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Research Article

The Impact of Digital Health in Healthcare Communication and Service Delivery, Rural Eastern Cape

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Abstract

This study explores how healthcare workers in rural facilities use digital communication platforms and messaging practices, such as mobile messaging apps and system-based reporting channels, to coordinate patient care, share clinical information, and sustain collaboration, highlighting the language, interaction, and Human Computer Interface (HCI) dynamics that shape effective digital health (DH) use. A qualitative method was employed, and data were collected through interviews with 19 healthcare professionals (HCPs) across various roles in healthcare facilities. The data was analysed thematically using ATLAS.ti v9. The findings revealed that DH offers promising benefits to improve data management, processing, and transmission. Additionally, the study revealed that DH has the potential to minimise cost and time in rural healthcare. Furthermore, social messaging platforms, such as WhatsApp, have the potential to facilitate effective communication among HCPs and patients across rural facilities. Nevertheless, this study identified several challenges, including digital literacy among HCPs, age-related barriers, and a lack of personnel. Moreover, the study revealed operational challenges, including system backlogs and potential data duplication and loss, all linked to poor internet connectivity and power failures. Notably, digital health enablers (DHEs), including backup power generators, solar systems, fibre and Wi-Fi connectivity, and uninterruptible power supply, were identified as key enablers to improve the operation of DH in rural communities. Furthermore, this study extended the conceptual framework by showing that infrastructural conditions at the facility level are active enablers of DH.

Keywords: Digital Health; Digital Health Tools; Mobile Health; Rural Healthcare; SMS Interventions; Telehealth; WhatsApp Messaging Technology.

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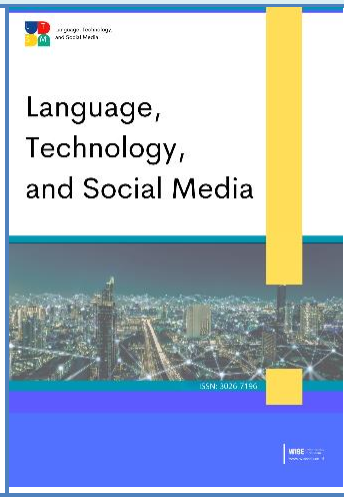

INTRODUCTION

In rural healthcare facilities, digital health (DH) is experienced first and foremost as digital communication: healthcare workers rely on WhatsApp-style messaging and platform-based channels to coordinate referrals, share updates, and sustain teamwork across distance and workload constraints. This article, therefore, foregrounds the language and interaction practices that emerge in these spaces, including communication norms, accuracy breakdowns, and privacy risks that shape how these tools are adopted and trusted.

The evolution of digital health has significantly transformed many healthcare systems, providing new ways of communication through social messaging platforms to enhance service delivery in rural areas. DH involves the use of advanced information and communication technology (ICT) to collect, store, analyse, and distribute information [1]. Due to the promising benefits of DH, digital health tools (DHTs) are increasingly adopted in rural healthcare. DHTs such as mobile health (mHealth), remote patient monitoring (RPM), electronic health records (EHRs), and telehealth have the potential to facilitate communication and sharing of patient data between patients and HCPs [2]. For instance, Telehealth often involves using RPM to examine patients from a distance [2]. Similarly, telemedicine has bridged geographical gaps, making healthcare services accessible in rural areas [3]. In rural healthcare, HCPs utilise mobile technologies, such as smartphones and tablets, to capture, retrieve, and transmit health data from satellite health facilities into the District Health Information System [4]. Study [5] noted a rapid spread of mHealth applications in the developing countries. Through mHealth applications, patients can schedule appointments, receive real-time health information, track their health metrics, and participate in Telemedicine consultations with their HCPs [6]. Additionally, mHealth enables HCPs to access patient data, promoting communication among co-workers, and assisting with decision-making at the moment of treatment [6]. EHRs further facilitate the reception and sharing of patient data in rural settings [7], while RPM facilitates real-time data collection for rural healthcare [6] and guarantees continuous care and support for patients, resulting in enhanced adherence and better healthcare outcomes [8]. Furthermore, monitoring devices enable individuals to manage chronic health conditions and track their health more effectively [9].

In today's era, DH is primarily utilised by both the healthcare and society as a communication tool [10]. Communication technologies, such as socially driven mobile healthcare and telemedicine, are increasingly used as they have the potential to improve communication and healthcare service delivery in rural areas. Social media platforms, such as Zoom, WhatsApp and Facebook, offer a low-barrier communication tool for voice messages, phone calls, video calls, and the sharing of phone calls and images [11]. Chianumba et al. [12] emphasised that communication channels such as WhatsApp and Short Message Service (SMS) have become more affordable means of sharing information as mobile phones become more common. Notably, WhatsApp facilitates interactive group communication in preventive care [13], share voice calls, video, text, and documents [14]. A prior study examined the utilisation of WhatsApp, revealing an enhanced average knowledge score among HCPs [15]. Studies have shown that WhatsApp offers an easily accessible platform for healthcare providers to consult, potentially eliminating the need for in-person sessions [16]. Furthermore, these communication platforms are considered a means to ensure that all individuals in rural communities have the opportunity to meet their healthcare needs, enabling communities to communicate digitally with HCPs regardless of location [17].

This global paradigm shift has created unusual challenges and opportunities in many healthcare systems [18]. Consequently, the escalation in the use of DH has attracted the attention of many researchers [18], [19], [20]. Sharman and Kshetri [5] pointed out 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 DH [21]. Study Rosa et al. [22] noted that the efficiencies, benefits and challenges of using DH should be thoroughly explored to assess their actual performance. The authors indicate that challenges remain evident, despite the evolutionary impact of coronavirus disease on the application of DH in rural areas. These challenges include network difficulties that lead to intermittent internet connectivity, interrupted reporting, and privacy and security complexities.

Existing digital health research in rural and low-resource contexts has largely focused on system implementation, efficiency, and clinical outcomes, with limited attention to how digital technologies shape everyday healthcare communication practices [23], [24]. In South Africa, studies often treat tools such as electronic health records, health information systems, and diagnostic platforms as technical solutions, overlooking how language, interaction, and social messaging mediate their use in clinical and administrative workflows [25], [26]. Although social messaging platforms are increasingly used for coordination, referrals, and information sharing, their communication role in rural healthcare delivery remains underexplored [27], [28]. Consequently, there is limited empirical insight into how healthcare workers in rural settings negotiate meaning, trust, and coordination through digital platforms. This study addresses this gap by examining digital health tools as communicative and sociotechnical systems within rural healthcare facilities in the Eastern Cape, foregrounding the interactional and social dimensions of digital health use.

The study is guided by the research question: How do digital health platforms shape healthcare communication practices and service delivery interactions in rural healthcare facilities in the Eastern Cape? To analytically examine healthcare communication and service delivery among healthcare facilities in rural areas, the study draws on selected constructs from the Technology Acceptance Model (TAM) [29], and the Social Cognitive Theory (SCT) [30]. In this study, the constructs of perceived usefulness and perceived ease of use [29] from TAM were employed to explore how HCPs integrate digital communication tools into daily practice in rural healthcare. The concept of new behaviour patterns [30] from SCT was utilised to interpret how HCPs adjust communication practices in response to infrastructure constraints like internet connectivity and power failures.

METHODS

Research Design

This study employed a qualitative approach to explore the impact of DH in healthcare communication and service delivery in rural areas in the Eastern Cape province. A qualitative inquiry is suitable for this study, as it enables the authors to gain insight into people's feelings and thoughts, which could serve as the foundation for a future independent qualitative study [31]. The researcher's goal as a qualitative researcher "is to know and understand" [32], hence the study employed a multiple case study. An exploratory multiple-case study was used to offer an in-depth understanding of the impact of DH in communication and healthcare service delivery in rural healthcare facilities. 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" [33].
- Facilitated the exploration of a "contemporary phenomenon in depth and its real-world context" [34].
- Offered an opportunity to collect rich and thick data directly from a healthcare real-world context [34], [35].
- Handled a wide range of evidence, including participant observation, direct observations, interviews, documents, and artefacts [33].

The four healthcare facilities were purposively selected based on geographic location. This selection focused on the rural areas of the Eastern Cape, not the urban areas, which are highly resourced. Furthermore, this selection excludes hospitals and clinics in urban areas of South Africa. The case study, as a chosen approach, was employed to organise and guide the conduct of the study [33].

Participants and Sample

The study collected data via four cases. The four cases include one hospital, a community health centre, and two clinics located in rural areas of the Eastern Cape under the Mnquma local municipality. Figure 1 displays the geographical location of the four case studies in the Easter Cape Province.

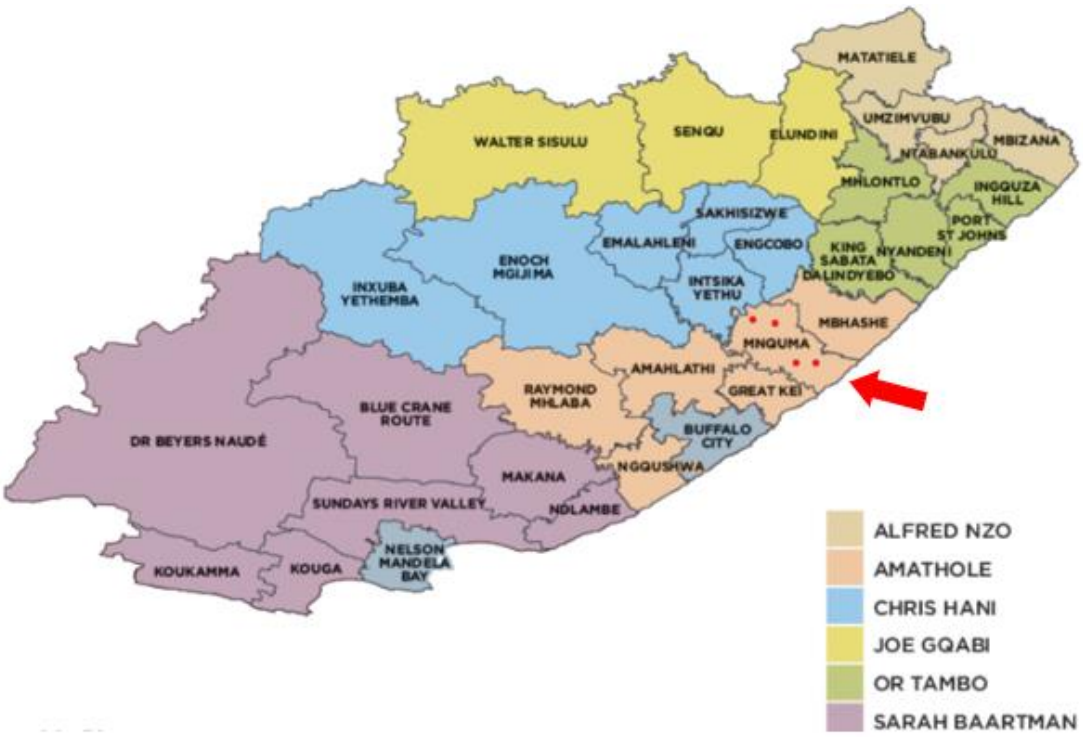

Figure 1. Geographical location of the four case studies in the Eastern Cape Province

This selection was based on a purposive sample, which was convenient to the researcher's situation and the study's context. Additionally, the researchers have purposively selected case studies that are relevant to the research questions. Qualitative samples are typically purposive rather

than random [36]. Participants were drawn from four cases and constituted a purposive convenience sample of nineteen across four healthcare facilities, including directors or managers, doctors, nurses, and administrators. The purposive sampling employed in this study enabled the researchers to select participants based on some predetermined characteristics before the study [37]. It enabled the researchers to identify participants who were knowledgeable about healthcare facilities in their respective communities. Before the analysis, the participants were given pseudonyms using the codes in Table 1.

Table 1. 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

Table 1 illustrates the roles of the participants from the four facilities who took part in this study. The sample in Table 1 excluded data collection from patients and technology suppliers. Instead, it focused on individuals with expertise in healthcare facilities, allowing the researcher to collect informed insights. Creswell [38] 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 [39], [40].

Research Instrument

The researchers employed semi-structured interviews as a data collection method Mack [41] and open-ended questions. Semi-structured interviews enable the researcher to probe for more information or refocus the questions if something interesting or novel emerges [42], [43]. The interview protocol for this study was based on the work of Castillo et al. [44], who indicated that the interview protocol refinement framework is suitable for clarifying semi-structured interviews. All interviews were conducted in English. No pilot interviews took place; the gatekeepers were the managers of the healthcare facilities. The gatekeepers in this study were the managers and directors

of the healthcare facilities, for whom the author needed permission to conduct the interviews, and they were also part of the interview process.

Data Collection Procedure

Data collection was conducted over a two-month period (November 2024 to December 2024) at four healthcare facilities in rural areas of the Eastern Cape province. Participants comprised facility directors and managers, doctors, professional nurses, and administrators. This enabled the researchers to compare data from different participants across facilities. Moreover, the authors identified consistent themes and patterns, thereby strengthening the validity and credibility of the findings. Gatekeepers managed the data collection. The interviews lasted approximately 20 to 40 minutes, allowing participants to respond flexibly. The audio responses from the interviews were digitally captured using a smartphone application. Upon completion, the interview data were transcribed using transcription software and stored securely.

Data Analysis

Data analysis was conducted using ATLAS.ti v9, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS) tool. The CAQDAS data analysis tool supported the researchers 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 [38]. The analysis followed the six steps of thematic analysis by [45]. These steps include:

- Familiarization with data: Repeatedly reading the transcripts.
- Coding: Generated initial codes and assigned labels to the codes.
- Generating themes: Merged codes and created data categories to develop initial themes.
- Reviewing themes: Revised and further developed the initial themes.
- Defining and naming themes: Defined and named the themes and analysed each theme to develop a clear and distinct meaning.
- Write the report: Presented the themes as an integrated narrative, supporting the narrative with the extracts from the analysis of the data [45].

Coder roles

The first author acted as a primary coder, coding the data, generating codes inductively from the data, and drafting the initial themes whilst maintaining an iterative version of the codebook. A second author served as a critical reviewer and assisted in refining and finalising the themes. This process enabled diverse perspectives while maintaining rigour in the analysis.

Reflexivity

Reflexivity was considered throughout the research process. As a researcher possessing a background and personal interest in rural healthcare delivery, we acknowledge that our values and experiences have significantly influenced our interpretation of the existing literature. Our familiarity with the challenges faced by rural healthcare professionals and communities has notably shaped our focus on issues such as digital divides, access barriers, and cultural resistance. While this familiarity equips us with a nuanced understanding of the local context, we recognise that it may also introduce potential bias in the interpretation of findings. To mitigate this, we have engaged in rigorous self-reflection and made concerted efforts to utilise diverse, credible sources to ensure

a balanced perspective. Furthermore, we have exercised diligence in employing a systematic approach to coding and analysis, thereby ensuring that our personal assumptions do not overshadow the voices and insights articulated within the literature.

Audit trail

An iterative codebook, coding decisions, and analytic memos were documented throughout the analytic process.

Trustworthiness strategies

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 [46]. According to Lincoln and Guba [47], 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 researchers applied these techniques: triangulation, member checking, audit enquiry, substantial descriptions and reflexivity [48], [35] to support the enhancement of credibility, transferability, dependability and confirmability.

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?"[49]. The study employed triangulation to ensure the credibility, reliability and validity of the data and findings [50]. Triangulating means using multiple sources of procedures or information from the field to generate identifiable patterns repeatedly [49]. The researchers incorporated participant triangulation to gather information from different sources that would support each other. Through triangulation, the researchers cross-examined the integrity of participants' responses and minimised systematic bias. Lincoln and Guba [47] inform that member verification is a vital technique for establishing credibility, as it allows participants to question and correct errors they perceive as incorrect interpretations.

Transferability in this study refers to how well substantial and rich data are presented and how other researchers can apply it in similar contexts [47]. In this study, substantial or detailed descriptions developed contextualised and explicit guidelines, leading to patterns for using DH in healthcare facilities [35].

Dependability was 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 [47]. 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 [35]. Peer review is a solid communication habit that creates trust [49]. Dependability was used to demonstrate the reliability and consistency of the study results. The purpose was 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 [35].

Confirmability is established when credibility, transferability and dependability are all achieved [47]. It refers to the point when research results can be confirmed by other academics. The researcher engaged participants who contributed to this research by confirming the interpretation of the results.

The researchers employed inductive thematic analysis to explore and understand shared and collective meanings and experiences of the participants across facilities [45]. The inductive analysis enabled codes and themes to emerge from the data. Additionally, the data analysis employed inductive reasoning [51], [52]. The thematic analysis approach enabled codes and themes to emerge from the data. Furthermore, this study employed an interpretive analysis to examine how digital health platforms shape healthcare communication practices and service-delivery interactions in rural healthcare facilities in the Eastern Cape.

Ethical Considerations

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. This study received ethical approval to collect empirical data from the Cape Peninsula University of Technology Research Ethics Committee. Thereafter, the researchers obtained permission letters from the Department of Health. After obtaining approval from both institutions, the researcher approached the gatekeepers (director(s) and managers) of the four healthcare facilities to outline the purpose and nature of the study and to request permission to collect data on their premises. The researchers also provided each facility gatekeeper with the study information letter. All four gatekeepers supported the study and permitted the researcher to conduct the study in their facilities. The gatekeepers played a significant role in helping the researchers approach other participants in the study. The appointed gatekeeper provided the researchers with the names of suitable interview participants. Respondents' participation in this study was voluntary. Crow et al. [53] 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 participated on a voluntary basis and were informed of their right to withdraw at any time.

All research participants received understandable information about the study, enabling them to make a well-informed choice regarding participation [53]. The researcher provided comprehensive information regarding participation to all participants before commencing the interviews. During the face-to-face interview, the respondents were asked to sign informed consent agreements. Therefore, all participants provided informed consent before participating in the study. The researcher kept the data collected from the participants on a password-protected computer. Among other ethical measures taken to protect the participants and the research's purpose, participants were informed of guaranteed confidentiality. The researchers informed and reassured the participants that their names would not be mentioned in the report for confidentiality purposes. Furthermore, the researcher ensured that all interview data and recordings were kept confidential and private in accordance with the Protection of Personal Information Act (POPIA) regulations [54].

RESULTS AND DISCUSSION

Results

The findings for this study are presented in alignment with Davis's TAM and Bandura's SCT, such that the TAM will reveal digital health tools, and infrastructure-related findings, and the SCT will reveal the organisational, human, and cultural-related results. The study's findings were presented as themes. From the analysis, four themes emerged, namely:

- THEME 1: Digital health tools (DHTs);
- THEME 2: Perceived benefits (PB);
- THEME 3: Perceived challenges (PC); and
- THEME 4: Digital health enablers (DHEs).

Table 2 outlines the findings under Theme 1, which comprises five subcategories and eleven associated codes.

Table 2. Themes, subcategories, and codes

Theme	Subcategories	Codes
Digital health tools (DHTs)	Chronic medication management, laboratory, and pharmaceutical systems	Central Chronic Medicine Dispensing and Distribution (CCMDD) Lab Trak RxSolution
	Data management systems	District Health Information System (DHIS) Electronic Tick register (e-Tick register) Health Management System 2 (HMS2)
	Digital diagnostics and monitoring tools	Digital health diagnostics
	Electronic health records and patient information systems	Electronic health records (EHRs) Health Patient Registration System (HPRS) Three Interlinked Electronic Registers.Net (TIER.Net)
	Social messaging platforms	Digital communication platforms
Perceived benefits (PB)	Optimised data management	Cost and time-efficient Enhanced communication process Optimised data processing and transmission Value-added outcomes
	Workflow processes and patterns	Improved data entry process Improved referral process Workflow integration
Perceived challenges (PC)	Infrastructure issues and resource gaps	Connectivity issues Backlog issues, data duplication and loss limited personnel
	Human factors	Digital literacy Technology resistance and age-gap barriers
Digital health enablers (DHEs)	-	Backup generators Facility fibre and Wi-Fi Solar power supply Uninterruptible power supply (UPS)

Table 2 highlights the themes and patterns that emerged from the analysis, providing insight into how DH impacts healthcare communication and service delivery in rural areas of the Eastern Cape province.

THEME 1: Digital health tools (DHTs)

This theme encompasses various DHTs currently in place in the rural areas of the Eastern Cape province. This section analyses five subcategories to highlight the diverse technological components that contribute to improved communication and service delivery, operational

efficiency, and patient outcomes in rural healthcare. THEME 1 encompasses the following sub-sections:

- Chronic medication management, laboratory, and pharmaceutical systems;
- Data management and monitoring systems;
- Digital diagnostics and monitoring systems;
- Electronic health records and patient information systems; and
- Social messaging platforms.

Chronic medication management, laboratory, and pharmaceutical systems

The findings revealed that all facilities are using CCMDD [CHCA3, C1M1, CHCN5, C2N7] to enhance access to stable patients with chronic medication by allowing them to receive treatment through external contact points, such as pharmacies and outreach clinics. The following statement confirms this: *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].*

One participant noted that CCMDD is integrated with other systems, such as TIER.Net, to ensure the traceability and continuity of patient care. The participant response illustrates this: *... 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].*

The Lab Trak system emerged as an important digital health tool for facilitating and tracking patient laboratory results. Participants from various roles, such as doctors, managers, and professional nurses, highlighted its use in ensuring continuity of care, especially in patients with chronic medical issues like HIV. One participant highlighted that: *... we have the Lab Trak system so 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].*

Another participant emphasised that, in many cases, patients claim it is their first time visiting a facility. Lab Trak assists HCPs in tracking the patient history [C2N8]. The study's findings highlight that RxSolution is an electronic pharmaceutical management system that improves medication management [HA1, HDR1].

This was confirmed as follows: *RxSolution… assists the pharmacy department in terms of managing stock and making orders of pharmaceuticals, which means of medicine [HA1]. RxSolution, it's specifically for the dispensary [HDR1].*

Data management systems

The findings revealed that DHIS is a web-based platform for managing and analysing health data [CHCA3]. Participants define DHIS as a data collection system [C2N7]. Whereas the e-Tick register is designed to replace the manual tick registers traditionally used by professional nurses for recording patient data. The HCPs register all their clients in the facility when they are in the consulting rooms with the patients [C1N3, C2M2]. This was pointed out as follows: *The purpose of the e-Tick register is to count the number of client that visits 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].

The e-Tick register ensures data accuracy and supports statistical reporting [C2N8]. The HCPs register all their clients in the facility when they are in the consulting rooms with the patients [C1N3, C2M2]. This was pointed out as follows: 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 that visits in the facility daily so that to know our data…and to keep the data… [C2N8].*

HMS2 is an integrated, newly digital patient management system [HA1] that improves access to patient data and efficiency. This is confirmed by the following: *…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].*

Additionally, HMS2 is used by the admitting clerks to admit patients and record patients' visits in the system [HDR1]. The findings revealed that HMS2 is linked with the Department of Home Affairs [HA2].

Digital diagnostics and monitoring tools

The findings revealed that the use of digital diagnostic tools like X-ray equipment, ultrasound machines and automated blood pressure monitors. This was confirmed as follows: *So we are no longer using those old manual BP machines that makes 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].

EHRs and patient information systems

Participants noted that the transition from paper-based records to digital health systems has reduced the risk of missing or loss of data [C1M1]. This was confirmed as follows: *Like, like everything is almost digitalised, like the Lab reports, X-rays and then…so that when you refer a patient to 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].*

The findings revealed that HPRS is a central system at the frontline or in the facility's reception area to register all patients [C1N3]. This is supported by the following: *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 be easy to retrieve the information [C1N4].*

One participant highlighted that: *TIER.Net is a software created mainly…for a specific type of diseases [CHCA3].*

Social messaging platforms

Participants highlighted the various communication channels they use across platforms, including email, SMS, MS Teams, Zoom, and WhatsApp. This is confirmed by the following: *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 the patients get assistance quickly through the ambulance system via our WhatsApp group [CHCN5].

Participants further highlighted that they are using WhatsApp as a method of communication for emergency responses, group communication and inter-facility support [HDR1, HDR2, C2M2, C2N7]. Figure 2 presents a network diagram illustrating THEME 1, offering insights into the currently used DHTs in rural healthcare settings in the Eastern Cape province.

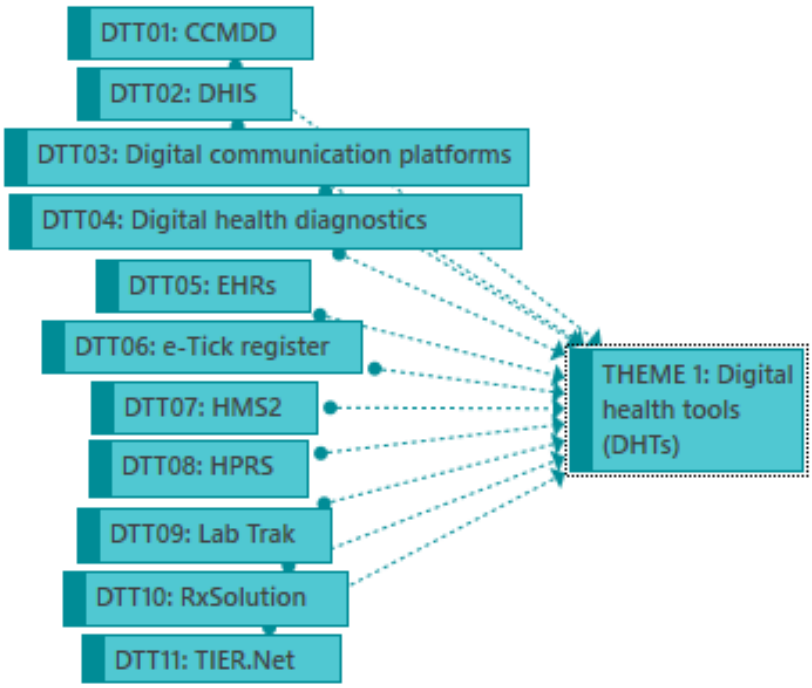

Figure 2. THEME 1: Digital health tools (DHTs) and associated codes

THEME 2: Perceived benefits (PB)

This section covers the perceived benefits of digital health in rural communities, as experienced by HCPs across healthcare facilities. THEME 2 covers two sub-categories: Optimised data management and Workflow processes and patterns.

Optimised data management

This section covers: cost-and time-efficient, Enhanced communication process, Optimised data processing and transmission, and Value-added outcomes.

Cost-and time-efficient

The participants indicated that using DH across facilities saves time and reduces transportation costs.

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].

... 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].

Enhanced communication process

Most participants emphasised that they are using WhatsApp across facilities. Participants noted these benefits:

...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].

Additionally, other participants highlighted that they use WhatsApp for emergency responses, group communication, and inter-facility support [HDR1, HDR2, C2M2, C2N7].

Optimised data processing and transmission

One participant noted that the benefit of DH in healthcare facilities is to manage information [HFD]. Other participants confirmed that and pointed out that:

... 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].

...Even now we can easily collect and distribute the information. And the information now moves faster,...it reaches the national level faster ... [CHCN6].

Value added outcomes

Several participants emphasised how DH add value to the healthcare service delivery as follows:

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... [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].

Workflow processes and patterns

This section comprises the four sub-categories: Improved data entry process, Informed decision-making, Improved referral process, and Workflow integration.

Improved data entry process, referral process, and workflow integration

The study found that the facility is using the TIER.Net system, an integrated electronic system that facilitates seamless patient transfers by connecting with other systems, and he stated that:

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…TIER.Net also helps to actually grant a transfer letter [CHCA4].

The integration of TIER. Net with other systems plays a significant role in ensuring continuity of care, especially when patients relocate [HDR2]. Additionally, TIER.Net enables HCPs to issue transfer letters without any issues [CHCA, C1N3]. One participant pointed out that:

Figure 3 illustrates the perceived benefits of using DH in rural areas of the Eastern Cape province.

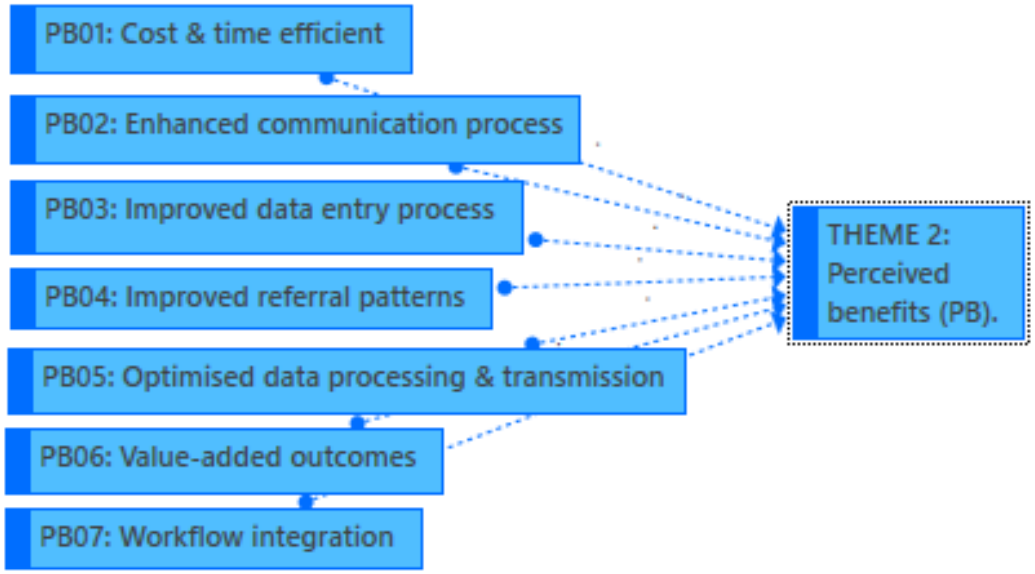

Figure 3. THEME 2: Perceived benefits (PB) and associated codes

THEME 3: Perceived challenges

This section focuses on the practical and systemic barriers that hinder the effective implementation and sustainability of digital transformation in healthcare settings. THEME 3 is linked to research objective 3: "To investigate the challenges that have been explored for adopting digital technology." The perceived benefits comprised two sub-categories: Infrastructure issues and resource gaps, and Human factors.

Infrastructure issues and resource gaps

This section comprises connectivity issues, backlog issues, data duplication and loss, and limited personnel. Several participants expressed concerns about connectivity issues due to power cuts, including electricity and internet signal problems. Their responses pointed out these challenges:

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].

One participant highlighted that backlog challenges are a result of power failures [HA2]. Participants raised concerns that during power outages, admin staff capture patient information in a paper-based system, and when power is restored, they capture all patient details in the system [HA2, HN2]. Another participant further revealed that this results in duplication of work [HN1]. Additionally, 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].

Participants indicated a shortage of qualified HCPs and IT personnel. This was pointed out as follows:

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].

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

Human factors

This section covers technology resistance, age-gap barriers and digital literacy.

Technology resistance and age-gap barriers

The participants indicated that in the early stages of DH implementation, it was not easy for them to adjust to the changes. However, over time, they grew accustomed to the digital health systems. The following statements support this:

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, … easy to use this technology and they save time [C1M1].

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 … [C1N4].

Digital literacy

Participants highlighted that computer literacy is a significant challenge in the facility, as most of them were not trained on computers. This was confirmed as follows:

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].

Figure 4 shows the perceived challenges to the adoption of DH in rural healthcare in the Eastern Cape province.

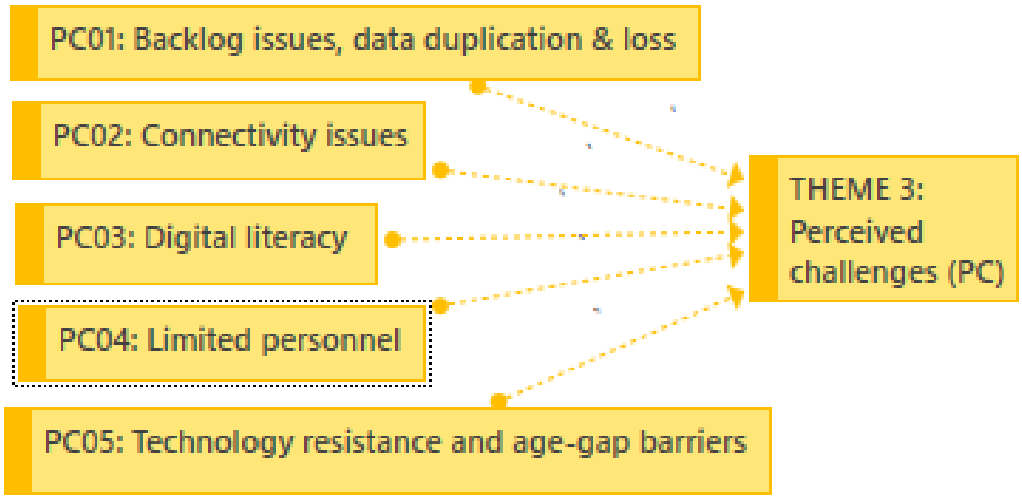

Figure 4. THEME 3: Perceived challenges (PC) and associated codes

THEME 4: Digital health enablers (DHEs)

Figure 5 presents a network diagram illustrating THEME 4: Digital health enablers (DHEs). THEME 4 is linked to research objective 4: "To identify the strategies that facilitated the success of digital health. "The participants identified the following strategies as digital health enablers: backup generators, facility fibre and Wi-Fi, solar power supply, and Uninterruptible Power Supply (UPS). One respondent noted that the digitalised systems require uninterruptible electricity [HFD].

The facilities have implemented strategies, such as backup generators, to ensure that all their digital systems are running effectively [HA1, HA2]. This was pointed out as follows:

That's an ISP server, so it works as a backup generator for the computer network [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 participants noted that there is a department installing fibre that is available in terms of power failure. One participant highlighted that:

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].

In the event of a power outage, a solar power system serves as a backup [C2M3]. Another participant confirmed and stated that:

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].

Uninterruptible Power Supply (UPS)

The facility was equipped with UPS for uninterrupted power supply, ensuring it remained up and running [CHCA3]. The following statement confirms this: *We have got the UPS which we are going to use it when we have got interrupted power supply [CHCM2].*

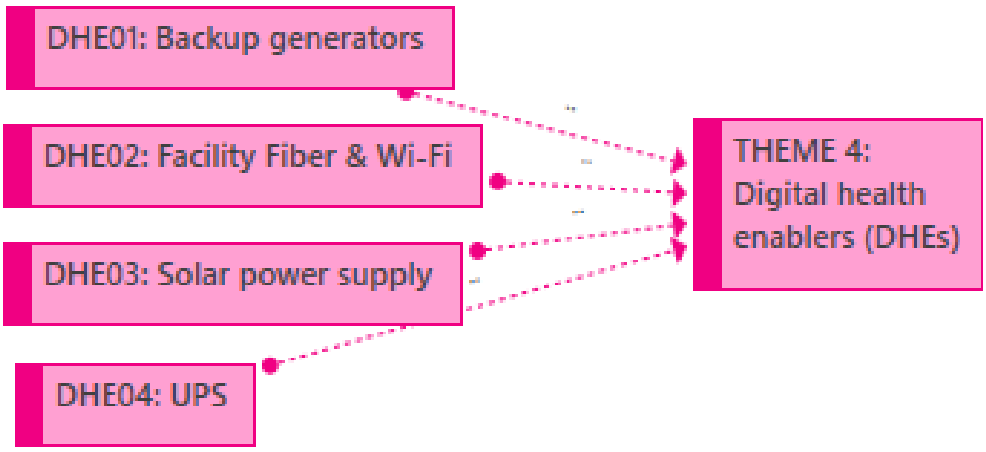

Figure 5. THEME 4: Digital health enablers (DHEs) and associated codes.

Discussion

The findings from the four case studies offer a comprehensive understanding of the DHTs currently in place, their perceived benefits and challenges, and the strategies adopted to ensure their success. Across facilities, DHTs such as digital communication channels, digital health diagnostics, EHRs, and HMS2 were identified, among others. This adoption aligns with Davis's TAM [29] as HCPs integrate these digital tools into their daily tasks to enhance communication and healthcare delivery in rural healthcare. For example, participants emphasised the use of WhatsApp, in particular, for rapid response to improve coordination and responsiveness. This finding mirrors prior studies indicating that social media platforms such as WhatsApp can facilitate communication between patients and HCPs, share health-related information, and foster peer support [11], [12], [13], [15],

[16]. The adoption of the DH across rural healthcare facilities demonstrates a significant transformation toward digitisation. This further aligns with the findings from the study conducted by Agbeyangi and Lukose [55]. This highlights significant progress in telemedicine, driven by mHealth technologies and other digital platforms. The digital tools currently in place appear to be tailored to the South African healthcare context and reflect localised digital health innovations that may not be widely documented in the international literature. This divergence highlights the importance of local content in shaping DH. The transition from manual to digital systems aligns with Bandura's SCT [25], which highlights the new behavioural patterns among HCPs in rural areas. DH has the potential to improve communication, minimise cost and time, ultimately enhancing healthcare service delivery in rural communities. This reflects Davis's TAM [29], where perceived use of DH influences acceptance and willingness of the HCPs to adopt the system. This further aligns with the study by Baskarada [42], which confirms that digital health tools have the potential to collect and retrieve data, bridge access gaps, and improve healthcare service delivery. This indicates that DHTs are enhancing collaborative care in addition to data management. Furthermore, the findings revealed that DHTs support longitudinal tracking of patient history, which is very important for managing patients with chronic disease. This demonstrates that DHTs are not merely supporting tools but are central to transforming healthcare communication and service delivery in rural settings. Despite the noted benefits, the study revealed several challenges that may hinder the successful adoption of DH in rural healthcare. These challenges include poor internet connectivity and power outages, resulting in data duplication and potential data loss. Limited personnel and resistance to digital systems, especially among elder HCPs, were identified as challenges across facilities. Additionally, limited digital literacy was identified among HCPs across rural healthcare facilities. This is consistent with Davis's TAM [29], which highlights that a lack of digital competence lowers technology acceptance and confidence. These challenges not only result in slow adoption but also compromise system efficiency across facilities in rural healthcare. Addressing these challenges is essential to fully realise the benefits of digital technology in rural settings. Without reliable infrastructure and capacity-building, DHTs remain fragile in rural healthcare. The study suggests the need for improved internet infrastructure and reliable power solutions to enhance efficiency and ensure stable internet connectivity in healthcare facilities in rural areas. Moreover, the study identified strategies that enable the successful use of DH in rural healthcare, such as backup power generators, solar systems, fibre and Wi-Fi connectivity, and UPS. This reflects a proactive strategy to prevent interruption of essential healthcare services caused by unexpected power failures in rural clinics. This behavioural response to environmental constraints aligns with Bandura's SCT [30], where HCPs adjust their practices to maintain service delivery. Rural healthcare facilities with these strategies reported smoother operations, better data management, and fewer disruptions. These strategies serve as practical digital enablers in rural contexts and should be prioritised in district-level healthcare plans. These strategies further reflect the operational realities of rural healthcare facilities, where stable power and connectivity are essential for digital systems to function effectively. 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.

CONCLUSION

The study revealed the transformative potential of digital health in enhancing communication and service delivery in rural areas. These include EHRs, mHealth, RPM and Telehealth platforms. The study also revealed limited digital literacy among HCPs. Additionally, the study identified context-specific operational challenges such as system backlogs and potential data duplication and loss, all linked to poor internet connectivity. The study provides context-specific insights into how DH was experienced and sustained in the real world. This research offers several actionable steps to strengthen digital health adoption in rural healthcare facilities. Prior to rolling out new digital systems, district managers should ensure that facilities have reliable power sources, such as backup generators, solar power systems, and UPS units, as well as stable internet connectivity via fibre or local Wi-Fi networks. Future studies should explore the transferability of DHEs identified in this study to other rural regions beyond the Eastern Cape province. Furthermore, longitudinal studies are recommended to evaluate the sustained benefits, challenges, and impact of DH adoption over time.

LIMITATIONS

Although this study offers insightful insights into the impact of DH on healthcare communication and service delivery in rural healthcare, it must be noted that it has several limitations. The study used four case study sites in rural areas of the Eastern Cape, 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 enabled cross-case comparison, strengthening the credibility of the findings and highlighting both shared and unique experiences across sites. All case studies were conducted in a rural setting in the Eastern Cape 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 and the use of social messaging platforms in rural healthcare, an area often underrepresented in the literature. As with all qualitative research, there is a risk that the researcher's interpretation will influence data analysis. To mitigate this, member checking and transparent coding procedures were employed to enhance trustworthiness.

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AUTHOR CONTRIBUTION

N.L.N. conceptualised the study, designed the methodology, managed data collection, conducted data analysis, findings, and drafted the discussion. E.F. supervised the study by providing valuable feedback that contributed to refinements and ensuring the rigour of the study. Both authors reviewed, edited, and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors declare that they used several generative AI tools in the process. Grammarly and QuillBot were used to improve grammar, style, readability, and overall clarity of the writing, while ChatGPT was utilised to help organise complex ideas. Although these tools were helpful, the authors were responsible for writing all the content and drawing the conclusions.

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