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The factors influencing the adoption and sustainability of digital technologies by healthcare providers in South Africa

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A research proposal submitted to the Faculty of Commerce, Law, and Management at the University of the Witwatersrand to fulfil the needs for the qualification of Master of Management in the field of Digital Business

Parktown, 30 April 2023

ABSTRACT

Healthcare has become the most rapidly growing sector in developing and developed countries due to it being a constitutional right and its importance in maintaining the lives of citizens in South Africa.

Evidence shows that the quality and access to health care in South Africa face several challenges which date back to the history of the country and the increasing burden of disease. Despite several initiatives and interventions that have been implemented, the state of the healthcare system continues to deteriorate.

The effect of rapid technology change has resulted in the emergence of digital health technologies which aim to transform the industry by reducing costs, improving efficiencies, introducing new players in the healthcare value chain and empowering patient and healthcare players with information that enables improved health outcomes. Despite, recognising the benefits of digital health technologies to address the challenges that the sector experience, the successful implementation of these solutions has been limited.

The purpose of this study is to understand the factors influencing the intended adoption and sustainability of digital transformation technologies in the South African Healthcare sector.

The factors influencing the intended adoption and sustainability of digital technologies are uncovered by understanding the critical factors experienced by various stakeholders in the South African healthcare sector value chain which include the implementation, funding, technology partnerships, technology development, governance, research, healthcare provision, and usage of healthcare services when adopting digital health technologies

To uncover the factors that influence successful digital health technology implementations, a qualitative design approach using in-depth one-on-one interviews is followed which, was chosen as this research is considered subjective and requires a deeper analysis and understanding of stakeholder

experiences in the health sector, which is best achieved through interviews. A snowballing methodology was then followed to identify additional participants by asking the interviewed participants to identify others that have the necessary experience to partake in the study.

Sixteen interviews were conducted with various stakeholders across the healthcare system and several factors were found that influence the success of the technology, namely policy regulation, funding, technology interoperability, business model, a clear value proposition, lack of infrastructure, minimal willingness to partake, data protection policies and technology mistrust.

The findings revealed that several digital health technologies have been implemented across South Africa, however, the focus of technologies has been on the smaller populated private sector. Data also showed that the implementations spanned across the common solutions of mHeatlh, eHealth, and telemedicine and are underpinned by AI, ML, Big Data and predictive analytics. However, the anticipated benefits are not being realised by the greater South Africa to improve health outcomes and improve the access and quality of healthcare.

Hence, it was concluded that greater focus is required to reach an expansive scale, by shifting from the smaller populated private sector to the public sector, by providing more funding and incentive opportunities, and a body in government that will be responsible for championing digital health technologies across the country is created.

It was also recognised that a critical aspect of transformation is to take an approach of implementing rudimentary solutions so that they can be accessible to the greater population, thus enhancing the potential adoption rates.

The following aspects have been identified as areas for further research:

- Identification of frameworks that can be researched to assist digital health technology implementers in effectively navigating the health sector landscape for developing countries

- What interventions and incentive programmes have successfully been implemented to assist in the mindset shift of healthcare professions to ensure buy-in and adoption of health technologies
- How can developing governments effectively implement a body/task force to oversee digital health technologies pilots, the regulations that affect them, the feasibility of implementation into the greater ecosystem and the coordination of the implementation from pilot to large scale
- Given the transformation of the healthcare system to include new players, who are the players, what are their roles, and how do they effectively leverage each other to improve the healthcare industry

KEYWORDS

Digital Adoption, Digital Sustainability, Factors Influencing Digital Technology Adoption, Digital Transformation, Digital Technologies, Digital Health Technologies, South Africa, Qualitative Research

DECLARATION

I, Luyanda Mhlauli, declare that this research report is my work except as indicated in the references and acknowledgements. It is submitted in fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. It has yet to be submitted for any degree or examination in this or any other university.

Name: Luyanda Mhlauli

Signature: 

Signed at: Sandton

Date: 30 April 2023

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LIST OF ACRONYMS

Acronym	Description
AI	Artificial Intelligence
AIDS	Acquired Immune Deficiency Syndrome
CSIR	Council for Scientific and Industrial Research
DoH	Department of Health
DT	Digital Transformation
eHealth	Electronic Health
EHR	Electronic Health Record
EPR	Electronic Patient Records
EVDS	Electronic Vaccination Data System
HSRC	The Human Research Science Council
ICT	Information and Communications Technology
IoT	Internet of Things
HIV	Human Immunodeficiency Virus
mHealth	Mobile Health

ML	Machine Learning
NDoH	National Department of Health
NHI	National Health Insurance
SMS	Short Messaging Service
TB	Tuberculosis
WHO	The World Health Organisation

1. INTRODUCTION

This qualitative study aims to understand the factors influencing the intended adoption and sustainability of digital transformation technologies in the South African Healthcare sector.

The factors influencing the intended adoption and sustainability of digital technologies will be uncovered by understanding the critical factors experienced by various stakeholders in the South African healthcare sector that are involved in the implementation, funding, technology partnerships, technology development, governance, research, healthcare provision, and usage of healthcare services when adopting digital health technologies.

1.1 Background of the study

The delivery of quality healthcare is a constitutional right (Department of Health, 2019; Ogundaini et al., 2021). In adherence to this right, the government has therefore introduced numerous initiatives to improve healthcare efficiency, safety, quality of delivery, and access for all users (Department of Health, 2019; Maphumulo & Bhengu, 2019). Changes in health policy and legislation to ensure compliance in delivering quality care have also been observed over the years (Pillay & Motsoaledi, 2018).

While there are some examples of nationally implemented programmes and initiatives, there remain vast differences in maturity, scale, infrastructure, and medical practitioner availability across and within each of the provinces in the country, with little coordination observed (Thulare et al., 2020). This results in unmet patient expectations and the failure of basic consistent healthcare standards (Ogundaini et al., 2021; Swartz et al., 2021a).

When compared globally, South Africa's health system appears to be deteriorating as the 2019 Global Healthcare Index ranked South Africa at 49th out of 89 countries surveyed, then later in 2021 ranked it 53 (Ireland, 2021).

Many problems faced by the South African healthcare system can be traced back

to the apartheid era, when the healthcare system was highly fragmented, with discriminatory effects between different racial groups (Maphumulo & Bhengu, 2019). Ten ethnic homelands were created across the country, and each homeland had its departments of health with its professional bodies, which led to the deterioration in health system delivery because of the lack of priority, resources, and overall coordination (Maphumulo & Bhengu, 2019; Ogundaini et al., 2021).

Since the apartheid era, efforts have been made to improve the access and quality of healthcare delivery in South Africa due to the importance and right to health. The WHO noted South Africa's improvements in life expectancy, HIV/AIDS, TB treatments, overall care, and access to immunisations (Ojo, 2018).

However, despite efforts, several issues remain, such as prolonged wait times due to a lack of human resources, unequal access, and quality of care across the country, operational inefficiencies, shortage of resources in medicine and equipment, poor record-keeping, lack of interoperability of systems and no real-time access to information (Maphumulo & Bhengu, 2019; Ojo, 2018). Illnesses, ageing, health costs, poverty, epidemics, and pandemics also affect healthcare access and quality (de Villiers, 2021; Pillay & Motsoaledi, 2018).

Healthcare has become the most rapidly growing sector in developing and developed countries due to its importance in maintaining the lives of citizens and South Africa, specifically because of the inequality of care between the private and public sectors (Marais et al., 2020). Over the years, patients have been raised to the centre of the process, and new organisational models have been established to provide patient-centred services. Additionally, the goal of health systems has expanded to encompass satisfying the health requirements and expectations of health professionals and patients (Marwaha et al., 2022).

Due to the importance and rapid growth of the sector, healthcare in South Africa and the rest of the globe have been affected by the introduction of emerging innovative technologies and health-related innovations and technologies (Deloitte, 2021a), which ultimately aim to curb the issues experienced in a way that is new to healthcare. This improves long-term health costs, efficiencies, and

the relationship and connectedness between patients and health practitioners by enhancing access to information and creating an extensive view of patient health information allowing for better decision-making, resulting in improved health outcomes and quality of care (The United Nations, n.d.). It also allows for the introduction of new players to the healthcare ecosystem to create and enhance value (Deloitte, 2021a, 2021b).

Marais et al. (2020) and Thulare et al. (2020) add that digital health technologies offer benefits such as improved disease diagnosis, management, and prevention through regular healthcare access, which is possible remotely. Remote access allows health services to be rendered to more people, including rural areas, at a lower cost.

Digital health technology is a multidisciplinary and expansive concept that combines technology and healthcare (Olu et al., 2019). It applies digital to the health industry by incorporating services, electronic systems, hardware, and software digital tools, and related emerging technology to ease societal challenges (Bernstein, 2021; Jain & Ranjan, 2020).

As a result, digital health technologies encompass mHealth, eHealth, IoT devices, connected devices, telemedicine, telecare, and health information technologies underpinned by AI, big data, predictive analytics, machine learning and blockchain technologies (Marais et al., 2020; Swartz et al., 2021b; WHO, 2021), which aim to intervene in the prevention of diseases and improvement of the quality of life (Bernstein, 2021).

Authors Bernstein (2021), Maphumulo & Bhengu (2019), and The United Nations (n.d.) agree that the critical stakeholders within digital health technologies include:

- Government: Oversee the governance and provide leadership on the policy development, guidelines, and requirements on overall implementation at the national and provincial levels (Bernstein, 2021; Maphumulo & Bhengu, 2019).
- Researchers: Provide necessary information on disease and technology trends and their outcomes, risk factors, beneficial factors, patterns of care,

health interventions, health costing, usage, etc., to improve the overall health and well-being of a patient (Marwaha et al., 2022; The United Nations, n.d.).

- Practitioners: Provide health care services (The United Nations, n.d.).
- Technology developers/ partners: Create or partner to implement and distribute solutions (Bernstein, 2021; Maphumulo & Bhengu, 2019).
- Funders: Provide capital and invest in solutions (Bernstein, 2021; The United Nations, n.d.).
- Patients: who use health care services (Maphumulo & Bhengu, 2019; The United Nations, n.d.).

The effectiveness and advancement of digital health technologies rely on more than the use of tools and technologies (Deloitte, 2021a) requires the use of new and emerging technologies such as IoT, AI, ML, and big data analytics to collect, analyse, predict, test, refine and deliver effective solutions along the entire health value chain (Asthana et al., 2019; Avenyo & Andreoni, 2021; Wang et al., 2021a) which, shapes the industry towards digital transformation and benefits realisation for all stakeholders (Grobbelaar & Uriona-Maldonado, 2019; Ogundaini et al., 2021).

Despite the emergence of these technologies, the penetration thereof is playing out unevenly across the public and private sectors and various regions in South Africa (Avenyo & Andreoni, 2021; Maphumulo & Bhengu, 2019), even with the understanding that today, digital adoption is seen as essential if the healthcare sector is to be attentive to patient requirements through digital health technology innovations (Deloitte, 2021a; Department of Health, 2019; Enterprise Agency, 2019). More so given that globally, digital health technologies are showing evidence that they have the potential to alleviate some of the healthcare challenges that South Africa faces (Asthana et al., 2019; Ogundaini et al., 2021).

Around the globe and within South Africa, there are several significant hurdles to implementing and sustaining digital technology (Asthana et al., 2019; Ojo, 2018). The most significant and disputed barrier is the patient's health record's privacy and security. Documents falling into the wrong hands and mistreated would be devastating and dangerous (Rahimi et al., 2018). Demographics, prescription

drugs, allergies, immunisations, lab tests, X-rays, and other sensitive information about a patient are all critical to digital health technology's effectiveness.

Another barrier to digital transformation in healthcare is the cost of setup/implementation; creating linked organisations is costly and time-consuming and requires years to realise benefits. Because technology allows physicians to access patient information via a centralised network, it supports integrated care (Ogundaini et al., 2021). Governments must ensure stakeholder buy-in and build up a centralised system to store, preserve, and manage records, which is highly expensive in a fragmented technological system environment.

Several studies show other barriers to health technology adoption to be a mismatch between costs and benefits or a lack of financial remuneration (Ogundaini et al., 2021). Other difficulties mentioned include technical issues in the form of enhancing data, system compatibility and interoperability, outdated technology, poor infrastructure, a lack of health information data standards, a lack of funding and stakeholder buy-in, the number of vendors in the market, vendor churn and fear of job loss (Rahimi et al., 2018; Swartz et al., 2021a).

In certain countries, doctors are prohibited from utilising health technologies due to legislative limits (Maphumulo & Bhengu, 2019; Swartz et al., 2021a). If policies and governance are not appropriately implemented, the innovations may find themselves in legal limbo regarding the healthcare provider's legal authority to practice and utilise innovative solutions.

Implementing health technologies requires a financial and mindset commitment from stakeholders; adding a digital toolset or technological solution will cost money, as with any other investment. Other costs, in addition to the technological system, are often incurred, such as training costs, infrastructure (WIFI connection, network availability, electricity, individual login credentials like e-mail addresses), the expense of equipment and systems to ensure interoperability with other technological systems, matching suitable products, software capabilities, and functionality. Many systems, for example, need specific hardware, networks, or interfaces. While the return on investment may not be

significant initially, studies indicate that adopting digital technologies may result in improved healthcare quality, access, and savings from inefficiencies and automation in each year of operation (Kim et al., 2019).

Stakeholder attitudes may also influence the efficacy of your implementation. Many individuals are afraid to adapt, fearing incompetency and job loss (World Economic Forum, 2020). Communication and alignment with key stakeholders are critical for successful adaptation, and the sustainability of technology is no different. (Javed & Brishti, 2020; Park & Lee, 2018).

In recent years the variety of digital health tools, technologies, and programmes has grown significantly, and generic factors that affect implementation have been documented (Rahimi et al., 2018); however, there is a lack of viewpoint for developing countries like South Africa, where the implementation, adoption, and sustainability of the technologies remain limited, while the need to improve the healthcare system continues to grow exponentially.

The value of digital health and the challenges of adoption and implementation is known. An overview of the literature shows that only some strategies exist, and only some factors are understood for a South African context where fundamental challenges still exist. Several factors (supporting and inhibiting) must be explored to understand better why a developing country with an extensive, complex yet dispersed healthcare system fails to successfully adopt and scale digital technologies at all levels for all its citizens.

To better understand what to consider when ensuring the successful implementation of digital health technologies, from validation to integration and scaling, for the betterment of all citizens; in this paper, the factors affecting them are to be investigated for the South African context.

1.2 Research problem

The South African healthcare sector is highly unequal where one is state-funded (public sector) and serves most of the population at 80%, and the other is the private sector which is individual-funded and serves 20% of the population

(Maphumulo & Bhengu, 2019; Ojo, 2018). Despite catering to most of the public, the public sector is burdened by many challenges that make the delivery of healthcare services unequal in access and quality compared to the private sector (Department of Health, 2019; Maphumulo & Bhengu, 2019). While in the private sector, despite catering to the smaller population of South Africans, it accounts for half of the annual health expenditure (Buswell, 2022).

The inequality in service and resources results in manual, slow service delivery with little integration across the value chain and little confidence in the system (Maphumulo & Bhengu, 2019; Ojo, 2018).

In recent years the number of digital health technologies which allow for the improvement of quality and delivery of health services has significantly increased across the globe, which is seen by the value of investments into these technologies and the health sector. As an example, the United States of America has seen a 33 billion USD investment for over 1200 digital companies (Marwaha et al., 2022). While globally, as of 2022, the investment into digital health is at $332.53 billion and expected to grow at 19.4% year on year between 2023 and 2032, collecting $1 694 billion in that period (Precedence Research, 2022).

However, implementing and adopting these tools in large, complex health systems remains comparatively limited, especially in developing countries such as South Africa (Department of Health, 2019; Marwaha et al., 2022). Limited research documents the factors that affect adoption in developing countries and the considerations to be made when attempting to implement, from validation to integration and scale-up.

Documented research on factors and considerations, including which stakeholders to involve, is difficult to operationalise because they need to be clearly articulated for dynamic developing countries, which this research report aims to contribute to in the pool of existing knowledge from a local and developing country perspective.

Digital health technologies are known to improve access to healthcare services, improve the quality and service of delivery and encourage a patient-focused

approach with streamlined operations to enable trust (Department of Health, 2019; Ogundaini et al., 2021). However, despite digital adoption attempts, the efforts have yet to yield the expected results (Ojo, 2018), and the challenges experienced in implementation impede their practical use (Ogundaini et al., 2021).

Most recently, the COVID-19 pandemic illustrated the value of many digital health tools and technologies. However, it also revealed that adoption and deployment challenges still lead to minimal value creation, frustration, and inefficiency (Marwaha et al., 2022; Mbunge et al., 2022; Wang et al., 2021). The need to critically evaluate this is increasingly evident.

The need remains for successful digital health technology implementations in South Africa in the future as the life expectancy of citizens remains below global averages (Department of Health, 2019), a burden of diseases such as TB, HIV/AID, and diabetes account for 17% of deaths and importantly there is poor health care access and quality of the majority of the population (Writer, 2019) which, ultimately lead to a relatively high mortality rate (Farao, 2020a; Ogundaini et al., 2021).

Given the current healthcare landscape, exploring factors and considerations that influence the adoption and sustainability of digital technologies in South Africa and similar developing countries becomes essential as failure to understand these factors hinders future attempts at implementing digital health technologies.

1.3 Research questions

The study aims to evaluate the factors that influence the adoption and sustainability of digital technologies by healthcare providers in South Africa by conducting a critical assessment of the variety of digital health technologies that have been implemented, to understand the use of emergent technologies such as AI, ML, blockchain and to further understand which category of digital health technologies are primarily implemented to cater for the health needs of South African citizens. The purpose is to understand the landscape of digital health technologies that exist in the South African healthcare context to assist with

answering the second research question of the study which is to understand what factors influence the implementation and sustainability of digital technologies in the Healthcare sector.

The study deems it important to understand the factors that influence the implementation and sustainability of digital health technologies because the identified challenge in South Africa is that several solutions have been implemented over the years from a variety of stakeholders across the healthcare value chain, however little to no solutions have reached the desired scale to positively impact the majority of South Africans to improve the overall health outcomes of citizens and to improve the healthcare challenges that exist in South Africa and developing countries

1.4 Rationale

After a systematic literature review on digital health and digital adoption in health care, Kraus et al. (2021), Maphumulo & Bhengu (2019) show how much research on this topic has increased over the last two decades and highlights the most common technology-related research themes within this domain, which now requires further updates given the rapid advances in technology driven by COVID-19 and speed of adoption of technology across industries and the globe.

The extent to which digital health interventions have improved health care outcomes is also widely reported; however, literature about the adoption, sustainability, and the factors that enable digital health technologies in large and complex health sectors in developing countries is not widely documented (Adeola & Evans, 2018; Kraus et al., 2021; Marwaha et al., 2022).

This study aims to add to the local pool of knowledge of developing countries seeking to improve their health sector challenges using digital technologies by identifying factors that enable successful implementation and sustainability in the long term due to few solutions in South Africa reaching the desired outcome of improving the existing challenges within the health sector resulting in the improvement of the majority of its citizen's health.

Due to the strict focus on technology or a focus on a specific technology against a specific disease (Kraus et al., 2021), research does not adequately highlight the various factors which affect digital adoption and their sustainability in the sector (Asthana et al., 2019; Swartz et al., 2021a).

Asthana et al. (2019) and Kraus et al. (2021) argue that a perspective of factors that includes stakeholders is critical to better understanding how, in practice, the various players of a healthcare ecosystem (policy regulators, healthcare providers, technology developers/implementors, researchers' pharmaceutical companies, hospitals, funders, etc.) can exploit digital technologies and contribute to its success. However, mainstream literature about digital adoption in health scarcely analyses the stakeholder perspective (Kraus et al., 2021).

Drawing on these observations, the study explores the factors that affect the successful adoption and sustainability of digital health technologies in the South

1.5 Delimitations of the study

The following delimitations have been identified as part of the study.

I. The South African healthcare sector has been identified as the market of interest to perform the study; therefore, all other sectors in South Africa will be excluded, e.g., mining, agriculture, etc.
II. Digital technologies and the factors influencing their implementation and sustainability within other sectors are not included.
III. Stakeholders in the South African healthcare sector have been identified and limited to funders, researchers, technology developers, partners and implementors, and the government who oversee and implement policies for the guidance and monitoring of digital health technologies.
IV. Only factors that influence digital health technology adoption and sustainability as defined by the following solutions are considered, including mHealth, eHealth, telehealth/ telemedicine, IoT wearable devices, health ICT and telecare.

1.6 Definition of terms

The following terms have been expanded on to assist in understanding the research report.

Table 1: Definition of critical terms

Term	Definition
Digital Transformation	Digital Transformation refers to business improvement by sparking changes to processes, operations, business models, skills required, metrics, and organisation structures through the use and adoption of technologies. The aim is to create value through efficiencies and automation, enhanced decision-making, customer experience, product, and service innovation, etc. (Deloitte, 2021a; Kraus et al., 2021).
Digital Health/ Health ICT	Digital health combines technology and healthcare by enabling digital adoption in the health industry by incorporating services, electronic systems, hardware, and software (Olu et al., 2019; Swartz et al., 2021b). As a result, digital health technologies encompass eHealth services, mHealth applications, telecare, telehealth/telemedicine, wearable devices, and any other emerging elements/technologies. Technologies such as the IoT AI, ML, mobile phones, and communication telecommunication technology, to name a few, are commonly utilised (Deloitte, 2021a; Kraus et al., 2021; Wang et al., 2021a)
eHealth	eHealth refers to the use of ICTs to deliver healthcare services and monitoring in a cost-effective and efficient manner using the Internet (Kim et al., 2019; Wang et al., 2021a).
IoT wearable device	An electronic device intended to be worn on a user's body that has sensors, processing ability, software, and other technologies that connect and exchange data with other devices and systems over the internet or other communications networks (Marais et al., 2020; Wang et al., 2021a)
mHealth	mHealth is a sub offering/innovation of eHealth and refers to the use of mobile phones and other wireless technology to access healthcare services (Wang et al., 2021a).
Telecare	The continuous, automatic, and remote monitoring of key vitals. Vitals are provided to the necessary healthcare providers via real-time alerts to manage risks (Deloitte, 2021a).
Telehealth/ Telemedicine	The remote diagnosis, monitoring, and treatment of health conditions to a patient by a health care provider, using information and communication technologies to exchange information (Deloitte, 2021a; Marais et al., 2020). ICT's and telecommunication technologies are essential to share medical information, imaging etc. from one technology device to another, or between patient

	and health care provider (Deloitte, 2021a).

1.7 Assumptions

The following assumptions have been identified that pertain to the research report:

I. The chosen respondents should possess and articulate their perspectives and experiences on digital technology implementations and sustainability in the South African health sector. The assumption is deemed reasonable as it links to the research questions the study aims to answer. With the knowledge of digital technological implementations/adoptions in the health sector, respondents will be equipped to provide their perspectives on the factors that influence them.

II. Respondent perspectives should relate to technological adoption in South Africa and similar environments. The study is performed in South Africa; thus, knowledge of factors outside South Africa or other healthcare environments, unlike South Africa, is not deemed valuable.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter addresses the research questions of the study by examining research conducted in the health sector specific to digital health technologies, with a focus on digitalisation, the factors driving digitalisation, its effect on society and all industries, digital health technology, their adoption and the factors that affect their influence.

2.2 Digital disruption and its driving force

The topics of discussion to contextualise the literature review to the research questions are the fourth industrial revolution and digitalisation. The fourth industrial revolution and introduction of technologies have become prevalent in all industries and have changed how all sectors deliver their products and services (Kraus et al., 2021). It has also allowed for innovations to address the challenges experienced (Armstrong & Lee, 2021; Kraus et al., 2021; Papadopoulos, 2022).

Digitalisation is a crucial topic to understand because it has come about because of society's revolution (Papadopoulos, 2022). The topics provide context on why technology and healthcare have combined to provide solutions to better the health sector.

2.2.1 Disruption because of digitalisation in society

Digitalisation has become a 21st-century phenomenon that has transformed all industries and traditional ways of operating (Kraus et al., 2021), affecting all levels of business and society (Armstrong & Lee, 2021). The increased use, variety, and volume of information has occurred in developed and developing countries (Armstrong & Lee, 2021). The information, which is widely spread across all industries, has been enabled through the advancements in technology, allowing for a shift of traditional functions, such as watching television, reading newspapers, and shopping as an example, to be performed via mobile, web technologies, and other digital tools (Armstrong & Lee, 2021; Papadopoulos, 2022).

Hence, technological advancements allow for traditional functions to be digitised across all industries, allowing for competitive advantage by enabling innovation and

addressing consumer requirements and challenges faster, which today has become a necessity for organisation/sector improvement and survival (Armstrong & Lee, 2021).

However, digitalisation encompasses more than digitising functions; according to a few authors, there is no specific and complete definition of digitalisation (Grobbelaar & Uriona-Maldonado, 2019; Kraus et al., 2021; Swartz et al., 2021a). Rather than presenting definitions, they introduce digitalisation by underlining its significant implications for society and businesses. According to (Ghobakhloo, 2020), the digitalisation process is essential not only at the level of individual enterprises/sectors: there is increasing demand from global and local network businesses to respond to all new and growing consumer requirements rapidly as possible.

According to Adeola and Evans (2018) and George (2020), digitalisation is how people use technology. Others, on the other hand, see it as a process, defined as "the act of transforming analogue signals or information in any form into a digital format that computer systems or electronic devices can understand." (Ghobakhloo, 2020, p. 3).

The first example defines digitalisation as a transition from analogue to digital; hence, this definition is aligned with the other authors. Vidiasova et al. (2019) built on this research, claiming that the word's definition may be regarded as rigorous or broad. According to Vidiasova et al. (2019), under the second scenario, it is critical to see digitisation as a long-term process encompassing both technical and strategic changes. This broader interpretation of digitalisation is also reflected in work by Armstrong & Lee (2021), who assert that, in addition to the introduction of new digital technologies that necessitate changes to the overall business model, digitalisation necessitates alignment between the latter and the processes, practices, and organisational culture.

Finally, Nachit and Okar (2020) and Ojo (2018) argue that for businesses to remain competitive, they must be ready to embrace new technologies. In this context, digitalisation is a must-have and inevitable development business cannot escape. When the authors debate this topic, specific characteristics are crucial in defining

digitalisation.

I. Digitising from analogue.
II. Digitalisation should be an adaptable and flexible process.
III. It is customer-oriented and easy to utilise.
IV. It is based on data for comprehensive and faster decision-making and value creation/innovating.
V. It is a cooperative effort across all functions in a business/sector.
VI. It is strategically vital to the success of an organisation.

The most digitalised organisation sees the highest productivity growth (Armstrong & Lee, 2021); therefore, digitalisation is necessary as it entails much more than just deploying digital technology inside an organisation or sector. Rather, it also comprises the change in the way of working, business models and offerings, creation of value chains, and social structures to address challenges (Avenyo & Andreoni, 2021).

Disruption because of digitalisation occurs across all industries in South Africa and globally at varying rates. Authors Ghandi et al. (2021) and Manyika et al. (2018) found a growing sector gap. However, the most significant gap appeared in the health sector, as the COVID-19 pandemic exposed the sector's slow speed to digitise. Manyika et al. (2018) express the same sentiment as authors de Villiers (2021) and Olu et al. (2019) by saying that currently, healthcare is where banking was in the 1990s.

Some parts of the value chain use sophisticated technology to diagnose and treat patients; however, there are several aspects where digital tools are not being exploited, and little to no technology is used in processes such as appointment booking, interactions, record keeping, medication dispensation, etc.

Most sophisticated technology use is in the private sector, which services 20% of the country (Avenyo & Andreoni, 2021; Ghandi et al., 2021). Even so, it is still less sophisticated than other sectors in terms of digitisation.

Given the importance of healthcare in the country, the several challenges experienced by the existing way of work in the sector, the lack of digitalisation, and, importantly, the understanding that there is a need, to exploit and better co-ordinate technology integration within the industry (Ghobakhloo, 2020; Marwaha et al., 2022; Matsoso, 2020). The priority to accelerate the pace of digitalisation remains critical (Department of Health, 2019).

2.2.2 Industry 4.0: Factor driving Digitalisation

Society has entered Industry 4.0 and describes the trend toward digitalisation and automation (Armstrong & Lee, 2021; Peerally et al., 2022). (Ghobakhloo, 2020; Papadopoulos, 2022) further describe the term to be: a conceptualisation of rapid technological change that interconnects embedded systems, industry, business, internal functions, processes, and business.

The fundamental driver of the Industry 4.0 revolution is the emergence of new technologies and their rapid adoption in society, resulting in the change of business models within businesses (Avenyo & Andreoni, 2021; Papadopoulos, 2022; Peerally et al., 2022).



Figure 1: Illustration of the evolution of the industrial revolution

Source: Papadopoulos (2022) and Peerally et al. (2022)

Figure 1 above details the shift from Industry 1.0, where the use of steam engineering was prominent in manufacturing processes, to where the globe is at now; industry 4.0, where newer emerging technologies are revolutionising the way businesses create, improve, and distribute their products and services

(Papadopoulos, 2022). At every stage of the revolution, a trend of technology is being introduced, which changes how that generation's society functions and evolves (Armstrong & Lee, 2021).

Moreover, at every stage, the time it takes for the technology to be fully integrated into society is shorter and shorter, with this revolution being the quickest and growing at an exponential pace (Armstrong & Lee, 2021).

The overall global reach demonstrates their rapid adoption; these technologies have reached around 50% of the global population within the last twenty years and have made great strides in transforming societies and industries to the next stage where the physical and virtual worlds start to combine (The United Nations, n.d.).

The enabling emerging technologies to the fourth revolution are detailed to be mobile devices, AI, ML, IoT, big data analytics, augmented reality, cloud computing, etc. (Armstrong & Lee, 2021; Peerally et al., 2022), which are known to improve product and service quality, efficiency, and flexibility (UKEssays, 2018), and, to have spread faster than any innovation in history (Armstrong & Lee, 2021).

New innovative technologies are said to be prevalent in society today because of the abundance of big data and the increased connectivity among individuals and industries across the globe (Armstrong & Lee, 2021; Ghobakhloo, 2020).

As an example, Shrivastava et al. (2021) and UKEssays (2018) describe how across the globe, public services and systems have become more accessible with the use of blockchain-powered technology; augmented and virtual reality technologies have created virtual learning spaces and enhanced learning experiences in the educational sector; agriculture has become smart and connected due to sensors and machine learning capabilities which provide real-time data to increase crop yields, efficiencies and decrease production costs.

As a result of the rapid advancement of technology, industries, businesses, and government organisations are under pressure to become digital before it is too late to survive (Armstrong & Lee, 2021; Ogundaini et al., 2021; Ojo, 2018).

2.3 Digital technologies in healthcare

The driving factors of digitalisation presented that the fourth industrial revolution is a crucial influence due to the emergence of new technologies, which are dramatically transforming industries and society as we know it.

In developed and developing countries, every sector and organisation is experiencing changes in automation, operations, organisational structure, new business models, and product and service innovation. It has been established that the changes are occurring exponentially, and the health sector needs to catch up. Thus, better coordination and integration of digital health technologies are needed to address the challenges and improve service delivery.

2.3.1 Overview of digital health technologies

Digital health is the utilisation of technology and ICTs to help address the health problems and challenges faced by the health sector by enabling digitalisation (Olu et al., 2019).

The umbrella of solutions that exist in digital health technologies includes mHealth, eHealth, IoT devices, telehealth/telemedicine, telecare, and health information technology (Marais et al., 2020; Swartz et al., 2021b; WHO, 2021), which aim to intervene in the prevention of diseases and improvement of the quality of life (Bernstein, 2021).

These solutions create opportunities for both health practitioners and patients/ users of healthcare to have an all-inclusive view of their patient's health digitally across a greater reach, resulting in better and equal service delivery and improved quality of care (Ogundaini et al., 2021; The Office National Coordinator for Health Information Technology, 2020).

This is required to improve the overall life span of citizens, which according to the Department of Health (2019), is the main goal for exploring digital health technologies.

2.3.1.1 Why digital technologies in healthcare are important

According to authors Bernstein (2021) and Deloitte (2021a) digital health technologies allow for the collection and analysis of an immense volume and variety of data to improve access to information, allowing healthcare providers to diagnose better and treat patient health conditions. Increased information leads to improved analysis and allows for better decision-making, which results in improved medical outcomes, quality of care and increased system efficiency thus improving the overall public health and health care institutions (Olu et al., 2019; Swartz et al., 2021b; WHO, 2021).

Authors Adeola & Evans (2018), George (2020) and The United Nations (n.d.) concur that it improves public health, healthcare institutions and the healthcare system overall by providing access to quality care via information by enabling the rapid dissemination of information among providers and professionals.

It also allows for AI, ML, and other emergent technologies to be used to fulfil the promise of patient/consumer-oriented solutions focusing on disease prevention resulting in higher life expectancies. Higher life expectancies are also achieved through the promotion of healthier lifestyle changes because the increased access to health treatment and information provides more education for individuals who may be at higher risk of common diseases such as diabetes, heart disease, TB, etc. (Bernstein, 2021; National Department of Health, 2019).

Achieving higher life expectancies and improved disease prevention is a priority as the number of people living with chronic diseases continues to rise, increasing the pressure on healthcare systems (Department of Health, 2019). Prevention before treatment solutions is preferred as people can self-manage their health conditions through regular monitoring and tracking of symptoms from early detection of significant changes to health conditions.

Another reason for its importance is that it increases the quality of healthcare provided to public and private health sectors; people have an expanded reach to healthcare professionals without the traditional constraints of distance, location, and time (Voogt et al., 2018). This, in turn, also assists with levelling the disparate healthcare offerings between private and public healthcare in South Africa, which is skewed towards the public sector and individuals living in rural areas (Department

of Health, 2019).

Reduced inefficiencies in manual processes are also identified as important as digital tools and technologies allow for stakeholders to automatically collect data that can be mined to provide more transparency and a better understanding of process performance and cost drivers and identify automation opportunities (Papadopoulos, 2022; Wang et al., 2021a). Digital health implementors have reported cost-cutting of up to 90 percent, and turnaround times improved by several orders of magnitude (Papadopoulos, 2022; Peerally et al., 2022).

2.3.1.2 Growth of digital technologies

Digital health market analysis shows that due to the benefits observed by digitalisation in the health sector, the global market size is anticipated to grow significantly over the next ten years. Figure 2 below reflects Precedence Research (2022) view, which reported that in 2022, the global market size was at $332 billion and is expected to grow at 19.4% compound annual growth to reach an estimated market size of $1694 billion in 2032.



Figure 2: Digital health market size, 2022 to 2023 (USD billion*)*

Source: Precedence Research, (2022)

Several authors reported that various drivers affect the significant growth in the global digital market; these include:

- The penetration of intelligent internet-connected mobile devices (smartphones and tablets) in society and mobile applications related to health

and fitness (Adeola & Evans, 2018; Precedence Research, 2022).

- Development of IT infrastructure in both developed and developing countries. (George, 2020; Matsoso, 2020)
- The global pandemic exposed weaknesses, including a lack of sophisticated technology adoption in healthcare sectors, which sparked the need to transform (Mbunge et al., 2022; Wang et al., 2021a).
- The pandemic also sparked a need for healthcare solutions to be provided remotely, given lockdown and distance measures that were implemented (Precedence Research, 2022).

2.3.2 Applications of digital health technologies

Several applications have been observed for digital health technologies globally, which fall under the categories of mHealth, eHealth, IoT wearable devices, telemedicine/telecare, and health ICT. However, the implementation in South Africa, when compared globally, is limited due to the country facing rudimentary challenges such as the lack of foundational infrastructure, interoperability of systems across the country, limited funding opportunities and restricting legislation/policies (Maphumulo & Bhengu, 2019; Marwaha et al., 2022).

2.3.2.1 Mobile and electronic health applications

The increasing proliferation of mobile devices, tablets and smart devices across the globe has seen mobile devices being used to deliver various healthcare services (Precedence Research, 2022). In categorising mHealth applications Ojo (2018), the WHO (2021) and (GSMA, n.d.) identify common applications across the globe to be in:

- Remote data collection, analysis, trend building and prediction using Big Data, ML, predictive analytics, and AI
- Video-enabled analytics
- Prescription management (eScripting); reception and submission thereof
- Medical schemes management, financial transactions monitoring and incentives
- Communication, education, and training for healthcare workers
- Healthcare provider work planning and scheduling
- Remote patient monitoring

- Patient treatment and compliance
- Patient access to laboratories and results
- Patient communication and education
- Sensors and point-of-care diagnostics
- Registries and vital events tracking
- Data collection and reporting
- Electronic health records
- Electronic decision support (information, protocols, algorithms, checklists)
- Provider-to-provider communication (healthcare user groups, consultation)
- Human resource management for health workers
- Supply chain management
- Consultation bookings and management

In South Africa, mHealth and eHealth implementations are skewed towards mHealth solutions, which also favour capabilities and technologies suitable for low-end smartphones and feature phones to reduce the barrier to entry of the technology (Maphumulo & Bhengu, 2019). As a result, authors Ojo (2018) and Morse et al. (2020) describe the landscape as burgeoning for mHealth applications. A report published by the (GSMA, n.d.). identified solutions to be fragmented; 101 mHealth solutions have been implemented, with most of the solutions addressing the same areas of HIV/AIDS and women and children utilising message-based solutions (Ojo, 2018).

Notable mHealth solutions that have been recognised to have measurable impacts on health outcomes are predominately SMS-based health solutions because they allow for an expansive reach as communication can be made to and between any user, whether they have a smartphone or a feature cell phone, which eliminates the need for internet connectivity (Barron et al., 2018).

The South African government used SMS health solutions to provide relevant information on COVID-19 during the pandemic (Mbunge et al., 2022).
Cell-Life MAMA (The Mobile Alliance for Maternal Action), a messaging solution that targets pregnant women and babies up to age three months, and MomConnect, a free service also offered to pregnant women aimed at improving maternal, foetal, and infant health outcomes, have been identified as the most prominent and

successful solutions (Barron et al., 2018; Coleman et al., 2020; Mbunge et al., 2022; National Department of Health (2019). Both solutions provide pregnant and postpartum women with health information via SMS twice weekly and helpdesk access for queries and feedback (Barron et al., 2018; Coleman et al., 2020). Their uses range from appointment reminders and adherence to maternal and infant health care to bridging existing gaps in access to quality health education and health education of caregivers and parents.

Another prominent SMS health solution is Project Masiluleke which aims to combat HIV/AIDS, and SIMPill, a medication adherence solution (Barron et al., 2018; Department of Health, 2019; Ojo, 2018).

Department of Health (2019), Barron et al. (2018) and Coleman et al. (2020) stated maternal and childcare digital health solutions to be South Africa's flagship initiatives for reaching over 2,5 million pregnant women and achieving a successful message send rate of 98% of which 81% then shared the relevant messages with others, and 70% requested additional messages weekly.

Although notable applications in South Africa cater for child and maternal care, feasibility studies performed for the South African landscape identified additional use for clinic reminders and adherence messages, cost-effective learning opportunities for healthcare providers and workers, data collection, monitoring and evaluation, reliable and sustainable injury severity scoring in a high-volume trauma centre, data for injury surveillance supporting the malnutrition management of children under the age of 5, cardiovascular screening, and mapping indoor residual spraying (IRS) spray events concerning malaria cases, all of which are in its infancy or studies detailing their effectiveness limited (Coleman et al., 2020; Morse et al., 2020; Ojo, 2018).

Within eHealth implementations, consultation bookings and the management thereof and patient treatment guidance in the private sector are the most prominent solution, with RecoMed and EM Guidance leading in their reach. RecoMed allows patients to secure a booking with their closest health professional, thereby reducing medical practice costs and enhancing a customer-centric approach; there are currently ten thousand health healthcare workers using their solution (Enterprise Agency, 2019; TechCrunch, 2021).

EM Guidance supports decision-making by assisting doctors in sourcing reliable information on patient treatment guidelines and medication dosages and has attracted over thirteen thousand health professionals to its platform (Enterprise Agency, 2019; TechCrunch, 2021).

2.3.2.2 IoT wearable device applications

The increase in IoT devices and wearable technology has allowed remote diagnosis and monitoring to become mainstream because of the increased internet use and technological progression (Marais et al., 2020). Authors Wang et al. (2021a) add that wearable and IoT devices allow healthcare providers to collect, aggregate and analyse patient information through sensors, mobile devices, video tools, audio tools and any other connected device to the internet.

Applications globally are identified by Ogundaini et al. (2021), Shrivastava et al. (2021), The United Nations (n.d) and Wang et al. (2021a) to be:

- Real-time in-hospital patient diagnosis and monitoring (including key vitals) with the ability to receive alerts should fundamental vitals change
- Remote patient real-time diagnosis and monitoring of patients using data collection, analysis, trend building and prediction from Big Data, ML, predictive analytics, and AI technologies
- AI-enabled check-ups with the use of the devices
- Connected ambulance to improve patient health outcomes by allowing ambulance staff to collect and transfer information to a hospital while driving to a hospital, allowing for a comprehensive understanding of the patient's state before arrival. Specialists can guide the paramedics on specific procedures, diagnosis assessments, occasional and chronic treatment, and medication adherence if needed.
- Augmented wearable glasses for guidance on performing complex treatments
- Medical scans and advanced imaging such as CT and ultrasound imaging, MRI etc.
- Devices that remotely measure glucose, heart rate and other critical vitals, cholesterol, pacemakers, sensors for stroke patients, asthma, coagulation,

depression, intelligent lenses, medical adherence, hearing, sleep, respiratory diseases etc.

- DNA printing

The number of medical conditions that IoT and wearable devices can measure is growing substantially daily, significantly reducing healthcare costs and the ease of access (Marais et al., 2020).

Applications within a South African context are gaining prominence in the private sector, where patients have access to medical schemes to subsidise the cost of devices (Marais et al., 2020; Mbunge et al., 2022). Typical uses are remote patient monitoring solutions such as the Hospital at Home solution offered by Discovery Health (Discovery Health, n.d.). Others include wearable devices for chronic patients that measure glucose, cholesterol, heart rate and oxygen (Mbunge et al., 2022).

Right ePhamarcy, is a digital technology solution that provides various robotics-related solutions like smart lockers that allow for the automated dispensing of medicines (Enterprise Agency, 2019; Mbunge et al., 2022). Due to the recent pandemic, advanced imaging solutions to diagnose COVID-19 X-Ray chest images have been developed with CapeRay and Lodox (Enterprise Agency, 2019; Mbunge et al., 2022).

Additional applications include HealthAlert, which uses chatbots to provide helpful health information to healthcare workers at any time in an interactive manner. AI-based intelligent wearable devices such as pedometers, various electrode-based chest saps, accelerometer-based arm straps, fashion bracelets, fitness bands and watches, earphones, and smart clothing that are utilised to monitor heart rate for self-management of health behaviours of individuals with chronic diseases or non-infectious diseases (Mbunge et al., 2022)

2.3.2.3 Telemedicine applications

Telemedicine has previously been defined as the use of information and technology, such as computers, phones, and messages, to enable remote health services in a virtual way using audio and or video; a key component is that the information is exchanged from one point to another (Deloitte, 2021a; Marais et al., 2020).

It also uses various digital technologies to provide virtual care, which enhances the quality of the care supplied (Mbunge et al., 2022); these technologies include mobile devices, IoT and connected wearable devices, which collect information and were discussed in the previous section.

Applications of telemedicine globally have been identified by Chitungo et al. (2021), Deloitte (2021a), Discovery Health (n.d), Hollander & Carr (2020), Mbunge et al. (2022) and Rabe (2022) as the following:

- Two-way video and audio between a healthcare worker and the patient are used to enable remote consultations allowing for visual and audio screening assessments, diagnosis, treatment, and all other health-related services
- Behavioural recognition in homes for care, psychiatric centres, etc.
- Therapy sessions with a phycologist or psychiatrist
- Text message-based care with healthcare providers
- Remote expert consultation for assistance in procedures, e.g., surgery, treatment etc.

Due to the COVID-19 pandemic, technological advances, and the use of connected mobile devices, telemedicine in South Africa has accelerated, resulting in healthcare workers using digital virtual solutions to provide care (Rabe, 2022). Several resources are now available for South African health practitioners to gain knowledge and skills on medicolegal, communication and practical aspects of telehealth and how to practise telehealth safely and effectively in primary care settings (Mbunge et al., 2022; Rabe, 2022). Data from the revised Health Professions Council of South Africa (HPCSA) General Ethical Guidelines for Good Practice in Telehealth, guidelines on remote or video consultations from the University of Oxford, the Royal Australian College of General Practitioners and the Royal College of Psychiatrists show that despite challenges, remote consultations are reliable, safe, and effective and healthcare workers should become efficient in their use (Rabe, 2022).

Several use cases of telemedicine exist in the South African context across various specialities, including psychology, psychiatry, chiropractors, radiology, ophthalmology, and physicians; notable solutions include DrConnect, which offers consultations via audio phone to provide remote diagnosis, monitoring, treatment,

and provision of scripts (Discovery Health, n.d.; Rabe, 2022). Phillips Hospital telehealth provides an electronic intensive care unit, remote patient monitoring and remote consultations (Mbunge et al., 2022).

Sophisticated telemedicine implementation across all fields of medicine remains challenging due to regulatory, technological, and organisational barriers. Technological barriers include poor internet connectivity, insufficient technological infrastructure, lack of interoperability and standardisation between devices and technologies, unavailability of supporting software, digital divide, and high cost of telecommunication equipment (Mbunge et al., 2022; Rabe, 2022). Organisation and financial barriers include the breadth of clinicians with hybrid expertise in telemedicine software, inadequate training, lack of financial incentives, low motivation to use telemedicine, lack of awareness about telemedicine products, resistance to change, duplication and fragmented implementation of telemedicine projects, language barriers, high cost of infrastructure development, implementation and maintenance, insufficient resources to implement and operating telemedicine technologies, high cost of electricity supply, high-cost of telemedicine services and insufficient funding (Mbunge et al., 2022; Rabe, 2022).

Policy and regulatory barriers include the need for full governmental support, lack of policy clarity, policy and regulatory framework, privacy, confidentiality in the telemedicine system application and limited budget support (Mbunge et al., 2022; Rabe, 2022). For example, in South Africa, the mHealth policy introduced in 2015 did not guide the use of telemedicine for the delivery of mental healthcare (Mbunge et al., 2022) but has since improved post-pandemic. Cultural barriers, such as socio-demographic and cultural dynamics and religion, discourage people from using telemedicine applications, digital illiteracy, and resistance to change (Mbunge et al., 2022; Rabe, 2022).

2.3.2.4 Health ICT applications

Health ICT applications include the use of emerging digital technologies such as blockchain to enable improved quality of healthcare. Blockchain is defined by Dario de Martino et al. (2019) and Deloitte (2018) as technology that facilitates the preservation and exchange of health data between healthcare workers, hospitals, laboratories, and pharmacies.

Applications of use observed by Ben Fekih & Lahami (2020), Deloitte, 2018), Kim et al. (2019) and Shrivastava et al. (2021) include:

- Blockchain technologies to share electronic medical and health records of patient information and Electronic documents
- Blockchain technology for a pharmaceutical supply chain to verify compliance with quality control

Globally, blockchain technology has been identified to make health records transparent, secure, auditable, and more reliable (Dario de Martino et al., 2019), thus making it appealing for managing patient information in the South African context (Deloitte, 2018; Matlebjane & Ndayizigamiye, 2022). However, despite the benefits, a survey by Deloitte (2018), corroborated by Matlebjane & Ndayizigamiye (2022), indicated that while blockchain applications are proliferating, the understanding of the technology and the potential it has is still far from being widespread. Dario de Martino et al. (2019) stated that the adoption of blockchain in the healthcare sector is still emerging and that the widespread adoption of the technology faces many challenges. Challenges in the South African context are increased due to the lack of data practices, policy regulation, technology interoperability and inability to collect and store patient information centrally across the country electronically (Ben Fekih & Lahami, 2020; Matlebjane & Ndayizigamiye, 2022; Matsoso, 2020). Due to the challenges, only some implementations were identified in the South African context, which is in the conception phase (de Villiers, 2021; Matlebjane & Ndayizigamiye, 2022; Ojo, 2018).

2.4 Factors that affect the technological implementation and sustainability

Several factors exist that could affect the implementation of digital health technologies. This section of the research report details the identified factors.

2.4.1 Risk of privacy and security breaches

Grande et al. (2020) and Precedence Research (2022) report that the risk of security and privacy to personal data because of personal breaches in the form of cyber security and endpoint leakages are significant concerns. Large amounts of sensitive data related to an individual's health are collected, and digital technologies are more

exposed to security risks such as phishing, spyware, hacking ransomware, and malware attacks (Paul et al., 2023). In addition, few regulations are in place to protect health information in creating a digital health footprint (Smidt & Jokonya, 2021).

Authors Grande et al. (2020). Paul et al. (2023) and Smidt & Jokonya (2021) iterate that one's privacy cannot be overlooked in the quest to advance digital health technology solutions, as data privacy and protection are a right. Five critical privacy challenges were identified, including transparency and visibility, as people are unaware of how they are being tracked and what information is being tracked about their health. Secondly, flawed data is identified as incorrect data could be collected, affecting the outcome of diagnoses and outcome of treatment, which is transferred with one's digital footprint. Thirdly, the immortality of data because data has no expiration date and may be deemed irrelevant at some point for analysis. Fourth, commercial value from marketing data has the potential to generate revenue and results in many organisations buying and selling data to generate additional revenue. Lastly, the nature in which the data is collected makes it easily identifiable to a person resulting in the lack of anonymity (Grande et al., 2020; Paul et al., 2023; Smidt & Jokonya, 2021).

To overcome the challenges related to personal information, digital health implementors need to consider the following (Grande et al., 2020; Paul et al., 2023):

- The consent of a patient, where their data is distributed, and the type of information collected.
- Personal information protection acts have been implemented to ensure the constitutional right to privacy for all and make it more challenging to collect data. Examples of such personal protection acts include POPIA in South Africa, the Genetic Information Non-discrimination Act, General Data Protection Regulation and the ePrivacy Directive in the European Union, California's Consumer Privacy Act, and more recently, the General Data Protection Law, which was implemented in Brazil.
- The transformation of personal health data as a patient's health changes over time.
- The various ways data might be provided over time may differ each time it is collected (i.e., imaging, vitals, reports, manual note, etc.).
- The application and transfer of the data into technologies assist with analysis,

outcomes, and predictability of health outcomes as well as the footprint generated through daily activities and the use of multiple technologies.

- A distinction between health and non-health personal information as it relates to the health of a patient.

If patient data is not well managed, it may affect a patient's willingness to share their information due to a lack of trust, resulting in financial constraints to maintain digital health-related services and personal information (Grande et al., 2020). Without reliable data, digital health technologies cannot provide reliable solutions to address healthcare challenges (Paul et al., 2023).

2.4.2 Penetration of the Internet and the development of mobile infrastructure

Typically, countries have varying capabilities to optimally harness and integrate digital technologies, such as the required infrastructure in which the digital technologies are to be implemented (Marwaha et al., 2022). A critical factor determining technology adoption is internet and mobile penetration rates, as seen in Figure 3 below, has experienced fast growth trajectories year on year (Statista, 2021). Mobile phones have become the most common technological device in the country's history and continue to grow (Adeola & Evans, 2018).

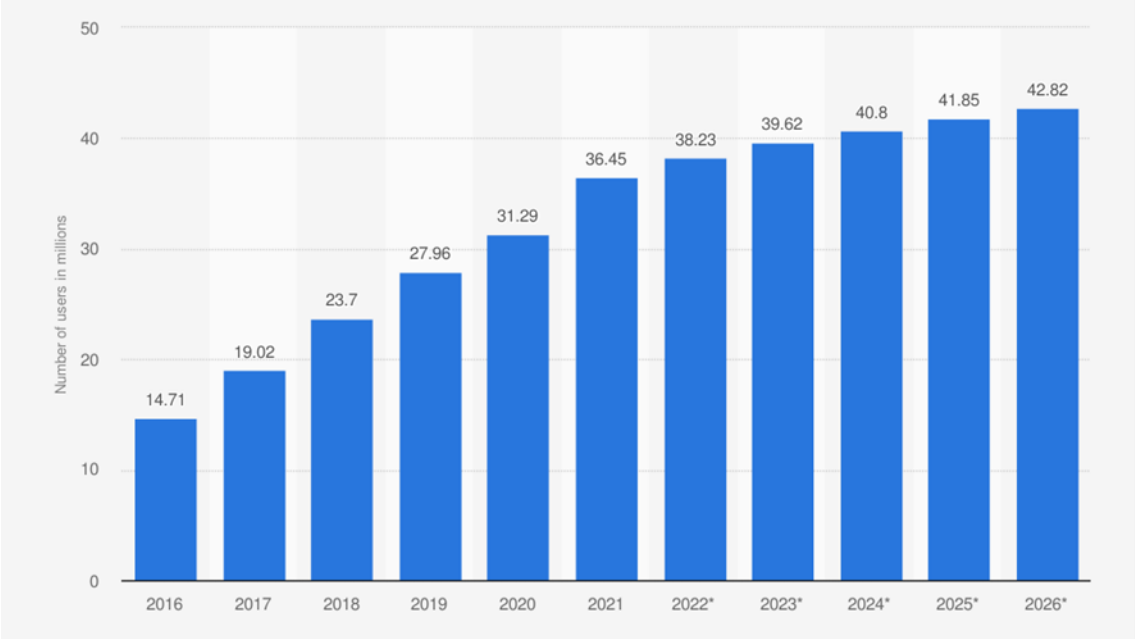


Figure 3: Number of mobile internet users in South Africa from 2016 to 2026 in millions

Source: Statista, (2021)

A study conducted by the Pew Research Centre identified that mobile access

penetration in South Africa in 2018 was 95% and that only 5% of South African adults did not own or share a phone with someone else (Adeola & Evans, 2018). The increased mobile and internet penetration has resulted in various innovations integrating mobile phones and the internet into healthcare at local, provincial, and national levels (Adeola & Evans, 2018; Marwaha et al., 2022).

As phone and internet penetration increases, consumer demands rise, resulting in a wider gap between the perceptions of patients and healthcare workers (Maphumulo & Bhengu, 2019). This results in a more complex patient care environment and an unavoidable demand for high-quality care delivery, while resource shrinkage continues and remains uneven (de Villiers, 2021).

The increased use of mobile and the internet makes it more possible to use digital health technologies via mobile applications and the internet in rural areas where the most significant gap remains (National Department of Health, 2019; Ojo, 2018).

2.4.3 Unequal distribution of resources in healthcare

As previously mentioned, the South African health sector is unequal in that 80% of the population is serviced and funded by the public government, and 20% is privately managed and funded by individual contributions to a medical health insurer and partly the government (Buswell, 2022; Maphumulo & Bhengu, 2019; Ojo, 2018).

South Africa is known to have developed well-established training institutions that are highly ranked globally and produce academically strong health professionals. However, the country's health care system is experiencing critical challenges, which has resulted in an unequal distribution of health workers between the well-resourced private sector and the poorly resourced public sector, as well as distributional disparities between urban and rural areas (de Villiers, 2021; Maphumulo & Bhengu, 2019).

The healthcare system in rural areas and government hospitals is overburdened and needs to be more capable of providing consistent and quality healthcare. According to Maphumulo & Bhengu (2019), Ojo (2018), and the WHO (2021), low-income patients are known to experience prolonged delivery resulting from poor infrastructure, poor

availability of medical supplies and equipment, substandard-quality treatments, frequent stock issues, and suboptimal provision and use of medicines.

Meaning more extraordinary efforts, resources, and focus is required to improve the state of health for much of the public in South Africa and shift the resources from private to public to fulfil the gap using technologies (Department of Health, 2019; Pillay & Motsoaledi, 2018).

2.4.4 High burden of disease causing strain on healthcare

South Africa, like most developing countries, faces a high burden of diseases; HIV/AIDS, TB, and a growing burden of non-communicable diseases (e.g., cardiovascular diseases, diabetes, chronic respiratory conditions, and cancer) are known to overburden the healthcare system, making it unable to meet the required demands of high-quality health care or seek to adopt emerging technologies (Maphumulo & Bhengu, 2019).

These diseases have also been labelled as some of South Africa's most significant causes of death (Department of Health, 2019; WHO, 2021). The recent COVID-19 pandemic also increased the strain on the healthcare system due to the increased demand for medical care for diagnosis, treatment, and vaccines (Farao, 2020a; Wang et al., 2021a).

The increased strain on the public sector makes it more difficult to focus attention and resources on digital health technologies until such a time that strategies that focus on reducing the strain and improving disease control are more effective (Buswell, 2022; de Villiers, 2021; Maphumulo & Bhengu, 2019; Matsoso, 2020; Pillay & Motsoaledi, 2018).

2.4.5 Critical technology considerations that affect the implementation and sustainability of digital health technologies

There are several key considerations to be made when adopting digital health technologies. These are important to consider as failure to do so affects the success of digital health technologies resulting in implementations that do not meet the required need or lack the anticipated benefits to be realised (Marwaha et al., 2022).

Table 2 below details those considerations as adapted by authors (Marwaha et al., 2022; Matsoso, 2020; Rambire, 2022).

Table 2: Key considerations for technology adoption

Consideration	Description
Financial Value	How will the technology achieve an ROI/generate revenue? Do the costs and maintenance outweigh the profits? How long will the technology take to recover the cost of operations and implementation? The financial value is considered one of the most crucial items to consider (Marwaha et al., 2022; Rambire, 2022). Adopting new technology is an onerous process that requires time dedication, stakeholder management and skill, understanding the cost benefits offered by the technology and how it affects the desired goal not only justifies the effort that is required to put in to implement the solution but more importantly, puts concrete numbers to determine the return on investment as well (Rambire, 2022).
Cost	Are the maintenance, development and upgrade costs well provided, understood, and planned for? Considering the overall costs of technology implementation and maintenance over the life cycle of the technology helps to determine whether the solution will be successful and whether changes are required to ensure long-term success by comparing various variables associated with the solution e.g., high maintenance costs resulting in lack of feasibility in the long-term (Marwaha et al., 2022).
Vendor	Does the vendor have a good reputation for delivering what was promised? Does the vendor have hidden terms and conditions, costs etc.? Who will be responsible for the long-term maintenance of technology? Critically assessing the considerations associated with the vendor reduces the risk of gaps in service delivery, the delivery of low-quality solutions and hidden inflated costs (Deloitte, 2021b).
KPI's	Are there KPIs that can be measured to determine the effectiveness of the technology? (E.g., increase in customer satisfaction, reduction in wait times etc.). Are the desired outcomes of the technology clearly stated and understood and trackable? Clearly identifying key KPIs allows for an improved measurement of the technology's performance over time resulting in the identification of trends and its effectiveness allowing the stakeholders to adjust key elements to ensure success (Matlebjane & Ndayizigamiye, 2022).

Product selection	Does the technology meet all the specified requirements? Does it align with institutional goals and regulatory compliance? Clearly identifying the requirements reduces the risk of a technology implementation that does not meet the overall goals and required benefits (Marwaha et al., 2022).
Outsourced or inhouse	How is the tool being developed- inhouse, outsourced by company, outsourced by a third party? If inhouse, are the required capabilities present to ensure success of implementation and sustainability. For outsourced and third-party considerations, see point above on Vendor. Whether the technology solution is developed inhouse or outsourced, the required skill and capabilities are required to ensure successful implementation, failure to do so results in incomplete delivery or low-quality delivery that does not meet the desired requirements (Marwaha et al., 2022; Rambire, 2022).
Resource availability	What is the existing technology, infrastructure, training, skills, resources, and budget required to implement and sustain the technology? Do we have the required resources for implementation and maintenance in the long term? Is it easy to acquire the required resources if not available? The resources and skills required to implement technology solutions is key to ensure that the implementation does not run over time, budget, and gets implemented as per the requirements (Matsoso, 2020).
Infrastructure	Can the technology be implemented in the current infrastructure or is work required? Developing countries experience challenges related to poor basic infrastructure such as access to the Internet in all regions which impacts the operational efficiencies of technology if unavailable (Marwaha et al., 2022). In addition, complex and decentralised legacy systems make it difficult to integrate into due to their incompatibility with new technologies, inflexibility, inability to adapt to changing requirements and high cost to maintain resulting in an implementation that will remain uncompleted, does not meet the requirements, runs over scope, budget, or time (Matsoso, 2020).
Data asset	Is the data required by the technology readily available? How well is the data, collected, stored, and managed? Is training data required for tuning of the technology? Has data governance been established? Is the technology interoperable with other technology systems (existing and planned)? If not interoperable, what amount of work is required to ensure interoperability? The power of using digital health technologies relies in the availability of data to revolutionise healthcare, data

	governance needs to be applied to ensure that the data is protected, accurate, reliable and is compliant with all systems (Marwaha et al., 2022; Matsoso, 2020). Further, the availability of accurate date is key to realising the benefits of digital health technologies by reducing medical errors, analysing patient health to identify inconsistencies, diagnosis, and potential medication error by providing a holistic view of a patients records (Deloitte, 2021a).
Security	What security measures have been implemented to protect sensitive and private information? Security is essential in healthcare data for several reasons: Protecting sensitive patient data: Healthcare organisations store a vast amount of sensitive patient data, including medical histories, diagnoses, and treatments. This information can be used to commit identity theft, fraud, or other crimes (Marwaha et al., 2022).
Implementation	Is training required? Do processes need to be modified to allow for easier implementation of the technology? What support, resources, timeframes etc. is required to ensure successful implementation? Understanding training requirements, processes to support solutions, resources, and timeframes aids in the success of implementation and sustainability of solution by ensuring that capabilities, processes, and all other support elements are in place to ensure the benefits are realised from the technology solution (Bernstein, 2021).
Institutional alignment	Does the technology align to the overall goals and strategy of the DoH/NDoH in the short and long term? Or aid in regulatory compliance? Effective alignment ensures that everyone involved in the process is aware of their responsibilities and the regulatory requirements that must be met (Maphumulo & Bhengu, 2019). By aligning stakeholders and technology requirements to the overall goal that it is aiming to achieve, it ensures that everyone is on the same page and working towards the same goals and that the technology meets the same goals (Marwaha et al., 2022)
Sponsors/ champion	Are there sponsors/ senior level advocates and internal champions that have been identified to support pay and champion the implementation and long-term sustainability of the project? Sponsors are leaders who play a key role in promoting, advocating, and shaping the implementation of the solution (Deloitte, 2021b). They oversee the project and programme management functions and remains accountable for ensuring the realisation of the specified benefits over time (Marwaha et al., 2022)

Sustainability	Has the long term sustainably, maintenance support been identified? Has the assessment on the quality and application of future requirements being added in a flexible manner been assessed? To ensure that benefits from a solution are continually realised, the sustainability of the solution needs to be considered to ensure that future requirements can be accommodated for, the cost of keeping the technology running is manageable and will not affect its use and that resources with the right skill are available to handle the maintenance and long-term running of the solution (Deloitte, 2021a; Marwaha et al., 2022). Failure to do so results in the ineffectiveness of the solution in the long-term.

Authors Maphumulo & Bhengu (2019), Marwaha et al. (2022), and Matsoso (2020) argue that to increase the probability of digital health technologies, all the considerations mentioned above need to be examined, failure to do so results in many implementations that cannot be integrated into the current environment, start, and remain unfinished, do not meet the requirements, run over the time, scope, and budget.

If a particular technology meets all considerations, prototyping is crucial to validating the requirements/functionality, ability to integrate, required skills and capabilities, and potential for adoption, by securing buy-in without significant investments being made. If the prototype is a success and adoption seems feasible, then the scale-up of the technology to more users and larger domains becomes the next step. A customer-centric approach should be followed to enable feedback and lessons learned to ensure the technology meets all requirements and considerations.

2.4.6 Poor healthcare system infrastructure to support new technologies

The South African Health care system has inconsistent basic infrastructure across the country between the public and private sectors, urban and rural areas, and various technologies that each hospital uses and with each province (de Villiers, 2021).

The public sector currently has fundamental infrastructure challenges, including an inconsistent supply of electricity, which makes it difficult to use technology as it may only sometimes be on and available (Pillay & Motsoaledi, 2018; Rensburg, 2021). A

consistent electricity supply is critical to ensure that all data relevant to patient care can be captured and processed and that healthcare providers refrain from resorting to manual processes (Pillay & Motsoaledi, 2018).

Healthcare providers prefer traditional working methods, including manually recording appointments, patient details, patient symptoms, patient test results, referral letters to other specialities, and scripts (Pillay & Motsoaledi, 2018).

Inconsistent power supply threatens the effectiveness of these technologies as, firstly, the preferred method of working will remain a manual process due to the reliability of the practice and the unreliability of the technology. Secondly, when there are times that the technology is not available, there is a risk of data gaps forming as there is an inability to collect the information. This results in an incomplete understanding of a patient's health needs and conditions, leading to unfavourable health outcomes and a lack of user trust in the system (Paul et al., 2023; Smidt & Jokonya, 2021).

In addition to electricity challenges, the availability of telecommunication services remains unstable and unreliable in rural areas, where the most significant gap in healthcare access and quality of delivery is experienced (Adeola & Evans, 2018; Grobbelaar & Uriona-Maldonado, 2019). Digital tools and technologies are practical because of their connection to the internet and the ability to share information between connected devices, systems, and other relevant technologies (Bernstein, 2021; Deloitte, 2021a). Like the electricity challenge, when data is unable to be shared between systems, relevant digital tools, and technologies, a holistic view of the patient is not achievable, also resulting in unfavourable health outcomes and ineffectiveness of the technology (Paul et al., 2023; Smidt & Jokonya, 2021).

Poor building structures, lack of running water, and outdated legacy systems are additional known factors affecting healthcare delivery and quality and hindering health technology implementation (Buswell, 2022; Maphumulo & Bhengu, 2019). These remain a hindrance because it is challenging to apply sophisticated technology on outdated technology that lacks the capabilities to run in parallel with or integrate with other systems due to the lack of functionality, updated communication protocols,

data collection capabilities, security, expensive maintenance, inflexibility, and siloed operations (de Villiers, 2021)

Author Marwaha et al. (2022) agree that infrastructure is the key to unlocking the pillars of digital technology implementation in both developed and developing nations. The key pillars are the necessary building blocks such as reliable electricity, telecommunication technology, medical equipment, building infrastructure, processes, staff, implementation and sustainability initiatives, ICT, and governance stakeholders.

The elements of infrastructure are required to be improved as they are considered the foundation to integrate the hospital, clinic, or practice into the more extensive healthcare system as it facilitates the elements of patient experience, effectiveness, connectivity, and sustainability (Precedence Research, 2022; The Office National Coordinator for Health Information Technology, 2020).

Marwaha et al. (2022) adds that although the infrastructure is vital, in parallel to strengthening the foundation of infrastructure, the healthcare system and necessary stakeholders should support the improvement of the sector by adopting and committing to the use of digital technologies.

2.4.7 Decentralisation of the healthcare system across South Africa

Digital health tools are typically informed by one or more data sources when generating outputs such as prognostic or diagnostic predictions, administrative tasks, or documentation recommendations. Familiar sources of structured and unstructured data include X-ray imaging, diagnostic reports, appointment scheduling, claims, billing, scripting, etc. The health system must ensure that the new digital tools access the appropriate data stream at the appropriate interval (e.g., real-time, weekly, or monthly) for full functionality and benefits realisation (Marwaha et al., 2022).

However, the collection of data from multiple sources is a challenge because South Africa has adopted a decentralised approach to how they have structured health care services across the country and is organised into three levels, namely the national, provincial, and local government (de Villiers, 2021; Maphumulo & Bhengu,

2019). There are nine provinces and multiple local governments within each province; each operates autonomously in the strategies, focus areas, technologies they implement, data they collect, etc. (Maphumulo & Bhengu, 2019; Ogundaini et al., 2021). This results in varying levels of technology maturity, governance, and health delivery in each province.

Figure 4 below displays the macro-organisation structure, split into public and private health. The government at a national level oversees policy regulation with their coordination and implementation at the provincial and local levels and caters to healthcare delivery in the public health sector. The Private health sector is run independently and includes private medical insurers, a network of private hospitals, clinics, and healthcare professionals.

On the right side in Figure 4, the organisation of the public health sector is displayed, showing the nine provinces that operate autonomously in their decision-making, governance, and health care delivery.

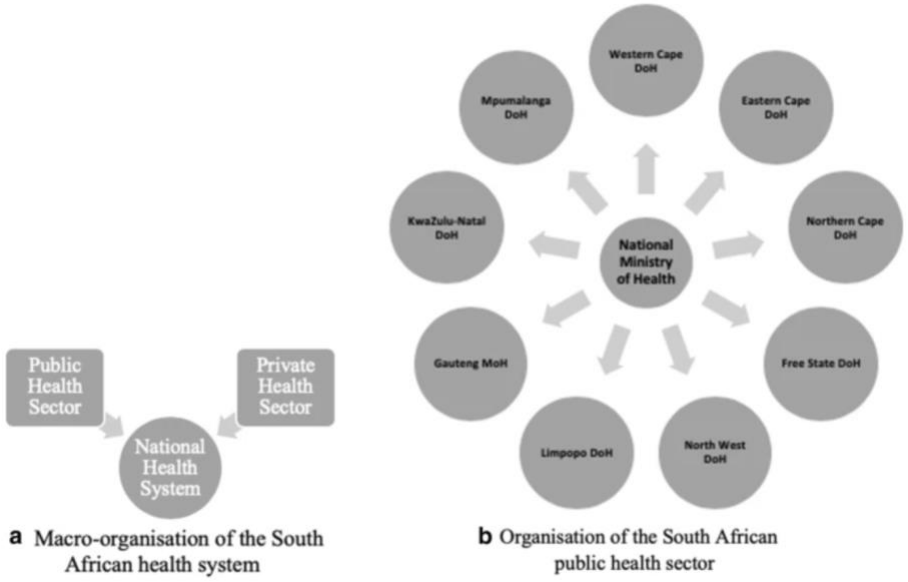


Figure 4: Organisational breakdown of the South African government health system and sector

Source: Buswell (2022)

The split between private and public, and a further split of nine provinces in the public sector means that there are varying maturity infrastructure foundations in technologies that are used and implemented because they are at varying levels of sophistication, different health care delivery processes that are followed, varying

medical infrastructures, equipment, resource availability and varying funding approaches that are followed, etc. (Buswell, 2022; de Villiers, 2021; Maphumulo & Bhengu, 2019).

Research by Maphumulo & Bhengu (2019) shows some benefits to decentralisation in developing countries by strengthening the capacity of local and provincial governments to enhance resource allocation to improve healthcare delivery outcomes. However, the authors believe that decentralisation intensifies the disparate delivery of healthcare, with disadvantaged citizens being affected the most.

The decentralisation approach results in inconsistent service delivery, which is enhanced because of infrastructure inconsistencies and inadequacies from the non-interoperable technologies, processes, data collection, assessment measures, etc., further hindering digital health technology adoption across the country (Ogundaini et al., 2021).

2.4.8 High cost of implementation

According to Carr (2020) and Rahimi et al. (2018), the cost of implementing digital health technologies has been determined to be costly, with the implementation and operationalisation of health technology being identified as the most significant contributor. Especially in an environment where large and complex technologies with varying maturity already exist (Marwaha et al., 2022).

Research by Marwaha et al. (2022) and Voogt et al. (2018) also conclude that costs are a substantial barrier to the adoption of fundamental technology; this includes the cost of acquiring the technology, resources required to effectively develop, deploy, and run the technology and, on-going operational costs (such as support contracts with vendors, ongoing license costs and, occasionally, upgrade costs, etc.).

Author Marwaha et al. (2022) state that costs with all software will vary with functionality and the level of automation required; thus, organisations must analyse to decide which technology solution work best based on the given resources, even though there is no perfect application.

2.4.9 Poor management, leadership, and the decentralisation of policy regulation

In South Africa, healthcare management and policy regulation are even more difficult with the decentralisation of policy creation and implementation across South Africa between the national and provincial governments (Buswell, 2022; Maphumulo & Bhengu, 2019). Marwaha et al. (2022) adds that the separation of policy determinates and policy implementers contributes to the complex nature of the South African healthcare sector due to the autonomy that policy implementors at the provincial level have.

According to the Centre for Development and Enterprise, poor healthcare delivery can also be attributed to poor leadership and management, lack of goal setting, lack of vision, and a lack of a clear philosophy (Maphumulo & Bhengu, 2019).

A specific focus on implementation and digital adoption in the sector beyond the policy formulation is required to ensure that goals and objectives are met (Maphumulo & Bhengu, 2019), resulting in progress and consistency of delivery using technology in rural and urban areas, as well as across the private and public sector.

2.4.10 Lack of funding and investment opportunities to fund solutions

The latest South African budget speech announced that R809 billion would be provided to support and provide health services, which amounts to 13% of its financial resources (SA News, 2022). Despite similar large allocations being provided over the years, the country remains largely inefficient and unequal as half of the allocated spending is spent in the private sector, which only caters to 20% of the country (Michel et al., 2020). The remaining population is under-resourced and served, despite the public sector experiencing a more significant disease burden and reliance on services (Michel et al., 2020).

Most funds that add to the overall pool of funding for the sector are financed through taxes collected, private medical health scheme contributions, and direct out-of-pocket payments. In contrast, the public sector is mainly funded through tax allocations (Ataguba, 2021).

Maphumulo & Bhengu (2019) and Marwaha et al. (2022) claim that implementors of policies do not restrict the health funds, which leads to those funds being re-directed to other spending based on priorities; due to their autonomous operations, this is difficult to manage and ensure that the funds are used for health services.

The government recognises fragmentation and a need to grow the funding pool to ensure technical and allocation efficiencies and attain universal health coverage (Ataguba, 2021; Michel et al., 2020). However, funding is limited, and funding towards digital health technologies is even less in South Africa, resulting in technology innovators and implementors relying on venture capital funding as a primary source (Deloitte, 2021b; Precedence Research, 2022).

2.4.11 Human-induced factors affecting technology adoption and sustainability

2.4.11.1 Fear of job loss

The United Nations (n.d., 2019) and UKEssays (2018), fear that tasks are being automated faster than jobs are being created; technology is changing the labour force by creating new patterns and ways of work, resulting in the need to upskill and reskill (including with digital capabilities) to remain relevant and succeed as digital tools and technologies become prevalent. As previously stated, the shift towards digitalisation has many benefits, including increased productivity when productivity is declining (McKinsey & Company, 2018). Despite the potential productivity increase of 85% that digitalisation is said to affect (UKEssays, 2018).

Advisory group and author McKinsey & Company (2018) and the World Economic Forum (2020) also report that as many as eight hundred million people globally could lose their jobs to automation by the year 2030, resulting in many employees fearing that they do not have the required skills for future work.

While competence in emerging technology and related skills is essential, the Future of Jobs Report from the World Economic Forum (2020) states that soft and human skills such as creativity, critical and strategic thinking, negotiation, etc., remain crucial elements for employees, and are difficult to replace with any form of technology.

Therefore, instead of only investments into technology and its associated skill requirements, companies should look to capability building, mentorships, and education to encourage employees to improve both personal and professional skills in the new technological ecosystem, to keep pace and excel with the vigorous change expected in the coming five to ten years (UKEssays, 2018; World Economic Forum, 2020).

2.4.11.2 Self-efficacy in technology use

In technology adoption models, self-efficacy is the most examined component. Technology self-efficacy is based on social cognitive theories in the belief of self-efficacy (Park & Lee, 2018). This relates to how people decide how much effort, perseverance, and worry they will exert when working on a specific task, whether existing or new ways of working .

Self-esteem and self-confidence are broader evaluations of an individual's talents. However, perceived self-efficacy is more specific to an individual's belief that they can perform certain tasks under set conditions. Self-efficacy is not identical to self-esteem or self-confidence; however, there is a relation to both, and they may influence each other (Park & Lee, 2018).

According to Sakka et al. (2022) individuals who demonstrate high efficacy are likelier to succeed in their tasks and demonstrate more enthusiasm to utilise ICTs; similarly, low efficacy results in a reduced likelihood of utilising ICTs.

Self-efficacy is a critical factor in determining the activities people partake in, the effort they put into pursuing the activity, and the perseverance they demonstrate in various situations (Park & Lee, 2018). Self-efficacy expands beyond belief in one's ability and includes the motivation required to perform a task(Javed & Brishti, 2020) .Self-efficacy is particularly well-suited to predicting broader technology engagement and performance, like comprehensive technology ability (Steyl, 2020).

Additional factors such as mastery experiences and social persuasion affect an individual's self-efficacy, according to Park & Lee (2018) . A favourable result will boost a person's confidence in their talents. Failing, however, will weaken it, especially before effectiveness has been formed.

When a person sees another person succeeding at an activity, including a digital one, he or she is motivated to strive for the same proficiency. If a person sees another person fail at a task, it may impair their feeling of drive, resulting in a drop in self-efficacy (Park & Lee, 2018; Steyl, 2020). Consequently, mastery experience is the most efficient way to develop a strong sense of effectiveness and is enhanced with social persuasion (Park & Lee, 2018)

Physiological and emotional elements are how a person assesses their confidence level when considering the task. Individuals' psychological and emotional conditions impact their perception of self-efficacy. Emotions like anxiety and tension must be managed to shift the experience and boost a person's initial perception .

2.4.11.3 Anxiety when using technology

ICT anxiety is the dread some individuals feel when faced with the possibility of being forced to utilise ICT (Park & Lee, 2018). Technology anxiety is an unpleasant reaction to the concern that using technology can culminate in a dire consequence, such as causing damage or making one seem unskilled and inexperienced. Anxiety over using ICT significantly influences the adoption and future ICT sustainability (Park & Lee, 2018).

Various elements affect user anxiety; higher anxiety in ICT negatively influences the learning of new technology skills and poor task performance (Park & Lee, 2018; Steyl, 2020). The experience also impacts anxiety. A previous failure in an activity might make a person nervous about attempting the activity again, resulting in a phobia that affects the adoption in the implementation of health ICTs

Feelings of threat and anxiousness might significantly hinder the acceptance of information technology. Anxiety is a big challenge that must be addressed if an increase in successful health technology implementations is anticipated.

2.4.11.4 Enjoyment and curiosity of technology use

The components of intrinsic motivation are enjoyment and curiosity. An optimistic view/experience of ICT use positively influences enjoyment and sparks curiosity,

and a negative one impedes it. Similarly, a positive performance improves drive. If individuals like their experience and thus are effective, they are much more likely to return (Park & Lee, 2018; Steyl, 2020).

Several studies have been conducted to determine the impact of playfulness and its influence on perception and mobile learning (Fenech et al., 2019). They observed that these characteristics were inextricably connected, stressing the need to develop mobile learning content or enjoyable learning opportunities to drive the adoption of ICTs (Fenech et al., 2019).

2.4.11.5 Acceptance of technology through trust and perceived control

Taking charge when using technology is referred to as perceived control. When one is in control of technology, experimentation, and exploration of the technology increase, influencing the acceptance of technology (Javed & Brishti, 2020).

Improving adoption and building trust in oneself and the technology is beneficial. According to Sakka et al. (2022), acceptance is a crucial factor in technical competence as it changes attitudes and increases the range of technological use. Park & Lee (2018) adds that building an understanding of failure from experimentation is required and should not deter users, as it leads to learning.

Trust is built from acceptance and increased technical use, which improves one's ability to use digital technologies, enabling adoption (Park & Lee, 2018; Sakka et al., 2022).

2.4.11.6 Previous use and experience of technologies

Research reports that a user's prior ICT experience has a favourable connection with their self-efficacy and experience views and provides the most consistent knowledge to perform similar functions (Javed & Brishti, 2020).

When piloting and implementing technologies with various stakeholders in the healthcare system, Park & Lee (2018) consider it essential to engage individuals with previous use and experience to ensure that buy-in is present to drive digital strategies for improvement. Where there is no previous use or experience, an emphasis on training to build that experience is necessary

2.5 Analytical framework

This section of the research report details the analytic framework of the theoretical and empirical concepts studied in the literature review

2.5.1 Theoretical framework

The prevalence of digital technologies in society today is brought about by the emergence of new technologies (Wang et al., 2021a). Authors Armstrong & Lee (2021) expand on this belief by stating that the industrial revolution we are in further integrates the digital and physical elements with new technologies by fundamentally changing how we live and work.

An additional definition by Ghobakhloo (2020) further details the industrial revolution as a conceptualisation of rapid technological change that interconnects embedded systems, industry, business, internal functions, processes, and business.

Kraus et al. (2021) detail that four disruptive technological concepts are supporting the transformation change, first, the fourth industrial revolution which is the integration of computing power to enable autonomy in daily life, second, AI which is the transformation of processes so that they don't rely on human interventions, third, Big Data which is the volume, variety and velocity in which data is available today and lastly, the Internet of Things which connects devices to the internet and allows for communication between other devices and systems.

The common characteristics between definitions stated by authors Armstrong & Lee (2021), Ghobakhloo (2020) and Wang et al. (2021a) are:

- Compared to previous industrial revolutions, the exponential rate of adoption in society today has no historic precedent
- Technologies are disrupting all industries across the world and are the driving force of digitalisation
- The breadth and depth of transformation impact all aspects, including systems, processes, way of work, business models, governance and required capabilities
- The possibilities are enhanced by the breakthrough of technologies like AI, ML, the Internet of Things, Big Data, predictive analytics, and blockchain

The health industry is no different, rapid technology change has resulted in the emergence of digital health technologies which aim to transform the industry by reducing costs, improving efficiencies, introducing new players in the healthcare value chain and empowering patient and healthcare players with information that enable improved health outcomes.

Several definitions of digital health technologies exist, Ojo (2018) and Rambire (2022) describe it as technology-enabled care, which sees the convergence of health, mobile devices, technology, and digital tools. Wang et al. (2021) expand on the definition to include eHealth, mHealth, telehealth, IoT devices, big data, and emerging fields as part of digital health. Which he further defined to be

- mHealth: provision of healthcare services using a mobile device
- eHealth: provision of healthcare services supported by electronic processes and communication using the internet
- IoT and connected devices: physical objects that connect and exchange information with other devices and systems over the internet.
- AI: a capability which allows for the perception and synthesis of information using technology to achieve a goal
- ML: a form of AI which enables applications to improve their accuracy and prediction outcomes
- Big Data: Large and complex data sets that cannot be processed using traditional methods
- Predictive analytics: the use of models to make predictions on future outcomes
- Blockchain: an advanced system that has a record of information within a network to allow for transparency

Asthana et al. (2019) further defined digital health as having the ability to significantly transform the management and provision of healthcare using constantly evolving digital technology to unlock countless possibilities that are attributed to healthcare, such as electronic records, telehealth, monitoring equipment (including wearable devices), electronic communications, the use of the web, cloud-based tools, and data analytics. These technologies aim to improve healthcare quality through

enhanced monitoring, knowledge, quality, and access to health care, improve efficiencies and reduce the cost of health-service delivery (Maphumulo & Bhengu, 2019; Rambire, 2022).

The definitions are aligned in that digital health technologies utilise technology to enhance the efficacy of healthcare delivery to achieve improved health comes that are more personalised and precise. Digital health technologies are therefore categorised by: mHealth, eHealth, IoT, AI, ML, Big Data, and predictive analytics.

The benefits that can be derived from digital health technologies are not contested by authors Bernstein (2021), Kraus et al. (2021) and Rambire (2022) and are defined to improve efficiencies, reduce cost, creates new business opportunities, and business models to address challenges in the healthcare sector and other problems related to, among others, to enable better health outcomes and universal access to healthcare.

While the adoption of digital health technologies is the goal of all countries across the globe, authors Deloitte (2021a), Maphumulo & Bhengu (2019) and Marwaha et al. (2022) recognise that there are several factors that need to be considered to ensure the success of implementations to address the current challenges in the sector.

The factors are commonly defined to be the technological focus on interoperability of systems and technology considerations that influence the result of successful digital health implementation and sustainability thereof to reach large-scale adoption (Aruleba & Jere, 2022; Maphumulo & Bhengu, 2019; Ojo, 2018; Wang et al., 2021a).

Authors Marques & Ferreira (2020) demonstrated that there is a growing body of knowledge on factors and more so during the COVID-19 pandemic (Farao, 2020b; Kraus et al., 2021; Wang et al., 2021a). Author Kraus et al. (2021) further highlight the technological focus remains with more considerations on the mindset shift required from people to achieve success, research does not appropriately detail the considerations for the multiple stakeholders including the new players such as technological partners across all aspects of the healthcare system.
Other approaches to determining factors also include understanding a specific

technology in relation to a specific disease (Marwaha et al., 2022), or applications of use in transforming developments related to disease i.e., HIV/AIDS, COVID-19, and other conditions (Mbunge et al., 2022). Examples of this include understating how virtual healthcare services and digital health technologies deployed during the COVID-19 pandemic.

Research approaches on the challenges and factors that are faced in large and complex health systems in developing countries is considered critical (Matsoso, 2020; Olu et al., 2019) as South Africa is seen as large and complex with many challenges because of its history. The challenges developing countries face with a divide inhibit potential improvements in services. However, research remains prominent in non-peer-reviewed articles and discussions.

The study recognises that a perspective from multiple stakeholders is required to deeply understand in practice how the various players of a healthcare system (pharmacies, hospitals, health workers and more) can take advantage of digital health technologies by considering factors relevant to funding, developing nations core infrastructure that the technology is based on, leadership and management support, policy regulation, stakeholder buy-in and more. It also recognises the need for a perspective to be applied to developing countries with complex health systems.

As a result, the multi-stakeholder approach combined with a view on the challenges faced by developing countries is considered best for this study as it takes into consideration the new players that are the primary developers of digital health technologies while exploring factors beyond technology that are relevant for developing countries like South Africa.

2.5.2 Conceptual framework

The conceptual framework which has been visually depicted in Figure 5 below was developed by identifying all the variables and their presumed relationship between them. Key variables identified include:

- The emergence of technologies
- Digital health solutions
- Factors impacting implementation

- An effective South African healthcare system
- Challenges within the healthcare system

As seen in the figure below the relationship between the variables is identified as the emergence of technologies today and their prevalence in society is caused by the fourth industrial revolution which affects the availability of digital health solutions (Papadopoulos, 2022). The technologies form the foundation for the solutions to address the challenges experienced in the South African health sector.

The various applications of digital health technologies and their implementation effectiveness in turn impact the overall sector by reducing inefficiencies, increasing lifespan etc.

The factors impacting implementation have been identified as a moderating variable as these factors influence the outcomes achieved i.e., how operationally efficient the health sector will be, how much the access and quality of healthcare improves the industry given the infrastructure, technology interoperability etc. factors.

The experience has been identified as a control variable as the research paper does not investigate the effects of piloting to achieve the desired outcomes of a transformed healthcare system, however, the paper acknowledges that pilots, incubators, and the like affect the results.

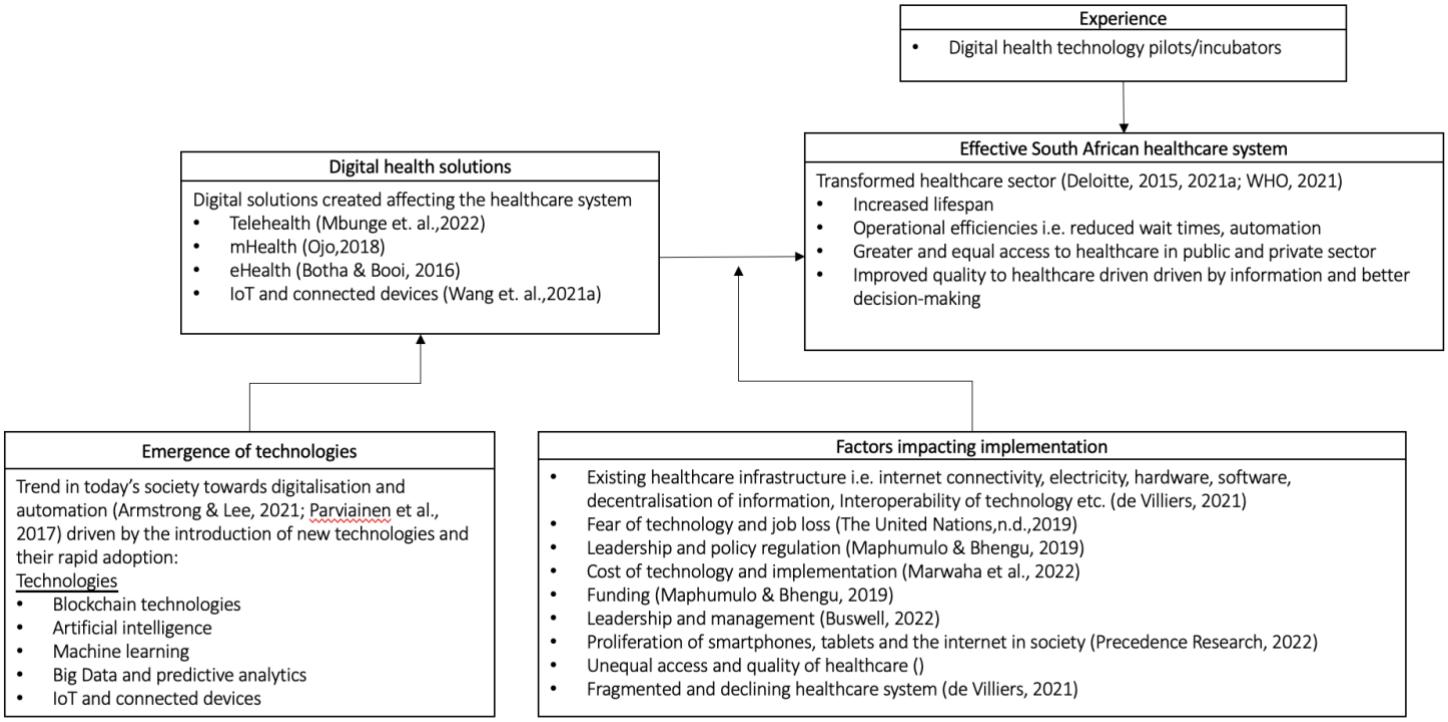


Figure 5 Conceptual Framework utilised to conduct research

Source: Researcher

2.6 Conclusion of literature review

The emergence of new technologies in society due to digitalisation and the fourth industrial revolution has impacted how industries across the globe operate, with new and innovative products and services being developed and new business models being applied (Armstrong & Lee, 2021; Papadopoulos, 2022; Peerally et al., 2022).

Authors Ghobakhloo (2020) and Papadopoulos (2022) further describe the fourth industrial to be: a conceptualisation of rapid technological change that interconnects embedded systems, industry, business, internal functions, processes, and business.

Resulting in industries being disrupted at varying rates, and digital technologies are becoming the foundation for solving existing challenges experienced, however, authors Papadopoulos (2022) and Marwaha et. Al. (2022) argues that despite this, the healthcare sector in developed and developing countries lags in implementing digital technologies (Adeola et. al., 2018; Rabe, 2022)

Authors agree that the South African healthcare sector is the same; there is unequal quality and access to healthcare between the public and private sectors, and between areas in the country, with rural areas most affected . The quality and access to healthcare continue to deteriorate as the burden of disease increases, poor infrastructure remains unchanged, and patient expectations of the health system rise.

South Africa has no choice but to focus more on using digital health technologies to better serve. As a result, the factors impacting the implementation and sustainability of digital health technologies are analysed to identify which critical factors need to be addressed to ensure more large-scale implementations that will improve the quality and access to healthcare across the country.

Digital health technologies are mHealth, eHealth, IoT, connected devices and other ICTs such as blockchain, machine learning, AI, Big Data, and predictive analytics (Marais et al., 2020; Swartz et al., 2021b; WHO, 2021). These have multiple applications of use broadly described as remote and improved decision-making in disease diagnosis, treatment, and management (Olu et al., 2019; Swartz et al., 2021b; WHO, 2021).

The vast applications of digital health technologies is driven by the penetration of intelligent internet-connected mobile devices (smartphones and tablets) in society and mobile applications related to health and fitness (Adeola & Evans, 2018; Precedence Research, 2022). Authors George (2020) and Matsoso (2020) adds that the maturity of development in IT infrastructure plays a key consideration. As well as the global pandemic which exposed weaknesses, including a lack of sophisticated technology adoption in healthcare sectors, which sparked the need to transform (Mbunge et al., 2022; Wang et al., 2021a).

A report published by the (GSMA, n.d.). identified solutions to be fragmented; 101 mHealth solutions have been implemented, with most of the solutions addressing the same areas of HIV/AIDS and women and children utilising message-based solutions (Ojo, 2018), however despite the number of solutions they were skewed towards mHealth solutions and SMS based solutions which favour capabilities and

technologies suitable for low-end smartphones and feature phones to reduce the barrier to entry.

Literature by Ojo (2018) and Morse et al. (2020) also shows that rudimentary applications are observed in South Africa because they can achieve an expansive reach as communication can be made to and between any user, whether they have a smartphone or a feature cell phone, which eliminates the need for internet connectivity.

Given the literature the study proposition is in alignment with Ojo (2018) and Morse et al. (2020) that

Marwaha et al. (2022) suggest that factors need to be explored with all stakeholders in the healthcare system to fully understand them as South Africa, like many developing countries, faces different challenges, and the approach to large-scale sustainable implementations requires factors to be addressed which include factors impacting implementation, including technology interoperability, limited funding, patient access to smartphones and the internet and poor infrastructures.

2.6.1 Proposition 1

Rudimentary applications in the categories of SMS-based and mHealth of digital health applications exist within the overall umbrella which include :mHealth and eHealth, IoT, connected devices, AI, machine learning, Big Data, and predictive analytics. These technologies and solutions are implemented separately and fragmented across the country due to challenges that remain.

2.6.2 Proposition 2

Although several identified factors affect the implementation of digital health technologies, the factors causing the most significant impact are technology interoperability, poor infrastructure, and funding.

3 RESEARCH METHODOLOGY

This section describes the research methodology approach to address the two previously mentioned propositions from the literature review.

3.1 Research approach

The research paper will use a qualitative design approach to determine the answers to the research questions and prove or disprove the propositions that have been made. A qualitative design approach was chosen and considered preferential as this research is subjective, it requires a deeper analysis and understanding of experiences in the health sector, which is best achieved through interviews (Archer, 2019; Flick, 2015).

3.2 Research design

The study's design is generic qualitative and has been chosen because although there is a breadth of knowledge about digital adoption and digital health implementations in health, more research is needed on the factors that affect the adoption and sustainability on a complex and large scale in developing countries. According to Flick (2015), a generic qualitative approach is best suited when little is known about a phenomenon.

Further, the study seeks to understand how people make meaning from their experiences in the phenomenon of digital health technologies in South Africa, which according to Busetto et al. (2020), is the focus of generic qualitative design approaches by providing a detailed description of the phenomenon under investigation. This is best achieved using interviews, as it allows the researcher to ask questions and further probe certain concepts/ aspects of interest.

Busetto et al. (2020) argue that a generic qualitative research approach is considered a more natural and inevitable approach for researching a topic when few theories are available.

The study acknowledges that a significant disadvantage of the chosen approach is that the methodology leaves its findings and interpretations open to questions and

contradictions between elements of the research framework (Flick, 2015; Stahl & King, 2020).

3.3 Data collection methods

Potential participants will first be asked to partake in the study by doing a one-on-one interview (either in person or online); Appendix A shows the letter which will be sent out with the request for an interview. Once a participant agrees, they will be required to sign a consent form, which has been included in Appendix B.

Data will be collected using interviews with healthcare professionals and individuals (in healthcare) involved in implementation who understand digital adoption attempts made in South Africa and what caused those initiatives to be successful and unsuccessful. During the interview, notes will be taken of everything, and an audio recording will be done to allow the researcher to refer to the interview later.

The interviews, either in person or online, will be structured using a guideline of questions about the necessary experience with digital health implementations. The researcher will also allow for probing questions to get more detailed experiences.

Interviews are considered the best data collection method for this study as the information provided is subjective to the participant, requiring detailed probing and documentation to be fully understood (Flick, 2015).

According to Korstjens & Moser (2018) and Stahl & King (2020),the benefits of using interviews include a lower possibility of inaccuracy since the researcher obtains data straight from the source. Furthermore, the data is objective, giving the researcher greater control over the data-gathering technique.

Busetto et al. (2020) add that the benefit of documenting experiences includes allowing for the distance between the participant and the researcher to discover additional topics that the researcher was not aware were relevant, which allows for deeper insights to be gained in the phenomenon under investigation.

3.4 Population and sample

3.4.1 Population and sample source

The chosen population is individuals in the South African (across all nine provinces) technology and healthcare sector with experience with digital health implementations. All nine provinces in South Africa are selected to gain insights across technology implementations in all conditions of healthcare across the decentralised system.

The sample within the population will involve individuals across the healthcare value chain in the digital health technology development, policy regulation, implementation, adoption, and sustainability of technologies which include the areas of funding/investing, researcher, regulatory, policy, implementor/implementation partner, technology developer, advisory, and end-user (health practitioner, i.e., nurse, doctor, practice manager).

The sample was chosen because analysis of the experiences of the identified sample is required to answer research questions as per the generic qualitative research design. To do so effectively, the chosen population must have first-hand experience with digital health implementations.

3.4.2 Sample and sampling method

The study aims to evaluate the factors that influence the adoption and sustainability of digital technologies by healthcare providers in South Africa by conducting a critical assessment of the variety of digital health technologies that have been implemented and analysing the identified factors that affect the benefits realisation required.

To answer the study's research questions, a population of individuals in the South African technology and healthcare sector with experience with digital health implementations was chosen and a sample of specific stakeholders across the digital healthcare value which includes the areas of funding/investment, research, policy regulation, implementation, technology development, advisory, and user was chosen

The sample in question will be:

- Funders/investors: Individuals responsible for funding companies looking to implement digital health technologies.
- Government individuals oversee and advise government regulatory activities, policy formulation, and management.
- Implementors/partners: Individuals that work in the health sector to implement digital health solutions. Examples are consultants assisting digitisation transformations and innovations, individuals working at start-ups and established companies operating within the industry, and medical health insurers implementing digital health technologies.
- Researchers: Provide research and add knowledge to the industry by trials, strategy development, operations management, and understanding the health sector digital technology landscape (trends analysis, interpretation, predictions, competitive landscape, etc.)
- Healthcare workers that have worked with digital health implementations that aim to be implemented and scaled up (Examples include nurses, doctors, and practice managers)

The range of sampling approaches available in qualitative research study include participant observation, in-depth interviews and focus groups, however, the approach to ensure the effective reach of the study's chosen sample is purposive sampling because it is known to be a sampling method most used in adoption and implementation research and information-rich cases where researchers are required to recruit participants who can provide in-depth and detailed information about the phenomenon under investigation (Busetto et al., 2020; Flick, 2015).

It is also most used because the purposive sampling method requires identifying and interviewing individuals or groups who are experienced or knowledgeable on a particular topic and demonstrate their willingness to participate and communicate their experiences and opinions reflectively and expressively (Stahl & King, 2020).

The planned sample size is between fourteen to eighteen participants; authors Busetto et al. (2020), Flick (n..), Korstjens & Moser (2018) suggest that to maximise validity and ensure that no new substantive information is acquired, a minimum of fourteen individuals need to be interviewed at least once.

The researcher will make conclusions based on their opinion to identify participants initially; then, a snowballing methodology will also be used to identify additional participants by asking the interviewed participants to identify others that have the necessary experience to partake in the study.

Author Busetto et al. (2020) encourage the use of this methodology because if it becomes difficult to locate all or a significant portion of the target population. The snowball sampling approach assists as one reference leads to the next, and so on, allowing for the required sample size to be reached. Referrals by the initially identified individuals will also ensure that the recommended individuals have the relevant experience and include all stakeholders from the required sample.

The researcher is currently employed at a medical insurer and works closely with the venture capital division, which seeks to identify critical capabilities to grow the organisation's product and service offering. Initial participants will be identified from the existing network of partnered and invested organisations from the current job and networks from a leading consulting health care practice, where the researcher worked prior.

3.5 The research instrument

The research instrument used is an in-depth interview guide found in Appendix C. An interview guide was chosen to ensure consistency in the questions asked to each participant and that as much experiential information is gathered on the topic.

The interview guide has five sections: introduction, digital health technology experience, effectiveness, sustainability, and future implementations with open-ended questions to ensure as many insights are gathered.

The first section aims to break the ice and make the participant feel more comfortable by asking preliminary questions about previous involvement in research interviews, their career, current role, and their experience in the healthcare sector.

The second section of the interview guide seeks to understand the participant's experience to ensure they have the required knowledge. Questions in this section seek to understand their knowledge of digital health technologies and personal

experience. This aligns with the first research question of the overall trend of technologies and South African specific technology implementations and their use cases.

The third section of the interview guide seeks to understand the effectiveness and the factors affecting these technologies by asking about participants' thoughts/opinions on the efficacy of the technologies and the factors that contribute to their successful and unsuccessful implementation and adoption.

The fourth section seeks to understand factors, concerns, risks, etc., related to the sustainability of the technologies. The third and fourth section of the interview guide aligns with the second research question, which aims to understand the factors which affect digital health technologies adoption and sustainability.

The last section seeks to understand future implementations and what elements/ factors must be considered to ensure sustainability.

While the participant is answering questions and recounting their experience, the researcher will write the details down and ensure that the conversation is being recorded. The researcher will also probe and ask follow-up questions on answers to ensure that as much detail and information are gathered and validate statements from other participants.

3.6 Data collection procedure

The instrument will be piloted, and data collection fulfilled by leveraging the relationships of past and existing colleagues, the required data will be gathered for the in-depth one-on-one interviews in person or online by approaching the participants directly from the company that the researcher currently works at as well as approaching participants within the researcher’s networks of past work experiences to invite people to participate in the study. The researcher will also request referrals from current and past work experiences to ensure that the target sample population and size is reached across all stakeholders.

The researcher used to work with the consultants that assisted with the EVDS

implementation and currently works in the medical health insurance sector with individuals that have been/are part of digital health implementations.

Once participants have agreed to partake in the study, one-on-one interviews will be conducted using the in-depth interview guide in Appendix C.

3.7 Data analysis strategies and interpretation

As previously mentioned, a qualitative approach has been chosen to answer the question of the factors affecting digital health technologies using interviews. For data analysis, interview notes and audio recordings are transcribed into transcripts and then coded for themes using a qualitative management software tool called NVivo.

The coding process is considered necessary to answer the research questions because it connects the raw data with the theoretical analysis and then moves toward analysing analytical insights (Busetto et al., 2020).

An iterative approach will be followed to collect, analyse, and interpret the data, as seen in Figure 6 below. According to Busetto et al. (2020, p. 2), “sampling, data collection, analysis, and interpretation are related to each other in a cyclical (iterative) manner, rather than following one after another in a stepwise approach,” and there will be several back-and-forth steps within the process.

It is understood with this process that some of the insights may require a revision of the research questions, and the process will end when little to no new relevant information is found during the interviews. All decisions, themes, interviews, insights, etc., will be documented for transparency within the process.

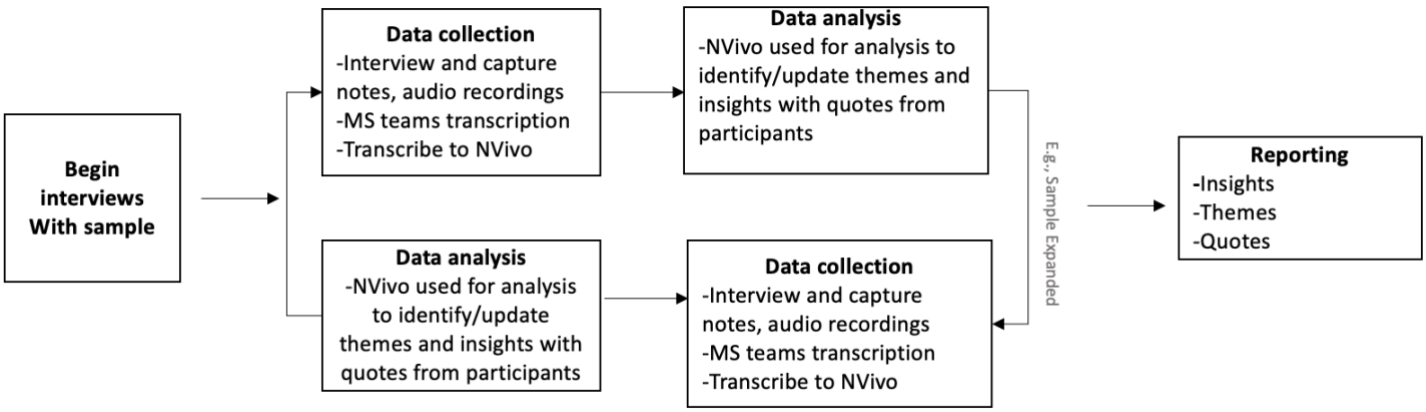


Figure 6: Iterative process for data collection, analysis, and reporting

Source: Busetto et al., (2020)

3.8 Possible limitations and challenges of the study

The following limitations have been identified as part of the study:

- Generic qualitative research has potential contradictions between elements of the research framework.
- The chosen methodology leaves the interview findings and interpretations up

Figure 7: Iterative strategy process for data collection, analysis and reporting

to the researcher, who has the potential to be influenced by personal biases.

- The individual participants may portray biases in answering the questions posed to them.
- There is a high reliance on participant accuracy in detailing their experiences.
- Rigour has been identified as an aspect to be more challenging to maintain, assess and demonstrate in qualitative research methodologies.
- The quality of research is dependent on the researchers' questioning skill to probe and uncover further information by follow-up questions.

3.9 Quality Assurance

3.9.1 External transferability

The study will meet the external transferability criteria by thoroughly documenting all necessary information required for transferability, such as the research context, critical assumptions, and methodology approaches central to the research. The next researcher can then judge the sensibility of the transfer. This is deemed appropriate

as the research by Korstjens & Moser (2018), Stahl & King (2020) states that it is the researcher's task to provide a database that makes transferability judgements possible to others, not to provide an index of transferability.

3.9.2 Credibility

Credibility in the study will be ensured by performing a check of findings/ interpretations with other participants interviewed as part of the study and using the interview guide with pre-set questions to ensure consistency in questioning across all interviews.

This will strengthen the data and findings as respondents, and the researcher view the information from different perspectives. The aim is for findings from various participants to be validated to demonstrate themes that will answer the main research questions (Korstjens & Moser, 2018).

Credibility is also maintained by ensuring that all interviews contain participants from all the identified sample stakeholders so that all perspectives are considered for the research report.

Busetto et al. (2020), Korstjens & Moser (2018), Stahl & King (2020) state that a detailed documented research methodology; documented notes of interviews with descriptions of participant behaviour; experiences; participant answers to questions; history, context, and other important information about the research questions, will enrich the data collected and outcomes of the study. The same authors also state that by testing participant feedback, the credibility of the research is maximised (Busetto et al., 2020; Korstjens & Moser, 2018; Stahl & King, 2020).

3.9.3 Dependability

The study meets the dependability criteria required because the research methodology and approach have been documented in full detail. According to Busetto et al. (2020) and Stahl & King (2020), it will ensure it is met.

In addition, the researcher will maximise the study's dependability by using a reliable and reputable qualitative tool NVivo to interpret the data and identify key themes from all the participants. The data analysis, interpretation and results process is

repeated iteratively with each interview to identify similarities in the results and enhance the findings (Busetto et al., 2020)

3.10 Ethical considerations

Ethics within the study will be maintained by submitting the ethics form after approval from the Post-Graduate Committee for the researcher's title and proposal.

Once the title and proposal have been accepted, the new detailed WBS ethics form is completed to attain approval from the Wits Business School Ethics Committee before any data is collected from the identified participants.

Once an approved ethics certificate is received, the researcher will send each participant an interview request with the participant information sheet. This will ensure that they know the research's purpose, what they are required to do, their involvement, who is conducting the research and what will be done with their information. Upon agreement to partake in the interview, the researcher will also obtain consent from participants by having them sign a consent form before commencing interviews.

The researcher will protect the anonymity and confidentiality of participants by keeping records stored securely, protecting identifiable information, and anonymising all participant responses.

The researcher will also ensure that all participants volunteer to participate in the study and, should they no longer want to participate, allow them to withdraw.

4. PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Introduction

The results from the data collection process are presented in this chapter from the fourteen interviews conducted with various stakeholders within the healthcare system in South Africa using the predefined research methodology.

4.2 Sample description

Sixteen interviews were conducted with various stakeholders within the healthcare system. The interviewed participants possessed detailed knowledge or experience on digital technology implementations their sustainability, and the related factors that impact them in the South African health sector. The following details the various roles the participants play within the healthcare system:

- Government
- Researcher
- Healthcare practitioner
- Technology developer/implementer (in the public and private sector)
- Funder

Table 3 below shows the stakeholder participant breakdown of the sixteen interviews that were conducted. Of the sixteen participants, eight are currently digital health technology developers and implementors in various aspects of health technologies, mHealth, IoT, connected devices and the like, and have been operating as such for a minimum of five years. A greater number of technology developers and implementors were chosen as the participants within this sample have extensive engaged with stakeholders across the healthcare value chain and possessed in-depth knowledge on the digital health technologies that existed and currently exist, as well as the factors that affect their adoption and sustainability.

Two of the participants work for the South African Government and are involved in health policy planning, advisory and implementation activities that affect the private and public sectors. One of the government stakeholders also has a digital health start-up.

Two researchers were interviewed that are involved in significant programmes related to HIV/AIDS, mHealth digital technologies and other innovative initiatives. The key activities of both researchers involved providing supporting research for initiatives and assessing, developing, and facilitating the transition of early-stage health technologies into practice.

The last two participants are healthcare workers that are currently using forms of digital health technologies in their practice.

Table 3: Showing the stakeholder profile breakdown

Stakeholder role	**Number of participants**
Digital health technology developer/ implementor	8
Policy regulator	2
Researcher	2
Funder	2
Health practitioner	2
Total	**16**

According to authors Korstjens & Moser (2018) and Stahl & King (2020) to maximise validity and ensure that no new substantive information is acquired, a minimum of fourteen interviews is required in a qualitative study using in-depth interviews. Sixteen interviews were conducted, and the researcher found that little to no new information was derived.

4.3 Presentation and discussion of results

4.3.1 RQ 1: Digital health technology implementation in South Africa

The first research question that the research report proposed was: What digital technologies have been implemented in the South African healthcare sector?

4.3.1.1 Presentation of results pertaining to research question 1

Table 4 below details the digital health technologies which were identified during the interviews that were conducted with participants, secondary data was also collected from authors de Villiers (2021) and the Department of Health (2019). Twenty-nine digital companies use a range of technologies across mHealth, eHealth, and telehealth and use technologies such as blockchain, AI, machine learning, Big Data,

and their respective analytics.

The information is split by the name of the company/ solution, the technologies that underpin their solution, their size, the primary user, and the province/ city in which they primarily operate. The table excludes small companies considered start-ups and still need to refine their business model and value proposition to compete in the market effectively. These companies were excluded as they were considered outliers because their technology implementation experience could be more extensive.

Three sizes were attributed to each solution/company, small, medium, and large. Each considered the number of users utilising the solution. The last column details whether their primary focus is in the private or public sector, driven by the fact that the public sector offers free services to patients. In contrast, the private sector requires a payment to be made either by the patient out of pocket or by their medical aid.

The described chosen presentation of results aligns with the research question as all of the detail demonstrates the name of the solutions offered, the various technologies used and the scale allowing one to understand what digital technologies have been implemented in the South African healthcare sector.

Table 4: Showing Digital health technologies from interviews

No:	Digital Health Technology	Technologies used	Size	Primary user	Province/City
1	A2D 24 builds various health technologies based on the need - Smart clinic - Real-time remote monitoring with IoT devices - Automated ambulance dispatch system - Training and education - Interactive HIV status reporting system	**Big Data and machine learning** - Collect data and use advanced analytics to survey HIV status reporting - Automated walk-in clinic to identify patients using facial recognition AI - Smart clinic uses AI to identify trends and associations **Whatsapp** - SMS and WhatsApp integration for triggers on reporting system **IoT:** - Real-time ambulance dispatch system (SMS based) - Mobile app for real-time tracking - eHealth for interactive training and education programmes	Large 30,000+ users	Private sector	Gauteng Bloemfontein
2	Quro Medical - Hospital at home with real-time monitoring - Clinical oversite	- IoT - mHealth - eHealth	Medium 500+ practitioners	Private sector	Gauteng Eastern Cape
3	Epione - Remote consultation booking and management -	- Health communication and consultation - Telemedicine - eHealth	Medium 1000+ practitioners	Private sector	Johannesburg
4	RecoMed	- Health communication and consultation - Telemedicine	Large 2200+ practitioners	Private sector	Cape Town Pretoria Johannesburg

	- Remote consultation booking and management - ePharmacy	- eHealth			Durban
5	EM Guidance - Health communication and consultation for professional seeking medicines and other scientific/medical information - Online and virtual chat support	- eHealth - mHealth - Big Data - AI - Machine learning	Large: - 9,000+ pharmacists - 25,000+ doctors - 5,000+ specialists	Private sector	Across the country
6	Altron Health Tech - Electronic medical records - Practice management	- Big Data - eHealth	Small	Private sector	Johannesburg
7	First Care Solutions - Electronic health records - Consult booking and management - Practice management	- eHealth - mHealth -	Large (primarily the private sector) Busamed Life Hospital group Netcare	Private sector	Johannesburg
8	MomConnect (government) - Pregnancy and maternal - Educational and communication	- mHealth (SMS based)	Large 2.5million + users	Public sector	Across the country
9	My Pregnancy Journey - Educational and communication	- mHealth (mobile app based)	Medium 3000+ users	Private and public sector	Across the country
10	Ribbon Protocol - Electronic medical health - Training and educational	- Blockchain - Machine learning - AI	Small	N/A	Johannesburg
11	Cell-Life MAMA (government) - Educational and communication	- mHealth (SMS based)	Large	Public sector	Across the country
12	Right ePharmacy - dispensing of medicine	- mHealth - Tele pharmacy - IoT (smart lockers)	Large 2,210,800+ patients served	Private sector	Western Cape Gauteng

13	Health Dart	- ePharmacy - Telehealth	Medium	Private sector	Johannesburg
14	Telecare - Consult with a healthcare professional - Ambulance dispatch	- Telehealth - IoT devices	Medium	Private sector	Across the country
15	EVDS (government) - Electronic medical record	- mHealth	Large	Private and public sector	Across the country
16	Dr Connect (Discovery Health) - Access to a health professional	- Telehealth	Large	Private sector	Across the country
17	Hospital at Home (Discovery Health)	- IoT - AI - Big Data	Large	Private sector	Across the country
18	Healthbridge - Communication - Electronic health records - Virtual care	- Telehealth - Big Data and analytics - mHealth (SMS based)		Private sector	Across the country
19	Binah (Momentum Health) - Wellness monitoring to measure real-time health data	- AI - Machine Learning - Predictive analytics - mHealth	Large	Private sector	Across the country
20	Kimi (Momentum Health) - Monitoring and management of vital signs using a screening app	- AI - Machine Learning - Predictive analytics - mHealth	Large	Private sector	Across the country
21	Hello Doctor (Momentum Health) - Access to a health professional	- Telehealth - Telehealth - mHealth	Large 1,900+ doctors	Private Sector	Across the country
22	Hi4Life - Educational and communication	- mHealth	Small	Public sector	Across the country
23	Mobenzi (government) - Data collection	- Big Data and analytics - MHealth		Private and public sector	Across the country, primarily Cape Town
24	SIMPill (government) - Medication reminders	- mHealth	Small	Public sector	Across the country

25	Project Masiluleke (government) - Educational and communication - Disease prevention	- mHealth	Small	Public sector	Kwa Zulu Natal
26	CapeRay - Medical imaging	- IoT - eHealth	Small	Private sector	Cape Town
27	Lodox - Medical imaging	- IoT - eHealth	Small	Private sector	Johannesburg
28	Aviro Health - Workflow automation - Virtual care	- Telehealth - mHealth - eHealth - AI - Big Data	Medium	Private sector	Across the country
29	BWiseHealth (government) - Access to healthcare professional	- mHealth	Medium	Private sector	Across the country

4.3.1.2 Discussion of research question 1

The first research question that the research report proposed was: What digital technologies have been implemented in the South African healthcare sector

The analysis of interviews indicates that many digital health technologies exist in the South African landscape and are in various maturity stages. These range from start-ups that have few users of the solution, to medium-sized solutions and large implementations that have scaled to being adopted by a large number of users across the country. The majority are medium to large-scale implementations which shows that there is traction being made, however, not enough to impact the majority of the country. This is in line with the literature discussed, which argued that more work needs to be done for digital health technologies to affect the healthcare system as a whole.

Various solutions are present in the health sector that aim to address challenges using mHealth, eHealth, and telehealth and use innovative technologies such as machine learning, AI, Big Data and predictive analytics to underpin their solutions. mHealth eHealth and telemedicine are the most commonly used technology which meets my expectations. The literature showed that the reason for the growth in these solutions is the proliferation of phones and tablets in society. This indicates that the easiest way to offer digital health solutions is to use mobile health solutions or eHealth solutions that can be accessed via a mobile device. Consequently, stakeholders in the healthcare system should prioritise these applications to drive adoption, however, it should be noted that as per the literature review in South Africa, there are still many people that use feature phones or don't have consistent access to the internet.

Blockchain technologies are in their infancy stage and appear to require further technological developments for them to be considered more broadly by companies as a solution, similar to what telehealth and respective technologies were years ago, as discussed in the literature review. This is seen by the prevalence of mHealth, eHealth and telehealth technologies today. In line with the literature review, results show that blockchain technologies are advanced, and focus should not be directed to blockchain until the infrastructure required by the technology has improved.
There is a correlation between government-implemented initiatives and their reach

across the country, public sector-focused initiatives that reach more significant adoption rates. Similarly, there is a correlation between initiatives implemented by medical aid schemes and their ability to get higher adoption rates. The implication is that a critical step to reaching widespread adoption would be to partner with medical schemes or government entities.

Despite this correlation, most successful implementations fall within the private sector and are implemented in metropolitan areas of the country, mainly Johannesburg, Cape Town, and Durban. In line with the literature review, this is linked to the private sector being privately funded and users having access to better infrastructure like more consistent WIFI and exposure to an urban lifestyle.

Given the results, the previously stated proposition was aligned as the data shows that mHealth, eHealth and Telehealth technologies are the preferred solution and are implemented in fragments across the country. The research also proves that urban area still greatly benefits from digital health technologies.

4.3.2 RQ 2: Factors influencing the implementation and sustainability of digital health technologies

The second research question that the research report proposed was: What factors influence the implementation and sustainability of digital technologies in the Healthcare sector?

4.3.2.1 Presentation of research question 2

The second research question that the research report proposed was: What factors influence the implementation and sustainability of digital technologies in the Healthcare sector?

Table 5 below details the key themes that were identified from interviews with the sixteen participants.

Table 5: Themes extracted from interview results

Theme	Sub Theme
Policy regulation	Inhibiting the growth of digital health technologies

	Viewpoint: implementors vs policy makers
Funding	Funding is critical for survival Securing investment Lack of framework
Technology interoperability	Technology incompatible with new software development designs Legacy systems Inconsistent framework usage
Business Model	End user doesn't want to pay
Infrastructure	Lack of basic infrastructure such as internet connection, electricity, and smartphone Simple solutions preferred
Lack of willingness to partake	Fear of job loss Lack of mindset change Fear of technology, lack of assistance
Protection of personal information	Personal ethics Protection of information Security of information
Immaturity of technology	Technology to new to consider

For each of the themes that were identified in the interviews, quotes are provided to demonstrate their relevance as a theme.

4.3.2.1.1 Theme: Policy regulation

The researcher found that regulators are often reluctant to hastily change regulations given the risks to human life and the consequences thereof. However, in instances of extreme radical change like COVID-19, the government can make changes.

"Regulators act from a place of fear, especially concerning a person's health. They would rather protect to ensure nothing bad happens unless there's a big push like COVID…Telemedicine was not allowed. No scripting, no diagnosing, no kind of nothing" (Interviewee 11, Digital Health Developer and Implementor)

"Virtual care has been around but before COVID, you were allowed to consult with a patient virtually if you had a prior relationship with that patient."
(Interviewee 7, Digital Health Developer and Implementor)

"COVID came along and all the restrictions, not all of them, but the majority of restrictions that were limiting, were lifted" (Interviewee 5, Researcher)

However, there was an outlier that expressed belief in government policies being progressive.

"If you sort look at the different government departments, they all have sort of advanced and progressive with policies" (Interviewee 10, Researcher)

There is a perception that provincial governments are responsible for their own adoption rate. At a national level, the government can only set guidelines in place and metrics to ensure that implementation occurs, and results are seen. National implementations are prioritised only when a challenge is considered a nationwide problem, such as the pandemic.

"You have policymakers, and then you have implementors.. We are a vast country, and we have different dynamics; provinces are autonomous *" (Interviewee 8, Government)*

"Coordination is what is very important and critical at this point because as national, we don't push ideas down to a province" (Interviewee 2, Government)

"There is very poor decision-making when it comes to digital health technologies because it's all decentralized to the different provinces, it becomes complicated to coordinate" (Interviewee 9, Digital Health Developer and Implementor)

4.3.2.1.2 Theme: Funding

Funding is critical for survival of digital health technologies as it is necessary to realise a solution; without adequate funding, the solution will not be successful.

"There's a high cost to digital transformation" (Interviewee 4, Digital Health Develop and Implementor)

"These platforms have to they're expensive to develop" (Interviewee 7, Digital Health Develop and Implementor)

Securing investment is challenging, there is a belief that funding opportunities in the country remain very limited. Given that, most start-ups operate in the private sector because of more funding opportunities.

If there is funding that is provided, then there are two challenges; first, there isn't an appreciation for how long medical research takes and funding rounds are typically too short; second, philanthropic funds typically fund digital health companies as traditional VCs don't understand the health start-up market well.

"What happens often is the funding rounds are too quick because there isn't an appreciation for how

long medical research takes" (Interviewee 11, Digital Health Developer and Implementor)

"For a lot of small start-ups, you know, they need that investment funding, and they need to quickly show results" (Interviewee 10, Researcher)

"I'm not getting the return that I wanted as quickly as I needed" *Interviewee 6, Funder)*

*"*Investment firms don't quite understand what they are investing into… Investment locally is basically non-existent." *(Interviewee 4, Digital Health Developer and Implementor)*

"*From a funding perspective, VCs lack expertise and knowledge, so Founders Factory is great. We work with them, but they don't know medical; they don't know the health landscape. You need a deeper understanding of health, technology, and healthcare in South Africa" (Interviewee 9, Digital Health Developer and Implementor)*

"Need to win over the private sector to win in the commercialization space.. Start small, then move to a larger population" (Interviewee 9, Digital Health Developer and Implementor)

Securing Investment from government entities is highly challenging because their sales cycles are long and could take up to two years, making survival difficult because the company needs funding in that time. Equally, the payment process takes a long, and companies run a risk of cash flow challenges while awaiting their payment while operating.

"I think at the beginning, it's more capital than looking for a return. So, it's philanthropic capital, its government capital, but the government takes forever. That's the other problem. Just to get funding for a small amount from the government, like a small grant, takes 2 years. And in two years, if you've just started your product and you're trying to get it into the market and haven't received funding in two years, you will die." (Interviewee 6, Funder)

"Small start-ups and you can't carry the cost of that long period of a sales life cycle" (Interviewee 9, Digital Health Developer and Implementor)

The private sector is perceived as a low-hanging fruit as more funding opportunities exist and they are more willing to trial digital technologies.

"Private sector has more funding opportunities as there is the medical scheme, so you don't have to appeal to the patient but to the schemes" (Interviewee 12, Digital Health Developer and Implementor)

4.3.2.1.3 Theme: Technology operability

Technological systems are typically built in a bespoke way, which does not allow other systems to be easily plugged into them. They also are not developed using a standard framework, which make it challenging to make configurations to the system many years later.

"They all are bespoke developed systems... Legacy systems are very complex, they're very large and they were very expensive, mostly... Systems didn't consider that they would need to interact or link into these smaller systems. Which makes integrations very difficult." (Interviewee 7, Digital Health Developer and Implementor)

"They've got legacies systems, and I think they probably have fragmented systems. So maybe the systems don't speak to each other." (Interviewee 6, Funder)

"When you look interact with government or the provincial governments or the implementing partners in those provinces, they want to implement it within the same old clinic structure, facility-based structure which makes it challenges because the existing systems are complex and difficult to integrate with" (Interviewee 5, Researcher)

4.3.2.1.4 Theme: Business Models

The business model needs to be sound in that the company knows how it will be making profits from its solution, as typically, end users don't want to pay for technologies

"People don't want to pay- you need to think of how the business model will work.
So, I don't know, maybe like partnerships with telecoms to make certain apps zero data rated. I mean, most do to find that it is difficult to get those types of partnerships to allow those opportunities to be available" (Interviewee 5, Digital Health Developer and Implementor)

"It's important that when you develop a technology for a specific target audience, it must take into consideration, what makes that audience tick. You know, what is it that they want? And I think a lot of the times solutions are not necessarily developed something for them, it must have a massive benefit for them to start using it given how hard it is to change their ways" (Interviewee 1, Digital Health Developer and Implementor)

"You have to understand that your target audience is there to help you optimize and Co design right from the beginning" (Interviewee 2, Governance)

" A large percentage of the population don't have access to healthcare because they don't have money, right? So, if that's the case, then those people are not going to buy the product." (Interviewee 5, Funder)

“Incubators assist with refining your business model and value proposition to ensure that it is aligned to what the customer needs thus reducing the probability of failure. Few investors are looking to fund start-ups in the early stages” (Interviewee 12, Digital Health Developer and Implementor)

4.3.2.1.5 Theme: Infrastructure

There are several challenges noted on the state of basic infrastructure, the constant supply of electricity is noted as a challenge as digital health technologies require for them to be always functional so that all necessary information is collected. WIFI access is another problem. Not all facilities are fitted with WIFI, or if there is, then the quality of the internet connection is not strong. There are times when the basic brick-and-mortar structure is provided, and companies are required to provide all infrastructure to function.

Staff are not provided with an email address to be able to use systems. Given the challenges, simple solutions are known to be more effective

“Obviously, the power was a major issue. And the results and dips and connectivity... I know for a fact in our practices we have to we have to put in all our own. Email address, internet etc. Infrastructure in terms of Wi-Fi or fibre or whatever it is that you must put in all our own technology, all the computers, all the phones, everything” Interviewee 7 (Interviewee 7, Digital Health Developer and Implementor)

"It’s difficult to provide everyone with unique IDs to collect, store and manage their data. People don’t have smartphones; hence SMS applications work better as they don’t need data or intelligent phones to access applications. The public doesn’t typically have data… Thus, small digital systems work best” (Interviewee 8, Government)

“*People don’t have email addresses, and they change their number very often, it’s difficult to keep track of them and follow up.. we don't communicate with clients on the e-mail from the government because not everybody has an e-mail because you see that all the shortcomings that one takes for granted. But there are many people who do not have emails because they don't have a laptop or anything that forces them to get that kind of a gadget for anything because they don't use them” (Interviewee 8, Government)*

”The unequal distribution of resources does have a major impact. A person must get along with an old cell phone or a feature phone and not a smartphone or they don't have regular access to Wi-Fi or data or airtime. Simply because they can't afford it, those all play big roles, and then, I mean, one of the big things that we found is also that people have old phones, they have a phone that is 6 or 7 years old. And it's tough to get the technology to work” (Interviewee 10, Researcher)

"There are certain elements that need to be in place in order for digital health technologies to be successful or implemented accordingly" (Interviewee 5, Researcher)

"There is no constant supply of electricity, the network is a problem, and places don't always have WIFI, especially in rural areas" (Interviewee 2, Government)

"You find some doctors don't even have a computer" (Interviewee 4, Digital Health Developer and Implementor)
Not all hospitals have Internet connectivity and electricity a consistent supply of electricity… If whatever technology you're coming up with always requires connectivity, or a constant supply of like there's no interruption in terms of Internet connectivity, so that could also be an issue." (Interviewee 5, Funder)

"You've seen the systems that they use; it's so 80s" (Interviewee 15, Health Practitioner)

"I think I'm simplifying digital systems will work better for this country. We are two heterogeneous. There are too many differences between, you know, the rich and the poor, even the middle" (Interviewee 2, Government)

4.3.2.1.6 Theme: Lack of willingness to partake

Doctors don't want to comply; if the current way they operate this still works, they will continue to do it that way. All respondents detailed how difficult it is to change a health worker's perspective on digital health technologies.

"I can tell you that most doctor practices, certainly in the emergency medicine space, are still operating on paper systems and the few that are digitised… Doctors don't want to transform, credit is not given, and you are not paid more because you are digitised, you are not. You don't earn more because you put in a digital system, and specifically, if you develop anything, you are certainly not paid more by the medical aid because you are operating on a digital platform. It may enhance your ability to improve the patient journey, where you may see more patients. It will give you more insights into your patient care to improve the quality of care, which may bring make you a better doctor. But you never receive a monetary benefit" (Interviewee 7, Digital Health Developer and Implementor)

"Doctors don't see the pain point; they see patient, write the necessary details as they always have" (Interviewee 15, Medical practitioner)

"Virtual means of seeing patients because it takes away some of the personal touch, and they haven't been trained to do it. They've all been trained. We've all been trained that you know you should examine your patient and you must touch your patient. So, it's changing that mindset" (Interviewee 4, Digital Health Developer and Implementor)

"The medical fraternity are the biggest laggards you can come across. Without that regulation, then the medical fraternity won't move, and the medical fraternity won't move because they have relied on other science. There needs to be a change in the mindset of the medical professional to take this up and really champion it and prove its value" (Interviewee 11, Digital Health Developer and Implementor)

"Doctors are reluctant to use another application, another something that doesn't stick with what they're doing. They think I'm a risk for medical liability or medical malpractice; I'm going to let somebody else try this out first. Because it's a new concept for them, right? There's just too much risk that's associated with it" (Interviewee 16, Medical Practitioner)

"I think doctors and practice managers have little knowledge and understanding of things they are terrified about. A technology may come along that makes them obsolete, or the data they use, or it will be stolen and held liable. Doctors are very conservative people, generally speaking, and they are not ones for a big change or big risk. Put a big high-risk high reward. It is not in a doctor's mindset generally " (Interviewee 11, Digital Health Developer and Implementor)

"Most nursing sisters and clinical health workers are afraid of technology, to be frank. You know they feel that it's easier just to use a pen and paper to do certain things, you have to invest a lot of time in training." (Interviewee 5, Researcher)

"Why is this space so manual, like everything else has gone so is gone digital, but doctors are still very, very manual" (Interviewee 14, Digital Health Developer and Implementor)

"mindset change is the biggest inhibitor to technology adoption" (Interviewee 16, Healthcare Practitioner)

Leadership and greater oversight of new technology implementation are required to change mindsets

"All provinces have difficulty not having one person responsible for the strategy of new technologies because you also need internal champions to take up your calls when you have a new digital technology. So, for anything new, you always have a resistance to change… Especially because healthcare is a highly regulated space" (Interviewee 9, Digital Health Developer and Implementor)

"When trying to implement and find parts you get pushed from pillar to post. Nobody wants to make decisions... your project will sit in limbo forever and the day because everyone was too fearful to make any decisions. I would say, the bureaucracy of trying to integrate into provincial, provincial, and national programs, there's a huge barrier obstacle as well not just for digital health but for implementation of anything " (Interviewee 5, Researcher)

There is no framework to assist start-ups in navigating the landscape when it comes

to piloting, finding a sponsor, and shifting mindsets enabling a higher chance of success. There is also no centralised team that will oversee innovations at a government level

"There's no framework to be able to pilot and navigate the government healthcare landscape that well. So, it's all based on personalities and opportunities presented to key stakeholders that will help. It's all based on people who they know it's based on, how they can get something into a higher system and there's no discussion upfront around the remuneration and how it should work... The government should introduce a framework on how to introduce new innovations." (Interviewee 9, Digital Health Developer and Implementor)

"We have a digital health strategy by that's issued by the DH and but there's no centralised place for all pilots in South Africa… that synchronises the learnings, centralises the failings so that you can actually learn from it, because now what happens is there's a pilot in Limpopo, there are guys in the Western Cape doing exactly the same thing, but no one is sharing that information" (Interviewee 9, Digital Health Developer and Implementor)

4.3.2.1.7 Theme: Protection of personal information ownership

People, hospitals, and other traditional stakeholders don't want to share their information, there is always a question on who owns the data

"Medical people don't want the risk. There have very robust security rules around who can and cannot integrate with their systems. POPIA supports that by not allowing sharing of information, or they certainly use it as a weapon not to share" (Interviewee 9, Digital Health Developer and Implement)

"We do try and take the time to explain to people why we're collecting data, what we're using it for, setting up our system so that it optimally collects the data that we need, not collecting data that we're not going to use" (Interviewee 13, Digital Health Developer and Implement)

"There is always a question of who owns the data. So, data becomes very sensitive and very conflictual…for cyber security, the question is how do you secure the contents of their patient information? What happens to consent from the participants? A lot of times you know, is there is proper consent that's been taken by from the patients to gather the information " (Interviewee 9, Digital Health Developer and Implement)

4.3.2.1.8 Theme: Immaturity of technology

Some technologies are too new to experiment with yet

"Blockchain also has its inhibitors in that it's not ready to scale at the level that it needs to. So, I think many people are walking away from blockchain as a solution because by virtue of the technology itself" (Interviewee 11, Digital Health Developer and Implement)

4.1.1.1 Discussion of research question 2

The second research question that the research report proposed was: What factors influence the implementation and sustainability of digital technologies in the Healthcare sector.

The results indicate there are several factors which influence the successful implementation and sustainability of digital health technologies in South Africa. Critical foundational factors typically experienced by developing countries appear to be a significant factor, these include the rolling power outages and lack of internet connectivity, especially in rural areas, which render digital technologies ineffective. While technological factors remain such as the interoperability of technology between systems across the country, greater focus is required to enable the better integration of new technologies to legacy systems, and for legacy systems to be phased out. In line with research, legacy systems is known to be a significant inhibitor to implementing new technologies

Policy regulation within the country appears to inhibit the rate of digital health technology growth, resulting in technology developers having to create solutions that are aligned with the existing guidelines and policies. However, it was observed that radical changes to policy occur in cases such as the COVID-19 pandemic. A shift in policymakers is required as there won't always be a scenario like COVID-19 to accelerate policy change. It is noted that there was an outlier who disagreed with the idea that policy is an inhibitor by stating that policies and regulations do support

The introduction of POPIA has made data collection more challenging as patients do not want to share their personal information, various healthcare stakeholders also do not want to share their data, and digital technologies require a holistic view of data to operate effectively. Without this view, the technology is rendered ineffective. An implication for the South African government is to consider more stringent data and security acts as described in the literature review which Brazil has implemented, the United States and the European Union. This is considered important as the adoption of digital technologies hinges on effectively gathering data to make better decisions.

A surprising factor that the results uncovered was the extent to which healthcare workers resisted the change brought about by technology; almost all participants

listed the need to change their mindset as an inhibitor to implementation. Although linked to that is the inability of some companies to co-create solutions with the healthcare workers. It's noted that an implication is to first co-create to better understand pain points so that companies and tech developers do not have to "sell" the solution to gain buy-in. Also linked to buy-in is the consideration of an incentive that will get healthcare workers to trial the technology faster.

Another surprising factor was the need for a framework for upcoming companies and solutions to navigate the healthcare landscape. Research conducted in the literature review did not highlight the use of a framework for developing and developed countries; given the importance of this finding, it should be a consideration for future research as it will provide a practical guideline on how to succeed given the common factors that exist.

The lack of funding especially in the private sector, is in line with research discussed in the literature review, however, the study did not uncover that the reason for the lack of funding is that VC firms lack knowledge and expertise in adequately supporting a health start-up in the preferred timelines.

The findings of the research were slightly in line with the propositions stated, the proposition was that the significant factors influencing technology implementation were technology interoperability, poor infrastructure, and funding. Interview participants corroborated that technology interoperability, infrastructure and funding were key. However, a critical factor to consider is the mindset shift required from practitioners and the need for a central body in government that will champion new digital health technologies that:

- Ensure funding is available for small pilots and that long sale and payment cycles are shortened.
- There is strong leadership and management to oversee the innovations and the feasibility of implementation.
- Priority is given to ensure that technological and infrastructure inhibitors are prioritised.

4.1.2 Summary of results and discussion

It was recognised that a transformation in the healthcare system is needed to

improve the challenges experienced. The existing solutions that have been implemented require more focus to reach an expansive scale, shifting focus from the smaller populated private sector to the public sector.

Proposition 1 was validated in that solutions mHealth, eHealth and telemedicine are the preferred solutions to be implemented by technology developers and that fragmentation occurs with the urban area still greatly benefiting from digital health technologies.

Proposition 2 was partly validated in that technology-related factors still remain, foundational infrastructure such as electric, constant internet also remain, and funding is critical for growth. However, additional factors such as mindset shifting and aligning value proposition to stakeholder pain points is equally as essential.

More funding and incentive opportunities need to be provided, and a body in government that will be responsible for championing digital health technologies across the country should be created.

It was also recognised that a critical aspect of transformation is to take an approach of implementing rudimentary solutions so that they can be accessible to the greater population, thus enhancing the potential adoption rates.

4.2 Limitations

Limitations of the study have been identified to be that the chosen research methodology as a qualitative approach is biased according to the literature presented. Additional limitations are identified as the selected sample as participant experience may not represent the overall sentiment of all stakeholders in the healthcare value system. Care was taken to validate the findings with all participants during the interview process to ensure that a fair and aligned representation was understood.

The study acknowledges that additional factors may exist that affect the implementation and sustainability of technologies, and additional stakeholders may be identified which could provide some insights to these factors.

The last limitation is that there may be research gaps in identifying specific concepts that are related to digital health technologies and the emerging technologies that underpin them.

Strengths identified in the study were the inclusion of stakeholder experience from practitioners, funders, the government, researchers, technology developers and implementors, ensuring that there is a holistic view from the full healthcare value chain.

5 CONCLUSION AND RECOMMENDATIONS

This chapter details the concluding observation and statements of the study by providing a synopsis of the study's aims.

5.1 Introduction

The understanding that the introduction of digital health technologies into the South African healthcare sector is known by governments, research contributors and the like. The South African government has also embarked on a journey of trialling and implementing various technologies to improve the challenges experienced by the sector which include unequal distribution of resources, long wait times, unequal access and quality of health services being delivered across the country and especially in rural areas. Their interventions have seen improvements in diseases such as HIV/AIDS and TB.

However, despite improvements in some diseases, most of the challenges remain and according to the World Health Organisation, the state of healthcare continues to decline. The literature revealed that there is increasing pressure to leverage digital technologies and to become successful in their implementation, several factors are to be considered.

Given the significant need for the sector to transform, two research questions were identified

- What digital health technologies have been implemented in the South African context?

- What are the factors that affect the implementation and sustainability of digital health technologies in the South African healthcare sector?

5.2 Conclusion

This study followed a qualitative approach to explore the research questions which was deemed most appropriate because to best understand the landscape of existing technologies and the factors that influence them need to be explored using interviews. Interviews were considered the best approach as detailed accounts of experiences is required which is best achieved by probing.

The study found that despite the private sector serving the population's minority, the majority of digital implementations were targeted to patients in the private sector. Solutions created were categorised as mHealth, eHealth and telehealth due to the proliferation of medical devices in the country which supports their implementation. However, it was also observed that implementations were fragmented and done in various provinces across the country.

A recommendation was made to shift focus from the private sector to the public sector to ensure that a greater impact is realised in transforming the sector. Additionally, rudimentary solutions of digital technologies are preferred given the challenges that exist with the sophistication of mobile phones and the inconsistent affordability of WIFI and data across the country.

The factors that influence the successful implementation and sustainability of digital health technologies found that the main factors are the following: policy regulation, limited funding, technology interoperability, business model development, value proposition development, fundamental infrastructure challenges involving water and internet, the lack in willingness to use digital technologies, difficulties that impact the collection of data and immature technology

Analysis of the findings showed that technology factors remain a consideration however, a mindset shift is required by healthcare workers to drive adoption and the government needs to play an active in incubating technologies at the centre to ensure successful implementation across the country.

This study contributes to the body of knowledge by first providing a view of the factors experienced by a developing country with a large and complex healthcare system—second, providing a perspective on the stakeholder perspective in the healthcare value system in implementing digital technologies.

This view is considered essential as the body to existing research that exists on digital technologies in healthcare is detailed concerning a disease or to a specific technology. Few authors have explored factors affecting large-scale implementation in developing countries where success is critical.

5.3 Suggestions and recommendations for further research

Following the analysis and discussion of the results, the following aspects have been identified as areas for further research:

- Are there frameworks that can be researched to assist digital health technology implementers in effectively navigating the health sector landscape for developing countries? Which include funding, value proposition development, business model development and buy-in solicitation
- What interventions and incentive programmes have successfully been implemented to assist in the mindset shift of healthcare professions to ensure buy-in and adoption of health technologies
- How can developing governments effectively implement a body/task force to oversee digital health technologies pilots, the regulations that affect them, the feasibility of implementation into the greater ecosystem and the coordination of the implementation from pilot to large scale
- Given the transformation of the healthcare system to include new players, who are the players, what are their roles, and how do they effectively leverage each other to improve the healthcare industry

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APPENDIX A: Participant Information Sheet



Participant Information Sheet

Dear Sir / Madam,

My name is Luyanda Mhlauli, and I am a master's student in Digital Business at the University of the Witwatersrand, Johannesburg. As part of my studies, I must undertake a research project. I am investigating the factors influencing the intended adoption and sustainability of digital transformation technologies in the South African Healthcare sector, supervised by Ms Ayanda Magida. This study strives to understand the factors so that future efforts to effectively implement and sustain quality health services using digital health technologies are more likely to be successful.

As part of this project, I would like to invite you to take part in an interview. This interview will involve discussing your experience in the health sector with digital technologies that are currently being implemented and/or have been implemented in the past and will take around 60 minutes. With your permission, I would also like to record the interview using a digital device if you opt to meet in person or over an online meeting platform such as Microsoft Teams or Zoom. This recording will be stored in Google Drive, and only the researcher will have access to this recording for reference and analysis purposes. It will be deleted after one year.

Participation in this study will bear no costs to you, nor will you receive any benefits for participating, and you may opt not to participate should you not feel comfortable. Your comfort is a priority; adjustments will be made to ensure this. If you choose to participate, you may opt out of the study at any time or only answer preferred questions. The interview will be completely confidential and anonymous- all information is stored securely, and no personal identifying information is shared during the research process. In my research report, your details/accounts will be represented as a number, e.g., participant 001.

At any point in the research process, please contact me on the details below regarding any concerns, complaints, or questions to receive the final report.
The final report will be published online on the University of Witwatersrand library website, and all interview data will be securely stored on Google Drive for one year.
For any ethical queries that you may have, please contact the University of Human Research Ethics Committee (Non-Medical) on their landline at +27(0) 11 717 1408 and via their email at: hrecnon-medical@wits.ac.za

Kindly,
Luyanda Mhlauli

Researching student: Luyanda, 302124@students.wits.ac.za, 083 527 8225

Supervisor: Ayanda Magida, Ayanda.Magida@wits.ac.za, +27 11 717 3953

APPENDIX B: Consent Form

The factors influencing the adoption and sustainability of digital technologies by healthcare providers in South Africa

A research report by Luyanda Mhlauli

I, ……., agree to participate in this research project. The research has been explained to me, and I understand what my participation will involve. I agree to the following:

(Please circle the appropriate options below).

I agree that my participation will remain anonymous.	YES / NO
I agree that the researcher may use anonymous quotes in his / her research report.	YES / NO
I agree that the interview may be audio recorded.	YES / NO
I agree that the researcher may take notes during the interview.	YES / NO
I agree that the information I provide may be used anonymously after this project has ended, for academic purposes by other researchers, subject to their own ethics clearance being obtained.	YES / NO

…… (Name of participant)

…… (Signature of participant)

…… (Date)

…… (Name of the researcher)

…… (Signature of the researcher)

…… (Date)

APPENDIX C Interview Guide

Focus Area	Questions
Introduction	1. Have you ever participated in an interview for a research report? 2. Can you tell me a little about yourself and how you came to work in the health sector with digital health technologies? a. Overall background? b. What is your current role? c. How long have you been working in the health sector? 3.
Experience	4. What digital technologies are you aware of in the sector? 5. Do you find these technologies beneficial? 6. What technologies do you know are in the pipeline or currently being implemented? 7. What digital technologies have you worked with?
Effectiveness of implementation	8. What thoughts/options do you have on the effectiveness of the implementations? 9. What have been the biggest inhibiting factors to adoption and implementation? (Understand from people, policy/strategy, implementor perspective) 10. What have been the positive contributing factors? 11. Was change management applied? If so, what was done?
Sustainability	12. What thoughts/options do you have on the sustainability of the implementations? 13. What have been the biggest inhibiting factors to sustainability of digital technologies implementation? 14. What have been the positive contributing factors?
Future implementations	15. What do you think needs to be done differently? / 16. What elements could be improved on for future implementations?

APPENDIX D Ethics Clearance

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB302124/788
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (belo

Project title	The adoption of digital technologies by healthcare providers in South Africa
Investigator / Researcher	Miss Luyanda Mhlauli
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed confidentialty.
Issue Date of Certificate	2022-10-21
Expiry date	Date of submission of the project / research report
Chairperson	Prof Anthony Stacey ☎ +27 11 717 3587 +27 82 880 4531 anthony.stacey@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

24 October 2022
Date: