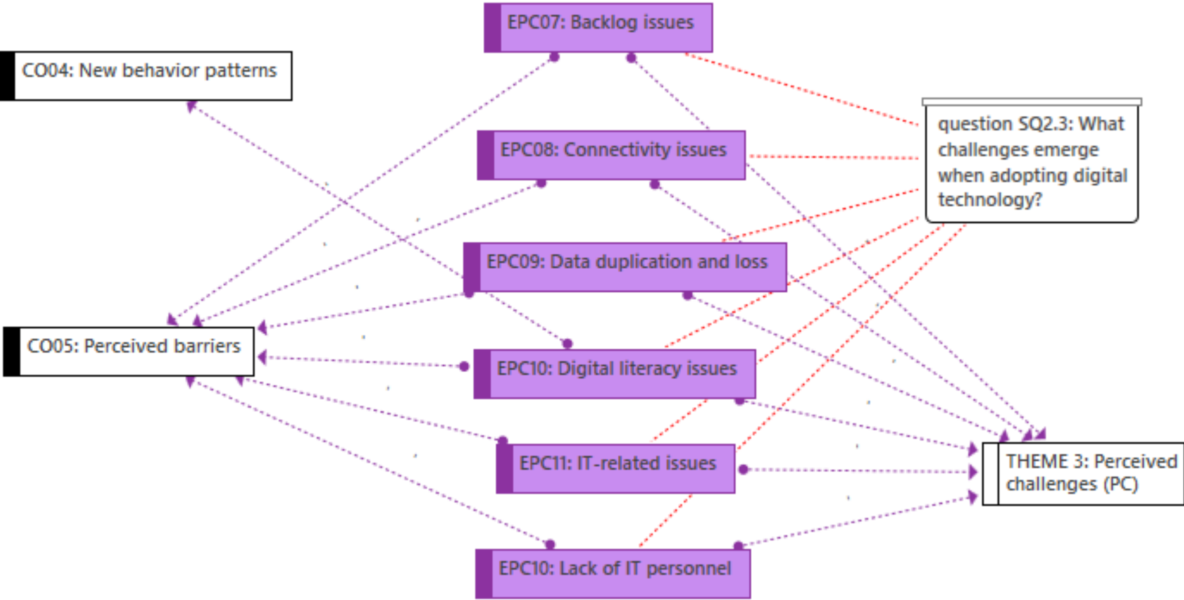


Figure 5-10: Network diagram for THEME 3: Perceived challenges, constructs, and associated items

In summary, to fully understand the impact of digital transformation in rural healthcare facilities, it is essential to investigate the human factors that influence the adoption and use of DT.

5.5.3.2 THEME 4: Human factors (HF)

The findings uncovered the following human factors: age-related barriers, adoption resistance and user perceptions, and the digital literacy gap.

i) Age-related barriers

Participants highlighted that age-related challenges significantly affect the adoption and use of DTs among HCPs in rural healthcare. For example, older HCPs expressed difficulty in adapting to new digital systems, citing unfamiliarity with the digital tools. Additionally, older HCPs cited that they had limited exposure to computer-based work. Despite their willingness to learn, the

transition to digital platforms has been slow and often requires additional support. The participants further indicated that the older HCPs frequently seek support from their younger colleagues, especially when managing digital tasks while also attending to patients. Rosenstock's (1974) HBM supports this by indicating that although older HCPs perceive the benefits of DT, the lack of tailored support acts as a barrier. This dependency significantly leads to increased pressure on both older and younger HCPs. These findings underscore the necessity for capacity building techniques and age-related support programmes to ensure that all HCPs, regardless of age, can engage with DT confidently.

ii) Adoption resistance and user perceptions

The findings revealed that there was resistance to adjusting to the new digital systems for some HCPs, particularly in the early phases of adoption. This resistance resulted from a lack of experience with computers or a concern about making mistakes such as clicking the wrong button or losing patient data. This resistance was further increased by the perception that digital tasks were not part of HCPs job descriptions. Professional nurses and medical doctors, for instance, felt that patient care should remain their primary focus rather than utilising DTs. Notwithstanding, the findings demonstrate a gradual change in use of DTs in rural healthcare. Across facilities, HCPs demonstrated a willingness to adapt to the new systems as they perceived the benefits of DT. This gradual change aligns with Rogers's (1983) DIT, which emphasises that adoption happens in such a way that early resistance can be addressed with support and exposure. These findings highlight the need for continuous support and change management to build trust among HCPs in rural communities.

iii) Digital literacy

Several participants pointed out that their level of digital literacy is low. Across facilities, some participants noted that they had not undergone any formal computer training. This is consistent with Davis's (1985) TAM, which highlights that a lack of digital competence lowers technology acceptance and confidence. Initially, it was not easy for some participants to adjust to new digital systems due to their lack of confidence when using digital systems. Additionally, some professional nurses, in particular, pointed out that their area of speciality is clinical care, not IT, and that they lack the digital skills to perform digital tasks. The findings underscore a need for continuous training in digital literacy so that HCPs can use digital systems in rural healthcare effectively.

Collectively, the study further revealed that hospitals are better staffed but still face shortages in specialised roles, whereas clinics are severely understaffed, with one nurse or administrator managing multiple roles. Although hospitals often benefit from stronger infrastructure, clinics face greater challenges due to limited staffing, inadequate training, and insufficient IT support.

Additionally, the hospital HCPs generally have higher exposure to digital tools and training in comparison to the clinic's staff members who often lack basic digital skills, relying on informal learning or outdated methods. Addressing these challenges requires a comprehensive approach that includes investment in IT infrastructure, digital literacy training, and leadership backing to drive digital transformation in rural healthcare.

Figure 5-11 reflects a network diagram for THEME 4 with four items, each linked to the relevant constructs. For example, Item 'EHF08: Adoption resistance' is linked to construct 'CO07: Willingness'.

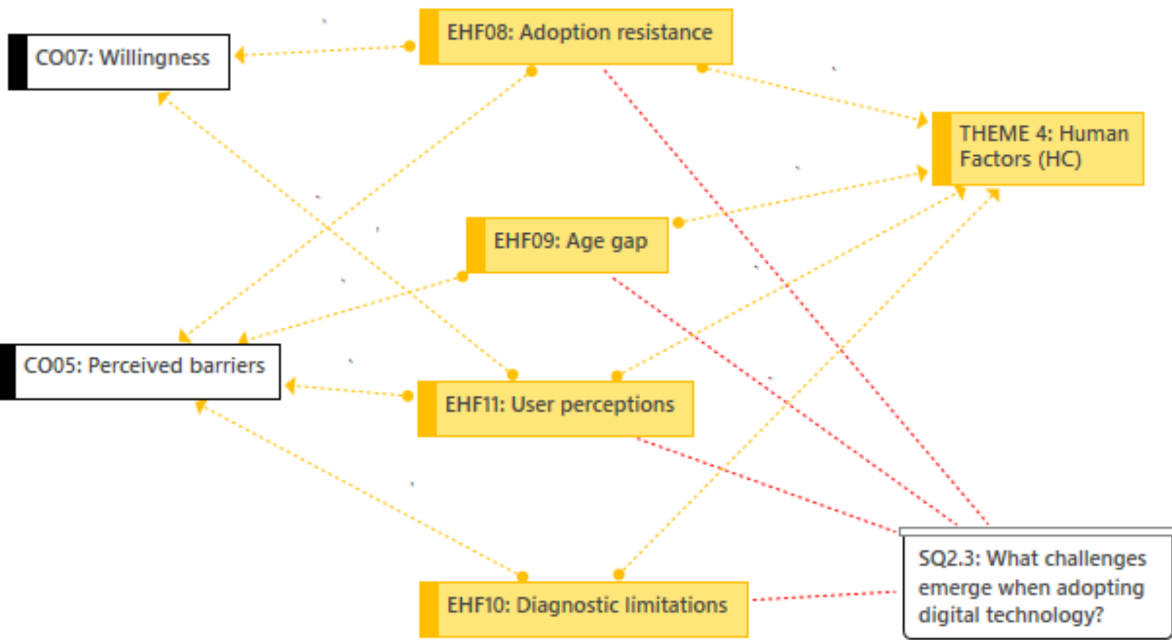


Figure 5-11: Network diagram for THEME 4: Human factors, constructs, and associated items

Table 5-8 presents a summary of the findings related to SQ 2.3: *"What challenges emerge when adopting digital technology?"* The table categorises the challenges that emerged when adopting DT into two main areas: 'Perceived challenges' and 'Human factors'.

Table 5-8: Summary of findings for SQ 2.3: What challenges emerge when adopting digital technology?

Perceived challenges: Items	Summary
THEME 3 - Perceived challenges	
EPC07: Backlog issues	During power cuts, patient data was recorded on paper-based files, then once electricity was restored, the data was entered into the digital system and that caused backlog.
EPC08: Connectivity issues	Unstable internet results to connectivity issues and that dirsupts the functionality of the digital systems.
EPC09: Data duplication and loss	Sometimes patient details are uploaded but not properly saved, leading to data loss or duplication
EPC10: Digital literacy	Some HPCs are unfamiliar with the new digital system due to long-term use of manual documentation, but training helped staff adapt and emrace the new digital systems. Although HPCs learned computer skills before, lack of regular use caused them to forget, but training helped refresh their knowledge; however, many still feel IT is outside their expertise.
EPC11: IT-related issues	The rollout was slower than expected due to the need to procure computers and related equipment.
EPC12: Lack of HCPs and IT personnel	IT support is delayed because skilled technical assistance has to come from urban facilities, and with limited staff serving multiple healthcare facilities and that results to long waiting times.
THEME 4: Human factors	
EHF08: Adoption resistance	Some HPCs were reluctant because they felt that its overwhelming to record information both in a physical book and on the computer
EHF09: Age-related barriers	Older HPCs find it difficult to use digital systems due to a lack of technological experience but they are making efforts to learn.
EHF10: Digital literacy	Most HCPs pointed out that initially, they were unfamiliar with the digital systems, but as they were given training, they adopted to the new digital systems.
EHF11: User perceptions	Initially, some HPCs were unwilling to learn the new system, which made adoption challenging, but over time, everyone gradually adapted and became more comfortable with the change.

Following the identification of challenges in adopting DTs in healthcare facilities in rural areas, the empirical data revealed strategies that have enabled successful adoption. These are captured under THEME 6, which emerged exclusively from the empirical findings, highlighting their relevance to real-world rural healthcare settings.

In summary, THEME 3 and THEME 4 addressed SQ 2.3: "*What challenges emerge when adopting digital technology?"* The two themes explored the challenges that may hinder the adoption of DTs in healthcare facilities in rural areas. The next section addresses SQ 2.4, which explores the strategies that have contributed to the successful adoption of DTs on healthcare facilities in rural areas.

5.5.4 SQ 2.4: What strategies contribute to the successful adoption of digital technology?

5.5.4.1 THEME 6: Digital health enablers (DHE)

The participants emphasised that the successful implementation of DTs is closely tied to the availability of reliable infrastructure, especially uninterrupted power supply in rural areas. In response to the challenges, the participants noted that many healthcare facilities in rural areas have implemented backup strategies such as fuel-operated generators, solar power supply, facility fibre and Wi-Fi, and Uninterruptible Power Supply (UPS).

i) Backup generators

The participants emphasised that uninterrupted electricity is essential for the effective operation of the digital systems in rural healthcare facilities. Participants acknowledged that power failures directly impact the availability of the digital systems, prompting the need for backup power supplies. In response to the power failures, the facilities, in particular, the hospitals, have implemented power generators to maintain facility operation during power failures. This approach reflects Rosenstock's (1974) HBM, where the recognition of perceived challenges motivates facilities to implement protective strategies to ensure continuity of care. However, some participants reported disparities in infrastructure. While one hospital reported having multiple backup power sources, a participant from a clinic indicated the complete absence of any form of backup power, highlighting significant disparities in infrastructure across rural healthcare facilities. Additionally, this implies that clinics without backup power may revert to manual systems of capturing data, which that may lead to backlog issues, data duplication and loss. While strategies to mitigate power disruptions have been successfully implemented in some facilities, there is a need for consistent investment, maintenance, and security measures to protect infrastructure.

ii) Facility fibre and Wi-Fi

Participants highlighted that the facilities have installed fibre-optic networks and government-supported routers. These strategies have improved healthcare delivery in rural areas through the fibre internet and Wi-Fi infrastructure as a strategy to DT success in rural areas. The participants emphasised that government provided routers for improved connectivity within facilities, allowing HCPs to stay connected to essential digital systems and services. The availability of facility fibre supports the use of digital systems for continuity of patient care and contributes to more streamlined workflows. The integration of fibre and Wi-Fi supports Rogers's (1962) DIT, as these technologies are being adopted across multiple facilities to strengthen digital resilience. Additionally, the availability of the internet enables HCPs to perform tasks more efficiently. However, while the installation of fibre and Wi-Fi is a strength, the findings suggest that ongoing maintenance, security, and equitable access across all facilities re necessary to ensure consistent healthcare delivery in rural areas.

iii) Solar power supply

One participant noted that the facility has installed a power solar supply as a backup strategy to maintain digital operations during power outages in rural areas. She pointed out that *"that solar system was helping us when we are having a load shedding"*. The participant further noted that the solar power supply serves to support the Wi-Fi connectivity especially for remote clinics far from hospital infrastructure. This behavioral response to environmental constraints aligns with Bandura's (1986) SCT, where HCPs adjust their practices to maintain service delivery. The implementation of solar power in rural hospitals demonstrates innovation and adaptation, yet challenges exist. For instance, one participant pointed out that the facility's solar system was vandalised, resulting in the loss of batteries and reduced reliability. This highlights the vulnerability of infrastructure in rural areas.

iv) Uninterruptible Power Supply (UPS)

One participant emphasised the importance of having a UPS system in place, particularly in a rural hospital where power outages are common. The UPS serves as a temporary power source, which is vital during power failure in rural hospitals. This reflects a proactive strategy to prevent interruption of essential healthcare services caused by unexpected power failures in rural clinics. By maintaining digital functionality during power outages, the UPS system not only safeguards sensitive patient information but also supports consistent workflow and service delivery. Subsequently, even in the event of power outages, facilities with a UPS are better equipped to offer reliable and effective healthcare delivery in rural communities. Each item of THEME 6 is connected to the appropriate constructs in a network diagram (Figure 5-12). For example, Item 'EDHE01: Backup generators' is linked to construct 'CO05: Perceived benefits'.

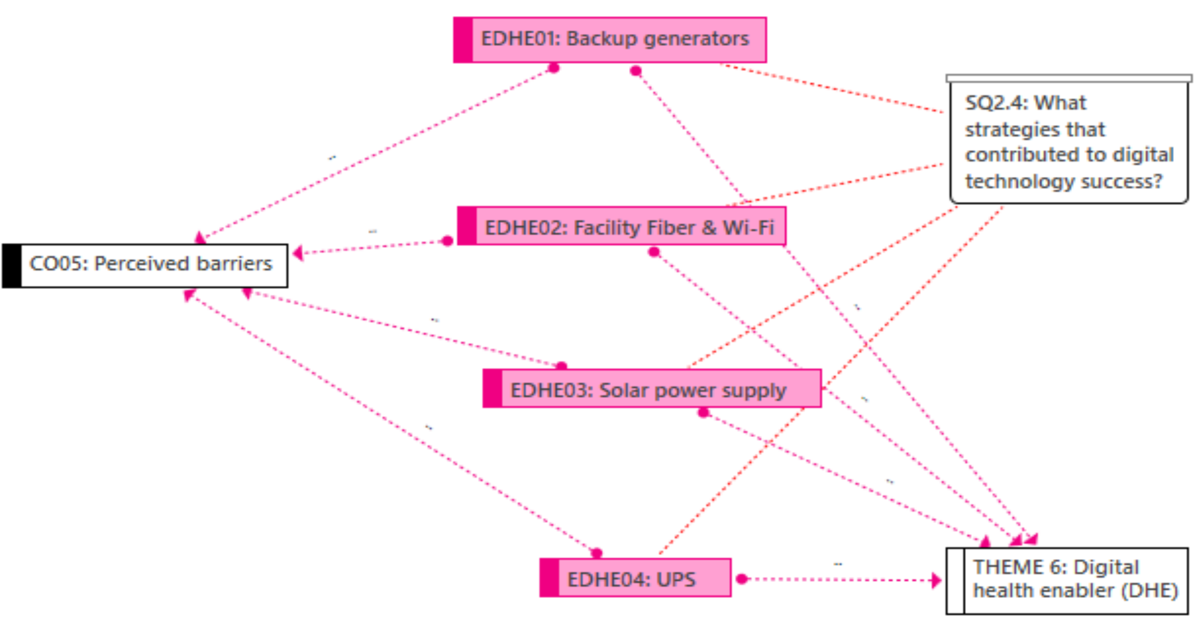


Figure 5-12: Network diagram for THEME 6: Digital health enablers (DHE), constructs, and associated items

Table 5-9 presents a summary of the findings identified in section 4.3.1, Chapter 4, detailing the purpose and the benefits of each DT adopted in rural healthcare facilities within the Eastern Cape province.

Table 5-9 Summary of findings for SQ 2.4: What strategies contribute to the successful adoption of digital technology?

Digital health enabler: Items	Summary
EDHE01: Backup generators	Implemented backup generators to ensure reliability, contributing to the successful adoption of digital technology.
EDHE02: Facility Fibre and Wi-Fi	Installed facility fibre and Wi-Fi on hospitals to ensure stable connection.
EDHE03: Solar power supply	Installed facility Solar Power Supply on clinics as a backup during power cutoffs.
EDHE04: UPS	Only one facilityis equipped with a UPS for uninterrupted power supply.

Digital health enablers such as backup generators, reliable fibre, solar power supply, and Wi-Fi serve as essential infrastructure for supporting digital health in rural areas. The DHEs enable HCPs to continue with their daily activities in rural healthcare communities. The DHEs ensure that digital systems are reliable, accessible, and sustainable in rural environments, even when faced with power outages and unstable internet connections. Moreover, these findings highlight the importance of investing in reliable power supply to support the sustainability of

digital transformation in rural healthcare.

In summary, THEME 6 addressed SQ 2.4: *What strategies contribute to the successful adoption of digital technology?* The theme explored the strategies that the clinics and hospitals have implemented for the success of DTs in rural areas.

5.5.5 SQ 2.5: What is the nature of the impact of adopting digital technology in rural communities?

Participants highlighted the dual impact of DTs on healthcare facilities in rural communities. This complexity is explored through SQ 2.2 and SQ 2.3, which are addressed under THEME 2 and THEME 3 respectively.

5.5.5.1 THEME 2: Perceived benefits (PB)

This section presents a synthesis of the positive impacts of digital transformation on rural healthcare, as identified in section 4.3.2 of Chapter 4, as follows:

- *Continuity of care:* DTs facilitate seamless access to patient records, especially during referrals, thus enabling HCPs to easily review a patient's treatment history. thereby supporting continuity of care in rural healthcare communities
- *Facilitates data transmission:* Digital systems facilitate seamless transfer of data among departments and across facilities, resulting in improved healthcare efficiency. For example, the findings mentioned that Lab Trak facilitates timely access to the lab results, regardless of the geographical location, thereby supporting seamless data transmission in rural healthcare settings.
- *Improved data management:* Digital tools assist in data capturing, organising, storing, and retrieving of patient data more effectively. For example, the findings highlighted that this leads to improved data analysis and easier reporting for the data administrators, and better monitoring and informed decision-making for senior management.
- *Improved healthcare delivery:* DT speeds and improves the quality of healthcare delivery. For example, Telemedicine enables remote consultations, and digital diagnostics can speed up treatment processes.
- *Improved system integration:* DTs can integrate various healthcare systems. For example, the study revealed that TIER.Net is connected with CCMDD, which facilitates seamless patient transfers during relocations.
- *Minimises expenses and time:* Embracing DT and transformation minimises the manual tasks and travel, resulting in time efficiency and cost savings in rural healthcare. For instance, the findings uncovered that platforms like MS Teams enable senior

management to participate in meetings virtually and collaborate with teams across provinces.

- *Value-added outcome:* Cumulatively, these advantages collectively lead to improved healthcare and increased patient satisfaction outcomes in rural healthcare settings.

These perceived benefits demonstrate the positive impact of digital transformation in improving rural healthcare, bridging geographical gaps, making healthcare services more accessible and efficient.

5.5.5.2 THEME 3: Perceived challenges (PC)

This section summarises the negative impacts associated with digital transformation in rural healthcare, as identified in section 4.3.3 of Chapter 4, as follows:

- *Age gap:* This study found that the generational gap in technology can hinder the adoption of DTs in rural healthcare. For example, the study revealed that older HCPs are reluctant to adapt to new digital systems as compared to their younger colleagues due to unfamiliarity with the system.
- *Backlog issues:* The findings revealed that digital transformation may generate backlogs in capturing data as a result of connectivity or power failure in rural healthcare. This can result in delayed service delivery and reduce efficiency.
- *Connectivity issues:* The study found that unstable internet access interrupts digital healthcare services in rural healthcare. This affects real-time communication across facilities and delays service delivery via digital platforms such as WhatsApp, email or SMSs.
- *Data duplication and loss:* The findings revealed that connectivity challenges contribute to backlog issues, which in turn lead to data duplication or loss once connectivity is restored.
- *Digital literacy issues:* The study findings highlighted that some HCPs lack the digital skills to effectively use the digital systems, resulting in workflow interruptions. This finding highlights the need for ongoing support in rural healthcare.
- *Staffing challenges:* The study revealed a shortage of qualified IT personnel. This can limit the capacity of healthcare facilities in rural areas to fully adopt DTs.
- *User perception:* The findings uncovered that there was resistance from some HCPs when the digital systems were initially implemented. This can limit adoption and reduce engagement with the digital systems in rural healthcare.

These perceived challenges outline the negative impacts of digital technology on healthcare facilities in rural areas. The findings revealed that digital transformation offers both benefits

and challenges in rural communities. This dual impact underscores the need for inclusive strategies that are not only innovative but also user-centric and equitable. The findings suggest that while DTs in rural healthcare offer potential benefits, their success depends on addressing the underlying challenges.

Figure 5-13 depicts the dual nature of the impact of DT on healthcare facilities, viewed through the dual perspectives of perceived benefits discussed in section 5.5.2 and perceived challenges in section 5.5.3.

5.5.6 Guidelines for empirically based items

The integration of Figures 5-7 through 5-13, along with Tables 5-6 through 5-9, provides empirical evidence that addresses the second main research question (MRQ2) through the secondary questions (SQ 2.1 to SQ 2.5). The categorised empirical findings from the studies are presented in Table 5-9 and further elaborated in Appendices E.1 to E.6, thereby expanding upon the findings outlined in this chapter.

Figure 5-13: Network diagram to illustrate the multifaceted nature of the impact of digital technology on rural communities

Table 5-10: Summary of findings for SQ 2.1: What is the significance of digital technology in healthcare facilities?

Perceived benefits: Items	Summary
THEME 1 - Perceived benefits	
EPB10: Continuity of care	Patient information from various healthcare facilites in South Africa, can be accessed and updated to ensure continuity of care across facilities.
EPB11: Minimises expenses and time	Assists unemployed patients to save money and avoid costly travel to distant healthcare facilities, thus making care more accessible and easier for them
EPB12: Facilitates data transmission	Digital health systems enable faster collection, distribution, and transmission of patient information, improving communication up to the national level.
EPB13: Improves healthcare delivery	Digital technology on healthcare facilities improves healthcare delivery by making patient information accessible, so patients no longer need to travel far for transfer letters or treatment details.
EPB14: Improves data management	Facilitates secure data storage and retrieval. Reduces reliance on manual documents, preventing loss or damage and making information easier to access.
EPB15: Improves system integration	Enhances interoparaility among healtchare systems for reporting. For example, HMS2 enhances system integration by connecting with Home Affairs and linking hospitals and clinics across the Eastern Cape.
THEME 5: Processes and patterns	
EPP13: Adoption process	The digital health systems are adopted in phases, for example, HMS2, a patient administration system, was piloted in the first phase at one of the facilities and manages workflow starting from patient registration through their care process
EPP14: Data entry process	After admission, patient details are entered into the system for both admission and delivery records, this results to a faster and more accurate data entry.
EPP15: Decision-making process	Digital technology on healthcare facilities assist in more reliable data for senior management. For instance, Data highlights issues, prompting relevant teams to discuss, develop strategies, identify root causes, and create improvement plans to address problems.
EPP16: Referral process	Improves tracking of patient referrals among healthcare facilities, for example, TIER.Net assists in generating patient transfer letters as part of the referral process
EPP17: Skills and training	Training is provided before adopting any new digital system to support capacity and digital literacy among HPCs.
EPP18: Workflow integration	Supports uninterrupted flow of information. The workflow integrates patient admission, delivery status, and discharge into the system to ensure accurate tracking throughout their hospital stay.

Table 5-11 presents the guidelines from the empirical perspectives associated with DT in healthcare facilities. The table highlights the key themes: Digital technology and transformation (DTT), Perceived benefits (PB), Perceived challenges (PC), Human factors (HF), and Processes and patterns (PP).

Table 5-11: Guidelines from empirical findings associated with DT in healthcare facilities

Theme	Items	Phase 1							Phase 2			Phase 3						Phase 4			GUIDELINES FOR BEST PRACTICES
		S 1.1	S 1.2	S 1.3	S 1.4	S 1.5	S 1.6	S 1.7	S 2.1	S.2.2	S 2.3	S 3.1	S 3.2	S 3.3	S 3.4	S 3.5	S 3.6	S 4.1	S 4.2	S 4.3	
		HFD	HDR 1	HDR 2	HN 1	HN 2	HA 1	HA 2	C1M 1	C1N 1	C1N 3	CHCM 1	CHCDR 3	CHCN 5	CHCN 6	CHCA 3	CHCA 4	C2M 2	C2N 7	C2N8	
THEME 1: Digital technology & transformation (DTT)	EDTT12: BAS	■															■		■		Manage financial transactions
	EDTT 13: CCMDD								■		■			■		■			■		Ensure timely updates on medication pick-ups
	EDTT14 DHIS Web	■					■			■		■				■	■		■		Ensure HIV and TB patient tracking
	EDTT15: Diagnostics					■							■						■		Ensure accuracy in checking vital signs
	EDTT16: EHRs			■	■				■												Provide real-time digital patient records
	EDTT17: e-Tik register					■					■							■		■	Ensure data accuracy
	EDTT18: HMS2	■	■				■	■													Enable seamless patient administration
	EDTT19: HPRS									■	■	■					■				Manages patient registration
	EDTT20: IHSR	■																			Ensure real-time compliance with the NHI
	EDTT21: ISP							■													Ensure real-time monoitoring of fetal care
	EDTT22: Lab Trak											■								■	Facilitate and track patient blood results
	EDTT23: LOGIS	■																			Manage logistical and financial operations
	EDTT24: OHSC	■																			Monitor healthcare safety & quality standards
	EDTT25: PERSAL	■					■														Manage human resource and payroll
	EDTT26: RxSolution	■	■	■	■	■					■		■	■		■		■	■	■	Improve efficiency
	EDTT27: Telecommunications	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	Enable seamless exchange of patient information
	EDTT28: TIER.Net															■	■				Enhance monitoring of chronic diseases
THEME 2: Perceived benefits (PB)	EPB10: Continuity of care			■					■												Embrace the benefits of using DTs
	EPB11: Cost & time efficient						■						■		■						Provide more cost-effective DTs
	EPB12: Data transmission					■				■					■						Ensure seamless data transmission
	EPB13: Healthcare delivery	■				■	■		■	■	■	■					■	■	■	■	Enhance quality of healthcare delivery
	EPB14: Data management	■		■		■	■		■					■							Ensure easy access to data
	EPB15: System integration	■					■	■							■						Improve system integration
	EPB16: Value-added outcomes	■	■											■	■				■		Improve patient outcomes
T	EPC07: Backlog	■	■		■	■		■	■	■		■		■							Reduce backlogs

Theme	Factor																				Recommendation
	EPC08: Connectivity issues		■	■	■	■	■	■	■	■			■			■		■			Increase broadband and connectivity
	EPC09: Data duplication and loss			■						■											Minimise data duplication and loss
	EPC10: Lack of IT Personnel	■					■														Enhance recruitment strategies
THEME 4: Human factors (HF)	EHF08: Adoption resistance				■				■		■										Create change management and provide ongoing support.
	EHF09: Age-related barriers	■		■																	Provide awareness on new DTs
	EHF10: Digital literacy			■	■			■													Develop necessary digital skills
	EHF11: User perceptions	■																			Provide awareness of technology potential
THEME 5: Processes & patterns (PP)	EPP13: Adoption process		■				■	■													Enable a multi-phase adoption
	EPP14: Data entry process			■																	Maintain data accuracy for decision-making
	EPP15: Decision-making	■						■							■		■				Provide timely and accurate data
	EPP16: Referral patterns			■												■	■				Ensure referrals include all documentations
	EPP17: Skills and training		■	■			■	■			■								■		Identify necessary digital literacy skills
	EPP18: Workflow integration																				Integrate DT into daily processes
THEME 6: Digital health enabler	EHDE01: Backup	■		■			■	■	■				■								Ensure the availability of power during power outages
	EHDE02: Fibre & Wi-Fi		■			■												■	■		Ensures wireless network availability
	EHDE03: Solar																	■	■		Provide cost-effective energy source
	EHDE04: UPS						■					■				■					Ensure short term power supply during outages

5.5.7 Framework for the empirical perspectives

Figure 5-14 presents the empirically based framework, which extends the theoretically based framework outlined in **section 4.3, Figure 4-8** and supports answering the second main research question (MRQ2). These two frameworks are merged into a synthesised framework presented in Chapter 5.

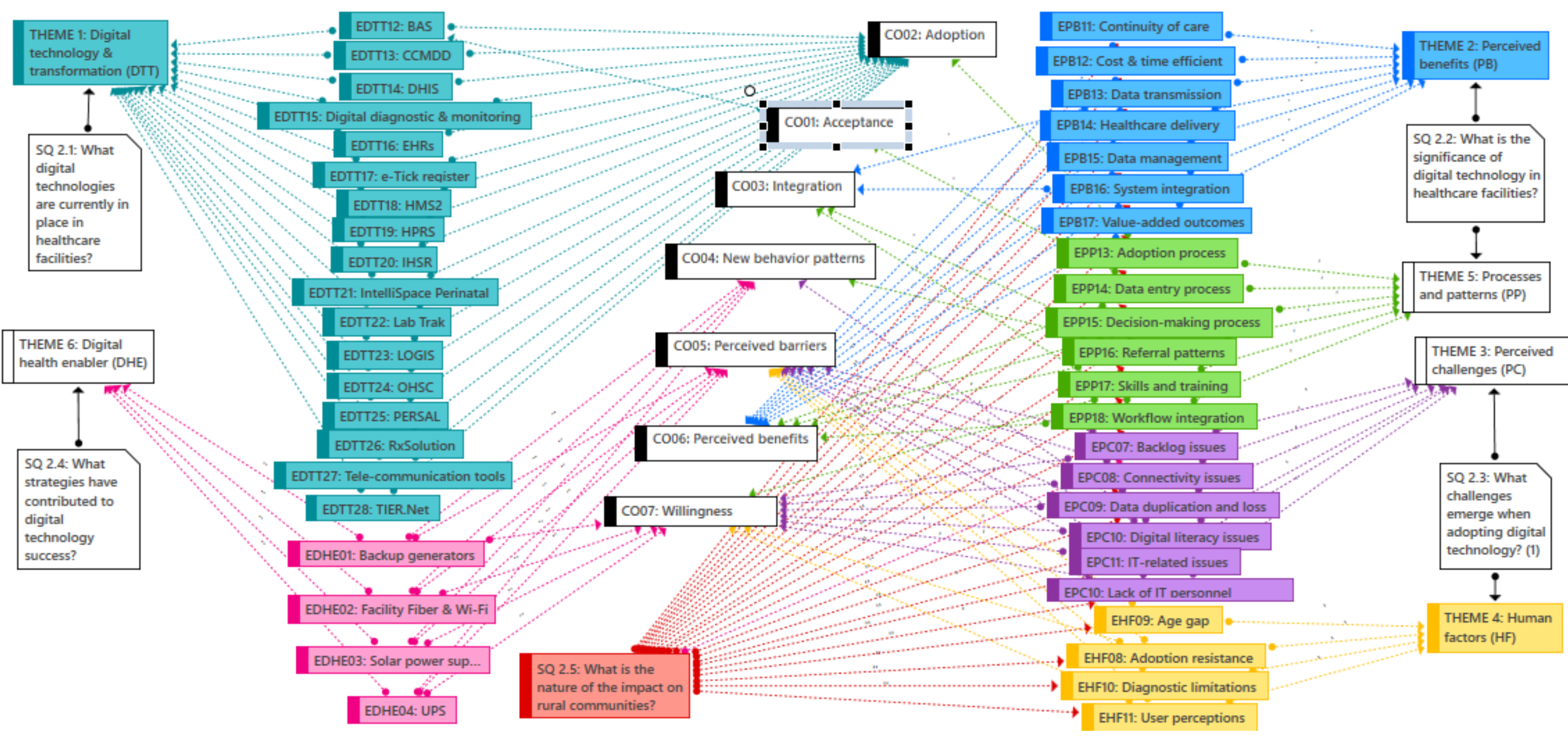


Figure 5-14: Empirically based contributions of constructs and items to the framework

5.5.8 Augmentation of theoretically determined items with empirically determined insights

While Chapter 4 presented the raw findings, Chapter 5 goes further by analysing and interpreting the findings in relation to the second main research question (MRQ2). This interpretation not only deepens understanding but also contributes to the augmentation of an existing framework, meaning it expands, refines, or adapts the theoretical or conceptual model based on the evidence gathered. By integrating these findings, the study strengthens the framework with context-specific insights from the Eastern Cape, making it more applicable and relevant to local healthcare realities.

Figure 5.15 presents a network diagram that visually augments the theoretically based framework introduced in section 5.4.7, Chapter 5. By mapping the relationship between these items, the diagram helps clarify how these items interact with the broader conceptual framework presented in section 2.2.7, Chapter 2, offering a more intuitive understanding of the conceptual framework.

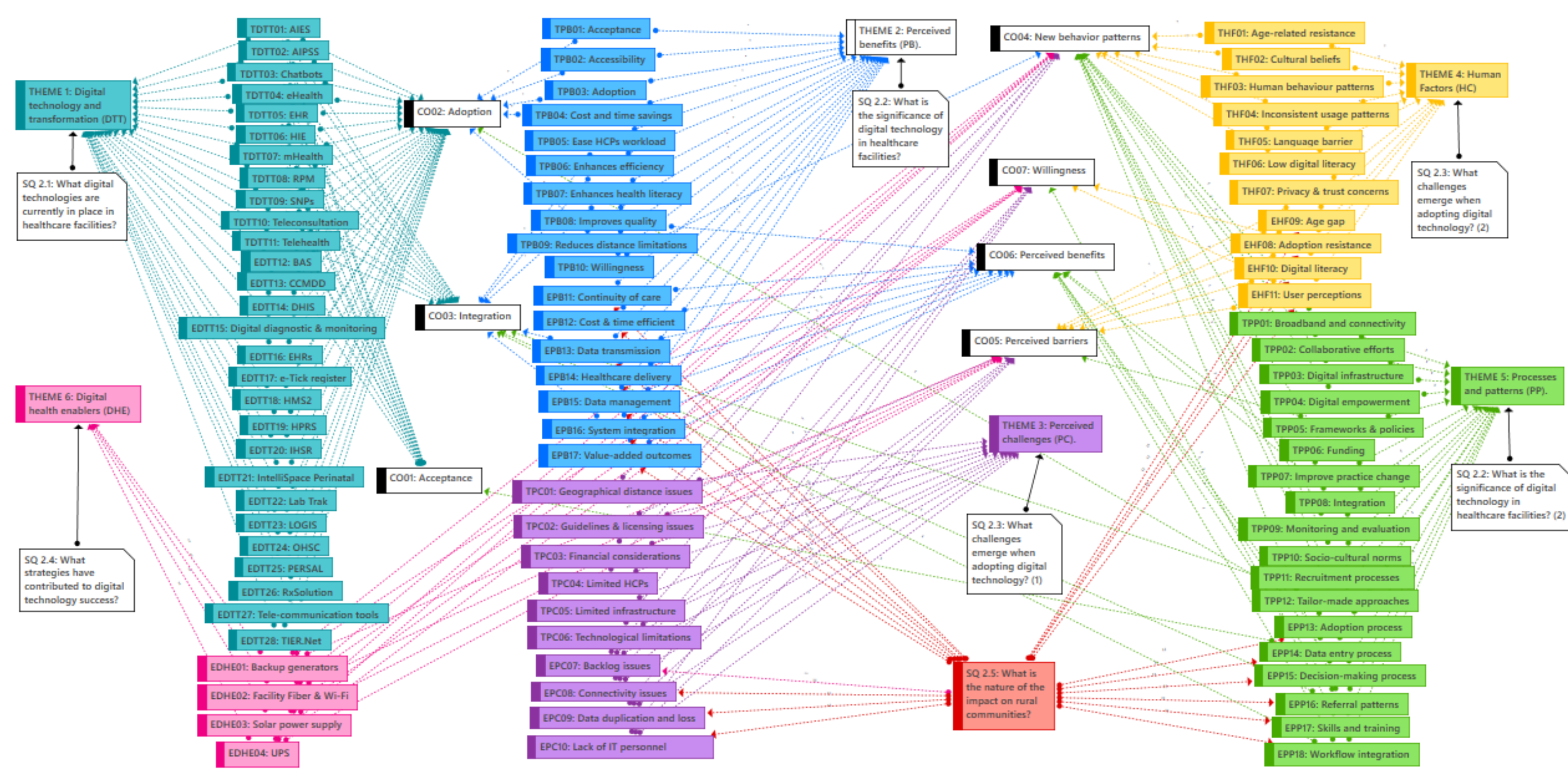


Figure 5-15: Augmentation of theoretically determined items with empirically determined insights

5.5.9 Extension of the conceptual framework

The integration of Digital Health Enablers into the conceptual framework represents a significant extension. It acknowledges that successful digital transformation in rural healthcare is not only a matter of individual and organisational readiness but also of environmental preparedness. This expanded framework offers a more holistic understanding of the factors influencing digital health implementation and provides a stronger foundation for future research, policy development, and practice. Figure 5-16 illustrates the extended conceptual framework presented in section 2.2.7, Chapter 2.

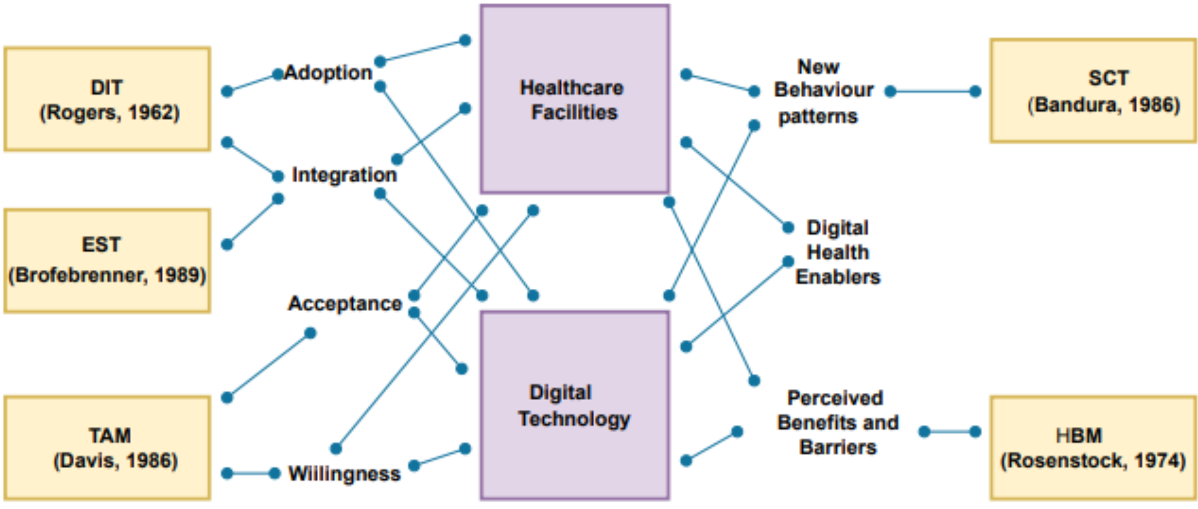


Figure 5-16: Digital Health Care Framework (DHCF)

In summary, the findings revealed that the nature of the impact of DTs on healthcare facilities in rural areas of the Eastern Cape is both promising in relation to the benefits and complex in relation to the perceived challenges. While digital systems offer clear benefits, their effectiveness is limited by issues such as connectivity issues, staffing challenges, backlog issues, data duplication issues, and age gaps, amongst others. A balanced approach that strengthens both technical infrastructure and human capacity is essential for sustainable and inclusive digital transformation.

5.6 Comparison with existing literature

This section compares the empirical findings with the existing literature, focusing on areas of alignment and divergence.

5.6.1 Alignment with existing literature

This section compares areas where empirical findings align with existing literature, particularly in relation to digital technology and transformation, perceived benefits, and human factors.

5.6.1.1 THEME 1: Digital technologies and transformation

This section compares the adoption of DTs as identified in the empirical data with those identified in the literature, focusing specifically on the theme of digital technology and transformation. Several DTs identified in both the empirical data and the literature demonstrate consistency in their relevance and application: HIE, eHealth, EHRs, mHealth, SNPs, RPM, teleconsultation, and Telehealth.

The findings of the empirical data showed that digital transformation through EHRs, eHealth, HIE, SNPs, RPM, teleconsultation, and Telehealth has significantly improved data sharing, reducing the chances of data loss or missing data, and improving healthcare delivery in rural areas. These findings align with the theoretical perspectives that highlight how DTs can enhance the delivery of healthcare in rural areas (Peh, 2024). The empirical data revealed that digital communication tools such as SMS, MS Teams, and WhatsApp support daily operations in rural healthcare. These findings align with the theoretical perspectives that highlight how DTs might improve communication accessibility. This alignment demonstrates the efficacy of digital tools in healthcare delivery in rural contexts.

Figure 5-13 illustrates the alignment of the digital technologies between the empirical and theoretical perspectives.

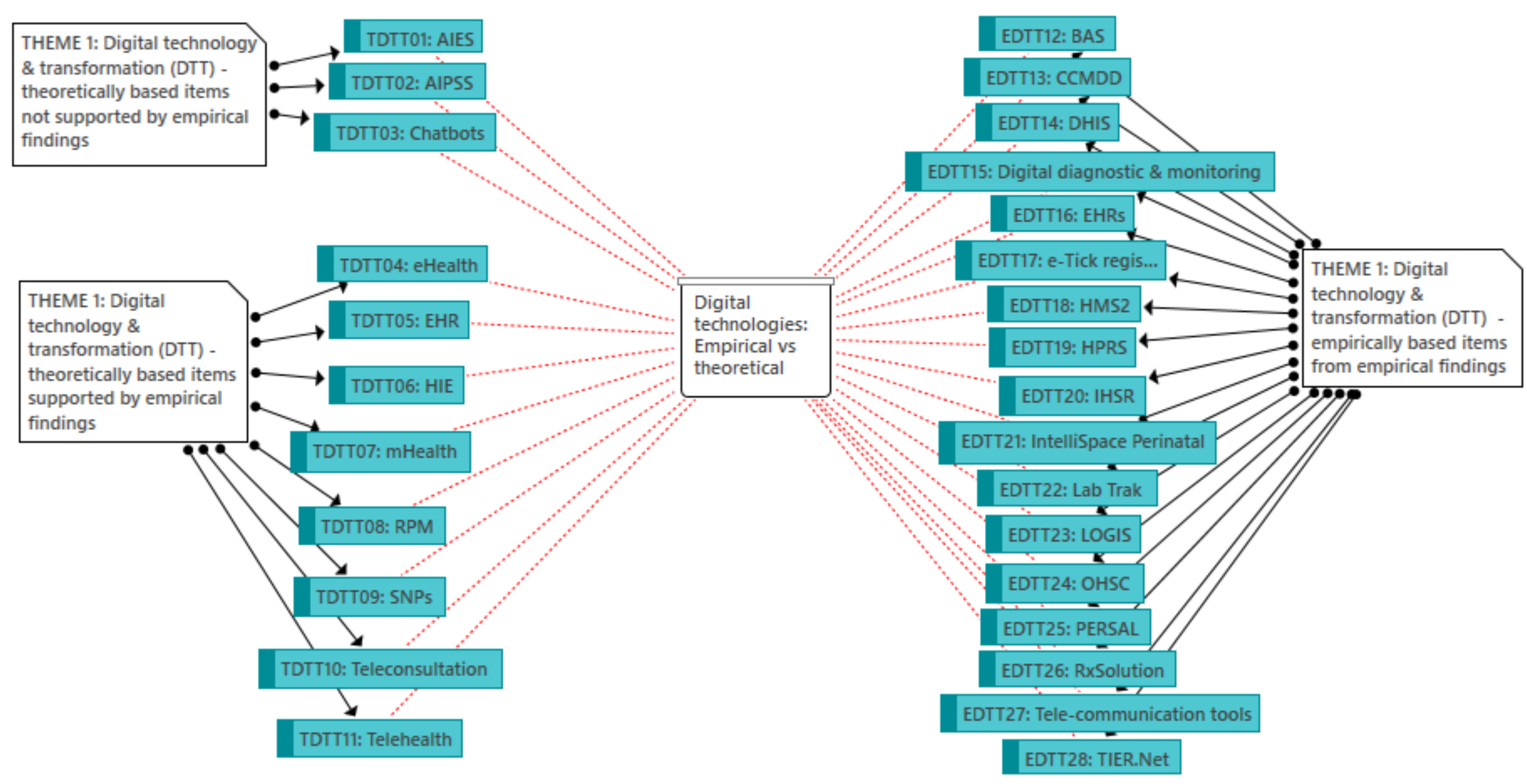


Figure 5-17: Digital technologies: Empirical versus theoretical perspectives

5.6.1.2 THEME 2: Perceived benefits

The perceived benefits from the empirical findings support the perceived benefits from the literature. Figure 5-18 illustrates the alignment of the perceived benefits between the empirical and theoretical perspectives. These perceived benefits reinforce the value of digital transformation in strengthening rural healthcare system performance.

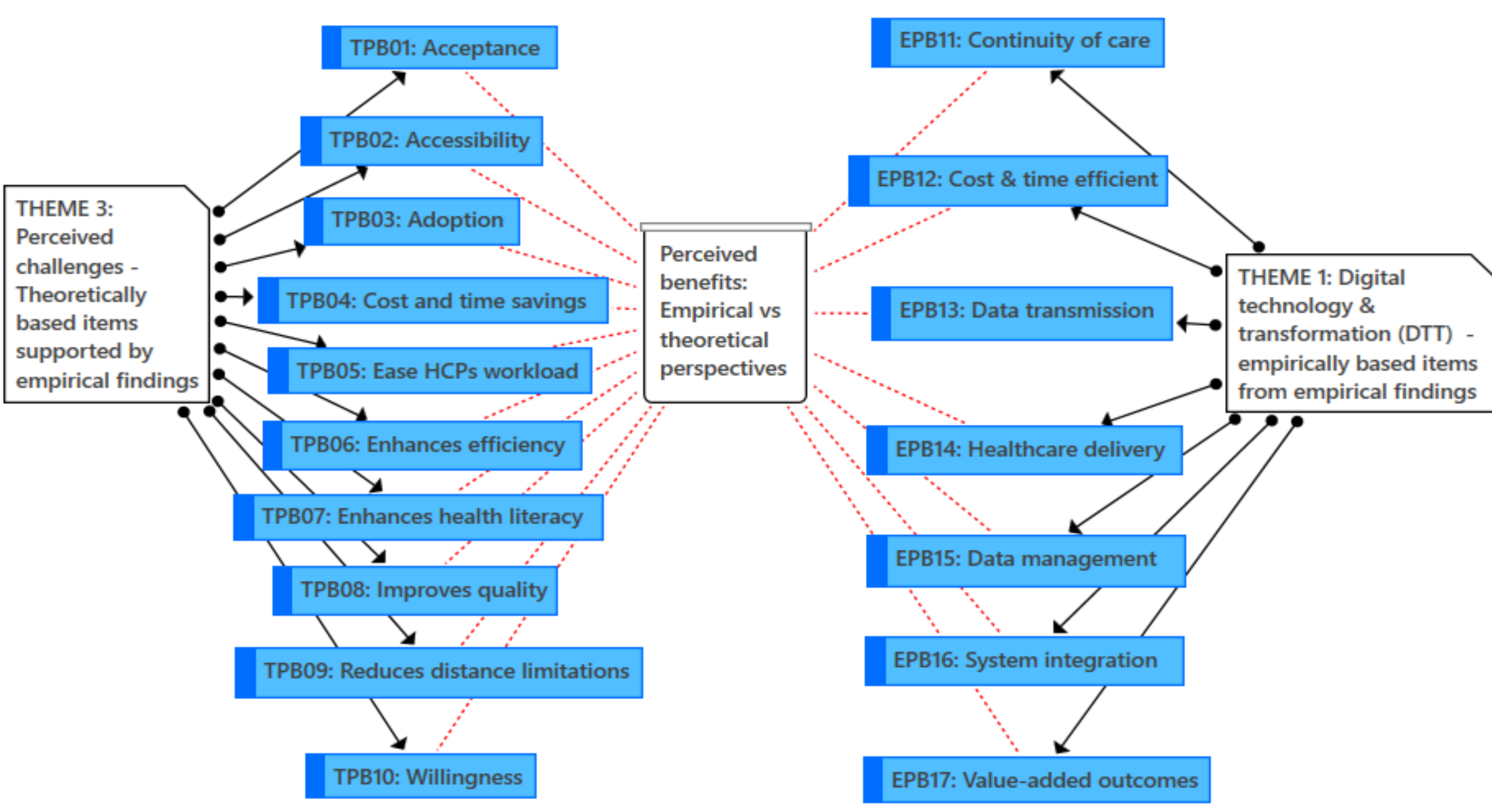


Figure 5-18: Perceive benefits: Empirical versus theoretical perspectives

5.6.1.3 THEME 3: Perceived challenges

The findings on perceived challenges showed considerable alignment between the literature and empirical data, particularly in areas such as unstable internet connectivity, poor digital infrastructure, and lack of resources. However, the empirical findings extend these challenges by illustrating their real-world consequences in greater detail. For example, while the literature identifies connectivity issues as a barrier to digital health, the empirical data reveals how these challenges lead to practical complications such as data backlogs, duplication, and loss. This deeper insight from the empirical perspective highlights the operational impact of technical challenges, emphasising the need for more context-specific solutions to address the day-to-day realities faced by HCPs in rural healthcare.

Figure 5-19 illustrates the alignment of the perceived challenges between the empirical and theoretical perspectives.

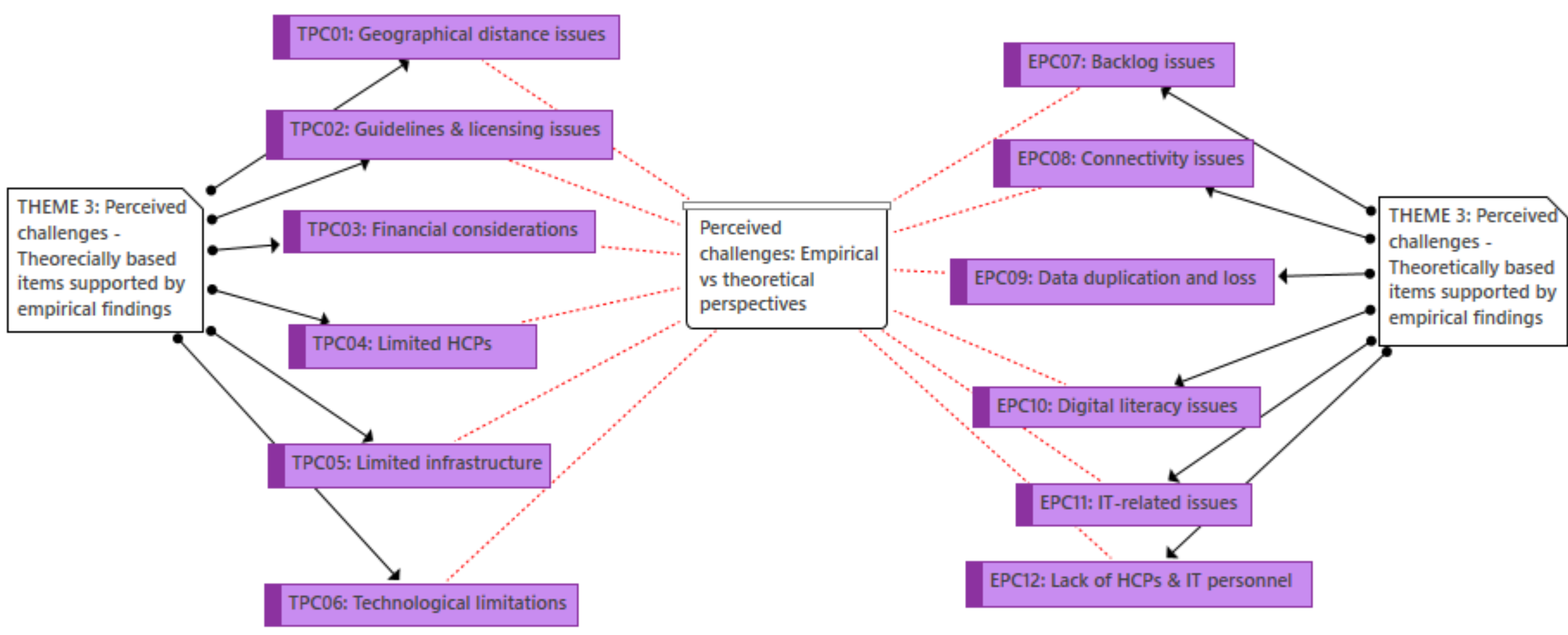


Figure 5-19: Perceived challenges: Empirical versus theoretical perspectives

5.6.1.4 THEME 4: Human factors

The findings on human factors shows strong alignment between the literature and empirical data. Both sources identify challenges such as poor digital literacy, generational gaps in technology use, and varying user perceptions toward digital health tools. These factors are consistently recognised as influencing the effectiveness and acceptance of DTs in rural healthcare settings. Figure 5-20 illustrates the alignment of the DTs between the empirical and theoretical perspectives.

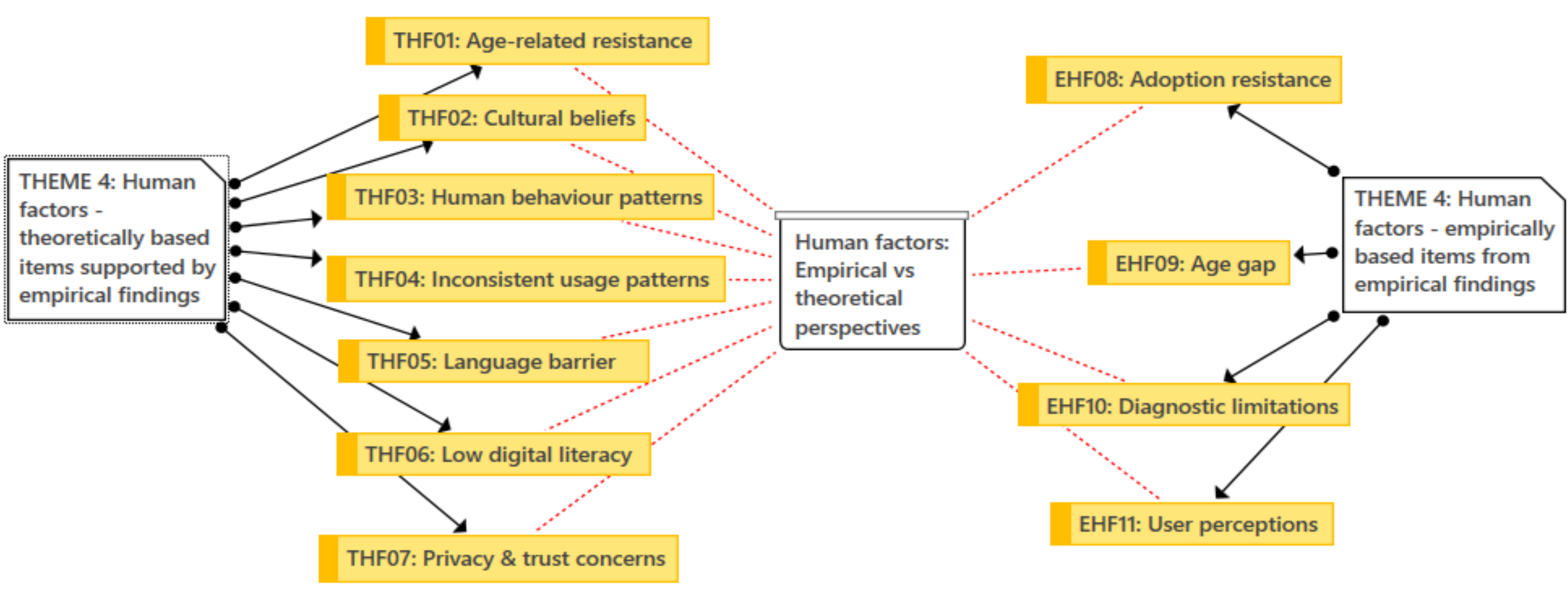


Figure 5-20: Human factors: Empirical versus theoretical perspectives

Figure 5-21 reflects a network diagram for the constructs and items associated with SQ 2.2.

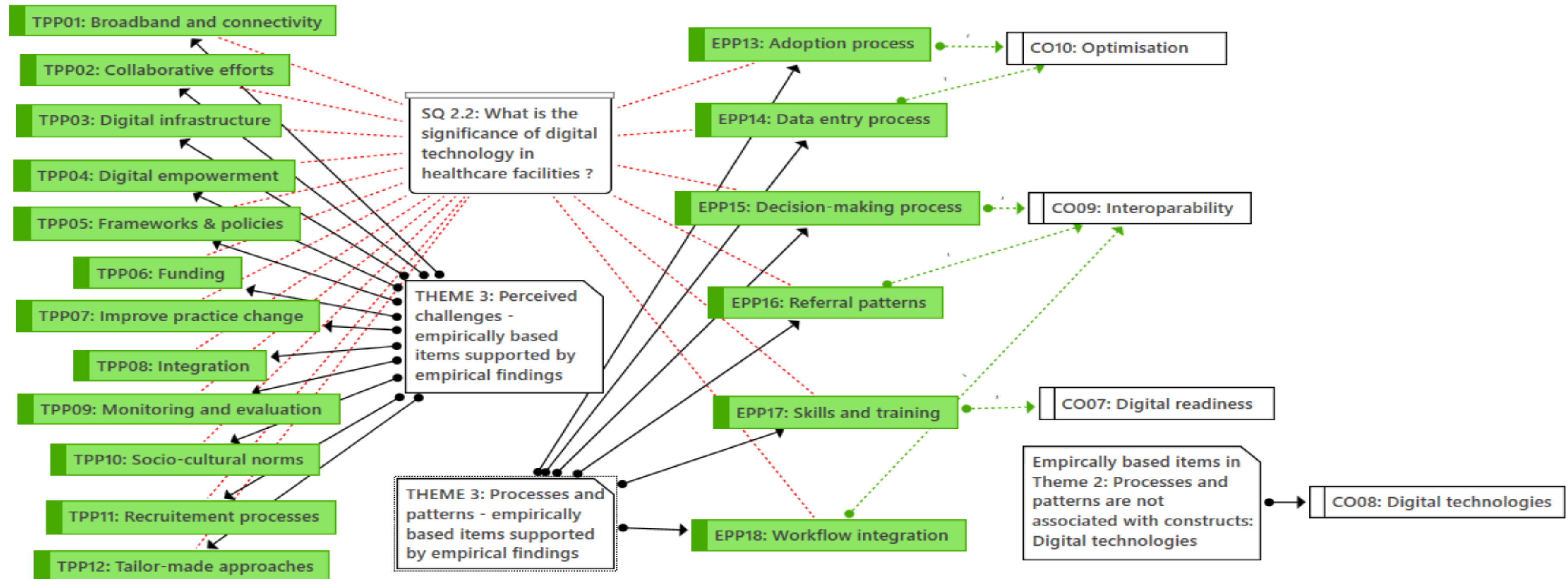


Figure 5-21: Network diagram for THEME 5 – Processes and patterns, constructs and items

The significance of the implemented DTs on healthcare facilities in rural areas is summarised in Table 5-7, which presents a summary of the findings for secondary question, SQ 2.2: "*What is the significance of digital technology in healthcare facilities*?" in relation to the perceived benefits and the processes and patterns.

5.6.2 Divergence from existing literature

This section compares areas where empirical findings diverge from existing literature, particularly in relation to the themes of digital technology and transformation, perceived challenges, processes and patterns, and digital health enablers.

5.6.2.1 THEME 1: Digital technologies and transformation

Several DTs such as BAS, CCMDD, e-Tick register, HMS2, Lab Trak, LOGIS, TIER.Net, and RxSolution are identified in the empirical data but are not identified in the literature. This divergence may be attributed to their content-specific nature, tailored to local health system needs in the rural areas of the Eastern Cape in South Africa. These tools appear to be tailored for the South African healthcare context and reflect localised digital health inventions that may not be widely documented in international literature. This divergence highlights the importance of local content in shaping digital health implementation and suggests that literature may not fully capture region-specific systems that are essential to service delivery. Refer to Figure 5-17.

5.6.2.2 THEME 5: Processes and patterns

This theme revealed a notable divergence between literature and empirical data. In the literature, the processes are generally discussed at a strategic level, emphasising initiatives to address challenges. These include improvements in broadband access, enhancement of digital infrastructure, increased funding, and the development of tailored design approaches. However, the empirical findings provide a more detailed and operational perspective, focusing on actual workflow patterns in rural healthcare. These include the phased adoption process of implementing DT. For example, the literature identified digital adoption as a standardised process. However, empirical findings revealed a more nuanced, phased approach to implementation. For instance, the deployment of HMS2 as a second version illustrates a phased development and adaptation based on contextual needs, followed by the data entry process, the decision-making process that is data-driven, and the referral process shaped by the digital systems in rural healthcare. This divergence suggests that the real-world adoption is shaped by operational realities and ongoing system refinement. Additionally, these contrasts highlight the gap between theoretical and practical realities, suggesting that successful digital health adoption requires not only strategic planning but also a deep understanding of context-specific operational processes.

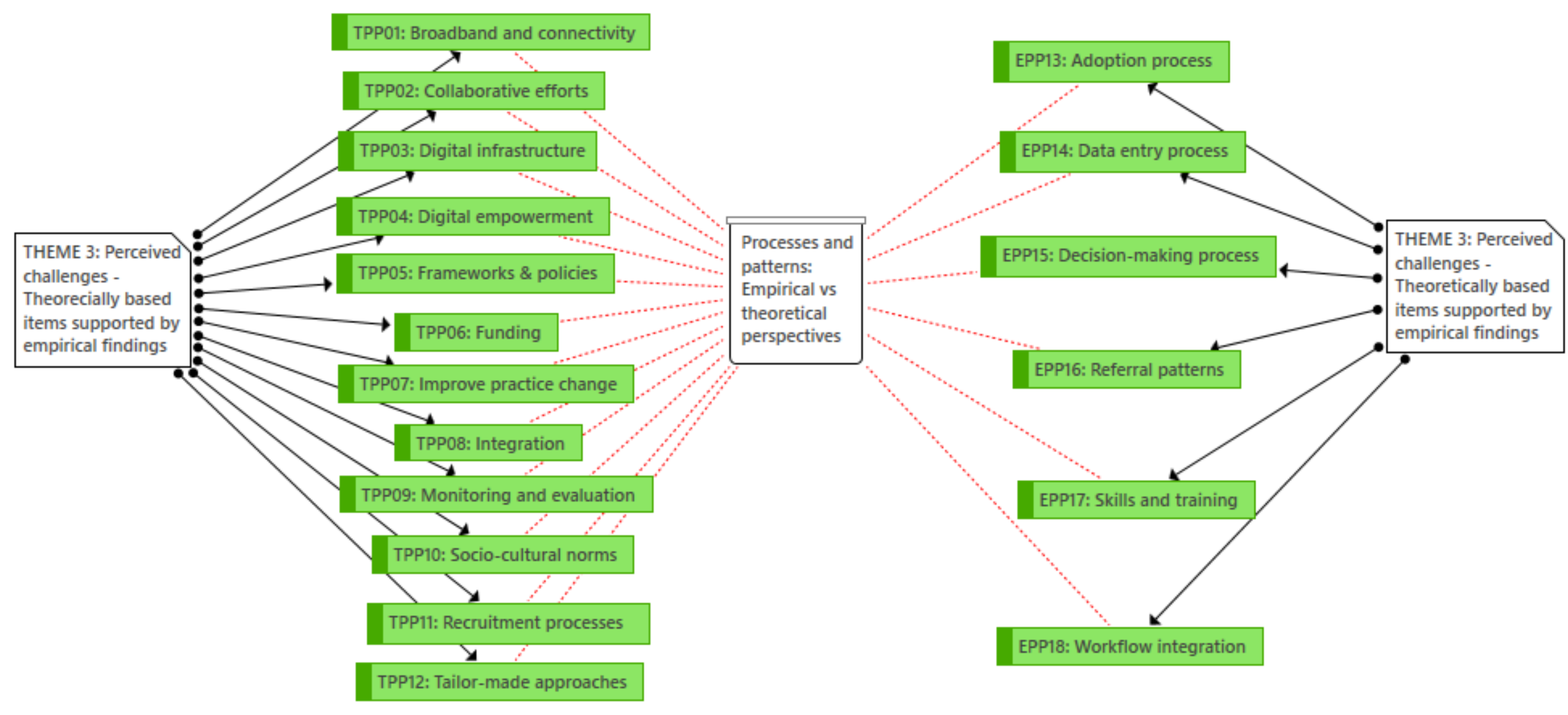


Figure 5-22: Processes and patterns: Empirical versus theoretical perspectives

5.6.2.3 THEME 6: Digital health enablers

THEME 6 emerged inductively from the empirical data but was not identified among the themes derived from the SLR. The empirical data highlighted practical infrastructural support such as backup generators, facility fibre and Wi-Fi, solar power supply, and uninterruptible power supply (UPS) as essential enablers for the successful implementation and sustainability of DTs. These strategies reflect the operational realities of healthcare facilities in rural healthcare, where stable power and connectivity are essential for digital systems to function effectively. The literature tends to focus more broadly on policy-level enablers such as governance, funding, and strategic planning without explicitly addressing these facility-level infrastructural supports. This divergence underscores the importance of incorporating context-specific enablers into digital health frameworks to ensure practical applicability in real-world settings.

5.6.3 Technologies identified in literature but absent in empirical data

Some DTs, especially artificial intelligence applications such as AI-based Emergency Service (AIES), AI-based Patient Support System (AIPS), and chatbots were identified in the literature but not identified in the empirical data. These DTs are emerging but not yet adopted in rural healthcare facilities in the Eastern Cape in South Africa. Refer to Figure 5-17.

5.7 Implications of findings

The findings of this study have important implications for both theory and practice in the field of digital health. By identifying 'Digital health enablers', a theme not previously mentioned in the literature, this research highlights the unique conditions that support the successful implementation of digital technologies in rural healthcare settings. These enablers such as backup generators, facility fibre and Wi-Fi, solar power supply, and UPS suggest that digital transformation in rural healthcare settings is not only dependent on policy but also on context-specific strategies. These findings suggest the need to expand digital health frameworks to include rural healthcare facility-driven enablers. For policymakers and practitioners, this highlights the importance of investing in leadership development, staff engagement, and community partnerships as part of digital health strategies. Furthermore, these findings suggest that digital health frameworks must be adapted to local realities, where human and contextual factors may outweigh technological readiness.

The implications of this study are particularly relevant for healthcare contexts that are navigating the adoption of digital technology in rural areas. By emphasising the subjective experiences of HCPs, this research suggests that successful adoption of digital technology depends not only on the technical functionality of the system but also on how HCPs interpret and engage with the digital system within their specific cultural and institutional contexts. This study contributes to a growing body of literature that calls for a more nuanced understanding

of technology adoption in healthcare.

5.8 Contribution to theory and practice

This section outlines the main contributions to both theoretical understanding and practical application within the field of digital health.

5.8.1 Contribution to theory

The findings support the Technology Acceptance Model, as academic staff who perceived the predictive system as easy to use were more likely to adopt it. However, the model's focus on ease of use and perceived usefulness may overlook critical factors such as institutional support and data privacy concerns.

This study contributes to theoretical understanding of digital health adoption in several ways. First, it introduces context-specific enablers, such as solar power, UPS, fibre connectivity, and backup generators that are not commonly addressed in existing digital health frameworks. These findings expand the conceptual boundaries of what constitutes digital health readiness in rural healthcare. Secondly, the study deepens theoretical insights into perceived challenges, showing how issues like poor connectivity are not just technical barriers but have cascading effects such as data duplication, backlogs, and loss. Third, the identification of a phased adoption process, decision-making workflows, and referral patterns add nuance to existing models of digital transformation, which often overlook the operational realities of rural healthcare communities. By grounding these insights in empirical evidence, the study enhances the relevance and applicability of digital health theories to real-world contexts.

The identification of digital health enablers as key enablers of DT success in the rural healthcare facilities of the Eastern Cape fills a notable gap in the existing literature, which has largely focused on digital infrastructure, connectivity issues, funding, and policymakers.

5.8.2 Contribution to practice

The study offers actionable insights for policymakers, HCPs, and technology developers. The emphasis on infrastructure enablers, including reliable power sources and connectivity solutions, highlights the foundational requirements for successful digital health adoption. The study underscores the importance of user-centric approaches, particularly in addressing digital literacy gaps, age-related differences in technology use, and varying user perceptions. This has implications for training, change management, and stakeholder engagement strategies. The detailed understanding of adoption phases and workflow integration can guide the design of more adaptive digital health solutions, ensuring they align with the operational realities of rural healthcare HCPs and systems. Overall, the study bridges the gap between strategic

planning and ground-level adoption, offering a more holistic view of digital health transformation.

This section has outlined the study's contribution to both theory and practice. The next section provides a summary of the main points presented in the chapter.

5.9 Emerging contribution

This study extends current knowledge by introducing the concept of 'Digital health enablers', a theme that did not emerge in the existing literature but emerged from the empirical insights from rural healthcare facilities. These enablers represent the foundational elements that facilitate the successful adoption and integration of digital technologies in rural areas. Unlike traditional facilitators often cited in digital health literature, digital health enablers encompass broader spectrum of contextual, infrastructural, and human-specific factors that uniquely shape digital transformation in healthcare facilities in rural areas.

5.10 Chapter summary

This chapter presented the detailed interpretation of findings for the SLR to address the first main research question (MRQ1). It also presented the interpretation of empirical data findings in response to the second main research question (MRQ2) with a focus on the related secondary questions and emerging themes. Thereafter, the chapter presented the comparison of empirical findings with existing literature. The study revealed areas of alignment, such as common views on digital literacy, user perceptions, and the benefits of improved data management. However, several divergences were identified, especially in how the literature and the empirical data conceptualise adoption process and infrastructural enablers. The empirical findings offered deeper, context-specific insights, including the operational consequences of connectivity issues that lead to backlogs and missing data and the emergence of facility-level enablers like solar power and UPS, which were not identified in the literature. The chapter also highlighted the study's contribution to theory, by expanding with new concepts, and to practice, by offering actionable recommendations for digital health adoption. These insights lay the foundation for the concluding chapter, which will present the overall conclusions, limitations, and recommendations for future research and practice.

In summary, the discussion chapter of this study has demonstrated that while digital technology offers significant perceived benefits for improving healthcare facilities in rural areas, its success depends heavily on factors such as stable internet connectivity, HCP training, and IT support personnel. These findings not only align with the DIT, TAM, SCT, HBM, and EST by confirming the importance of perceived usefulness and ease of use. They also extend the conceptual framework by highlighting the role of digital health enablers in adoption processes for rural

healthcare. By addressing both the theoretical and practical implications, this research contributes to a deeper understanding of digital technology implementation in healthcare settings. It opens opportunities for further investigation of similar systems in broader healthcare contexts.

In conclusion, this study's findings reflect the constructivist and interpretivist philosophical foundations, emphasising the subjective realities of HCPs and the role of institutional culture in shaping the adoption of digital technology. The insights provided are context-specific and contribute to a deeper understanding of how digital technology is perceived and implemented in rural healthcare. The following chapter will summarise the overall conclusions of the study and provide recommendations for future research and practice.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This study aimed to explore the impact of digital technology on healthcare facilities in a South Eastern Cape rural environment. This chapter summarises the key findings, links them to the questions and objectives, sets out contributions, notes limitations, and offers recommendations with a conclusion.

6.2 Summary of key findings

The study revealed the transformative potential of digital technology to enhance healthcare services in rural areas. These include using eHealth, EHRs, mHealth, RPM, Telehealth, and Telemedicine platforms. Additionally, the study uncovered context-specific digital tools such as CCMDD, DHIS, HMS2, e-Tick register, HPRS, Lab Trak, and TIER.Net. Moreover, the study also revealed limited digital literacy among HCPs. Furthermore, the study identified context-specific operational challenges such as system backlogs and potential data duplication and loss, all linked to poor internet connectivity.

Notably, the data revealed a novel theme, 'Digital health enablers'. These digital health enablers (DHEs) refer to infrastructure-based solutions and informal practices to support the adoption of DT in healthcare facilities in rural areas. Key enablers identified in the study included backup power generators, solar energy systems, facility-based fibre and Wi-Fi connectivity, and UPS. Additionally, poor internet connection and power cut-offs pose significant obstacles to the successful adoption of DTs in rural healthcare facilities in rural settings.

6.3 Interpretation of findings and their significance

DTs such as Telehealth, Telemedicine, remote patient monitoring, mHealth, eHealth, and electronic health records may mitigate significant barriers in rural healthcare. The challenges include geographic isolation and limited access to HCPs in rural areas. The adopted DTs have the potential to improve healthcare delivery in rural settings in various ways, for instance:

- *Telehealth and Telemedicine:* bridge geographical gaps between patients and HCPs, allowing virtual consultations.
- *Remote patient monitoring:* facilitates a reduction in the need for frequent clinic visits by allowing ongoing monitoring of patients with chronic conditions in their homes.
- *eHealth:* facilitates the delivery of health services online, thus benefiting both the patients and the medical providers.
- *mHealth:* leverages smartphones or tablets to set reminders, making healthcare more

accessible.

- *Electronic health records:* enhance the continuity of care by enabling real-time access to patient data across facilities.

Collectively, these DTs improve efficiency, access, and continuity of care in rural healthcare communities.

The findings uncovered context-specific digital tools such as CCMDD, DHIS, HMS2, e-Tick register, Lab Trak, and TIER.Net are transformative in improving healthcare delivery in rural communities. These tools are designed to address the unique challenges rural healthcare facilities face such as high patient volumes, limited infrastructure, and the need for accurate data management. For example, the adoption of CCMDD streamlines the dispensing and distribution of medication to patients with chronic diseases. Ultimately, this process decreases overcrowding of patients in rural healthcare facilities. HMS2, HPRS, and e-Tick register digitise patient records, track patient attendance, improve efficiency and reduce HCPs' administrative tasks. Lab Trak enables real-time tracking of the patient's blood results. Furthermore,TIER.Net links patients' data and enables the tracking of patients across the healthcare system in rural settings. The adoption of these digital systems in rural healthcare facilities demonstrates how digital technology can significantly improve healthcare delivery.

Across healthcare facilities, there is poor digital literacy among healthcare professionals. This implies that HCPs in rural healthcare facilities lack the capacity to utilise digital health technologies with confidence and efficiency. In some healthcare facilities, the study found that HCPs lack sufficient training to use the digital systems. This made other HCPs reluctant to utilise the digital systems. It streamlines the need for continuous training and digital skills programs specifically tailored for rural healthcare facilities. Furthermore, capacity building and technical support must be incorporated into the adoption of digital technology in healthcare facilities to empower HCPs in rural communities.

Therefore, this study underscores a need for reliable infrastructure as it is a foundational requirement for the successful deployment of DTs in rural healthcare. A novel theme that emerged, 'Digital health enablers', captures the essential support systems that facilitate the functionality and sustainability of digital health technologies in rural areas. These DHEs include backup power generators, solar energy systems, facility-based fibre and Wi-Fi connectivity, and UPS. These context-specific digital health enablers enable HCPs to have ongoing access to digital systems. Moreover, the DHEs have the potential to alleviate the effects of poor internet connectivity and power interruptions in rural healthcare. Additionally, DHEs support operational reliability of healthcare facilities and improve the resilience of rural health systems.

Furthermore, DHEs enable HCPs to deliver timely, data-driven, patient-centred care, ultimately improving healthcare delivery in rural healthcare settings.

Finally, the findings identified unstable internet connectivity and power outages as critical barriers to the effective adoption of DT in healthcare facilities in rural areas. The challenges significantly hinder the functionality of critical digital systems such as CCMDD, DHIS, EHRs, e-Tick register, HMS2, HPRS, Lab Trak, and TIER.Net systems, which depend on consistent power and internet access to operate efficiently. In rural healthcare, these infrastructural challenges can lead to backlog issues, data duplication and loss, and delays in service delivery. This encourages cooperation among various stakeholders to address the challenges that limit the effective adoption of digital technology in rural healthcare. Addressing these barriers is essential to fully harness the capabilities of DTs in improving healthcare access, improving service quality, and ensuring smooth and uninterrupted healthcare delivery in rural areas.

6.4 Addressing research objectives and questions

The two main research questions guided this study. The first main research question (MRQ1) aimed to explore what is known about the role of digital technology in rural healthcare. MRQ1 was addressed through a systematic literature review (SLR). The SLR findings formed the theoretical foundation for understanding an exploratory case study in the broader landscape of DT in rural healthcare. Building on this foundation, MRQ2 explored the practical realities of DT adoption in rural healthcare facilities, which were addressed through empirical investigation. The empirical phase of the study was supported by five secondary questions. These findings addressed five research objectives as follows:

6.4.1 Objective: To explore digital technologies currently in place in healthcare facilities.

Conclusion: Across rural clinics, hospitals, and the community health centre, a range of digital technologies (DTs) that are currently in place were identified. These DTs include: BAS, CCMDD, DHIS, digital communication channels, digital diagnostics, EHRs, e-Tick register, HMS2, HPRS, IHSR, ISP, Lab Trak, LOGIS, OHSC, and TIER.Net. The adoption of the identified DTs reflects the growing digital footprint in rural healthcare settings.

This finding confirms that rural healthcare facilities are not digitally excluded but actively engaging with a variety of digital tools. However, the diversity of digital systems also highlights the need for integration, standardisation, and support to ensure these DTs function effectively in rural healthcare environments.

6.4.2 Objective: To examine the significance of digital technology in healthcare facilities

Conclusion: DTs have been demonstrated to significantly improve healthcare access and efficiency across all facilities in rural communities. The digital tools enable real-time access to patient data, improve data management, and empower HCPs through mobile tools. This demonstrates that DTs are not merely supporting tools but are central to transforming healthcare delivery in rural settings. The integration of DTs into daily healthcare processes can bridge the service gaps in rural healthcare settings.

6.4.3 Objective: To investigate challenges that emerge when adopting digital technology.

Conclusion: Across rural clinics, hospitals, and the community health centre, the study identified challenges such as poor internet connectivity, power outages, system backlogs, data duplication, and potential data loss. Additionally, limited digital literacy was identified among HCPs across rural healthcare facilities. Facilities with fibre or local Wi-Fi plus uninterruptible power supplies reported shorter turnaround times and fewer data losses. Addressing these challenges is essential to fully realise the benefits of digital technology in rural settings. Without reliable infrastructure and capacity building, the adoption of DTs remains fragile in rural healthcare.

6.4.4 Objective: To gain information about the success of the adoption of digital technology.

Conclusion: The study identified strategies that enable successful adoption of DTs in rural healthcare, such as, backup power generators, solar systems, fibre and Wi-Fi connectivity, and UPS. Healthcare facilities with these strategies reported smoother operations, better data management, and fewer disruptions. However, the adoption and sustained use of the deployed DTs depend on guaranteed connectivity and power redundancy across facilities. These strategies serve as effective digital enablers in rural contexts and should be prioritised in district-level healthcare plans.

6.4.5 Objective: To explore the nature of the impact of adopting digital technology in rural communities.

Conclusion: The study demonstrated that DTs offer significant potential to enhance healthcare delivery in rural areas. However, the success of DTs depends on robust internet connectivity and the capacity of HCPs to utilise them effectively. This dual nature of the impact highlights both the benefits and the challenges of DTs on healthcare facilities in rural areas. On the one hand, DTs can transform service delivery; on the other hand, the benefits of DTs are limited by power outages, unstable internet connectivity, and limited digital literacy. This

highlights the need for context-specific adoption strategies that not only introduce digital platforms but also address infrastructural gaps and invest in continuous training and support for HCPs. The complete effect of DTs in rural healthcare facilities cannot be realised without this dual focus.

6.5 Contributions to knowledge

This section presents the theoretical, methodological, and practical contributions of this study.

6.5.1 Theoretical contributions

This study introduced a construct of facility-level enablers in rural healthcare. This contribution emerges from the integration of an SLR with multiple case studies. While the conceptual framework emphasised individual and organisational factors influencing adoption, this study extended the conceptual framework by showing that infrastructural conditions at the facility level are active enablers of DT. This theoretical refinement is important because it shifts the focus from purely behavioural or organisational factors to a more holistic understanding of adoption that includes environmental and infrastructural enablers. It provides a more accurate lens for designing and evaluating digital health interventions in rural contexts and offers a foundation for future research to build context-aware adoption frameworks.

6.5.2 Methodological contribution

The dual strategy integrating an SLR with multiple case studies in rural health provides a replicable approach for similar infrastructure-constrained contexts. The SLR offered a comprehensive overview of global and national trends in the use of DT in rural areas. Additionally, the SLR provided theoretical foundations and existing digital health interventions, helping to frame the study within a broader scholarly context. The case studies, on the other hand, provided rich, context-specific insights into how DTs are actually adopted, experienced, and sustained in real-world rural healthcare facilities.

While an SLR alone might highlight what technologies are effective in theory or other settings, the case studies revealed how local infrastructure, staff capacity, and healthcare communities use the deployed digital technologies. The case studies exposed practical challenges, such as power outages, unstable internet connectivity, and digital literacy gaps, that are often underreported in the literature. The combination identified a novel, grounded theme of ‘Digital health enablers’ which may not have surfaced through the literature review alone. Moreover, the findings from the SLR were validated and enriched through the real-world interviews and observations, enhancing the credibility and transferability of the results. Furthermore, this study ensures that digital health strategies are evidence-based and grounded in the lived realities of rural healthcare systems.

6.5.3 Practical contributions

This study offers several actionable steps to strengthen digital health adoption in healthcare facilities in rural areas. Before rolling out new digital systems, district managers should ensure that facilities have reliable power sources, such as backup generators, solar power supplies, UPS, and stable internet connectivity through fibre or local Wi-Fi networks. These foundational elements are essential for the consistent operation of digital health tools.

Healthcare facilities often struggle with maintenance and troubleshooting. Allocating resources for dedicated on-site IT support can reduce downtime, improve system reliability, and build staff confidence in using DTs. Digital literacy among HCPs was found to be limited. Training should be ongoing and tailored to the specific systems in use. Digital health tools such as CCMDD, DHIS, HMS2, HPRS, e-Tick register, and TIER.Net are already in place. District managers should focus on integrating these systems, reducing duplication, and ensuring interoperability to streamline workflows and improve data quality in rural settings. District managers should also monitor and evaluate the continuous implementation of digital technology in rural communities. This will help identify gaps early and inform adaptive strategies that respond to the realities of rural healthcare delivery.

6.6 Limitations of the study

Although this study offers insightful information about the adoption of DT in rural healthcare, it must be noted that it has several limitations. The study used four case study sites in the rural areas of the EC in South Africa. Focusing on only rural healthcare facilities may limit the generalisability of the findings to other provinces. The specific infrastructural and contextual conditions of these facilities may have shaped the results, particularly in relation to facility-level enablers and challenges. However, the multiple case study design allowed for cross-case comparison, which strengthened the credibility of the findings and highlighted both shared and unique experiences across sites. All case studies were conducted in a rural setting in the EC province. Although this purposive focus provided rich, context-specific insights into infrastructure-constrained settings, it may limit the transferability of findings to urban healthcare contexts. However, this contextual depth is also a strength, as it provides a grounded understanding of digital technology adoption in rural healthcare settings, an area often underrepresented in the literature. As with all qualitative research, there is a risk of the researcher's interpretation influencing data analysis. To mitigate this, member checking and transparent coding procedures were employed to enhance trustworthiness.

Despite these limitations, the study's methodological rigour, including integrating an SLR with multiple case studies, provided both breadth and depth. The findings offer a nuanced understanding of DT adoption in rural contexts, offering theoretical, methodological, and

practical contributions to the existing body of knowledge.

6.7 Recommendations for policy, practice, and future research

The primary scope of the recommendations is for the rural healthcare facilities in the Eastern Cape province of South Africa. This scope is inline with the thesis title and the case study design. Policymakers should prioritise creating comprehensive digital health policies that address data governance and infrastructure constraints to improve the adoption of DTs in rural settings. These priorities include:

- Investing in stable internet connectivity and power backup systems in rural healthcare.
- Establishing clear guidelines for data privacy and security in rural contexts.
- Supporting multi-stakeholder collaboration between government, technology providers, and local communities to ensure sustainable and inclusive digital health strategies in rural areas.

By taking these steps, the primary barriers identified in this study would be minimised, thus allowing smoother adoption of DT in rural communities. Moreover, provincial planners and healthcare facility leaders should prioritise investments in power redundancy systems and stable internet connectivity in rural settings. Additionally, healthcare leaders should wait until digital systems are completely functional before scheduling digital literacy training for HCPs. Furthermore, healthcare facility leaders and provincial planners should set aside funding for facility-level technical support. This would reduce downtime, support troubleshooting, and build staff confidence in using digital systems.

Healthcare facilities should provide specialised training programmes for HCPs to enhance digital literacy and confidence in using digital tools. Additionally, it is important to develop standard, clear operating procedures for managing digital systems and the secure handling of patient data. User-friendly platforms tailored to the needs of low-literacy users should be encouraged to promote accessibility and usability. Furthermore, informal digital health enablers, such as community engagement and local champions, should be promoted to support the adoption and sustainability of DTs in rural healthcare.

Future studies should explore the transferability of DHEs identified in this study to other rural regions beyond the EC province. Further investigation is needed into the long-term impact of digital literacy interventions on technology adoption in rural healthcare contexts. Additionally, longitudinal studies are recommended to evaluate the sustained benefits, challenges, and impact of DT adoption over time. Furthermore, future studies should investigate the ethical considerations and feasibility of deploying DT in rural areas.

6.8 Final conclusion

The aim of this study was to explore the impact of digital technology on healthcare facilities in a rural environment in the Eastern Cape of South Africa. This chapter offers a final reflection on the research findings, situated within the constructivist ontological and interpretivist epistemological frameworks of the study. Throughout this research, the subjective realities and experiences of HCPs regarding DT have been highlighted, providing context-specific insights into the benefits and challenges of adopting these systems. The findings support the constructivist perspective that the adoption of DT in healthcare settings is not a uniform or objective process but is influenced by the diverse, socially constructed realities of HCPs. Different roles within facilities and personal experiences resulted in varying interpretations of the benefits and challenges of digital technology, emphasising that technology adoption is a context-dependent process.

From an interpretivist epistemological viewpoint, this study has generated knowledge that reflects the subjective experiences and perceptions of HCPs regarding digital technology. The knowledge produced is specific to the context, influenced by the cultural and organisational environments where the HCPs work, and cannot be applied universally across all institutions. Nonetheless, it offers valuable insights into how digital technology is understood and applied within particular settings.

This research recognises a value-laden approach, acknowledging that my role as both a researcher and a lecturer within higher education may have influenced the interpretation of the findings. Reflexivity was practised throughout the study to remain aware of potential biases, and ethical considerations, such as ensuring participant confidentiality and securing informed consent, were maintained at all stages. The values and ethical commitments that shaped this study have led to conclusions that are respectful of the diverse perspectives of participants. The implications of this study highlight that the successful adoption of DTs in healthcare facilities in rural areas is not solely dependent on the availability of digital tools but is also critically reliant on the presence of enabling infrastructure and the readiness of HCPs. The study suggests that digital health strategies must be context-specific, addressing both technical and human resource challenges simultaneously.

In conclusion, this study is grounded in a constructivist ontological and interpretivist epistemological framework, emphasising the subjective experiences of HCPs in influencing the adoption of DTs in healthcare facilities in rural areas. Ethical considerations and reflexivity were central to the research process, ensuring that the conclusions respect participants' perspectives and values. The findings offer a deeper understanding of how digital technologies are perceived and implemented in rural healthcare settings, with implications for future

research.

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APPENDIX A: A SYSTEMATIC LITERATURE REVIEW

A.1 Search items

Digitisation
Digital healthcare
Digital technology
eHealth
Electronic health
mHealth
Mobile health
Rural health
Rural healthcare
Sparsely populated
Systematic literature review
Telehealth
Telemedicine

A.2 Academic publications – final selection of articles

ID	Article details - abbreviated title	Author(s)	Origin	DTT	HF	PP	SC
P01	Chatbots to Support Mental Wellbeing in Rural Areas	Potts et al. (2021)	INT.	■	-	-	-
P02	Evolution of Smart Healthcare - Telemedicine	Sageena et al. (2021)	INT.	■	-	-	-
P03	Integrating digital tech and innovations	Ude-Akpeh & Ezegwu (2022)	INT.	■	-	-	-
P04	m-Health framework for improving malaria	Mbunge et al. (2021)	INT.	■	-	-	-
P05	Mobile-enabled telemedicine system	Kingslin (2023)	INT.	■	-	-	-
P06	Neonatal jaundice detection - possibilities and barriers	Jiménez-Díaz et al (2024)	INT.	■	-	-	-
P07	Revolutionising community health literacy	Maha et al. (2024)	INT.	■	-	-	-
P08	Strengthening rural healthcare through digital health	Woods et al. (2024)	INT.	■	-	-	-
P09	Transforming healthcare rural systems via digital health	PEH, C.A (2024)	INT.	■	-	-	-
P10	Preparing Nurses for Roles in Telehealth	Rutledge & Gustin (2021)	INT.	-	■	-	-
P11	Older people and rural eHealth perceptions	Lindberg et al. (2021)	INT.	-	■	-	-
P12	Older service users' experiences of learning to eHealth	Rasi et al. (2021)	INT.	-	■	-	-
P13	Patient and provider perspectives on eHealth	LeBlanc et al. (2020)	INT.	-	■	-	-
P14	Perceptions of Telehealth-based cancer support groups rural	Holtz et al. (2024)	INT.	-	■	-	-
P15	Perceptions of telemedicine	Shardha et al. (2024)	INT.	-	■	-	-
P16	Perspectives of health care professionals' on delivering mHealth	Laar et al. (2022)	INT.	-	■	-	-
P17	Rural patient and provider perceptions of Telehealth 2023 Klee et al.	Klee et al. (2023)	INT.	-	■	-	-
P18	Telemedicine in rural Africa	Omaghomi et al. (2024)	INT.	-	■	-	-

P19	The affective atmosphere of rural life and digital health	Lindberg & Lundgren (2022)	INT.	-	■	-	-
P20	The experiences of HCW using Telehealth services	Graham et al. (2023)	INT.	-	■	-	-
P21	An evaluation of a framework for supporting eHealth	Mwase (2022)	INT.	-	-	■	-
P22	Digital ageing in Europe a comparative analysis on eHealth	Valokivi et al. (2023)	INT.	-	-	■	-
P23	Enhancing healthcare access in rural communities - Telehealth	Selvaraj (2024)	INT.	-	-	■	-
P24	Implementing an intersectoral telemedicine	Sommer et al. (2023)	INT.	-	-	■	-
P25	Implications for implementation for Telehealth	Ye (2023)	INT.	-	-	■	-
P26	Telehealth impact in frontier critical access hospitals	Haque et al. (2023)	INT.	-	-	■	-
P27	Telemedicine and electronic health record implementation	Alfiyyah et al. (2022)	INT.	-	-	■	-
P28	The role of telemedicine in rural America	Benjamin et al. (2024)	INT.	-	-	■	-
P29	A case study of using Telehealth in a rural healthcare	Anderson & Singh (2021)	INT.	-	-	-	■
P30	A scoping literature review of rural beliefs towards Telehealth	Pullyblank (2023)	INT.	-	-	-	■
P31	Before and during pandemic telemedicine use	Larson et al. (2022)	INT.	-	-	-	■
P32	Challenges and facilitators in telemedicine	Arora et al. (2024)	INT.	-	-	-	■
P33	Evaluating variations in the barriers associated with Telehealth	Peng et al. (2024)	INT.	-	-	-	■
P34	Examining disparities in ownership and use of DH	Okobi et al. (2023)	INT.	-	-		■
P35	Factors critical for the successful delivery of Telehealth rural	Barry et al. (2024)	INT.	-	-	-	■
P36	Feasibility and utility of mHealth interventions	McCarthy et al. (2024)	INT.	-	-	-	■
P37	Learning and use of eHealth among older adults	Airola (2021)	INT.	-	-	-	■
P38	Lessening barriers to healthcare in rural Ghana	Peprah et al. (2020)	INT.	-	-	-	■
P39	mHealth technology in providing health services	Bekyieriya et al. (2023)	INT.	-	-	-	■
P40	Providing mHealth solutions rural Bangladesh	Begum & Nemshevichum (2021)	INT.	-	-	-	■
P41	Similarities and diff btw rural and urban telemedicine	Sheets et al. (2021)	INT.	-	-	-	■
P42	Telehealth in response to the COVID-19 pandemic	Hirko et al. (2020)	INT.	-	-	-	■
P43	Telehealth in response to the rural health disparity	Kolluri et al. (2022)	INT.	-	-	-	■
P44	Telehealth use in rural health practitioner education	Calleja et al. (2022)	INT.	-	-	-	■
P45	Telehealth-guided provider-to-provider	Totten et al. (2022)	INT.	-	-	-	■
P46	Telemedicine adoption in rural healthcare	Molli (2021)	INT.	-	-	-	■
P47	Telemedicine and the rural dementia population	Sekhon et al. (2021)	INT.	-	-	-	■

P48	Telemedicine for healthcare - capabilities, features & barriers	Haleem et al. (2021)	INT.	-	-	-	■
P49	Telemedicine in Cardiology	Tolu-Akinnawo et al. (2024)	INT.	-	-	-	■
P50	The impact of effective collaboration in telemedicine on Rural	Kobi et al. (2024)	INT.	-	-	-	■
P51	The potential value of e-health in a rural Limpopo province	Sumbana et al. (2024)	SA	-	-	-	■
P52	The right care in the right place – digital health	Woods et al. (2024)	INT.	-	-	-	■
P53	The role of digital health	Morris et al. (2022)	INT.	-	-	-	■
P54	Use of Telehealth amid the C-19 pandemic	Svistova (2022)	INT.	-	-	-	■
P55	Telemedicine & mHealth apps for rural areas	Sánchez Castillo et al. (2023)	INT.	-	-	-	■

A.3 Quality assessment details

ID	Author(s)	Article details - abbreviated title	QAC1	QAC2	QAC3	QAC4	Index
P01	Potts *et al*. (2021)	Chatbots to support mental wellbeing in rural areas	1	1	0,5	1	3,5
P02	Sageena *et al.* (2021)	Evolution of Smart Healthcare - Telemedicine	1	1	0,5	1	3,5
P03	UDE-AKPEH & EZEGWU (2022)	Integrating digital tech and innovations	1	1	0,5	1	3,5
P04	Mbunge *et al.* (2021)	m-health framework for improving malaria	1	1	1	1	4
P05	KINGSLIN (2023)	Mobile-enabled telemedicine system	1	1	0,5	1	3,5
P06	Jiménez-Díaz *et al.* (2024)	Neonatal jaundice detection - possibilities and barriers	1	0,5	1	0	2,5
P07	Maha *et a* l. (2024)	Revolutionizing community health literacy	1	1	0,5	1	3,5
P08	Woods *et al.* (2024)	Strengthening rural healthcare through digital health	1	1	1	0,5	3,5
P09	PEH (2024)	Transforming healthcare systems in medically underserved rural	1	1	0,5	1	3,5
P10	Rutledge & Gustin (2021)	Preparing nurses for roles in telehealth	1	1	1	1	4
P11	Lindberg *et a* l. (2021)	Older people and rural eHealth perceptions	1	1	0,5	0	2,5
P12	Rasi *et al.* (2020)	Older service users' experiences of learning to eHealth	1	1	0,5	1	3,5
P13	LeBlanc *et al.* (2020)	Patient and provider perspectives on eHealth intervention	1	1	0,5	1	3,5
P14	Holtz *et al.* (2024)	Perceptions of telehealth-based cancer support groups rural	1	1	0,5	1	3,5
P15	Shardha *et a* l. (2024)	Perceptions of telemedicine	1	1	0,5	1	3,5
P16	Laar *et al.* (2022)	Perspectives of health care professionals' on delivering mHealth	1	1	1	0,5	3,5
P17	Klee *et al.* (2023)	Rural patient and provider perceptions of telehelath	1	1	0,5	1	3,5
P18	Omaghomi *et al.* (2024)	Telemedicine in rural Africa	1	1	0,5	1	3,5
P19	Lindberg & Lundgren (2022)	The affective atmosphere of rural life and digital health	1	1	0,5	0	2,5
P20	Graham *et al.* (2023)	The experiences of HWCs using telehealth services	1	1	0,5	1	3,5
P21	Mwase (2022)	An evaluation of a framework for supporting eHealth	1	1	1	1	4
P22	Valokivi *et. al* (2023)	Digital ageing in Europe - a comparative analysis on eHealth	1	1	0,5	0	2,5
P23	Selvaraj (2024)	Enhancing healthcare access in rural communities - Telehealth	1	1	0,5	1	3,5
P24	Sommer *et al.* (2023)	Implementing an intersectoral telemedicine	1	1	0,5	1	3,5
P25	Ye (2023)	Implications for implementation for telehealth	1	1	1	1	4
P26	Haque *et al. (2023)*	Telehealth impact in frontier critical access hospitals	1	1	0,5	1	3,5
P27	Alfiyyah *et al. (2022)*	Telemedicine and EHR implementation	1	1	0,5	1	3,5
P28	Benjamin *et al. (2024)*	The role of telemedicine in rural America	1	1	0,5	1	3,5
P29	Anderson & Singh (2021)	A case study of using telehealth in a rural healthcare	1	1	0,5	1	3,5
P30	Pullyblank (2022)	A scoping literature review of rural beliefs towards telehealth	1	1	0,5	0	2,5
P31	Larson *et al.* (2022)	Before and during pandemic telemedicine use	1	1	0,5	0,5	3
P32	Arora *et al.* (2024)	Challenges and facilitators in telemedicine	1	1	0,5	1	3,5
P33	Peng *et al.* (2024)	Evaluating variations in the barriers associated with telehealth	1	1	0,5	0	2,5
P34	Okobi *et. al* (2023)	Examining disparities in ownership and use of DH	1	1	0,5	1	3,5
P35	Barry *et. al* (2024)	Factors critical for the successful delivery of telehealth rural	1	1	0,5	1	3,5
P36	McCarthy *et. al* (2024)	Feasibility and utility of mHealth interventions	1	1	0,5	0,5	3
P37	Airola (2021)	Learning and Use of eHealth among older adults	1	1	1	1	4
P38	Peprah *et al.* (2020)	Lessening barriers to healthcare in rural Ghana	1	0,5	0,5	1	3
P39	Bekyieriya *et al.* (2023)	mHealth technology in providing health services	1	1	0,5	1	3,5
P40	Begum & Nemshevich (2021)	Providing mHealth solutions rural communities of Bangladesh	1	1	0,5	1	3,5
P41	Sheets *et al.* (2021)	Similarities and diff btw rural and urban telemedicine	1	1	0,5	1	3,5
P42	Hirko *et al.* (2020)	Telehealth in response to the COVID-19 pandemic	1	1	0,5	0	2,5
P43	Kolluri *et al.* (2022)	Telehealth in response to the rural health disparity	1	1	0,5	1	3,5
P44	Calleja et al. (2022)	Telehealth use in rural health practitioner education	1	1	1	0,5	3,5
P45	Totten *et al.* (2024)	Telehealth-guided provider-to-provider	1	1	0,5	0	2,5
P46	Molli (2021)	Telemedicine adoption in rural healthcare	1	1	0,5	1	3,5
P47	Sekhon *et al*. (2021	Telemedicine and the rural dementia population	1	1	0,5	0,5	3
P48	Haleem *et al.* (2021)	Telemedicine for healthcare - capabilities, features & barriers	1	1	0,5	1	3,5
P49	Tolu-Akinnawo et al. (2024)	Telemedicine in Cardiology	1	1	0,5	1	3,5
P50	Kobi *et al.* (2024)	The impact of effective collaboration in telemedicine on rural	1	1	0,5	1	3,5
P51	Sumbana et el. (2024)	The potential value of e-health in a rural Limpopo province	1	1	1	1	4
P52	Woods et al. (2024)	The right care in the right place - a scoping of dHealth	1	1	1	1	4
P53	Morris *et al.* (2022)	The role of digital health	1	1	0,5	1	3,5
P54	Svistova (2022)	Use of Telehealth amid the COVID-19 pandemic	1	1	0,5	1	3,5
P55	Castillo et al. (2023)	Telemedicine and mHealth Applications for Rural Communities	1	1	0,5	1	3,5
Overall aggregated indices			**1,0**	**1,0**	**0,6**	**0,8**	**3,4**
			100%	**98,2%**	**60,0%**	**80,0%**	**84,5%**

APPENDIX B: EXPLORATORY CASE STUDY

B.1 Institutional ethical clearance (Extended)

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (CPUT HWS-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

31 July 2025
REC Approval Reference No:
CPUT/HWS-REC 2024/S27 (Renewal)

Faculty of Health and Wellness Sciences

Dear Ms. Nomputumo Ngesimani

Re: APPLICATION TO THE HWS-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to **Ms .Nomputumo Ngesimani** for ethical clearance. This approval is for research activities related to research for **Ms. Nomputumo Ngesimani** at Cape Peninsula University of Technology.

TITLE: **The Impact of Digital Technology on Healthcare Facilities in a Sparsely Populated Environment of the Eastern Cape South Africa**

Supervisor: Dr. Errol Francke and Dr Patricia Harpur

Comment:

Approval will not extend beyond 1 August 2026. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the CPUT HWS-REC in December of that particular year, for the CPUT HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Dr. Shanel Raghubeer
Deputy Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

B.2 Institutional ethical clearance

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (CPUT HWS-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
Tel: +27 21 959 6917
Email: sethn@cput.ac.za

05 August 2024
REC Approval Reference No:
CPUT/HWS-REC 2024/S27

Faculty of Health and Wellness Sciences

Dear Ms Nomputumo Ngesimani

Re: APPLICATION TO THE HWS-REC FOR ETHICS CLEARANCE

Approval was granted by the Health and Wellness Sciences-REC to **Ms Nomputumo Ngesimani** for ethical clearance. This approval is for research activities related to research for **Ms Nomputumo Ngesimani** at Cape Peninsula University of Technology.

TITLE: **The Impact of Digital Technology on Healthcare Facilities in a Sparsely Populated Environment of the Eastern Cape South Africa**

Supervisor: Dr. Errol Francke and Dr Patricia Harpur

Comment:

Approval will not extend beyond 06 August 2025. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the ethical conditions under which they are authorized to carry out this study and they should be compliant to these conditions. It is required that the investigator(s) complete an **annual progress report** that should be submitted to the CPUT HWS-REC in December of that particular year, for the CPUT HWS-REC to be kept informed of the progress and of any problems you may have encountered.

Kind Regards

Ms Carolynn Lackay
Chairperson – Research Ethics Committee
Faculty of Health and Wellness Sciences

B.3 Case study protocol

Activities	Sections
1. An overview of the research tools used in this study. • Laptop device allows data to be stored locally in MS Word and MS Excel files. • Primary data is securely stored in the institutional repository.	3.3.5
2. A dual strategy consists of a theoretical (SLR) and empirical perspectives, addressing two main and five secondary research questions underpinning the study.	
3.The theoretical component incorporates a SLR that collects secondary via the PRISMA dataflow diagram, which has four phases: • Phase 1: Identification • Phase 2: Screening • Phase 3: Eligibility • Phase 4: Included	3.4.1
4. The empirical component is exploratory and qualitative. It includes four case studies, one hospital, one community health centre, and two clinics in rural areas. • Data collection occurred between November 2024 and December 2024. • Instrument: semi-structured interviews • Participants: Facility Directors and managers, doctors, professional nurses, and administrators • Gatekeepers managed data collection.	3.4.2, 3.5
8. Qualitative data analysis consists of several steps, such as: • iterative thematic analysis • data analysis tool: ATLAS.ti V9.0 as a CAQDAS tool • qualitative data analysis leading to the emergence of themes, sub-categories and items. • A conceptual framework was used as a lens to analyse the data. • network diagrams illustrating findings. • an evolving codebook of theoretically-based and empirically determined codes.	3.6
9. Reporting of findings communicates via: • Future-based academic publications e.g. conference papers and journal articles; • A contribution to the body of knowledge, concerning the impact of digital technology on healthcare facilities in rural areas. • Journal articles	4.2 and 4.3
10. Ethical issues are addressed: informed consent, anonymity, confidentiality, and the right to withdraw.	3.7
11. Trustworthiness measures review: • Credibility • Transferability • Dependability • Confirmability	3.7
12. Limitations include: • Limitations: researcher bias, interviews, sample size.	6.6

B.4 Letter of information

LETTER OF INFORMATION

Principal researcher

Name(s) of the researcher: Nomputumo Linah Ngesimani

Qualifications:

- MTech: Information Technology - Cape Peninsula University of Technology, Cape Town:
- PgDip: ICT Software Development - University of the Western Cape, Cape Town, Honors;
- BTech: Information Technology - Cape Peninsula University of Technology, Cape Town; and
- Diploma: Information Technology - Cape Peninsula University of Technology, Cape Town.

Supervisor: Dr. Errol Francke

Co-Supervisor: Dr. Patricia Harpur

Dear Prospective Participant

My name is Mrs. Nomputumo Linah Ngesimani, a PhD Informatics student at the Cape Peninsula University of Technology. I am conducting a research and I am inviting you to participate in a study entitled "The impact of Digital Technology on Healthcare Facilities in a Sparsely Populated Environment in the Eastern Cape South Africa".

1. **Brief introduction to the study**

   The fourth industrial revolution has impacted many healthcare environments. However, the body of knowledge remains scant on the impact of DT on healthcare facilities in a South African Eastern Cape sparsely populated environment.

2. **Rationale of the study**

   The study plans to enlighten and guide medical decision makers and health professionals working in sparsely populated communities of South Africa on how healthcare facilities should change to make the best use of digital technologies to enhance the quality of their services.

3. **Aim of the study**

   The aim of this study is to explore the impact of digital technology on healthcare facilities in a Sparsely Populated Environment in the Eastern Cape South Africa.

B.5 Informed consent

ETHICAL CONSENT LETTER

Full Title of the Study: The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Names of Researcher: Nomputumo Linah Ngesimani

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher about the nature, conduct, benefit and risks of this study.
- I have also received, read, and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study will be anonymised.
- In view of the requirements of the research, I agree that the data collected during this study can be processed in a computerised system for the researcher.
- I may at any stage without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunities to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significance, new findings developed during this research which may relate to my participation will be made available to me.

Full Name(s) of the Participant:

Date:

Time:

Signature:

I, Nomputumo Linah Ngesimani herewith confirm that the above participant has been fully informed about the nature, conduct, benefit and risks of the above study.

Full name(s) of the researcher: Nomputumo Linah Ngesimani

Date:

Signature:

B.6 Site permissions

B.6.1 ECDOH_Letter_1

Room 31 • First Floor • Grosvenor Lodge • 31 Taylor Street • King Williams Town• Eastern Cape
Private Bag X0038 • Bhisho • 5605 • REPUBLIC OF SOUTH AFRICA
Tel.: +27 43 605 4540/4518 •

Email: ncebagixela22@gmail.com

Date: 26 May 2023

Title: The Impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment.

Dear Ms. Nomputumo Linah Ngesimani

The Department of Health would like to inform you that your application for conducting a research on the above-mentioned topic has been **PROVISIONALLY** approved pending your submission of the following documents:

1. Final research proposal and
2. Ethical approval *(Research Ethics Committee registered with the National Health Research Ethics Council)*

NB: Final approval will only be granted after submission of the above required documents.
Submissions are done online using the address nhrd.health.gov.za

Your compliance in this regard will be highly appreciated.

Secretariat: Eastern Cape Health Research Committee
EASTERN CAPE DEPARTMENT OF HEALTH

B.6.2 ECDOH_Letter_2

Province of the
EASTERN CAPE
HEALTH

Room 5 • Ground Floor • 19 St James Road • Southernwood • East London • Eastern Cape
Private Bag X002 • East London • 5200 • REPUBLIC OF SOUTH AFRICA
Tel: +27 (0)43 707 6781 • Fax: 043 707 6786
Email: xoleka.bushula@echealth.gov.za • Enquires: XO Bushula

Date: 11 September 2023

Mrs. N Ngesimani
CPUT
Cape Town
8001

RE: REQUEST FOR PERMISSION TO CONDUCT STUDY: THE IMPACT OF DIGITAL TECHNOLOGY ON HEALTHCARE FACILITIES IN A SOUTH AFRICAN EASTERN CAPE RURAL ENVIRONMENT.

Dear Mrs. Ngesimani

In view of the above subject request, the office of the District Manager at Amathole Health District acknowledges your request and is delightedly granting you a permission to conduct your research.

Please be advised:

- That during your research, you will follow the submitted protocol with ethical approval and can only deviate from it after having written approval from the Eastern Cape Department of Health (ECDOH).
- The results of the subject matter must be presented to the District Manager and the District Research Committee.
- That your research must not, by any means violate people's rights and cultures.
- That you maintain confidentiality of their identities and shall not collect any information which can be used to link the participants.
- That your research must not contravene with the policies of the ECDOH.
- That your research must not in any way be harmful to the reputation of the department nor dent its image.

We wish you a very successful results with your adventure.

Yours in service delivery

Mrs. S Gede
District Manager: Amathole District

DATE 18/09/2023

Together, moving the health system forward

Fraud prevention line: 0800 701 701
24 hour Call Centre: 0800 032 364
Website: www.echealth.gov.za

NDP 2030

B.6.3 ECDOH_Letter_3

Room 111 • 1st Floor • Old Medical Centre Building • Southernwood • East London • Eastern Cape
Private Bag X002 • East London • 5201 • REPUBLIC OF SOUTH AFRICA
Tel.: +27 (0)43 706 6766 • Fax: +27 (0)43 707 6843 • Email: lungiswa.gobe@echealth.gov.za

Ms. L. Gobe 07/11/2023

RE: The impact of digital technology on Healthcare facilities in a South African Eastern Cape rural environment

Dear Prof Nomputumo Ngesimani

In view of the above subject request, please be advised that the Office of the District Manager at Amathole Health District acknowledges your request and is gladly granting you permission to do data collection in the following Health Establishments:

- Ngqamakwe CHC
- Butterworth Hospital
- Butterworth Gateway Clinic
- Nqancule Clinic

1. During your data collection, you will follow the submitted protocol with ethical approval and can only deviate from it after having a written approval from the ECDoH in writing.
2. That the results of the subject matter must be presented to the District Manager and the Team.
3. Your data collection must not, by any means violate people's rights and cultures.
4. You must maintain confidentiality of their identities and shall not collect any information which can be used to link the participants.
5. Your data collection must not contravene with the policies of the Department of Health.
6. Must not in anyway be harmful to the reputation of the Department nor dent its image.

We wish you a very successful result with your adventure.

Yours in service delivery.

Mrs. N.P. Makeleni
Acting District Manager: Amathole

7/11/2023
Date:

Together, moving the health system forward

Fraud prevention line: 0800 701 701
24 hour Call Centre: 0800 032 364
Website: www.echealth.gov.za

2030 NDP

B.7 Phase 1: Hospital - Semi-structured interview protocol

Study 1.1 Hospital director

Interview Schedule for the Hospital Directors

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option……………………

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

Digital technology (DT) involves the use of advanced information and communication technology (ICT) to collect, store, analyse and distribute information ((Yu, Chen & Ahuja, 2022). The outbreak of coronavirus disease of 2019 (COVID-19) pandemic has escalated the deployment of DT due to the urgent need for healthcare treatment and prevention (Abdolkhani, Petersen, Walter, Zhao, Butler-Henderson & Livesay, 2022). This global paradigm shift in many healthcare systems has created unusual challenges and opportunities (Mbunge, Batani, Gaobotse & Muchemwa, 2022). The escalation in the use of DT has attracted the attention of many researchers (Hassounah, Raheel & Alhefzi, 2020; Abdolkhani et al., 2022; Mbunge et al., 2022). However, there is a limited knowledge in the use of a set of guidelines for digital technologies in the healthcare space in South Africa (SA).

Therefore, the aim of this study is to explore the impact of digital technology on healthcare facilities in a South African Eastern Cape rural environment.

SECTION C: DIGITAL TECHNOLOGY IMPACT ON HEALTHACRE FACILITIES

Main Research Question: How does digital technology impact healthcare facilities in rural communities in South Africa?

Research sub-questions:

1. What digital technologies are currently in place in healthcare facilities?
2. What is the significance of digital technology in healthcare facilities?
3. What is the nature of the impact on rural communities?
4. What strategies have contributed to digital technology success?
5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 1.2 Doctor 1

Interview Schedule for the Hospital Doctors

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option……………………….

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SRCTION B: BACKGROUND INFORMATION

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 1.3 Doctor 2

Interview Schedule for the Hospital Doctors

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option……………………….

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SRCTION B: BACKGROUND INFORMATION

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5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 1.4 Nurse 1

Interview Schedule for the Hospital Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option…………………………

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 1.5 Nurse 2

Interview Schedule for the Hospital Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option……………………

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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7. What problems or issues do you experience?

Study 1.6 Administrator 1

Interview Schedule for the Hospital Administrators

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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7. What problems or issues do you experience?

Study 1.7 Administrator 2

Interview Schedule for the Hospital Administrators

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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B.8 Phase 2: Clinic - Semi-structured interview protocol

Study 2.1 Manager 1

Interview Schedule for the Clinic Managers

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option..............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

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7. What problems or issues do you experience?

Study 2.2 Nurse 3

Interview Schedule for the Clinic Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 2.3 Nurse 4

Interview Schedule for the Clinic Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option...............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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6. What kind of training is given?
7. What problems or issues do you experience?

B.9 Phase 3: CHC - Semi-structured interview protocol

Study 3.1 Manager 2

Interview Schedule for the Hospital Directors

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option…………………………

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 3.2 Doctor 3

Interview Schedule for the Hospital Doctors

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option………………………

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SRCTION B: BACKGROUND INFORMATION

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4. What strategies have contributed to digital technology success?
5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 3.3 Nurse 5

Interview Schedule for the Hospital Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 3.4 Nurse 6

Interview Schedule for the Hospital Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option..........................

Number of years you have worked in the facility.

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 3.5 Administrator 3

Interview Schedule for the Hospital Administrators

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

Digital technology (DT) involves the use of advanced information and communication technology (ICT) to collect, store, analyse and distribute information ((Yu, Chen & Ahuja, 2022). The outbreak of coronavirus disease of 2019 (COVID-19) pandemic has escalated the deployment of DT due to the urgent need for healthcare treatment and prevention (Abdolkhani, Petersen, Walter, Zhao, Butler-Henderson & Livesay, 2022). This global paradigm shift in many healthcare systems has created unusual challenges and opportunities (Mbunge, Batani, Gaobotse & Muchemwa, 2022). The escalation in the use of DT has attracted the attention of many researchers (Hassounah, Raheel & Alhefzi, 2020; Abdolkhani et al., 2022; Mbunge et al., 2022). However, there is a limited knowledge in the use of a set of guidelines for digital technologies in the healthcare space in South Africa (SA).

Therefore, the aim of this study is to explore the impact of digital technology on healthcare facilities in a South African Eastern Cape rural environment.

SECTION C: DIGITAL TECHNOLOGY IMPACT ON HEALTHACRE FACILITIES

Main Research Question: How does digital technology impact healthcare facilities in rural communities in South Africa?

Research sub-questions:

1. What digital technologies are currently in place in healthcare facilities?
2. What is the significance of digital technology in healthcare facilities?
3. What is the nature of the impact on rural communities?
4. What strategies have contributed to digital technology success?
5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 3.6 Administrator 4

Interview Schedule for the Hospital Administrators

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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7. What problems or issues do you experience?

B.10 Study 4: Clinic - Semi-structured interview protocol

Study 4.1 Manager 3

Interview Schedule for the Clinic Managers

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option..............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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6. What kind of training is given?
7. What problems or issues do you experience?

Study 4.2 Nurse 7

Interview Schedule for the Clinic Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.............................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

Study 4.3 Nurse 8

Interview Schedule for the Clinic Nurses

The impact of Digital Technology on Healthcare Facilities in a South African Eastern Cape Rural Environment

Preamble

The interview will take approximately 40 minutes of your time.

Interview questionnaire

SECTION A: ORGANISATIONAL FUNCTIONS

Role: ☐ Director ☐ Senior management ☐ Other option.................................

Number of years you have worked in the facility.

☐ Less than a year ☐ 1-3 years ☐ 4-6 years ☐ 7-10 years ☐ Above 10 years

SECTION B: BACKGROUND INFORMATION

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5. What challenges emerge when adopting digital technology?
6. What kind of training is given?
7. What problems or issues do you experience?

APPENDIX C: EMPIRICIAL DATA

Raw data collected from the hospital director, hospital doctors, hospital nurses, hospital administrators, CHC manager, CHC doctors, CHC nurses, CHC administrators, clinic managers and clinic nurses via interviews respectively during Studies 1, 2 and 3, may be accessed via the university repository.

C1. Study 1.1 Hospital director (CEO) - Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the hospital director, a Chief Executive Officer. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C2. Study 1.2.1 Hospital doctor 1 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the hospital doctor. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C3. Study 1.2.2 Hospital doctor 2 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the medical doctor. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C4. Study 1.3.1 Hospital Nurse 1 -Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the hospital director, professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C5. Study 1.3.2 Hospital Nurse 2 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary explored several questions and elicited a general summary concerning strategic aspects

C6. Study 1.4.1 Hospital Administrator 1 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the administrator. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C7. Study 1.4.2 Hospital Administrator 2 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the administrator. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C8. Study 2.1 Clinic manager – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the manager. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C9. Study 2.2.1 Nurse 1 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects.

C10. Study 2.2.2 Nurse 2 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C11. Study 3.1 CHC manager – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the CHC manager. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C12. Study 3.2 CHC doctor – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the CHC medical doctor. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C13. Study 3.3.1 CHC Nurse 1 -Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the CHC professional nurse, professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C14. Study 3.3.1 CHC Nurse 2 -Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the CHC professional nurse, professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects associated with an Architectural Technology programme.

C15. Study 3.4.1 Administrator 1 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the administrator. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C16. Study 3.4.2 Administrator 2 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the administrator. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C17. Study 4.1 Clinic manager – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the manager. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C18. Study 4.2.1 Nurse 1 – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the professional nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

C19. Study 2.2.2 Assistant Nurse – Transcript

Interviewer: Myself

Date of the interview: Monday 1 September 2014 at 12:00 midday

Interview environment: The researcher established an appointment with the assistant nurse. A conversational and unstructured interview explored several questions and elicited a general summary concerning strategic aspects

APPENDIX D: SYNTHESISED CODEBOOK

D.1 Category A: Digital technology and transformation (DTT)

Code	Theoretically-based items	Guidelines for best practices
TDTT01	AIES	Improve emergency response
TDTT02	AIPS	Tackle specific healthcare challenges
TDTT03	Chatbots	Facilitate quick response to enquiries
TDTT04	eHealth	Improve efficiency
TDTT05	EHR	Facilitate transmission and reception of data
TDTT06	HIE	Enable smooth transmission of patient data
TDTT07	mHealth	Facilitate communication between patients and practitioners
TDTT08	RPM	Provide clinicians with real-time data
TDTT09	SNPs	Improve access to healthcare
TDTT10	Teleconsultation	Facilitate prompt medical advice
TDTT11	Telehealth	Provide video and audio modalities to patients
Code	**Empirically determined items**	**Guidelines for best practices**
EDTT12	BAS	Manage financial transactions
EDTT13	CCMDD	Ensure timely updates on medication pick-ups
EDTT14	DHIS	Ensure HIV and TB patient tracking
EDTT15	Digital diagnostic and monitoring	Ensure accuracy in checking vital signs
EDTT16	EHRs	Provide real-time digital patient records
EDTT17	e-Tick register	Ensure data accuracy
EDTT18	HSM2	Enable seamless patient administration
EDTT19	HPRS	Manage patient registration
EDTT20	IHSR	Ensure real-time compliance with the NHI
EDTT21	IntelliSpace Perinatal (ISP)	Ensure real-time monitoring of foetal care
EDTT22	Lab Trak	Facilitate and track patient blood results
EDTT23	LOGIS	Manage logistical and financial operations
EDTT24	OHSC	Monitor healthcare safety & quality standards
EDTT25	PERSAL	Manage human resource and payroll
EDTT26	RxSolution	Improve efficiency
EDTT27	Telecommunication tools	Enable seamless exchange of patient information
EDTT28	TIER.Net	Enhance monitoring of chronic diseases

D.2 Category B: Perceived benefits (PB)

Code	Theoretically-based items	Guidelines for best practices
TPB01	Acceptance	Embrace benefits of DT
TPB02	Accessibility	Enhance access to rural patients
TPB03	Adoption	Increase the adoption of DTs
TPB04	Cost and time savings	Provide more cost-effective DTs
TPB05	Eases HCPs workload	Improve the work of HCPs
TPB06	Enhances efficiency	Automate manual tasks
TPB07	Enhances health literacy	Identify necessary digital literacy skills
TPB08	Improves quality	Enhance quality of care.
TPB09	Reduces distance limitations	Utilise DT to tackle challenges
TPB10	Willingness	Encourage HCPs to accept and adopt DT
Code	**Empirically determined items**	**Guidelines for best practices**
EPB11	Continuity of care	Embrace the benefits of using DTs
EPB12	Cost and time efficient	Provide more cost-effective DTs
EPB13	Data transmission	Ensure seamless data transmission
EPB14	Healthcare delivery	Enhance quality of healthcare delivery
EPB15	Data management	Ensure easy access to data
EPB16	System integration	Improve system integration
EPB17	Value-added outcomes	Improve patient outcomes

D.3 Category C: Perceived challenges (PC)

Code	Theoretically-based items	Guidelines for best practices
TPC01	Geographical distance	Improve transportation networks
TPC02	Guidelines and policies	Define proper guidelines and policies
TPC03	Financial considerations	Utilise DT to optimise financial issues
TPC04	Limited HCPs	Improve recruitment strategies
TPC05	Limited digital infrastructure	Improve digital infrastructure
TPC06	Technological limitations	Invest in affordable and accessible technologies
Code	**Empirically determined items**	**Guidelines for best practices**
EPC07	Backlog	Reduce backlogs
EPC08	Connectivity issues	Increase broadband and connectivity
EPC09	Data duplication and loss	Minimise data duplication and loss
EPC10	Lack of IT personnel	Enhance recruitment strategies

D.4 Category D: Human factors (HF)

Code	Theoretically-based items	Guidelines for best practices
THF01	Age-related resistance	Include software packages, mobile apps and web-enabled systems
THF02	Cultural beliefs	Review attitude to technology use in educational contexts
THF03	Human behavior patterns	Encourage HCPs to adapt to new innovation
THF04	Inconsistent usage patterns	Offer relevant training and support
THF05	Language barrier	Improve communication skills
THF06	Low digital literacy	Provide user-centric digital literacy training
THF07	Privacy and trust concerns	Protect user privacy and data integrity
Code	**Empirically determined items**	**Guidelines for best practices**
EHF08	Age-related barriers	Develop age-related, inclusive training support programs
EHF09	Adoption resistance	Create change management and provide ongoing support
EHF10	Digital literacy	Develop necessary digital skills
EHF10	User perceptions	Provide awareness of technology potential

D.5 Category E: Processes and patterns (PP)

Code	Theoretically-based items	Guidelines for best practices
TPP01	Broadband and connectivity	Increase broadband and connectivity
TPP02	Collaborative efforts	Enable collaborative efforts
TPP03	Digital infrastructure	Invest if robust digital infrastructure
TPP04	Digital literacy	Outline required and acquired digital literacies
TPP05	Frameworks & policies	Develop clear guidelines ad policies
TPP06	Funding	Assess cost considerations
TPP07	Improve practice change	Quickly adapt
TPP08	Integration	Integrate systems
TPP09	Monitoring and evaluation	Enable continuous improvement
TPP10	Recruitment strategies	Improve hiring process
TPP11	Socio-cultural norms	Incorporate diversity of groups, beliefs and patterns
TPP12	Tailor-made approaches	Design user-centric digital solutions
Code	**Empirically determined items**	**Guidelines for best practices**
EPP13	Adoption process	Enable a multi-phase adoption
EPP14	Data entry process	Maintain data accuracy for decision-making
EPP15	Decision-making process	Provide timely and accurate data
EPP16	Referral patterns	Ensure referrals include all documentations
EPP17	Skills and training	Identify necessary digital literacy skills
EPP18	Workflow integration	Integrate DT into daily processes

D.6 Category G: Digital health enablers (DHEs)

Code	Empirically determined items	Guidelines for best practices
EDHE01	Backup generators	Provide stable power during power outages
EDHE02	Facility Fibre & Wi-Fi	Ensure wireless network availability
EDHE03	Solar power supply	Provide cost-effective energy source
EDHE04	UPS	Provide uninterruptible power during power cutoffs

APPENDIX E: FRAMEWORK CONSTRUCTS

Theoretically and empirically based constructs

Construct	Theoretical source	Definition in the rural healthcare context	Relevance to the study
Adoption and integration	Diffusion of Innovations Theory (Rogers, 1983); Ecological Systems Theory (Bronfenbrenner, 1989)	Infusion of DT in healthcare facilities in rural communities. How DT interacts with various systems in healthcare facilities in rural areas.	Explains how DT is adopted and becomes routine in healthcare facilities in rural communities. Explain systematic uptake of DTs in rural healthcare.
Acceptance and willingness	Technology Acceptance Model, (Davis, 1986)	The willingness of the healthcare professionals (HCPs) to use DT is based on perceived ease and use in rural areas.	Access attitudes and readiness for digital transformation in rural healthcare settings.
New behaviour patterns	Social Cognitive Theory (Bandura, 1986)	Changes in HCPs' learning, practices, and interactions due to DTs.	Explain how DT influences work practices in rural settings.
Perceived barriers	Health Belief Model, (Rosenstock, 1974)	Perceived benefits such as internet connectivity issues, digital infrastructure gaps, data backlogs and data loss.	Captures the challenges experienced by HCPs in the adoption of DT in rural healthcare.
Perceived benefits	Health Belief Model, (Rosenstock, 1974)	Perceived benefits include improved access to patient information, enhanced digital skills, efficiency, and improved healthcare delivery.	Captures the benefits experienced by HCPs on the adoption of DT in rural healthcare.

APPENDIX F: EDITING CERTIFICATE

17 November 2025

NOMPUTUMO LINAH NGESIMANI
Faculty of Informatics and Design
Cape Peninsula University of Technology
Cape Town

CERTIFICATE – EDITING OF DOCTORAL THESIS

I, the undersigned, herewith confirm that I am the editor of the Doctoral thesis of NOMPUTUMO LINAH NGESIMANI titled, *"THE IMPACT OF DIGITAL TECHNOLOGY ON HEALTHCARE FACILITIES IN A SOUTH AFRICAN EASTERN CAPE RURAL ENVIRONMENT"*.

This certificate has been submitted to Dr Francke on 17 November 2025.

Sincerely

Professor Annelie Jordaan
DTech: Information Technology
Ph: 062 948 9027

Member: SATI 1003347

SATI

South African Translators' Institute