Persuasive technology mHealth self-monitoring model for patients with chronic lifestyle disease in South Africa

Persuasive Technology mHealth self-monitoring model for patients with Chronic Lifestyle Disease in South Africa

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DECLARATION

I, Sarah Molepana Mamabolo, do hereby declare that this dissertation entitled "***Persuasive Technology mHealth Self-monitoring Model for Patients with Chronic Lifestyle Diseases in South Africa";*** submitted for the degree Master of Computing: Informatics at the Department of Informatics, Tshwane University of Technology; is my own original work and has not previously been submitted for assessment to another university or for another qualification. I further declare that all sources consulted and used, are acknowledged by citation and they have been included in the reference list.

Sarah Molepana Mamabolo

Signed: ……..

Date:……..

DEDICATION

This study is dedicated to my Mum and late father. May the Almighty God bless my Mum and give my father an everlasting resting peace.

ACKNOWLEDGEMENT

First, I would like to thank the Lord my God the Almighty and my creator for making it possible for me to complete this study. The journey has not been very smooth.

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GLOSSARY OF KEY TERMS

Behaviour Intension	It is the direct predecessor of behaviour that determines an individual's act of intention to perform a particular behaviour.
Chronic diseases	Conditions that last one year or more and require ongoing medical attention or limit activities of daily living or both.
Constructs	Is a concept or a variable that is intended to be measured in a research study.
Contextualization	This refers to putting information into a particular context related to a desired situation.
Correlation Analysis	It is the statistical tool used to predict the relationship between two or more variables.
Demographics	The statistical characteristics of human populations used especially to identify markets.
Hypothesis	A theory or a proposition made as a basis for reasoning without its actual truthiness.
mHealth Monitoring System	A mHealth communication systems developed based on mobile technology.

Patient Monitoring	Is a continuous observation of patient' s condition and other related medical parameters like drug adherence over given period of time.
Regression Analysis	Statistical procedures of estimating the relationships among variables as well as showing the prediction power for each variable and the overall model
Variables	It is an element which does not have a fixed pattern and it is liable to change.

LIST OF ACRONYMS

ARV	Antiretroviral
COVID-19	Coronavirus disease novel 2019
HIS	Health Information Systems
ICT	Information and Communication Technology
IT	information Technology
GDP	Gross Domestic Product
GPRS	General Packet Radio Service
LHWs	Lay Health Workers
MDOT	Mobile Directly Observed Therapy
mHealth	Mobile Health
NCDs	Non-Communicable Diseases
OECD	Organisation for Economic Co-operation and Development
PDA	Personal Digital Assistant
SA	South Africa
SPSS	Statistical Package for Social Sciences
TAM	Technology Acceptance Model
TOE	Technology Organization Environment
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TUT	Tshwane University of Technology
VIF	Variance Inflation Factor
WHO	World Health Organization

ABSTRACT

Sub-Saharan African countries continue to be affected by infectious diseases and currently are going through a period of globalization that increased the prevalence of lifestyle chronic diseases. These chronic diseases are caused by behaviour change making it difficult to control them, as there are no specific trends of control. South Africa has a high prevalence of lifestyle non-communicable diseases (NCDs) due to the fact that the post-apartheid era saw many people migrating to urban areas as a result of black empowerment. A, large part of the population in the country leaves in rural or urban areas with under resourced health facilities. This implies that patients who suffer from chronical conditions spend heavily on medication and hospital visits in an attempt to monitor and control their conditions. However, many patients with chronic incurable diseases fail to comply with the regimens of self-management that end up seeing them revisiting hospitals even before the time they have been booked for their next visit. This study sought to develop a model for self-monitoring mHealth system based on persuasive technology for patients with chronic lifestyle diseases in South Africa. The study was informed by data collected from health practitioners and social workers in the South Africa provinces of Limpopo, Mpumalanga and Gauteng. The collected data was analysed quantitatively using the statistical package for social scientists (SPSS). Results of the study revealed that, apart from patients' attitude, the rest of the constructs that included mobile technology, patients' beliefs, culture, environmental factors, social influence, planned behaviour control and behaviour intention are significant in the development of a mHealth self-monitoring model for lifestyle chronic diseases. This study contributes to the ongoing debate of using mHealth for self-monitoring of chronic diseases patients. More still, this study makes a significant contribution of combing three aspects namely; mobile technology, persuasive technology and factors that influence a patient's surroundings including culture, environment and social surroundings. This study recommends that this model be put to use and be extended to include the analysis of the interacting effects of demographic and situational variables of participants as behaviour change may vary with change in demographics or situational variables. More still, this study further recommends the use of varied methods or triangulation of methods to allow participants to demonstrate their actual feelings towards behaviour change of patients to adhere to medical prescriptions.

CHAPTER ONE: INTRODUCTION

This chapter presents the introduction and background of the study. It details the effects of chronic lifestyle diseases and how such can be combatted using modern means based on persuasive technology mHealth self-monitoring. The chapter also highlights the problem this study sought to address, the objectives that needed to be achieved as well as the research questions that needed to be addressed. Furthermore, this chapter gives a synopsis of the contribution this study makes in terms of theory and practice. Lastly, the chapter gives a research flow that recaps chapters in their chronological order.

1.1 Introduction to the field of the study

Information and Communication Technology (ICT) is increasingly becoming an influential tool in enhancing the competence and effectiveness of organisations. Various industries have taken effective steps towards the use of these technologies to ensure that they remain existent and active in the fast growing technological environment. The pervasiveness of the internet has increased the use of technological application like e-services in various sectors of life including health, education, government and many others. The application of technology as-a-service in the health sector, also known as electronic health (e-health), has been applauded as a sign of improving the quality of lives especially in developing countries that have been traditionally been known to have healthcare challenges (Kalema & Busobozi, 2019).

Ashrafzadeh and Hamdy (2019) allude to the fact that developing countries especially those in Africa have heterogeneous healthcare challenges arising from political and economic instabilities, weak public health, environmental disasters, unresponsive governance, poor infrastructure as well as lack of medical experts. They further note that developing countries need to leverage ICT and its applications in order to minimize these medical challenges. This implies that developing countries need to take advantage of the current global trend of healthcare delivery technology where researchers and developers are actively innovating tools to help patients self-manage their health. This is so important especially in the current wave of Covid-19 where the

improvement of virtual facilitation of patient-physician interactions is more than ever needed.

The pervasiveness of computing technology has created opportunities to redesign the traditional patterns of healthcare systems and such has led to the widespread increase in the number of telemedicine projects in the recent years (Ajami, Mcheick & Mustapha, 2019). This remote monitoring and care of patients outside the hospital setting (telemedicine) is one kind of innovative intervention that is needed in many developing countries like South Africa, which are already facing a double burden of infectious and chronic diseases whose prevalence is increasingly becoming a threat to the economic growth of the country (Mayosi, Fisher, Lallo et al., 2009; Kalema & Mosoma, 2019).

In the wake of the use of ICT applications in healthcare, smartphone-based healthcare provision and monitoring, also known as mobile health (mHealth), has emerged as a promising approach to empower patients with self-monitoring of their lives (Mena, Félix, Ostos et al., 2020). Earlier researchers Kırcı and Ünal (2016) indicated that, the increasing number of patients that need long term healthcare monitoring calls for the leverage of technology and its applications to provide healthcare solutions at home, hospitals or anywhere and at any time. They note that the use of mHealth applications enhance person-centred and person-driven care for patients suffering from chronic health conditions.

The use of mobile devices and their applications has been inevitable in healthcare. This is because healthcare sectors in almost all countries be developing or developed, are facing challenges such as resource constraints including lack of medical personnel, rising costs, unequal accessibility, and poor early detection (Mayosi et al., 2009; Sibiya, Makitla, Ogunleye et al., 2014). Other challenges include brain drain as a results of their qualified medical personnel migrating to developed countries in search for greener pastures (Ashrafzadeh & Hamdy, 2019). Due to these many challenges impeding healthcare, remote and self-monitoring of patients' become a matter that calls for urgent attention. This can be done in form of resources, strategies, methods and installations that enable doctors or other medical professionals to work

remotely to consult, diagnose and treat patients as well as empowering patients to take care of their own health (Ajami et al. 2019; Mahmood, Kedia, Wyant et al., 2019).

Remote self-monitoring of patients with chronic diseases should be a priority for all countries that are fighting to reduce mortality rates. According to Mohammadzadeh and Safdari (2016), chronic conditions are the most communal sources of death and disability across the globe. Mayosi et al. (2009); WHO (2015) indicated that from 2008 chronic diseases has caused about 28% of the total burden of diseases in South Africa with diseases like cardiovascular, diabetes mellitus, respiratory diseases, and cancers being the leading cause of death that have greatly affected poor communities in the country's urban and rural areas. Acccording to Kalema and Mosoma (2019), developing countries have suffered most the burden of lifestyle chronic disease both communicable and non-communicable. The researchers further note that giving treatment and monitoring of patients with chronic diseases especially in developing countries rural areas is increasingly becoming difficult due to high numbers of patients and limited healthcare resources.

Researchers such as (Köhler, Mehnert & Götze, 2017; Kalema & Mosoma, 2019) allude that chronic diseases cause misery to patients suffering from them due to routine visiting of hospitals, hence causing increasing health budgets and effects on their economic activities since these conditions require large amounts of medication that patients need to take regularly. Chatterjee (2019) observed that this regular taking of medicine sometimes leads to side effects; strain and depression due to the fact that patients are treating incurable diseases. As a result, many patients end up being reluctant to take their prescribed medicine yet it is the only way to reduce the effects of the chronic sickness and their related symptoms (Debon, Coleonea, Bellei, & De Marchi, 2019).

The use of mHealth for the provision of timely medical services in remote areas enables immense opportunities of offering real-time quality medical resources and services to patients suffering from chronic diseases (Mahmood et al., 2019). However, as Debon et al. (2019) noted, the reluctance to follow regular medical prescriptions poses a threat to the successful use of mHealth for patients' self-monitoring. This implies that mHealth should be enhanced with persuasive technology in order to

provide a seamlessly integrated healthcare interventions and monitoring system that puts into consideration the behaviour and social aspects of patients and their surroundings in their everyday lives, regardless of space and time.

Persuasive technologies leverage the fact that when individuals perceive social presence, they naturally respond in social ways and perform a social task (Fogg, 2002). This implies that developing a mHealth application based on persuasive technology will help to enlist automatic responses from chronic patients to respond to the application that is prompting them to take medicine at the prescribed time. Huzooree, Khedo and Joonas (2019) note that the use of persuasive mobile healthcare system for self-monitoring of chronic disease patients, has a potential to improve their quality of life by empowering them to continuously monitor their situations and adhere to medicine. They allude that persuasive healthcare involves the use of ubiquitous computing like mobile technology to trigger the behaviour of patients to respond to medical prescriptions. This implies that a persuasive mHealth application acts as a reminder system to patients and provide motivations that can help them attain their health goals.

1.2 Background of study

Many sub-Saharan African countries continue to be dominated by infectious diseases and currently going through a period of globalization that increased the prevalence of lifestyle chronic diseases (Gouda, Charlson, Sorsdahl et al. 2019). These researchers note that, mostly these chronic diseases are caused by behaviour change which make them difficult to control, as there are no specific trends of control. South Africa has a high prevalence of lifestyle non-communicable diseases (NCDs) due to the fact that the post-apartheid era after 1994 saw many people migrating to the urban areas as a result of black empowerment and democratization (Nojilana, Bradshaw, Pillay-van Wyk et al., 2016). This migration saw many people changing their life style due the high standards and conditions of living in the urban areas as compared to their previous life in rural settings (Mayosi et al., 2009). As a result, people changed diets, young ones as well as those others who failed to get employment engaged in risky behaviours like sexual activities, smoking and heavy alcohol consumption (Puoane, Tsolekile, Sanders & Parker, 2008; Debon et al., 2019).

South Africa has diverse communities with a larger part of the population that needs significant medical attention being situated in rural or urban areas with under resourced health facilities (Sibiya et al., 2014). As such, patients who suffer from chronical conditions spend heavily on medication and hospital visits in an attempt to monitor and control their conditions. Gouda et al. (2017) note that the routine visiting of hospitals, clinics, and the heavy spending on medicine and consultations negatively affects these patients' economic activities and situations. These researchers allude that this in turn causes frustration and ends up affecting their compliance to medicine. Chatterjee (2019) adds that, many of these patients with chronic incurable diseases fail to comply with the regimens of self-management that ends up seeing them revisiting hospitals even before the time they have been booked for their next visit.

Chronic conditions require large amount of medication to keep them in check and such medications mostly lead to side effects, further reducing the quality of life for most of the patients (Mishra, Haldar, Pollack, 2016). More so, patients suffering from chronic conditions become traumatized and develop psychological tiredness, depression and fatigue that lead to challenges of adherence to medication because of the lack of advanced technologies that could be used to help them monitor their conditions (Mishra et al., 2016). Hence, there is a need for mHealth applications for patients living with chronic conditions to help them participate in the taking care of their lives by adhering to drug prescriptions at anytime and anywhere.

According to Köhler et al. (2017) in order to solve the problem of medication adherence, patients need to be empowered to take care of their own conditions by making use of the mHealth applications available. Köhler et al. (2017) further note that different technological applications like those based on mobile technology such as smartphones, smart watches and intelligent bracelets can be used to act as reminder systems to enable patients adhere to medical prescriptions.

According to Debon et al. (2019), using mHealth in self-management of patients with chronic diseases makes better the control of complications that would arise to patients suffering from such conditions. The researchers allude that by effectively using technology such as persuasive technology, patients' adherence to medication and

treatment improves quite well. They further indicate that to effectively use such technologies, factors such as cultural, social, local economic, political, technical as well as the environment surroundings of the patients need to be paid attention to. Chatterjee (2019) indicate that the mHealth self-monitoring system should be developed with various functionalities such as reminders and medical monitoring.

Earlier researchers such as (Chigona, Nyemba-Mudenda, & Metfula, 2013; Sibiya et al., 2014) attribute the major hindrances to health monitoring and non-adherence of medication to factors such as culture, poor communication, discrimination and drug abuse as well as lack of education. They, however, indicate that these factors have to be in the context of the communities or countries in which such mHealth systems are developed. Another challenge has been that , many health systems have their emphasis on monitoring the performance and support of health workers in communities leaving patients out of the picture, yet they would have been the major actors (Sibiya et al., 2014). In order to address self-monitoring of chronic disease patients mHealth monitoring systems should be built on the foundation of persuasive technology that stimulates patient's behaviour to act to the situation, which in this case is medical adherence (Chatterjee, 2019).

Leveraging technological applications like mHealth to support patients with chronic diseases, changes the patient's role from being passive recipient to active consumer of health information (Mishra et al., 2016). Additionally, Huzooree et al. (2019) note that to achieve a proactive approach mHealth monitoring systems should leverage persuasive technology by incorporating an integration of both invasive and non-invasive sensors as well as mobile applications.

1.3 Research problem

Patient engagement in managing their lives leads to better health outcomes (Huzooree et al., 2019). However, the existing patient engagement systems have been mainly focusing on their passive reception of information rather than the active empowerment to manage their lives (Mishra et al., 2016; Chatterjee, 2019). The increasing mobile telephony penetration in South Africa has been greatly limited to communication and to less extent banking but little has been done to utilize it to support basic services like

education and health. In addition, South Africa has not been open to the use of persuasive technology in mobile health system (Sibiya et al., 2014).

Physical and psychosocial consequences, and lifestyle changes inherent in living with a chronic condition, has been cited as a key component of chronic disease management (Huzooree et al., 2019). The use of self-management for patients' monitoring of their health enables the adherence treatment or behavioural modifications outside the traditional healthcare setting; supportive tools are needed to maintain practice in daily life (Lucas, 2015). However, each developed system needs to be contextualized in a particular country's perspective due to the varying social and culture backgrounds (Chatterjee, 2019; Debon et al., 2019).

1.4 Research goal and objectives

This section discusses the goal and objectives this study set to achieve.

1.4.1 Goal of the study

The goal of this study was to design a model for self-monitoring mHealth system based on persuasive technology for patients with chronic lifestyle diseases in South Africa.

1.4.2 Research objectives

To achieve the goal of the study, three objectives that were deemed necessary had to be achieved. These objectives were;

1. To review the existing persuasive technology mHealth self-monitoring models and determine their applicability to the South African context
2. To determine and analyse factors that influence the development of a persuasive technology mHealth self-monitoring systems for patients with chronic lifestyle diseases

3. To describe the role of persuasive technology in enlisting the desired behaviours and psychological influence of patients while interacting with technology

1.5 Research questions

This study sought to answer the following research questions:

1.5.1 Primary research question

The primary research question for this study was:

What persuasive technology mHealth self-monitoring model can be developed for patients with chronic lifestyle diseases in South Africa?

1.5.2 Secondary research question

The secondary research questions of this study are:

1. Which persuasive technology mHealth self-monitoring models have been developed and to what extent do they apply to the South African context?
2. What factors influence the development of a persuasive technology mHealth self-monitoring systems for patients with chronic lifestyle diseases?
3. What behaviours and psychological factors do patients exhibit while interacting with technology?

1.6 Scope of the study

This study sought to develop a model for self-monitoring mHealth system based on persuasive technology. This implied that the study only concerned itself on model development and implementation of the mHealth system was out of the scope. The developed model could later be extended by other researchers to implement the self-monitoring mHealth system. Due to the fact that this study intended to develop a model that can assist to stimulate patients' behaviour, the participants of the study were only

medical personnel and social workers who deal with patients of chronic diseases as it was believed that these experts know how patients behave when they are given drug prescriptions.

1.7 Justification of the study

The use of (ICT) in the health sector as an enhancement tool to improve the healthcare systems across the world has become a slogan for every country. According to the South African health review report (Gray & Vawda, 2018), recent years have seen large sums of money being spent to procure health ICT and Health Information Systems (HIS) in South Africa. However, the report indicates that the ICT and HIS within the Health System are not meeting the requirements to support the business processes. This has rendered the healthcare system incapable of adequately producing data and information for management and for monitoring and evaluating the performance of the national health system. The report emphasizes that this is mainly due to the lack of technology regulations and a lack of policy frameworks for all aspects of infrastructure delivery.

South Africa can achieve more and better results in using ICT to enhance the healthcare sector if a suitable framework can be developed and contextualized in the South African perspective. The South African mHealth strategy 2015-2019 (Department of Health, 2015) indicates that existing and future mHealth initiatives and projects categorized as focus on the patient or citizen, focus on providing support to health professionals and support to healthcare institutions in healthcare delivery. Researchers such as (Lucas, 2015; Debon et al., 2019) attest that, much as the South African government spends a big percentage of its Gross Domestic Product (GDP) on mHealth initiatives, it still lack proper guidelines to use mobile technology for delivery of healthcare as it is still using mobile technology as a service supporting daily tasks such as phoning to make doctor appointments. This also concurs with what other researchers such as (Leon & Schneider, 2012; Sibiya et al., 2014) had earlier indicated that much as health monitoring systems already exist in the South African health sector, some are developed to monitor performance of health workers whereas others lack contextualization.

1.8 Contribution this makes

The contribution this study makes is theoretical and practical.

1.8.1 Theoretical contribution

Chronic non-communicable diseases such as stroke, cancer, chronic respiratory conditions, heart diseases, and diabetes have been identified as the leading global cause of high mortality. Despite the availability of mHealth system applications, the health care industry in the South African context is still reliant on the traditional health monitoring systems to monitor and manage chronic diseases. This research investigated closely the perceptions surrounding the implementation and deployment of mHealth applications to monitor patients living with chronic conditions based on persuasive technology.

Literature shows that there are few health monitoring frameworks contextualized in the South African perspective and those existing were designed to support health workers (Leon & Schneider, 2012; Sibiya et al., 2014). By using persuasive technology to develop the proposed model, this study is a step towards the solving of the challenge of self-monitoring of patients with chronic diseases. The developed model will then be used by other researchers to extend research in mHealth self-monitoring systems for chronic diseases. By so doing, this study will be making a significant theoretical contribution in the computing body of knowledge.

1.8.2 Practical contribution

The use of persuasive technology in the development of self-monitoring mHealth systems are recent innovation trends in the field of computing even though persuasive technology has been in existence for some time. Government, hospitals and other stakeholders will use the developed model as a pillar to improve patients self-monitoring which is paramount to improve their health. The developed model by this study will then serve as a guideline for health professionals to stimulate and elevate policy discussions on monitoring of patients. Further still, the implementation of this model into a mHealth system will help patients to monitor their lives. Using this model

to implement a self-monitoring system will be a significant practical contribution, as developers will base on the developed model to solicit the functional and non-functional requirements of the self-monitoring mHealth system.

1.9 Research outline

This section presents a recap of each chapter as guidance to the reader of this dissertation of what is expected to be found in each chapter.

Chapter 1: This chapter discusses the concept of mHealth and mHealth self-monitoring of patients with chronic diseases. The chapter highlights the prevalence of chronic diseases in developing countries and South Africa in particular that calls for the need to develop a contextualized model for self-monitoring. The problem statement is given as well as objectives and questions of the research. Based on the goal of the study, the chapter gives the scope of the study and discusses the aspects that justifies this study. Finally, this chapter gives the contribution this study makes in relation to theory and practice.

Chapter 2: This chapter revisits the concept of mHealth and explains the concept in relation to mHealth and health systems in South Africa. More to that the chapter discusses the burden of chronic disease by putting much emphasis on chronic lifestyle diseases. The chapter gives a brief synopsis of persuasive technology and how such has been applied in healthcare. Literature related to the study is discusses by giving special attention of what other researchers have recommended to be done in the field of mHealth monitoring. The discussion of the related work led to the discussion of the theoretical foundations based on which a conceptual for this study was designed. Lastly, the chapter discusses how the hypotheses for this study were developed in relation to literature and practice.

Chapter 3: This chapter presents the methodology that was followed by this study. The chapter explains why a positivist approach was deemed appropriate for this study based on which data was collected and analysed. The sampling of the study's participants is discussed as well as methods of data analysis. Finally, the chapter

discusses the ethical standards that were considered in the process of collecting, analysing and disseminating the collected data.

Chapter 4: This chapter presents the results obtained from data analysis. The chapter first presents result of the frequencies of the situational and demographic variables of the participants of the study. Further to that, the chapter presents the correlation and regression analysis based on which the suggested hypotheses were tested.

Chapter 5: This chapter discusses the findings of the study. The chapter first discusses the findings in relation to the set hypotheses and then those of the set objectives. All discussions are made in relation to theory and practice. Based on the findings and their discussion the chapter gives an evaluation whether the set objectives of the study were achieved from which recommendations of further research are given.

CHAPTER TWO: LITERATURE REVIEW

This chapter discusses the literature related to this study. The chapter first highlights the health systems in developing countries but much emphasis on the South African perspective. The chapter also discusses the burden of chronic diseases and gives the need for close monitoring of such burden. More still, the chapter discusses the concept of mobile health and how this could be leveraged to improve health delivery in developing countries. The chapter further discusses the related work to this study from which theoretical foundations that underpins this study are discussed. Based on theoretical underpinnings, the chapter discusses the conceptual model that guided the remaining flow of the study. Lastly, the chapter discusses how the theorized hypotheses were developed.

2.1 Health systems

According the World Health Organization [WHO] report on global health and data repository, health system also referred to as healthcare system may be looked at as the arrangement of different units, institutions, people, and resources to deliver healthcare services to the targeted population (WHO, 2020). The report indicates that these systems should be flexible and scalable to accommodate different activities and behaviour relating to healthcare provision and services. Han (2012) indicates that much as various healthcare systems are developed for different purposes, their potential to scale enables them to be customized or parameterized to handle a particular health hazard. Additionally, WHO (2020) indicates that a health system should encompass preventive, curative, and rehabilitative health care services with a main activity of promoting, restoring and/or maintaining health. Hence, a good health system is one that is flexible enough to deliver quality health services to all people, when and where they need them.

The Organisation for Economic Co-operation and Development [OECD] (2017) indicates that, many developing countries' health systems are faced with various challenges that include but not limited to insufficient financial and human resources support, limited or poor institutional capacity and infrastructure, lack of health information systems, lack of comprehensiveness as well as inequality and

discrimination in accessibility and availability of services. However, the report further indicates that countries may improve their health systems by educating their citizens, noting that education is essential for securing safer jobs, improving health literacy that helps to avoid riskier health behaviours, adhering to preventive healthcare measures as well as living and demanding better-quality health services.

2.1.1 Health systems in South Africa

The South African health system is classified under two major categories namely public and private health sectors. The public sector is operated by the various provincial government health departments and is divided into primary, secondary and tertiary health services. These healthcare services are provided through various health facilities located within and managed by the different provincial departments, monitored by the National Department of Health (Mahlati & Dlamini, 2015). Since the beginning of the democratization process in South Africa, the government has been developing and implementing charters, policies, strategies and plans in an effort to strengthen public health system performance and enhance service delivery. However, public health programme performance and outcomes have remained poor while the burden of disease has increased (Malakoane, Heunis, Chikobvu et al., 2020).

The South African government spends heavily on healthcare almost more than on other needs besides basic education (Huzooree et al., 2019). Earlier research efforts by Chigona et al. (2013); and Sibiya et al. (2014) indicate that South Africa's challenges range from lack of supervision of the community–based health services to lack of standardized suitable integration of information technology in the health system. They note that, other factors that impede the South African health systems are the lack of dedicated monitoring supervision of staff, evaluation of health staff as well as insufficient budget to provide proper training at all levels. It is worth noting that health outcomes are not proportionate with spending as considering spending alone leaves other factors that put healthcare at a disadvantage unattended to. This implies healthcare challenges in South Africa need to be looked at in a holistic way rather than from the budget perspective only.

Lately South Africa (SA) has joined the list of those developing countries that are experiencing the challenge of brain drain in the medical area. South Africans, like many developing countries' experts in medicine, are migrating to other developed countries for better pay leaving a gap in medical provision in the already constrained healthcare domain (Ashrafzadeh & Hamdy, 2019). More still, the increasing urbanization is making SA to be one of the countries with high number of patients suffering from chronic conditions this is in addition to the infectious diseases and the current wave of Covid 19 that has hit SA most compared to other African countries (Malakoane et al., 2020).

2.1.2 The burden of chronic disease

Non-communicable chronic diseases burden are attributed to the high mortality and morbidity rates in Sub-Saharan Africa (Gouda et al., 2017). This, in addition to the traditional burdens of infectious diseases like malaria, communicable diseases, nutritional diseases and accidents, claims a good number of lives in the region. In South Africa, like in many other developing countries, the challenges of chronic disease is still worrying and has caused a number of deaths (Nojilana et al., 2016). Other challenges to health in SA are due to injuries caused by interpersonal violence and motor vehicle accidents whereas some are due to mental health disorders because of alcohol and drugs abuse. Nojilana et al. (2016) and Gouda et al. (2017) concur that other traditional chronic disease are also prevalent and these include diabetes, heart disease and cancer.

2.1.3 Chronic lifestyle diseases in SA

The democratization of South Africa has led to urbanisation where the Black population have left villages and migrated to towns to look for employment. According to Puoane et al. (2008), approximately 56% of the population are living in urban centres and this number has drastically increased due to the enforcement of the affirmative action and Black empowerment (Kalema & Mosoma, 2019). However, the survival for the fittest in the urban areas and the increasing globalisation dictate changes in people's lifestyles as they strive to cope with the cost and standard of living in the urban environment (Nojilana et al., 2016).

Mayosi et al. (2009) allude that the last fifteen to twenty years saw societal changes in lifestyles that led to exponential increase of risk factors for chronic diseases. They indicate that besides the historical burdens of communicable, perinatal, maternal, and injury-related disorder, the westernization in the urban areas has brought up poor dietary patterns, reduced level of physical activity, increased tobacco consumption and alcohol use. Shifts in dietary patterns are a major concern and are highly attributed to the increased prevalence of chronic diseases such as obesity, diabetes and cardiovascular diseases in many African countries (Steyn, Nel, Parker, Ayah & Mbithe 2012). Further more, researchers Bricas, Barles, Billen and Routhier (2019) asserts that, traditional African diets was mainly composed of legumes, grain products and traditional vegetables. They indicate that, the change to food products that are rich in fats and oils, sweeteners, and animal based products high in saturated fats easily leads to adiposity which is a major risk factor for chronic diseases.

Chronic diseases of lifestyle are said to share similar modifiable risk factors, such as hypertension, tobacco smoking, diabetes, obesity, hyperlipidaemia and physical inactivity (Nojilana et al., 2016). According to Chatterjee (2019), the chronic diseases of lifestyle are normally due to individuals' change in behaviour as they face changes in their life conditions. He indicates that conditions such as obesity and diabetes are caused by lack of exercise, improper diet and fail regimens, whereas others diseases like heart disease, lung cancer, chronic obstructive pulmonary disease and asthma caused by the abuse of tobacco, drugs and alcohol. These diseases require regular medication to combat their related symptoms and failure to adhere to these medical prescriptions is tantamount to increased mortality.

2.2 Mobile Health

The Department of Health South Africa (2015) in its mHealth strategy 2015 -2019 report referred to mHealth as fast growing subset of eHealth based on mobile computing, medical sensor, and communications technologies to deliver and support medical and public health practices. The report indicates that such services are delivered by using mobile telecommunication and multimedia technologies like mobile phones, patient monitoring devices, PDAs, and other wireless devices. On the other

hand, Kaiuma et al. (2019) give mHealth applications to include remote monitoring, remote data collection, education and awareness, disease and epidemic outbreak tracking, communication and training for healthcare workers as well as diagnostic and treatment support. Additionally, WHO (2020) indicates that mHealth offers many uses that include, but not limited to, remote patient and healthcare monitoring and reporting, emergency response systems, human resources coordination, management, and supervision, disease surveillance and control, as well as synchronous and asynchronous mobile telemedicine diagnostic and decision support for medical personnel.

Cresswell and Sheikh (2013) define mHealth as the use of mobile communication devices such as mobile phones, patient monitoring devices, tablets, personal digital assistants and other wireless devices to monitor and provide healthcare services. They allude that patients can leverage mHealth as reminder system to enable them adhere to drug prescriptions which helps them to control ailment that reduce hospital visits. By the patients adhering to medical prescription they become involved in the care for their lives and reduce health care expenditures by improving the quality of life (Kalema & Musoma, 2019).

According to Kırcı and Ünal (2016), technologies such as wireless communication have highly been used to provide reliable health monitoring to patient including those with chronic disease. Many health devices and applications have been advanced in developed counties to monitor and manage patients with chronic conditions but such technological development have been of little benefit to developing counties (Lucas, 2015; Debon et al., 2019).

2.2.1 mHealth monitoring systems

The increase of chronic diseases is now a serious social issue in the world and failure to manage them will results in serious consequences that include, but not limited to, lower quality of life, increased economic burden, and social problems (Huzooree et al., 2019). Additionally, Varshney (2014) note that there is an increasingly high need for cost-effective healthcare services that could work as intervention methods for chronic disease patients to be provided with healthcare everywhere and at any time

so as to avoid expensive hospital-based care. Mobile health monitoring systems have been seen as a major innovation that can serve this purpose.

The mHealth monitoring systems are designed to empower patients to self-monitor their lives anytime and anywhere (Varshney, 2014). According to Huzooree et al. (2019), the monitoring can be classified into four major categories namely self-monitoring, assisted monitoring, supervised monitoring and continuous monitoring. They note that, these systems are mostly developed based on persuasive technology that helps to trigger the patients' minds to adhere to drug prescriptions. They further indicate that, besides being built on persuasive technology, other factors also need to be taken into consideration and these include targeted audience characteristics and culture, the wearable sensor types, the contextual information or parameters to be monitored, the architecture of the monitoring system, the network communication protocols, the intended incentives and motivations as well as the decision-making techniques.

2.2.2 mHealth monitoring systems developed in the South African perspective

Researchers such as Betjeman, Soghoian, and Foran (2013), carried out a systematic review in which they summarized peer-reviewed literature on PubMed relating to mHealth in Sub-Saharan Africa. They generally observed that most of the studies reviewed concluded that mHealth could improve patients' medication adherence and healthcare worker communication as well as reducing the cost of patient monitoring especially in rural areas. More still, they observed that most reviewed studies had identified mHealth barriers as poor infrastructure, lack of necessary knowledge, limited operating costs and poor policies and standards. They indicated that such challenges have hindered large-scale implementation of existing mHealth interventions in the region. Betjeman et al. (2013) indicated that some projects on mHealth monitoring systems have been developed in Sub-Saharan Africa though on small scale and these include;

- SIMpill that works on the principle of sending an SMS text to a central server whenever a pill bottle is opened.

- Wisepill also works on the same principle of promoting medication adherence by transmitting data to a central server whenever a patient opens the pill bottle. Both the SIMpill and Wisepill use the general packet radio service (GPRS) technology to send SMS from patients to the central server.
- Another system is the mobile directly observed therapy (MDOT) model for tuberculosis developed in Kenya but also used in Southern Africa. The system uses a combination of video and text messaging to encourage medication adherence.
- WelTel Kenya1 was designed to promote antiretroviral (ARV) medication adherence using a weekly SMS text messages inquiring about patients' general wellbeing for which a patient is supposed to respond within 48hours and failure to do so prompts a social worker to make a follow up.

Additionally, Ojo (2018) also conducted a systematic review of literature of the studies between 2011 and March 2016 of mHealth interventions on health outcomes in South Africa. The study revealed that mHealth interventions basing mobile phones and text messages had been researched on with an intention to improve treatment adherence by eliciting patients' behaviour. The study also revealed that due to lack of contextualization, there is lack of sufficient evidence that mHealth interventions have made significant improvements on healthcare outcomes in South Africa. The findings of his study further indicated that despite the many on-going mHealth projects in the country many are likely to remain pilot projects. The study recommended more intervention of mHealth in healthcare delivery processes.

In the same perspective, Odendaal, Lewin, McKinstry et al. (2020) conducted a study to implement mHealth system in South African rural settings of Western Cape Province. The proposed system was to improve the communication between the teams of the lay health workers (LHWs) so as to enhance continuity of primary healthcare. Their study noted that there are several challenges that impacts on successful implementation of mHealth in South Africa including poor internet access and telecommunication infrastructure, changes in staffing and clerks already burdened with other duties, poor automation of patients' details and low literacy levels.

2.3 Persuasive technology

When perceived as social actors, computer products can leverage the principles of social influence to motivate and persuade users. Consequently, people will respond to them as though the computers were social entities that use principles of motivation and influence (Fogg, 1997). From this understanding, persuasive systems, in principle, influence individuals' behaviours and perceptions, hence various techniques could be used by these technologies to enlist different outcomes and behaviour change strategies.

Chatterjee (2019) indicate that persuasive technology influences patient's behaviour and change of attitude for those that miscarry to comply with regimens of managing their lives such as sticking to a good diet, check blood glucose every day and exercising to decrease number of patients to visit hospitals at all the time. Huzooree et al. (2019) note that having technology that can be used as a tool to assist patients to make use of technology to support themselves in managing their lives is an important factor in fighting chronic diseases. They allude that with self-monitoring, the patients do not need the involvement of healthcare givers but rather motivation to focus on self-discipline, self-confidence and self-care to manage their own personal health chronic diseases.

2.3.1 Persuasive technology health monitoring systems

Persuasive systems work on the principle that technology is used to influence individuals' behaviours and perceptions, hence various techniques could be used by these technologies to enlist different outcomes and behaviour change strategies (Fogg, 1997; Mishra et al., 2016; Kırcı & Ünal, 2016). On the other hand, Huzooree et al. (2019) allude that persuasive technology system involves the new use of computing technology to easily provide preventive healthcare service. Monitoring systems make use of mobile technologies for self-management of conditions, use of remote system for patients to have a healthier living to reduce cost of healthcare (Kırcı & Ünal, 2016). Persuasive technology health monitoring system aim to ensure monitoring solution for improvement of system efficacy and efficiently. Use of persuasive system helps to

remind people, motivate and trigger their mind to adhere to medicine and help them to reach their goals via text messages or using apps (Chatterjee, 2019).

2.3.2 Factors influencing mHealth self-monitoring systems

Literature search from various publications reveals factors that are thought to be relevant for the use of mHealth self-monitoring system for patients with lifestyle chronic diseases. Several researchers such as (Betjeman et al., 2013; Chigona et al. 2013; Sibiya et al., 2014; Nojilana et al., 2016; Mishra et al., 2016; Kırcı & Ünal, 2016; Gouda et al., 2017; Huzooree et al., 2019; Chatterjee, 2019; Debon et al., 2019; Ashrafzadeh & Hamdy, 2019; Odendaal et al., 2020) have highlighted different factors positively or negatively influence mHealth self-monitoring of patients with chronic lifestyle diseases. Much as many of these factors are repetitive, others could be summarized into eight categories as demonstrated in Table 2.1.

Table 2.1: Summary of factors influencing mHealth self-monitoring

Constructs	**Factors**
Mobile technology	• Scalability • Ease of use • Usefulness • Flexibility • Behaviour change support system • Availability • Security
Patient's Attitude	• Patient commitment, • Patient self- reminder attitude towards technology • Patient self- efficacy • Patient self -monitoring • Self-commitment

Patient's belief	• Self-motivation • Voluntary compliance patient • Belief & strength • Inner feelings
Social behaviour	• Social facilitation • Budgeting • Social learning • Social support • Social influence
Culture	• Patient needs • Descriptive norms • Support • Behaviour change • Cultural beliefs
Environment factors	• Government strategies • Politico- economic • Health policies • Network availability • Patient literacy • Universal standards
Perceived behaviour control	• Likelihood to change • Expected personal responsibility • Continued behaviour change
Behaviour Intension:	• Intention to use • Intention to recommend usage • Intention to support usage • Continuance usage

2.4 Related work

Pinzon and Iyengar (2012) carried out a systematic review of objectives on mHealth development to persuade long-term behaviour change among healthcare workers and patients. They observed mHealth need to be integrated with persuasive technology in order to benefit from self-monitoring. The study revealed that there are positive recent aspects of persuasion in mHealth and provides a model to developers as well as designers of mHealth solution, with the aim of changing people‘s behaviour or attitude without deception or pressure. These researchers emphasise that mHealth systems that apply values could certainly provide the potential of monitoring patients. However, the study did not make use of all principles of persuasive features like behaviour change which, as noted by Chatterjee (2019), is paramount for self-monitoring. Therefore, there is a need to increase the potential of mHealth by integrating persuasive features and such is the core for this study.

Chigona et al. (2013) conducted a study to investigate the level of mHealth usage in developing countries by looking at the different components of mHealth projects deployed in developing countries. The study acknowledged that the use of mHealth is an innovative opportunity to overcome resource barriers in healthcare with more focus on the developing countries especially for monitoring patients. These researchers noted that most of the health monitoring devices used in many developing countries are imported and as a result, they do not address the realities of rural settings in the developing countries. Their study observed that culture factors play a significant role when technology usage relating to behaviour is concerned. They recommended that future studies should contextualize the developed models in order to fit the perspectives of the patients’ culture and environment.

Matthews, Win, Oinas-Kukkonen and Freeman (2016) did a research on persuasive technology in mobile applications intended to support physical activity. The study reviewed the current state of mobile applications for health behavioural change with an emphasis on applications that promote physical activity. The inbuilt persuasive features of mobile applications were evaluated using the persuasive systems design model. The study established that the advantage of persuasive technology is a reward endeavour as it plays a critical role in mHealth self-monitoring applications. They,

however, recommended for further studies contextualized to the culture and behaviour of patients being targeted for monitoring.

Saare, Hussain and Yue (2019) conducted a study on the relationships between the older adult's cognitive decline and quality of life by examining the mediating role of the assistive mHealth applications. The study revealed that explaining the mediating role of assistive mHealth application has remained unaddressed. Their goal was to give the insight that the adoption of assistive mobile application will give people the potential solution to their challenging aging life, therefore improving their features of life. They conceptualized the use of assistive mHealth application to increase the quality of life of older adults by integrating older adult 's cognitive understanding of the causes of decline and understanding of quality of life. Their study recommended that the principle of self-involvement in one's life is important and should be encouraged.

Kaiuma et al. (2019) conducted a systematic review intended to understand the factors affecting mHealth adoption. The investigation showed that there are major theoretical and practical implications for mHealth to policy makers, researchers, and service providers. Their analysis indicated that they were many influential factors that influence the use of mHealth tools such self–efficacy, cost and resistance to change. They, therefore, recommended that when using mHealth individual factors play an important role and should be given preference.

Kalema and Mosoma (2019) conducted a study to develop a mHealth monitoring systems model for chronic diseases patients in developing countries. Their study indicated that for self-monitoring of patients the use of persuasive technology is paramount. They indicated that in the self-monitoring processes of patients, it is essential to consider their planned behaviour which stimulates the actual performance of the intended act. Their study recommended the inclusion of individual characteristics in the designing of the self-monitoring model as patients may have different levels of understanding, learnability and beliefs.

2.5 Related information systems theoretical frameworks

Several studies have been conducted to highlight the factors that influence the adoption and use of a new technological innovation. From the review of related works, it was established that the use of mHealth self-monitoring embraces technology adoption factors, planned behaviour change factors, the environment as well as individual characteristics. More so, Wisdom, Chor, Hoagwood and Horwitz (2014) allude that the adoption of a technological innovation is highly influenced by the technology and organization's characteristics as well as the environment in which the technology is being implemented. This understanding has seen the technology, organization and environment (TOE) theory by De Pietro, Wiarda and Fleischer (1990) an important theory in many studies of technology adoption, acceptance and use. The technology acceptance model (TAM) Davis (1989), has also been very popular in studies dealing with the acceptance, adoption and use of technology. These two models are also discussed in addition to the theory of planned behaviour.

2.5.1 Theory of Planned Behaviour

The theory of planned behaviour (TPB) postulates that people develop the desire to perform given tasks as long as they have conditioned their minds to do so (Ajzen, 1991). The theory builds on an understanding that individuals make logical, reasoned decisions to engage in specific behaviours by evaluating the information available to them. The TPB has six constructs namely; behavioural intention, social norms, attitudes, subjective norms, perceived power and perceived behavioural control as well as actual behavioural control and actual behaviour. Since mHealth self-monitoring involves the stimulation of behaviour of patients all these six constructs will be used in a detailed manner.

2.5.2 Technology Acceptance Model (TAM)

The technology acceptance model (TAM) (Davis 1989) theorizes that perceived ease of use and perceived usefulness when mediated by intention to use, influence actual usage of technology. TAM, which further hypothesizes that perceived ease of use directly impacts perceived usefulness, has been widely used by several researchers to predict the acceptance, adoption and use of technology (Tarhini, Arachchilage, Masa'deh & Abbasi, 2015; Gefen & Larsen, 2017). The antecedents of TAM namely;

perceived ease of use and perceived usefulness have been widely examined to explain individuals reaction to technological innovations, their intention to use them as well as actual usage. Some studies have incorporated these constructs as variables of the technology construct of the technology, organization and environment (TOE) model (De Pietro et al., 1990). These constructs along with the intention to use were incorporated in the conceptual model of this study.

2.5.3 Technology, Organization and Environment Model (TOE)

By the fact TAM's constructs are more to do with user's perception of the technology, when using TOE TAM's constructs are normally included in the technology construct with the exception of behaviour intention. The TOE explains a deeper understanding as to why individuals resist or accept a technology that is being adopted. Wisdom et al. (2014) allude that besides reluctance to use technology, there are other technological issues that need to be investigated to inform usage and such should be coupled with the environment in which the technology is being adopted. The technology, which in this case is the mobile technologies including wearable sensors and environment constructs of this framework, are incorporated in the conceptual framework of this study.

2.6 The conceptual model

From Table 2.1 and the discussion of the theoretical perspectives, it could be deduced that the conceptual framework for this study could be governed by the planed behaviour constructs, individual's characteristics such as beliefs, attitudes and self-efficacy as well as the technology and environmental factors. As highlighted by Fogg (1997, 2002), the use of persuasive technology enlists the behaviour of an individual to respond to stimuli triggered by a technological device and behave as if that individual is interacting with another human being. This implies that persuasive technology has much to do with a planned behaviour, beliefs and attitude of the participating individual. This makes the constructs of behaviour control and planned behaviour essential for this study.

On the other hand, several researchers on lifestyle chronic disease monitoring and control have expressed the influence of the patient's environment as essential for controlling the risk factors, reduce prevalence and also affecting medical adherence (Gouda et al., 2017; Debon et al., 2019; Huzooree et al., 2019). The TOE model's construct of environment, as put forward by De Pietro et al. (1990), allows other factors such availability of networks especially in rural settings; government influence including support, policies and strategies; as well as medical literacy and awareness to be included. Lastly, the study suggests that the ubiquitous technology like mobile telephony that easily be scaled to rural settings. Both the integration of this pervasive technology and behaviour are paramount to the success of persuasive technology. From this understanding, a conceptual model for this study is illustrated in Figure 2.1.

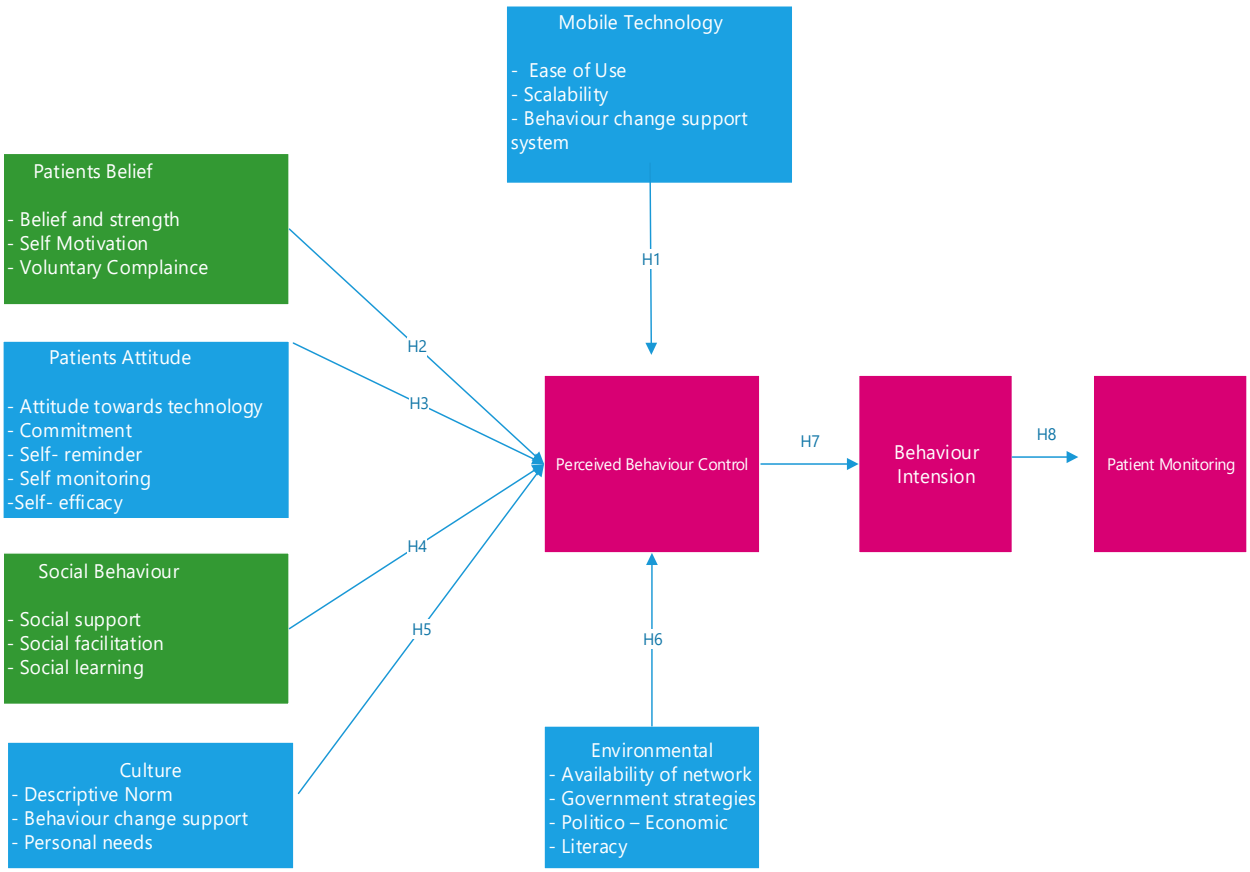

Figure 2.1: The conceptual Model

2.7 Hypotheses development

Based on the conceptual model illustrated in Figure 2.1, the constructs are discussed as follows;

a) Mobile Technology: In this study, the mobile technology construct refers to the mobile phone, wearables and wireless equipment that need to integrated to design a mHealth self-monitoring system. Goldfine, Lai, Lucey, Newcomb and Carreiro (2020) indicate that, there are a variety of wireless technologies that could be used for self-monitoring of patients however, wearable sensors are the most commonly used technology since the play a major role in self-monitoring by increasing geographic availability and continuously providing feedback and monitoring while remaining relatively non-invasive. However, since self-monitoring needs to integrate a patient-controlled behaviour this construct will be mediated by perceived behaviour control variable. From this understanding the first hypothesis was derived.

H1: Mobile technology has a positive influence on a patient's behaviour intension to self-monitor his/her health.

b) Individual's beliefs, attitude and social norms play an important role in his/her acceptance of an innovation (Ajzen, 1991). This is mainly because an innovation may lead to change in the way one does work or live one's life. Positive beliefs and attitudes will lead to acceptance of innovations whereas negative or biased beliefs may lead to an innovation being rejected as they control behaviour change for one to perform a given act (Wisdom et al., 2014; Tarhini et al., 2015). The influence of behaviour change in self-monitoring of chronic diseases is paramount and cannot be down played (Chatterjee, 2019). Based on this understanding, hypotheses H2, H3 and H4 were developed.

H2: Patients beliefs has a positive influence on a patient's behaviour intension to self-monitor his/her health.

H3: Patients attitude has a positive influence on a patient's behaviour intension to self-monitor his/her health.

H4: Social behaviour has a positive influence on a patient's behaviour intension to self-monitor his/her health.

c) Culture defines ones' belonging and association to a given norm, community or religious belief (Chigona et al., 2013). The influence of culture in technological innovations acceptance cannot be down played as it dictates whether an individual's association to community or religion entrusts the new change that is being suggested. This is a reason explaining why different researchers such as (Sibiya et al., 2014; Debon et al., 2019; Huzooree et al., 2019) recommended the culture factor to be included in the models intending to contextualize mHealth monitoring. This discussion formed the basis of developing the fifth hypothesis (**H5**) of this study.

H5: Culture has a positive influence on a patient's behaviour intension to self-monitor his/her health.

d) Environmental factors: In this study this construct refers to the patients surroundings including all aspects that could influence the mHealth development and use for self-monitoring. This study examined the influence of government support, strategies, as well as political influence in the provision of healthcare and this led to the development of the sixth hypothesis (**H6**).

H6: Environmental factors has a positive influence on a patient's behaviour intension to self-monitor his/her health.

e) Perceived behaviour control: In relation to this study, this constructs refers to the patient's change of behaviour to adhere to medicine prescriptions when triggered by the mHealth self-monitoring system. This understanding led to the development of the seventh hypothesis (**H7**) of this study.

H7: Perceived behaviour control has a positive influence on a patient's behaviour intension to self-monitor his/her health.

f) Behaviour intention: Several researches such as (Davis, 1989; Tarhini et al., 2015; Gefen & Larsen, 2017; Wisdom et al. 2014) have alluded to the influence

of behaviour intention to actual usage of technology. In this study, this constructs refers to the patient's actual use of the mHealth self-monitoring system when being reminded. Based on this understanding, the eighth hypothesis (**H8**) was developed.

H8: A patient's behaviour intention has a direct influence on self-monitoring of his/her health

2.8 Summary

The increasing penetration of mobile telephony in South Africa could be leveraged to improve healthcare accessibility and reduce inequality. However, this can be achieved if common standards are developed and maintained in form of a model to govern mobile health implementation. This chapter discussed the literature related to the development of a model that could lead to successful implementation of mHealth self-monitoring model for lifestyle chronic diseases.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

This chapter presents the research design and methodology that were followed by the study. The chapter highlights the research design, approach, paradigm and strategy, as well as the methods that were used to collect and analyse data. Furthermore, the chapter discusses the sampling technique that was used in selecting participants of the study from whom data was collected. Lastly, the chapter explains the ethical considerations and standards that were followed in the collection, analysing and dissemination of information from the collected data.

3.1. Research design

A research design is the blue print or the plan that a research study follows (O'Neil & Koekemoer, 2016). This study started by reviewing relevant literature related to mHealth and persuasive technology. The review of the literature enlightened the research problem and gave a rich understanding of the different mHealth monitoring systems. More to that, the literature highlighted the role of persuasive technology in changing patient's behaviour that prompts them to respond to the triggers from the mHealth self-monitoring systems. Additionally, the study also carried out an extensive review of related work to establish the gaps that were still outstanding in relation to mHealth monitoring systems and the integration of persuasive technology to do self-monitoring. Based on the reviewed literature, a close-ended questionnaire was designed and used for data collection from the participants of the study that were health practitioners and social workers. this group was chosen as the population of the study as it was sought that since they deal with patients suffering from chronic diseases on a routine basis, they had good understanding of them in relation to how they respond to medical prescriptions.

The collected data was then analysed quantitatively using the SPSS for both descriptive and inferential statistics that included correlations and regressions. This implies that this study followed a deductive reasoning where hypotheses were derived

from the conceptual model and later the collected data was used to carry out tests with an intension to confirm them or not. Based on this, a final model for mHealth self-monitoring for lifestyle chronic diseases was deduced.

3.2 Research paradigm

Creswell and Creswell (2018) define a research paradigm as the researcher's beliefs or assumptions of his/her worldviews. It is the path a research believes that a research study should be conducted to the satisfaction of his/her audience and, to some extent, his/her own beliefs. Alghamdi (2015) notes that social science-based research normally makes use of four most common paradigms namely Interpretivism or the constructivism, Postpositivistism (and or positivistism), Pragmatism and the Transformative paradigm. Lincoln, Lynham, and Guba (2018) allude that before an appropriate paradigm of the study is chosen, three major aspects are considered and such provide an understanding of the best approach a research study should follow. These aspects are the ontology (What is reality?), epistemology (How do you know something?) and methodology (How to go about finding out the unknown?). Following these aspects of paradigms gives holistic understanding of how individuals view, discover and use knowledge.

3.2.1 Ontology

Considering this study, the ontological perspective explaining the reality is that developing countries SA inclusive are faced with a high prevalence of a double burden of infectious and chronic diseases (Mayosi et al., 2009; Kalema & Mosoma, 2019). These countries are also faced with various challenges that make the treatment of patients with these chronic conditions difficult (Ashrafzadeh & Hamdy, 2019). From this reality, the use of mHealth self-monitoring systems becomes inevitable. This implies that the reality is objective and whether the mHealth self-monitoring system is developed or not the burden of chronic lifestyle diseases will remain.

3.2.2 Epistemology

After knowing the reality, Lincoln et al. (2018) allude, the next step is to establish the sources of knowledge by clearly identifying what and what does not constitute knowledge and such must be centred towards the reality. In this study, this could relate to the nature, sources, possibilities, and limitations of knowledge of mHealth monitoring systems developed in the South African perspective. Therefore, the epistemological stance of this study was to follow a positivism paradigm that leads to a quantitative approach, which allows gathering of views of best mHealth self-monitoring system could be developed.

3.2.3 Methodology

Methodology refers to the process followed to find knowledge. It is the strategic approach followed for data collection and analysis (Creswell & Creswell, 2018). This study followed a positivism paradigm that allowed a quantitative approach. This implies that the data for this study was collected and analysed using quantitative methods. The graphical representation of paradigmatic characterisations used in this study is as illustrated in Figure 3.1.

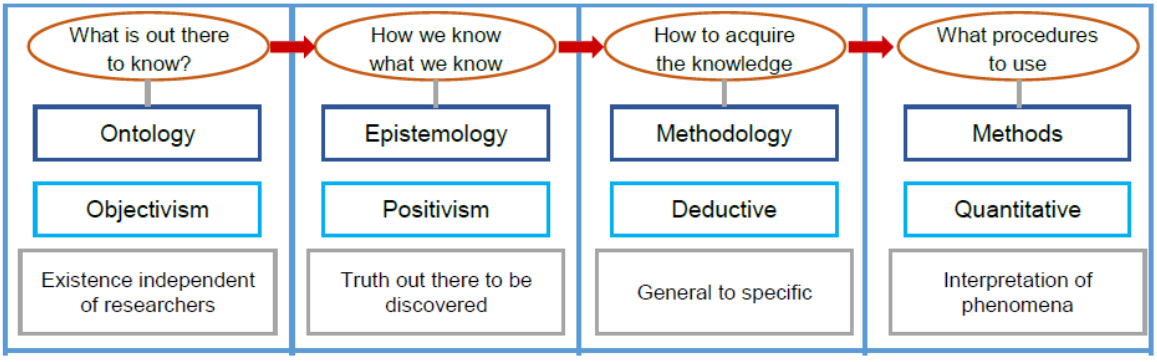

Figure 3.1: Paradigms Classification used for this Study (*Modified from Lincoln et al. 2018*)

3.3 Research approach

According to Creswell and Creswell (2018), a research study can follow a qualitative, quantitative or a mixed methods approach. This study followed a quantitative

approach. This study intended to collect data from medical personnel as well as other healthcare personnel like social workers who interact with patients on a day-to-day basis. Because of the nature of the intended participants, this study found it prudent to request the research participants to complete the measuring instrument during their free time as compared to seeking interviews with them yet they are too busy to have such time. The questionnaire that was used for data collection contained an accompanying letter that explained the intent of the study and also highlighted some important issues like ethical concerns. The accompanying letter emphasized that the study had no intention to investigate patients' conditions but beliefs and attitude towards medical prescriptions as seen by the medical personnel.

3.3.1 Advantages of using a quantitative approach

It should be noted that this study was conducted in the most difficult time of Covid-19 lockdown where most employees like social workers were working from home. On the other hand, the medical personnel were ever stressed with high number of covid-19 patients hence using a quantitative approach helped to get at least a good number to respond to the questionnaire as compared to what it would have been if interviews had been scheduled.

Another advantage was that using a quantitative approach allowed the use of online questionnaires where participants were only sent a link that they could open and answer the questions without the researcher visiting their working places. This helped as due to the countrywide lockdown, many organizations had put strict rules against visiting their working places, and besides it was also safe on the researcher's side.

3.4 Research strategy

A research strategy is an overall plan of how the researcher reach the intended participants of the study in order to collect the study's desired data (Creswell & Creswell, 2018). This study followed an online-survey strategy. The questionnaire was captured online using Survey Monkey and a link was sent to the participants. Survey monkey has an option of exporting the collected data to SPSS that makes it easy for analysis. The advantages of using an online-survey for this study was that it helped to

get a good response rate as participants could only be reached online due to the fact that many were working from home.

3.5 Data collection methods

Data collection is the process of gathering relevant information used to address the research problem and such data may be either primary or secondary (Saunders, Lewis & Thornhill, 2015). This study sought to collect primary data from medical personnel and social workers from hospitals of 3 provinces in South Africa namely; Limpopo, Mpumalanga and Gauteng. In their report of the district health barometer of 2018/19, Massyn, Barron, Day, Ndlovu and Padarath (2020) indicated that the prevalence of chronic lifestyle diseases in SA has an almost even distribution. They allude that much as it is accelerated in urban centres due to urbanization and westernization, its dramatic increase in rural areas is due to lack of awareness, unequal accessibility of medical resources and high levels of poverty. This led to this study to have a balance in data collection by choosing an urban hospital and others from rural settings.

This study used a close-ended questionnaire that was uploaded online and links sent to participants to collect primary data. The questionnaire was designed based on the conceptual model demonstrated in Figure 2.1. The conceptual model's constructs formed the categories of the questionnaire whereas their attributes formed the question items. The questionnaire design followed a 5-point Likert scale that was structured as follows: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree (Appendix 1). After data collection, the questionnaire was coded, and then transcribed in SPSS v 25 for analysis. The questionnaire was designed in such a way that personal information that could identify the participants was not asked.

3.6 Sampling Techniques

By the fact that this study followed a quantitative approach, the researcher sought to reach to as many participants as possible. Besides the indicators given by Massyn et al. (2020) for the prevalence of lifestyle diseases, judgmental sampling was used to choose the hospitals and healthcare centres from which the participants were selected. This implied that, putting in mind the covid-19 wave that was going on in the

country, only those hospitals and healthcare centres where the researcher expected to get access were chosen. One hospital and two clinics were selected for data collections from each province. As Massyn et al. (2020) allude these hospitals and clinics are understaffed and the pre-exploratory study conducted by reviewing documentation in relation to these health facilities it was assumed to have a maximum of 60 respondents from each province giving a total population of 180 expected respondents. According to Krejice and Morgan's (1970 as demonstrated by Table 3.1 for determining sample size of population a population of 180 respondents the sample size needed will be 123 respondents.

Researchers such as Ashrafzadeh and Hamdy (2019); Massyn et al. (2020) indicate that most health facilities in SA are under resourced which factor forces them to be under staffed. Hence, to attain the required number needed for a quantitative analysis, this study used simple random sampling was used. This study based on the inclusion criteria of the situational nature of clinical work that all respondents were doing similar tasks with the patients. This motivated the use of simple random sampling a probability sampling techniques that ensures that every single member of the population was chosen randomly also given the fact that the questionnaire was distributed online using a Survey Monkey link. The simple random sampling ensured that each medical personnel or health worker available was requested to participate in the study. At each health institution, the research got a contact person assisted with the distribution of the survey link.

Table 3.1: Table for Determining Sample Size from a Given Population (Source: Krejice and Morgan's, 1970)

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.

3.7 Data analysis

Creswell and Creswell (2018) assert that data analysis is the process of converting raw meaningless data into fully processed information used for decision-making. Collected data was analysed quantitatively using SPSS v 25, by carrying out descriptive analysis, correlations and regression analysis to determine how each of the identified factors contribute to a mHealth self-monitoring model that could be leveraged the develop the needed system.

3.7.1 Questionnaire distribution

Since this study used inclusive sampling, the online survey link was sent to as many participants as possible. In all the link was sent to 170 participants and out of these 126 responded giving a good response rate of 74%, though only 120 questionnaires were fully completed. It is also presumed that the participants picked interest in the study due to the fact that many of them were working from home by that time. It is assumed that participants appreciated the development of a system that could self-monitor patients in their home places bearing in mind social distancing and travel restriction that were in place.

3.7.2 Piloting the study

Before the main survey was conducted, the researcher requested personnel working in a nearby health centre to assist review the questionnaire by answering it. One doctor and three nurses participated and the filled questionnaire was used as a pilot survey based on which rectification to the questionnaire was done. However, prior to piloting, validity check had been conducted by both the researcher and the study leaders and the questionnaire was coded to ease transcription.

3.7.3 Coding of the questionnaire

For easy transcription into SPSS, the questionnaire was coded by abbreviating each constructs' name for easy recording in SPSS. Patients' beliefs was coded as PB, Patients' attitude this was coded as PA, Social behaviour as SocB, Culture as Cu Environment as Envt, Mobile technology as MobT Perceived behaviour control as PBC, Behaviour intention as BI and lastly the Patients monitoring which was the dependent variable as PatientMon.

3.8 Validity and reliability of the study

Research studies endeavour to ensure the quality of both the collected data and the results obtained from its analysis by guaranteeing credibility, trustworthiness, conformability, and dependability (Yin, 2014). Therefore, the measuring instrument used for data collection should be verified to ensure that it consistently measures what it is supposed to measure. Cohen, Manion, Morrison and Morrison (2018) assert that to achieve that goal in research, the two most common quality of standards checks are done using validity and reliability, which are discussed below.

3.8.1 Validity

Validity refers to a set of tests carried out to check the truthfulness of the measuring instrument by ensuring that it actually measuring what it is supposed to measure (Yin, 2014). In this study, four different checks were carried out to ensure that the measuring instrument meets these validity standards and these were;

i. **Face validity**: This check was conducted to ensure that the questionnaire that was used to collect data conforms to the common agreement (Cohen et al., 2018). In this study, this was done by the study leader/supervisor who assisted to check that the questionnaire was free from semantics, syntax, and typographical errors. More so, the supervisor also ensured that questionnaire items are aligned with the attributes of the construct as illustrated in the conceptual model as well as ensuring that questions make sense to the participants.

ii. **Content validity**: This intends to check that the measuring instrument is designed to cover the range and meaning of the research at hand (Yin, 2014). In this study, content validity was done to ensure that the question items relate to mHealth self-monitoring. The supervisor assisted in checking this form of validity. More so, when submitting the questionnaire for pilot testing, participants were invited to identify misplaced questions and to add those others that they felt important for the study.

iii. **Construct validity:** This refers to the identification of the correct operational measures of mHealth self-monitoring of lifestyle chronic diseases. Construct

validity checks the logical relationships between variables whereby the questionnaire used for the study measures the intended concept, which is mHealth self-monitoring (Yin, 2014). This study ensured that the underpinning theories' constructs, as demonstrated in Figure 2.1, were used in the questionnaire development. Furthermore, the study based on the correlation analysis results to test the interdependencies between the constructs.

iv. **Criterion validity:** This is also referred to as predictive validity and it checks how a measure predicts performance on an external criterion (Yin, 2014). For this study, this validity check was done in the process of designing the questionnaire. During the design, question items were compared to those of other questionnaires that had previously been developed by other researchers for mHealth self-monitoring.

3.8.2 Reliability

In relation to this study, reliability refers to the level of consistency the study's questionnaire measures the mHealth self-monitoring. This implies that reliability could be defined as the dependability or trustworthiness of the constructs and the measuring instrument used for the study. In other words it is the degree to which a test consistently measures whatever it measures (Salkind, 2017). According to Yin (2014), a reliability test is carried out to ensure that the current study produces similar results like those of the previous one that used similar measuring instrument. This study used Cronbach's alpha also known as alpha co-efficient was used to determine the reliability or internal consistence of the questionnaire and its constructs.

The testing of each construct's reliability was preceded with that of the whole questionnaire to detect the fit of the measuring items. The reliability of the whole questionnaire was found to have an alpha co-efficient of 0.865 which was deemed good since it was above the recommended threshold of 0.7 (Pallant, 2010). The reliability results for all the constructs are as demonstrated in Table 3.2.

Table 3.2: Statistics of Constructs Reliability

Constructs with their coding	Cronbach's Alpha (α)	α -Based on Standardized Items	Number of Items
Patients Beliefs (PB)	.732	.775	3
Patients Attitude (PA)	.702	.746	6
Social Behaviour (SocB)	.667	.704	3
Culture (Cu)	.757	.788	5
Environmental (Envt)	.695	.712	5
Mobile Technology (MobT)	.618	.662	4
Perc. Beh.Control (PBC)	.822	.854	3
Behaviour Intention (BI)	.788	.812	3
Patients Monitoring (PatientMon)	.883	.896	3

As illustrated in Table 3.2, all constructs exhibited a good reliability measure of above the recommended threshold of 0.7 with the exception of Social Behaviour (SocB), Environmental (Envt) and Mobile Technology (MobT) whose reliability coefficients of .667, .695 and .618 respectively were below the threshold. However, the reliability coefficients of these three constructs were all above 0.6 that is too close to 0.7 and the constructs were included for further analysis.

3.9 Ethical consideration

Research studies, whether academic or market research, follow ethical standards so that the obtained results do not antagonize with the subjects of the study. This means when reporting the findings of the study, researchers ensure that the participants of the study are protected and their privacy is observed. Cohen et al. (2018) hold that research studies are carried out within the limits of political, systems and societal codes and these codes are referred to as research ethics. They further note that ethics should be looked at as the standards and norms that govern and control researchers' behaviours while conducting research.

It is mandatory at TUT that all academic studies are cleared for ethics before data collection commences. All questionnaires for quantitative research are accompanied by a cover letter that gives a clear explanation to the participants about the purpose of the study, protection of their privacy, rights of the participants, anticipated potential risks if any as well as the fairness in the distribution of the questionnaire. All these standards were followed during the collection and analysis of the research data.

3.10 Summary

This chapter discussed the methodology of the study. It first highlighted the design of the study thereafter it discussed the philosophical stance this study followed. The chapter discussed the paradigm that this study followed to direct the collection of data using online questionnaire. This chapter also explained how online data was collected and analysed. Furthermore, the chapter discussed the process that was followed to ensure the validity and reliability of the findings by making sure that the questionnaire that was used conforms to the appropriate standards for research. Lastly, in this chapter, the ethical standards that were followed by the study were detailed in line with those of general standards for research as well as those recommended by TUT.

CHAPTER FOUR

ANALYSIS AND PRESENTATION OF RESULTS

This chapter presents the analysis and results of the study. Firstly, the chapter presents the descriptive analysis of the participants' demographics and situational variables and then presents the results as frequencies. The descriptive analysis results are presented in tabular format while others as pie-charts. This chapter also presents the descriptive analysis results of the constructs showing how the measuring items questions were answered by the participants. More still, the correlation and regression analysis results are presented. Lastly, the chapter presents the results of the tested hypotheses.

4.1 Frequencies of the participants' demographic and situational variables

The demographic variables that were analysed for this study included participants age group and their level of education whereas the situational variables included work experience and mHealth awareness. Results are as presented in Table 4.1.

Table 4.1: Frequencies of the participants' demographics and situation variables

Variable	Item	Frequency	Per cent	Cumulative Per cent
Age Group	Below 20 Years	8	6.7	6.7
	21 - 30 Years	24	20	26.7
	31 - 40 Years	38	31.7	58.4
	41 - 50 Years	32	26.6	85
	51+ Years	18	15	100
	Total	120	100.0	
Highest Level of Education	Grade 12 and Below	2	1.7	1.7
	Diploma	78	65	66.7
	Degree	28	23.3	90

	Postgraduate	5	4.2	94.2
	Other	7	5.8	100
	Total	120	100.0	
Experience	0 - 5 Years	30	25	25
	6 - 10 Years	38	31.7	56.7
	11 - 15 Years	16	13.3	70
	16 - 20 Years	19	15.8	85.8
	21 - 25 Years	11	9.2	95
	26+ Years	6	5	100
	Total	120	100.0	
m-Health Awareness	Yes	88	73.3	73.3
	No	32	26.7	100.0
	Total	120	100.0	

Results demonstrated in Table 4.1 indicates that only a small number of participants 6.7% (n=8) were below the age of 20. This implies that the majority of the participants 93.3% (n = 112) were mature people. Also putting into consideration that 75% (n=90) of these participants had an experience of over 5years, it gives more validity to the answers of this study since mature people with good experience have a good understanding of patients' behaviours and altitudes, are more likely to give more informed answers.

Developing mHealth self-monitoring requires people with some good educational background that could inform what is to be involved in the development process. The results of this study shows that 92.5% (n=111) of the participants had a good education background of a level, diploma and postgraduate whereas only 1.7% (n=2) had education background of matric and below yet those with other related qualifications were 5.8% (n=7). This implies that participants of a good education level were in position to give good and relevant answers to the questionnaire items. This is in terms of comprehension, knowledge and understanding of the concept being asked. Education background is also paramount for the acceptance and use of technological innovations. In relation to this study, this could imply that much as the participants were answering the questionnaire questions basing on what they expect from patients,

their analysis could as well be much trusted as they could compare their understanding of the mHealth to that of the patients they have interacted with. The graphical representation of the participants' education background is illustrated in Figure 4.1.

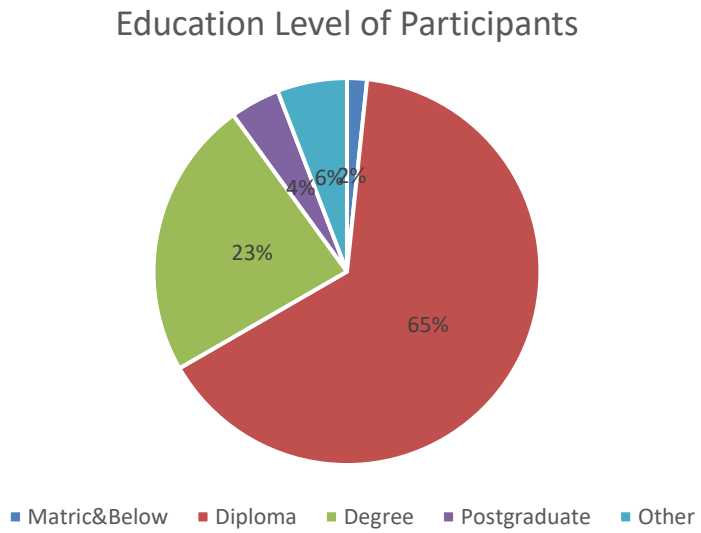

Figure 4.1: Education Background of the Participants

Lastly, participants were asked to express their awareness of mHealth. Results indicated that a good number 73.3% (n = 88) were aware of the mHealth concept whereas only 26.7% (n= 32) were not. One challenge that was identified in the literature as barrier to using mHealth by both healthcare personnel and patients was lack of awareness (Ashrafzadeh & Hamdy, 2019; Massyn et al., 2020). This implies that with good awareness of mHealth and a good working experience, participants were in position to give answers that are well thought of and, therefore, the obtained answers could be trusted. The graphical presentation of the awareness results is demonstrated in Figure 4.2.

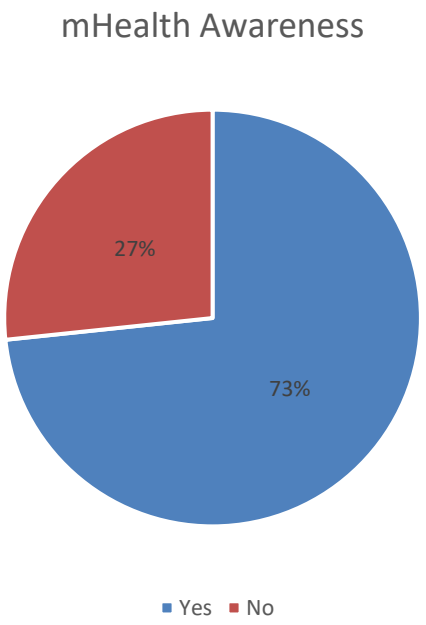

Figure 4.2: Participants Awareness of mHealth

4.2 Correlation analysis of constructs

Correlation analysis demonstrates a statistical method that evaluates the relationship between two variables in a quantitative study whereby the correlation may either be weak or strong depending on the displayed values (Pallant, 2010). Correlation coefficients range between -1.00 to +1.00 whereby high positive values represent a direct relationship that is highly correlated and negative values indicates an indirect relationship that could either be highly or no correlation at all. Pallant (2010) further indicate that two major correlation types are used to determine the relationships. One of these is the Pearson product-moment correlation that measures the relationship between two or more continuous variables, or one continuous variable and one dichotomous variable. The other is a Spearman rho that caters for ordinal level or ranked data. Table 4.2 presents the correction between constructs as expressed in the conceptual model.

Table 4.2: Correlation of Constructs

		PB	PA	SocB	Cu	Envt	MobT	PBC	BI	Patient Mon
PB	Pearson Correlation	1								
	Sig. (2-tailed)									
	N	120								
PA	Pearson Correlation	.741**	1							
	Sig. (2-tailed)	.000								
	N	120	120							
SocB	Pearson Correlation	. 484**	.398**	1						
	Sig. (2-tailed)	.000	.000							
	N	120	120	120						
Cu	Pearson Correlation	.434**	.326**	.523**	1					
	Sig. (2-tailed)	.000	.002	.001						
	N	120	120	120	120					
Envt	Pearson Correlation	-.063	-.066	.072	-.021	1				
	Sig. (2-tailed)	.433	.427	.385	.805					
	N	120	120	120	120	120				
MobT	Pearson Correlation	.423**	.345**	.490**	.457**	-.055	1			
	Sig. (2-tailed)	.000	.000	.000	.000	.522				
	N	120	120	120	120	120	120			
PBC	Pearson Correlation	.508**	.414**	.536**	.324**	-.157	.395**	1		
	Sig. (2-tailed)	.001	.000	.000	.000	.053	.002			
	N	120	120	120	120	120	120	120		
BI	Pearson Correlation	.033	.062	.033	.083	.085	.322**	.054	1	
	Sig. (2-tailed)	.678	.447	.667	.315	.305	.001	.503		
	N	120	120	120	120	120	120	120	120	
Patient Mon	Pearson Correlation	.003	-.065	.024	-.124	.027	.018	-.087	.016	1
	Sig. (2-tailed)	.971	.411	.752	.141	.765	.812	.275	.827	
	N	120	120	120	120	120	120	120	120	120

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

As illustrated in Table 4.2, the constructs of the conceptual model showed a good correlation at 0.05 and 0.01 levels of significance respectively. The construct of mobile technology (MobT) showed a good correlation at 0.01 level of significance with all other constructs with the exception of the environmental construct (Envt). Mobile technology's highest significant correction was with social behaviour (SocB) that was 0.490 significant at 0.01. Perceived behaviour control (PBC) was another construct

that had significant correlations at 0.01 level of significance with all other constructs with the exception of behaviour control (BI).

Given that correlation between variables shows the direction of change, results presented in Table 4.2 shows that besides environment construct (Envt) that has a negative change with MobT and PBC, the rest of the constructs show their change in value enlists a positive change in the value of another construct. This implies that based on the value of one construct, it could easily be possible to predict the value of another. According to Samuel and Okey (2015), based on correlation results it is easier to provide an understanding of how the regression analysis will predict the values of the dependent variable based on the relationships between the independent variables and the dependent one. This implies that based on the correlation results with positive significant values, there is a high likelihood of developed hypotheses to be accepted and for the regression analysis to show a high prediction of the model.

4.3 The regression analysis

Samuel and Okey (2015) note that correlation and regression analyses are related whereby while correlation shows the relationship between variables and the degree of their strength as well as the direction of the relationship, regression bases on the already established existing relationship to predict the outcome of the dependent variable. This implies regression shows the overall prediction of the model and how much each independent variable contributes to this prediction. According to Pallant (2010), the contribution of the independent variable to the overall prediction of the model is said to be significant if the *t-value* is equal or greater to ± 1.96 and *p-value* ≤ 0.05. The regression analysis is explained in Tables 4.3 and 4.4 that shows the model summary and constructs contributions respectively. While the model summary illustrates the overall prediction of the model, the constructs regression analysis on the other hand illustrates the contribution of each independent construct to the overall prediction of the model.

Table 4.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.798[a]	.637	.694	.496	.057	3.638	12	102	.000

a. Predictors: (Constant), PB, PA, SocB, Cu, Envt, MobT, PBC, BI

The model summary presented in Table 4.3 explains the strength of the relationship between the model and the dependent variable which is mHealth self-monitoring. In the model summary table, R, the multiple correlation coefficient denotes the linear correlation between the observed and model-predicted values of the mHealth self-monitoring. According to Hair, Ringle and Sarstedt (2013), r-squared (R^2) explains how well the regression model fits the observed data whereby, higher R^2 values demonstrates a better fit for the model. They further allude that in scholarly research, R^2 values of 0.25, 0.50, or 0.75 for endogenous latent variables can, as a rough rule of thumb, be respectively described as weak, moderate or substantial. This implies that, for this study an r-squared (R^2) value of .637 (63.7%) indicates that 63.7% of the data fit the regression model. Table 4.4 demonstrates the contributions for each independent variable towards the overall model prediction along with the variance inflation factor (VIF) that was included to the examine the existence of multicollinearity.

Table 4.4: Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.979	.487		6.106	.000		
	PB	.146	.065	.184	2.246	.037	.369	2.710
	PA	-.038	.056	-.059	-.678	.484	.411	2.433
	SocB	.161	.048	.217	3.354	.001	.515	1.942
	Cu	-.198	.051	-.253	-3.882	.000	.533	1.876
	Envt	.353	.068	.292	-5.191	.000	.889	1.124
	MobT	.157	.071	.167	-2.211	.034	.481	2.079
	PBC	.172	.060	.178	2.867	.008	.779	1.284
	BI	.235	.077	.186	3.052	.002	.948	1.055

a. Dependent Variable: Patient Monitoring

Results presented in Table 4.4 indicate that environmental construct (Envt) had the highest contribution to the overall prediction of the model towards mHealth self-monitoring with β-value of .292 and t-value of 5.191 which implies that the environmental construct has a significant contribution of 29.2% to the overall prediction of the model with p= .000 < 0.05. The environmental construct is followed by culture (Cu), social behaviour (SocB) and behaviour intention (BI) with β-value of -.253, .217 and .186 that have t-values of -3.882, 3.354 and 3.052 respectively. On the other hand, it is only patient's attitude towards mHealth that was found to have an insignificant contribution to the overall prediction of the model with β-value -.059 (5.9%), t-value of .679 and p = .484 that shows that much as the contribution is there, it is not significant to the overall prediction of the model. On the other hand, much as the constructs of mobile technology and patients' beliefs had good correlation coefficients, their overall contribution to the prediction of mHealth self-monitoring usage was minimal though significant.

On the other hand, this study also tested the existence of multicollinearity using the variance inflation factor (VIF). As a rule of the thumb, it is stated that for multicollinearity to exist, the value of VIF should be greater than 10 (VIF > 10). This implies that for a research to be free from multicollinearity VIF < 10 though most preferred values should be VIF < 5. Based on the results demonstrated in Table 4.4, all values of VIF were less than 5 implying that multicollinearity did not exist. Lower values of VIF implies that there was no confusion among the questionnaire items and that participants understood all the questions without confusing one with the other. Lastly, based on the correlation results presented in Table 4.2 and the regression analysis results demonstrated in Table 4.4, the set hypotheses of the study could be answered and the findings are reported in Table 4.5.

4.4 Testing the hypotheses

The hypotheses that were set for this study were tested and their significance was deduced based on the correlation of the constructs. The results of the tested hypotheses are as demonstrated in Table 4.5.

Table 4.5: Testing the hypotheses of the study

Construct	Hypothesis	Significance value (P value)	Action
Mobile Technology (MobT)	**H1:** Mobile technology has a positive influence on a patient's behaviour intension to self-monitor his/her health	P =.034 < 0.05	Supported
Patient beliefs (PB)	**H2**: Patient beliefs has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .037 < 0.05	Supported
Patient attitude (PA)	**H3**: Patient attitude has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .484 > 0.05	Not Supported
Social behaviour (SocB)	**H4:** Social behaviour has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .001 < 0.05	Supported
Culture (Cu)	**H5**: Culture has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .000 < 0.05	Supported
Environmental (Envt)	**H6**: Environmental factors has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .000 < 0.05	Supported
Perceived behaviour control (PBC)	**H7**: Perceived behaviour control has a positive influence on a patient's behaviour intension to self-monitor his/her health	P = .008 < 0.05	Supported
Behaviour Intensions (BI)	**H8**: Behaviour Intension has a direct influence on patients' use of mHealth Self-monitoring system	P = .002 < 0.05	Supported

Results demonstrated in Table 4.5 indicate that of the eight tested hypotheses, seven were supported and only one was not supported. The third hypothesis (H3) that postulated that "*patient's attitude when mediated by perceived behaviour control and behaviour intention influences a patient' s use of mHealth self-monitoring system"* was

not supported. The rest of the hypotheses were supported though mobile technology and patients' beliefs had lower significant values. Among the hypotheses that were supported, culture and environmental factors had the weakest link. This implies that much as a hypothesis may be supported, its influence on the overall prediction of the model may be minimal though not negligible. Results demonstrated in Tables 4.2, 4.4 and 4.5 agree with Samuel and Okey (2015) who observed correlation provides a platform for regression to predict the outcome of the dependent variable which forms a basis for the development and testing of theoretical models.

4.5 Summary

Analysing immense data discloses a great deal of information that is essential for decision making. Hence, it is important that relationships within the data are examined to show the interlinkages between the different variables. Through correlation analysis, these relationships that exist between variables could be studied in-depth and such information could be used by organizations to make informed decisions. At the same time the link between correction and regression analysis can't be downplayed. This chapter explained these statistical tools and techniques used for data analysis and thereafter presented the results obtained after analysis. The testing of the hypotheses based on the correlation and regression results also provided a way forward in the development of the model that is needed to inform the mHealth self-monitoring system.

CHAPTER FIVE

DISCUSSION OF RESULTS AND CONCLUSION

This chapter discusses the study's findings in terms of the research objectives and hypotheses and interprets them in relation to theory and practice. Firstly, the chapter gives an overview of the study detailing what new lessons have been learnt in relation to mHealth self-monitoring and patient's empowerment. Secondly, the chapter discusses the objectives of the study and in each case gives a clear explanation whether the set objectives were achieved. In addition to the objectives, the chapter also discusses the results of the tested hypotheses and the findings are reported in relation to theory and practice. The chapter further discusses the contribution this study makes and also the limitations of the study based on which recommendations for future research are given. Lastly, the chapter concludes the study by recapping the main themes of the study and by also highlighting the positioning of this study in the current trends of using technology to facilitate the delivery of healthcare services.

5.1 Overview of the research

The purpose of this study was to develop a persuasive technology mHealth self-monitoring model for patients with chronic lifestyle diseases in South Africa (SA). This study was motivated by high prevalence of chronic diseases in SA amidst high medical access inequality, yet the country is considered to be one with high penetration of mobile telephony networks in Sub-Saharan Africa. Apart from communications, mobile telephone could be leveraged as a service to improve healthcare provision especially in developing countries like SA that have a high inequality of healthcare accessibility (Ashrafzadeh & Hamdy, 2019; Ajami et al., 2019; Mena et al., 2020).

Many rural areas in SA have people with high levels of poverty coupled with low education levels and lack of awareness, and have immensely suffered from lifestyle chronic conditions (Mena et al., 2020). These long-term chronic conditions often require frequent primary care practices, continuous self-management techniques and

increased collaboration between healthcare personnel and patients (Mohammadzadeh & Safdari, 2016; Malakoane et al., 2020). By so doing, there is an assurance of providing good healthcare, having patients that are satisfied as well as having reduced healthcare providers' workload. However, due to various challenges including limited healthcare manpower, leveraging technology like mHealth for self-management of patients' life is paramount. Using persuasive technology based mHealth is important since the work mostly done by these healthcare providers is to help patients make behaviour changes that can easily be done by a mHealth self-monitoring system (Huzooree et al., 2019).

Using self-management systems allows healthcare workers to have a holistic understanding of working with patients and how to find better solutions of improving their health making them optimistic about their lives (Chatterjee, 2019). It should be noted that managing chronic illness while changing patients' behaviour is a challenging task that takes good time for both healthcare providers and patients to come on board. Steinman, Heang, van Pelt et al. (2020) allude that utilizing self-management support principles in primary healthcare is essential for positive effects on patients with chronic conditions as well as having a positive impact on healthcare workers' and patients' satisfaction. However, this calls for patients to manage an array of factors that contribute to their health self-monitoring in order to improve their long-term health engagement.

Successful self-monitoring of lifestyle chronic diseases patients requires several strategies that target unhealthy behaviours in order to enlist positive change leading to adherence. This implies that patient's empowerment tools like mHealth need to be built with that kind of technology like persuasive technology to achieve this objective. Mahmood et al. (2019) observe that, ongoing research on chronic diseases has been widely focusing on how to build competencies among patients in order for them to take care of their own lives. These researchers indicate that self-monitoring is a better way forward, bearng in mind the increasing failures of social services and the overcrowded healthcare systems in many developing countries. This calls for a joint effort between healthcare policy makers and IT researchers to create an understanding of translational competences that prioritize patient's empowerment. Although the

effectiveness self-monitoring tools like mHealth varies depending on the developers, their use have profound health benefits.

5.2 Discussion of results in relation to the hypotheses

This study theorized eight relationships between independent variables and the dependent one which is the use of mHealth self-monitoring system. Out of these eight hypotheses, seven were accepted and one was not. The discussion of these findings presented in Table 4.5 in relation to theory and practice is presented in the proceeding subsections.

5.2.1 Discussion in relation to the first hypothesis

The first hypothesis (H1) postulated that *Mobile technology has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. Chronic diseases, both communicable and non-communicable, are a significant cause of morbidity and mortality worldwide. Literature shows that much as there are various therapies and medicines that help fight these diseases, adherence and self-management are often suboptimal, leading to large annual financial burden to healthcare systems in many developing countries and economic difficulties to the patients (Gouda et al., 2017; Saare et al., 2019; Malakoane et al., 2020). The advancement of technology in all aspects including healthcare is seen as a major effort to address chronic disease management and such makes mobile technologies an important factor. This is because the use of mHealth applications which are computer programs on smartphones could be seen as an important innovative intervention intended to improve patient's self-management as they can be used at anyplace, anytime and anywhere. Moreover, the high penetration of mobile telephony suggests that there is a high likelihood of usability of mHealth that can lead to efficiency, effectiveness and satisfaction.

The findings of this study concur with those of other researchers who alluded that a technological innovation with a high ease of use and usefulness will have a good usability and such will lead to effectiveness and satisfaction (Tarhini et al., 2015; Gefen & Larsen, 2017). Additionally, Mahmood et al. (2019) attribute the significance of

mobile technology to the fact that mobile technology is an enabler for self-monitoring. Features of mHealth, including short messaging services (SMS), smartphone applications, and decision-support systems, can assist in bridging the gap between required levels of self-management and current practice by providing personalized data, active reminders, and disease information. This implies that mobile technology is very essential for self-monitoring of chronic diseases.

5.2.2 Discussion in relation to the second hypothesis

The second hypothesis (H2) predicted a significant relationship between patients' beliefs and the use of self-monitoring. H2 postulated that *Patient beliefs has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. Individual beliefs, one's understanding and thinking that the new innovation may create good or harm to him/her determine whether that person will accept or reject the technology (Ajzen, 1991). In respect to this study, patients' beliefs are paramount to their acceptance or their intention to use mHealth monitoring system. The findings of this study are in agreement with those of pervious researchers such as (Wisdom et al., 2014; Tarhini et al., 2015) who indicated that besides the concerns of privacy, individuals have positive beliefs that the new technological innovation like mHealth has the potential of improving information storage and retrieval, and at the same time support the way information is retrieved and used by various personnel within an organization.

5.2.3 Discussion in relation to the third hypothesis

The third hypothesis (H3) predicted that *patient attitude has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was not supported. Using technology impacts the way individuals communicate, learn, and think. It helps society and determines how people interact with each other on a daily basis. This implies that when individuals appreciate the good things that come with technology, they will have positive beliefs towards it. The positive or negative effects on the people's lives due to technology will obviously change their attitude towards the innovation. The findings of this study may imply that patients may not immediately see

the influence of mHealth as factor of improving their health especially when they could prefer the health worker or medical personnel to physically communicate to them.

The findings of this study agree with those of previous researchers such as (Ajzen, 1991; Pinzon & Iyengar, 2012) who also indicated that due to the increasing technological advances in today's environment, a lot of things have changed and such has changed the mind set of people who are faced with these technological changes. Better technological changes have led to positive mind set whereas unappreciated changes have led to negative mindset. Patients could appreciate mHealth as a medium of communication rather than a tool to improve their own health. Besides communication, mHealth has improved people's health and safety but this improvement could only be appreciated if sufficient awareness campaigns are made. Much as with self-monitoring patients would have expected to benefit a lot, including saving on transport costs, consultation times and money as well as reducing stigma, patients will only be communicating with the mobile system rather than with an individual. The already existing inequality in accessing medical services may have worsened patients' expectations and could just see mHealth as a means of widening the inequality gap.

5.2.4 Discussion in relation to the fourth hypothesis

The fourth hypothesis (H4) postulated that *social behaviour has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. In the context of this study, social influence may include all other aspects that involves a third party into the wellbeing of another person or in the life of a patient suffering from chronic disease. In terms of lifestyle chronic conditions social influence has a greater influence in terms of diet and eating habits, social behaviour like drinking of alcohol, engagement in sexual activities as well as smoking tobacco all of these are risk factors of chronic lifestyle diseases. Social settings or peer influence are pre-conditions for many of these lifestyle conditions especially with the low-income patients.

The findings of this study concur with those of many other researchers such as (Ajzen, 1991; Wisdom et al., 2014; Tarhini et al., 2015) who also found social influence to be

an important factor in situations of behaviour elicitations. In respect to mHealth, Chatterjee (2019) observes that in relation to lifestyle chronic diseases, medicalized interventions focused on individual dietary behaviour change may not successfully apply to lived realities of low-income patients. In low income settings, the adapted diet is a matter of choice and patients may have little influence on it if they are not the home breadwinners. Patients with lifestyle chronic diseases may at many instances rely on the mercies of their families to cope with day to day life, which families may even be unaware of the dangers of some of food diets to which they expose the patients. It is, therefore, important that that healthcare systems and government policies help healthcare providers deal with these structural and social determinants of health to reduce paternalism and improve patient care.

5.2.5 Discussion in relation to the fifth hypothesis

This study further hypothesized the influence of culture to mHealth self-monitoring usage in the fifth hypothesis (H5) which postulates that *culture has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. Under normal circumstances healthcare providers and social workers use their competencies to show empathy and mitigate cultural differences that may arise from structural inequity, historical backgrounds such as apartheid in SA and colonialization as well as violence and dispossession. By so doing the culture of a particular society may require much effort and emphasis as compare to that of another. For instance, in SA there are some communities that were much affected by apartheid than others and such require valuing some cultures over others making culture a significant antecedent of mHealth self-monitoring for patients with lifestyle chronic diseases.

The findings of this study agree with those of many other researchers such as (Chigona et al., 2013; Sibiya et al., 2014; Matthews et al., 2016; Debon et al., 2019) who noted that when dealing with patients of lifestyle chronic disease, healthcare workers should apply a transitional understanding whereby they move away from the moral weight that is associated with patient non-compliance to drug prescription and focus their attention to the cultural perspective of the individuals they are dealing with. By so doing, the healthcare providers will be in position to practice both knowledge

and context, making them become sympathetic to the patients especially those with bad history of drug prescription adherence.

5.2.6 Discussion in relation to the sixth hypothesis

The sixth hypothesis (H6) for study postulates that *environmental factors has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. Environmental factors in this study are factors due to the patient's surroundings that could influence the use of mHealth self-monitoring. Such factors may include but not limited to availability of networks. mHealth depends on the availability of telephone network coverage hence areas with good network will receive good signals and the mHealth system will work perfectly well. Another factor to consider is government strategies. This applies more to developing countries where better health services are concentrated in urban areas where there are rich people who can afford to pay for the services unlike in rural areas where the government will be forced to subsidize the impact with a lot of money. Other factors like political and economic challenges as well as literacy and awareness also depend on whether the government have better strategies and plans to evenly provide healthcare services. Poor strategies in relation to environmental settings will negatively impact mHealth self-monitoring whereas good ones will positively impact.

The findings of this study concur with those of other researchers such as Ashrafzadeh and Hamdy (2019) who also indicated that poor government planning leads to weak public health, and such when not managed leads to environmental disasters. Mena et al. (2020) add that the increasing prevalence of chronic diseases may widely also be attributed to nonresponsive governance right from the central to the district level. They further indicate that this nonresponsive governance is also responsible for poor infrastructure as well as lack of medical experts that worsens the already bad situations of running with limited budgets.

5.2.7 Discussion in relation to the seventh hypothesis

The seventh hypothesis (H7) of this study postulated that *perceived behaviour control has a positive influence on a patient's behaviour intension to self-monitor his/her health*. This hypothesis was supported. Fogg (1997, 2002) indicate that the essence of persuasive technology is to provide guidance by external or situational factors so as to enlist a behaviour change within an individual to adjust to a certain condition. In this study, it is indicated that for better control and management of lifestyle chronic diseases, a patient needs to adjust his/her behaviour to adhere to medicine prescriptions which condition works hand in hand with behaviour adjustment and control. This makes perceived behaviour control a very significant factor for the use of mHealth self-monitoring since continuance of usage is a result of satisfaction. Patients become satisfied with the process of self-managing their lives and as a result they continue using the mHealth self-monitoring system.

The findings of this study concur with those of (Ajzen, 1991) who observed perceived behaviour control, helps individuals to engage in a health behaviour that they believe will lead to particular outcomes that are being desired. The perceived behaviour control is also influenced by social factors and personal beliefs to enlist intension to use mHealth. In this case it should be noted that patients will tend to use the mHealth self-monitoring if they believe that people whose views they value think they should use it, and if they feel that they have the necessary resources and opportunities to enable them use the self-monitoring system. More still the findings of this study also concur with those of other researchers such as Chatterjee (2019) who observed that the influence of behaviour change in self-monitoring of chronic diseases is paramount and cannot be down played.

5.2.8 Discussion in relation to the eighth hypothesis

The eighth hypothesis (H8) postulated that behaviour intension has a direct influence on patients' use of mHealth self-monitoring system. This hypothesis was supported. Several studies have indicated the significance of behaviour intention (BI) to actual usage of technology (Wisdom et al., 2014; Tarhini et al., 2015). In the case of this study it is assumed that patients will show their intention to use and further use of mHealth self-monitoring system if they are satisfied that using the system will lead to their attainment of the goal of self-management of chronic conditions. This is in line

with Ajzen (1991) who holds that the intention to use a specific technological innovation is only attained when and only when an individual is convinced that the technological innovation comes with special benefit that are not provided with the usual methods.

5.3 Discussion of results in relation to the research objectives

The following section discusses the results of the study in relation to the set research objectives.

5.3.1 Discussion of results in relation to the first research objective

The first objective of this study was; *to review the existing persuasive technology mHealth self-monitoring models and determine their applicability to the South African context.* This study devoted subsection 2.2.2 to the discussion of mHealth models and their applicability in the South African perspective. The review in the subsection revealed that much as there are various mHealth monitoring systems and models that have been developed in SA and other neighbouring countries in the Sub-Saharan region, many lack contextualization which has made them to remain on small scale projects (Betjeman et al., 2013; Ojo, 2018; Odendaal et al., 2020). Another shortfall of these mHealth models and systems is that much as they are called self-monitoring, they lack the component of empowering the patients and they remain mostly reporting and coordinating systems among healthcare workers. The findings of this study echo the call by previous researchers such as (Huzooree et al., 2019; Chatterjee, 2019; Steinman et al., 2020) for integration of persuasive technology and mobile technology in the development of mHealth self-monitoring systems. The influence of persuasive technology boosts the objective of eliciting patients' behaviour to respond to the system triggers to adhere to medicine prescriptions.

5.3.2 Discussion of results in relation to the second research objective

The second research objective was; *to determine and analyse factors that influence the development of a persuasive technology mHealth self-monitoring systems for patients with chronic lifestyle diseases.* This objective was achieved by reviewing relevant literature of mHealth and its applicability to self-monitoring of chronic diseases more especially in the South African perspective. In subsection 2.3.2 and section 2.4. from the discussion of the literature, eight constructs were identified namely; mobile technology; patient attitude; patients' beliefs; culture; social behaviour; environment; perceived behaviour control; behaviour intention; with a dependent construct mHealth self-monitoring summarized in Table 2.1. Each of these constructs had its factors that formed the measuring items of the questionnaire that was used for data collection. Based on the questionnaire, quantitative data was collected and the constructs and their factors were tested for significance. The testing of data revealed factors that fits the context of SA. However, some factors were eliminated during the testing of the internal consistence where as others were eliminated during the testing of the hypotheses.

Table 5.1 presents the factors that were found significant for the contextualization of the m-health self-monitoring system in SA. The factors that were not significant were excluded.

Table 5.1: Constructs needed to contextualize an m-health monitoring system

Constructs	Attributes
Mobile technology	• Scalability • Ease of use • flexibility • Behaviour change support system • Availability
Patient's belief	• self-motivation • Voluntary compliance patient • belief & strength
Social behaviour	• social facilitation

	• social learning • social support •
Culture	• Patient needs • Descriptive norms • support • behaviour change
Environment factors	• government strategies • politico- economic • Network availability • patient literacy
Perceived behaviour control	• Likelihood to change • Expected personal responsibility • Continued behaviour change
Behaviour Intension	• Intention to use • Intention to recommend usage • Intention to support usage

5.3.3 Discussion of results in relation to the third research objective

The third objective of the study was; *to describe the role of persuasive technology in enlisting the desired behaviours and psychological influence of patients while interacting with technology.* Persuasive technology plays the role of behaviour change when humans interact with technology (Fogg, 2002). The discussion of individual's change in behaviour is devoted in section 2.3 and subsection 2.3.1 whereby, according to Fogg (1997, 2002), individuals change their behaviours to respond to technology as if they were responding to fellow human beings. As alluded by other researchers such as (Huzooree et al., 2019; Chatterjee, 2019), self-monitoring systems developed based on persuasive technology will see lifestyle chronic disease patients respond to technology triggers and adhere to drug prescriptions. This is the

essence of this study which is to see that patients respond to triggers from the mHealth self-monitoring systems to adhere to medicine prescriptions so as to supress the diseases and side effects of chronic diseases.

5.3.4 Discussion of results in relation to the goal of the study

The goal of this study was; *to design a model for self-monitoring mHealth system based on persuasive technology for patients with chronic lifestyle diseases in SA.* Based on the results of regression and correlation analysis as well as those of hypotheses testing, the significant factors were used to construct the final model as proposed by the goal of this study that is illustrated in Figure 5.1.

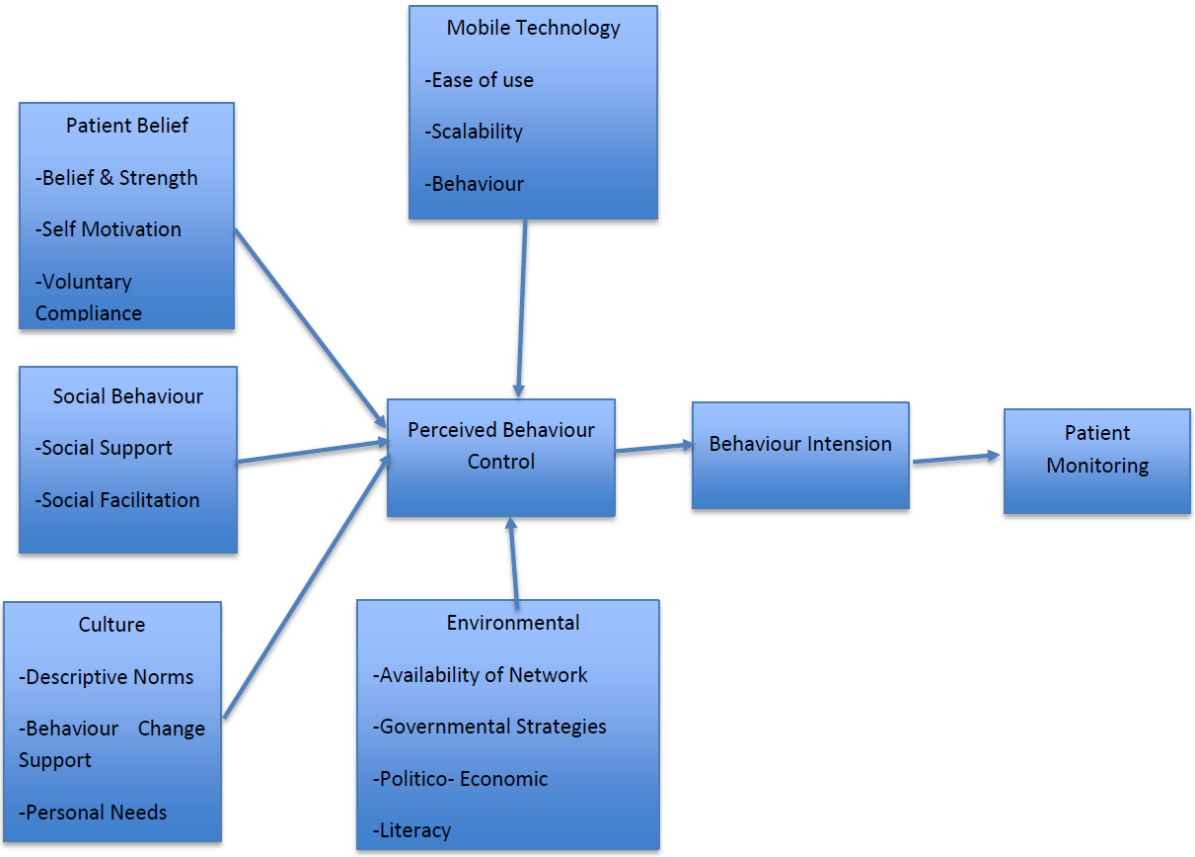

Figure 5.1: Model for mHealth self-monitoring system for lifestyle chronic diseases

The designed model comprises of the mobile technology construct, constructs relating to patients' beliefs, culture, environment and social behaviour these were mediated by perceived behaviour control to inform behaviour intention and then elicits actual

mHealth self-monitoring usage. This model could serve in any situation where technology needs to be boosted by behaviour change and so is the role of persuasive technology.

5.4 Limitations and recommendations of the study

This study collected data from three provinces and in each province a hospital and two clinics were selected. As indicated earlier, these hospitals and clinics were selected using judgemental sampling basing on where the researcher could get access. The selection of these medical facilities was based on who could willingly participate in the study bearing in mind the Covid-19 wave, without considering an even selection of which hospital to participate. Much as this was the best alternative to use during the strict Covid-19 related rules, the results obtained from these medical facilities may lack generalization in the overall South African context. This is because, data collected from different medical facilities in different provinces might have yielded different results that would have a better understanding for contextualization of mHealth usage in the South African context. This study therefore recommends that future research should try its best to include as many participants from different settings as possible to allow generalization of results. Such will help in developing a model that could apply in all South African provinces without reservations.

Technology usage like mHealth self-monitoring usage that involves behaviour needs to be examined over a good period of time to attest whether continuance usage really took place (Kalema, 2014). This study only collected data over a short period of time which implied that it was difficult to measure continuance of usage. More still, the timing of data collection that took place during lockdown due to the Covid-19 pandemic only allowed data to be collected using online close-ended questionnaire which technique enabled healthcare providers to participate in the study from their homes. This study recommends that future studies that involves behaviour change should be examined over a good time implying that such studies should use longitudinal analysis rather than cross sectional data analysis. Longitudinal study would also allow a chance to measure whether usage really took place after acceptance and adoption of mHealth self-monitoring system. More so, articulation of data collection methods including the use of triangulation and/or mixed methods should be used to give more room details

of the data being collected and also to allow more active participation of the participants of the study.

Another factor to consider is that when technology usage spans over time. Users' demographical variables need to be measured as usage may change with time (Kalema, 2014). This implies that interacting effects of demographic and situational variables need to be measured to ascertain which factors become salient with time and which ones have their influence diminished. This study, therefore, recommends that future research should investigate the interacting effects of users' demographic and situational variables as changes may occur with time and such measure may give a clear understanding of variables become salient with time.

5.4.1 Recommendations to government and policy makers

This study's results indicate that among the numerous challenges and barriers of mHealth implementations and success are technological infrastructure including lack of reliable network connectivity, lack of awareness and insufficient resources including man power (Gouda et al., 2017; Ashrafzadeh & Hamdy, 2019; Malakoane et al., 2020; Mena et al., 2020). These are central challenges that calls for government's interventions. This study recommends that government and policy makers should not only stop at making good and promising policies but should put in place mechanisms to ensure that such policies are supported and are effectively implemented.

This study also highlights the challenge of brain drainage due to the exodus of healthcare providers looking for greener pastures outside SA. Much as SA has an influx of foreign qualified medical personnel, South African medical policies are too strict to allow all of them to be absorbed even with the high demand that exist (Nojilana et al., 2016; Ashrafzadeh & Hamdy, 2019; Malakoane et al., 2020). This implies that South Africa need to reconsider its policies in this domain bearing in mind of the many people in rural areas that are suffering due lack of medical personnel to consult. Lifestyle chronic diseases are one type of diseases that need continuous consultations with medical personnel and if such is not possible then leveraging technological applications that can work as medical personnel should be supported.

5.4.2 Recommendations and direction for future research

Literature has highlighted various limitations and challenges impeding successful implementation of mHealth to support the fight against lifestyle chronic diseases. Among the many challenges the ones that came out most are poor accessibility of medical services, limited healthcare workforce, lack of awareness of chronic disease health information, limited financial support, poor remuneration of healthcare workers often leading to low motivation and brain drain (Ashrafzadeh & Hamdy, 2019; Steinman et al., 2020). Literature further show that most research that have been conducted have highlighted these challenges. This has left out a gap for the implementation of actual model needed for mHealth self-monitoring of lifestyle chronic diseases. The model developed in this study should be leveraged to implement the needed mHealth self-monitoring system as it has combined all the essential factors needed for full implementation. This study, therefore, recommends that future research should leverage this contextualized model and evaluate it to enable the implementation of a mHealth self-monitoring system.

5.5 General contribution of the study

The review of literature on mHealth self-monitoring models contextualized in the South African perspective, indicated that many of these models are developed to support collaborations between healthcare workers but not to empower patients (Betjeman et al., 2013; Sibiya et al., 2014; Ojo, 2018; Odendaal et al., 2020). This implies that if the mHealth self-monitoring system is to empower patients, it needs to unveil the link between the developed systems and patients that need to be empowered to take care of their lives. This study based on loopholes between what was suggested by other studies and what has been actually done and is available on the ground (Huzooree et al., 2019; Chatterjee, 2019). The findings of this study and the design of the contextualized model of mHealth self-monitoring usage in the South African perspective is step forward towards the fight against lifestyle chronic diseases.

5.6 Conclusion

Mobile technology has proved to have a significant value in the healthcare provision in many developing countries, SA inclusive (Nojilana et al., 2016). Countries as well as independent researchers need to emphasize the relevancy of leveraging technological applications like mHealth to ensure that all loopholes in healthcare provision that might have been existing due to routine work structures related health services are plugged. The fact that mobile telephony has leapfrogged land-based telecommunication infrastructure and now has a high penetration in many countries including developing ones, leveraging it for lifestyle chronic disease monitoring is a much welcome idea. More so, as it has been highlighted by several researchers such as (Mishra et al., 2016; Kırcı & Ünal, 2016; Ashrafzadeh & Hamdy, 2019; Steinman et al., 2020), chronic diseases are such a complication that needs constant monitoring due to poor adherence of medicines by patients suffering from them. Using mHealth developed based on persuasive technology is a major step in the fight against these complicated chronic conditions.

Literature has confirmed that the use of mHealth in information dissemination using sms has been less successful mainly due to two major reasons. Firstly, patients are left to be consumers of information rather than participants in taking care of their own life (Mishra et al., 2016; Chatterjee, 2019). Secondly, most of the systems have been developed to enhance communication between healthcare providers (Betjeman et al., 2013; Sibiya et al., 2014; Ojo, 2018). This implies that active engagement of patients in the taking of their own lives needs a system that communicates directly with patients rather than healthcare providers. This study is a step forward towards this call. Lastly like Betjeman et al. (2013) many systems that need internet connections have also been falling short of achieving their objectives due to the fact that many of rural areas where the majority of patients live lack internet connectivity and such may also be impeded by the sustainability problem due to high operation costs. mHealth remains a better alternative and any effort devoted to it should be supported by both government and private healthcare providers.

This study, therefore, designed a mHealth self-monitoring model for lifestyle chronic disease patients. The model developed in this study combined three important aspects namely; mobile technology that is pervasive and reach most areas including rural community settings. The second one is the use of persuasive technology that

combines two aspects of persuasiveness and behaviour change. The last aspect is the contextualization that brought in a picture of patients' culture and environment. A model that combines these three aspects like the one developed in this study is paramount to approach lifestyle chronic conditions as, besides the technology itself, it also deals with behaviour that is essential for health promotion.

Lastly, the inbuilt persuasive features of mHealth is expected to enhance behaviour change that may yield many positive results. Apart from medical adherence, other good behaviours that prevent illness may also be promoted and these may involve, though not limited to, detecting early illness symptoms, being physically active, practicing healthy eating, avoid and/or stop smoking and excess drinking of alcohol as well as avoiding risky sexual behaviours.

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Appendix 1: Research Questionnaire

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

DEPARTMENT OF INFORMATICS

PROJECT TITLE: Persuasive Technology mHealth Self-monitoring Model for Patients with Chronic Lifestyle Diseases in South Africa

Primary investigator: Ms. SM Mamabolo, MComp-Informatics (MDIF17) – Candidate
Study leader: Prof BM Kalema, PhD, School of Computing and Mathematical Sciences, University of Mpumalanga, and Ms RC Mogase, Tshwane University of Technology

Dear Potential research participant,

You are invited to complete a survey questionnaire that forms part of my formal MComp studies**.**

Patient engagement in managing their lives leads to better health outcomes however, the existing patient engagement systems have been mainly focusing on their passive reception of information rather than the active empowerment to manage their lives. The increasing use of mobile telephony and its high penetration in South Africa, has been greatly limited to communication and to less extent banking yet little has been done to utilize mobile telephone to perform and support basic services like education and health.

Therefore, this study seeks to develop a model that can be used to develop a Self-Monitoring Mobile Health system based on persuasive technology Physical and psychosocial consequences, and lifestyle changes inherent in living with a chronic condition, has been cited as a key component of chronic disease management. This study has a high belief that the use of self-management for patients' monitoring of their health enables the adherence treatment or behavioral modifications outside the traditional healthcare setting; supportive tools are needed to maintain practice in daily

life. Literature shows the great need to contextualize the developed models to support self-monitoring of their health by using mHealth.

The goal of this study is to develop a model for self-monitoring mHealth system based on persuasive technology for patients with chronic lifestyle diseases in South Africa. This study will be informed by data collected from three provinces of Limpopo, Mpumalanga and Gauteng. In each province a hospital and at least two clinics are selected to participate in the study.

Please note that your participation in this study is voluntary and in case you wish to terminate your participation at any point you will freely do so. All responses will be completely anonymous, and will only be presented as findings of the study without disclosing your identities. Your participation in this study will have no negative impact on you and will not be used against you in any way. Your name or any of your personal identities will not appear anywhere in the survey results.

Completing and returning the questionnaire constitutes your consent to participate and you are kindly appreciated. Answering this questionnaire will only take 15-20 minutes of your time. Your cooperation is highly appreciated and will contribute to the success of this study. Participation in this study by answering this questionnaire involves no foreseeable emotional discomfort or inconvenience to you and your family. The findings of this study will make contributions towards a better understanding of the contextual factors that may be used to develop a framework for mHealth monitoring system.

It is a policy at TUT that a research questionnaire complies with the integrity standards. The questionnaire is therefore first validated and approved by the faculty research and ethics committee before it is distributed to the respondents and these standards are strictly followed.

The primary researcher, Ms.SM Mamabolo can be contacted on her cellular phone at 076 459 8398 and the study leader Prof BM Kalema, can be contacted during office hours at Tel 013 002 0395. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the Faculty of ICT Research Ethics Committee, Dr C Du, during office hours at Tel 012 382 9943, E-mail: DuC@tut.ac.za. Alternatively, you can report any serious unethical behavior at the University's Toll Free Hotline 0800 21 23 41.

Your cooperation is highly appreciated and will contribute to the success of this study.

THANK YOU.

<u>This questionnaire consists of two sections.</u>

Section A: Participants Demographics

Section B: Participants perceptions towards mHealth monitoring system for chronic life style diseases.

In this study:

Mobile health monitoring system *is an application of mobile computing technology for enhancing communication among health care workers , physicians and patients with a view to provide better health care system.*

<u>SECTION A: PARTICIPANTS DEMOGRAPHICS</u>

Please make a cross (*X*) to the alternative that corresponds to the choice of your answer to the question.

1. **What is your age group?**

20 years and below		21- 30 years		31- 40 years		41 -50 years		51 years and above	

2. **What is your highest level of Education?**

Grade 12 and Below		Diploma		Degree		Post Graduate		Other please specify		

3. **What is your overall working experience?**

0-5 years		6-10 years		11-15 years		16 -20 years		21-25 years		26 years and above	

4. I am aware of Mobile health monitoring systems Yes No

<u>SECTION B:</u>

Using the rating scale from 1-5 where ***1 = strongly disagree, 2 =Disagree, 3 = Neutral, 4= Agree, 5 = strongly agree*** please indicate your level of agreement or disagreement on the following statements.

Mobile health technology (*is defined as mobile computing, medical sensors and communications technologies for healthcare.*)		**1**	**2**	**3**	**4**	**5**
1	I expect mobile health technology to be easy to use by patients					
2	I expect mobile health technology to be scalable enough to accommodate various features					

3	I expect mHealth monitoring system to motivate behavior change and also act as a support system towards such change					
4	I believe mHealth built on persuasive technology will change patients behavior to adhere to medicine					
Social Behaviour (*this refers to a beviour shared by a group of people who also share the same norms and values***)**						
5	I believe close relatives, family members and friends will offer their support towards the use of the m-health monitoring system					
6	It is more likely that patients will use mHealth monitoring system if they know of others using it					
7	I believe medical personnel and patients will be keen to learn about mHealth monitoring system					
Patient Attitude ***(****It refers to the manner in which one is thinking , feeling or behaving which shows his opinion)*						
8	I believe patients will have a positive attitude towards mHealth monitoring system					
9	I expect medical personnel and social workers to embrace mHealth monitoring system					
10	I believe the mHealth monitoring system will increase patients' drug adherence					
11	I believe that the frequent use of a mHealth system will help patients eventually to remember their medication schedule even in the absence of such device					
12	I believe persuasive technology has the ability to produce effective results.					
13	I believe people are familiar with the use of electronic health systems					

Culture *(refers to the attitudes, behavior, values and norms of certain social group or society)*		**1**	**2**	**3**	**4**	**5**
14	I believe patients' culture may have an influence to the acceptance and use of mHealth					
15	The communities and environment people live in may influence the using a technological innovation					
16	The culture in the medical fraternity may prohibit their support to the implementation mHealth monitoring system.					

Patients' Beliefs ***(****refers to the personal attitude of a patient relating to a particular system or medical professionals****)***						
17	Patients believe that monitoring their health is rewarding.					
18	Many patients will prefer their health being monitored by mHealth monitoring system than social workers					
19	The possibility of patients to resist the mHealth system may be higher than expected					
Behaviour Intention ***(****refers to those motivational factors which captures how hard people are willing to try to perform a behavior and intentions are said to be the most influential predictor of a behavior****)***						
20	I intend to use the mHealth monitoring system					
21	Intend to support the use of mHealth monitoring system					
22	I intend to recommend people I know with similar condition to use mHealth monitoring system					
Perceived Behaviour Control *(it refers to a person's perception of how easy or difficult it would be to carry out a behaviour)*						
23	I expect patients to understand that irrespective of their health condition the use of the mHealth monitoring system depends on them					
24	There is a great likelihood that mHealth will be liked by both patients, medical personnel and social workers					
25	The continued use of mHealth will enlist positive medical adherence results					
	Environmental Factors					
26	I hope the network is available to people to use mHealth system					
27	I believe that SA government has policies which support the use of IT					
28	I believe people will be able afford the mHealth system					
29	I believe that there are infrastructural resources in place to support the use of mHealth system					
30	I think there is educational support for people who does not know how to use mHealth systems					

Overall patient's monitoring *(This is the expected effectiveness of the mHealth towards monitoring patients*).

I expect the mHealth monitoring system to be seen as an effective tool to be used for monitoring drug adherence

		1	2	3	4	5
25	By patients					
26	By medical personnel					
27	By social workers					

END – THANK YOU

Appendix 2: Ethics Approval

Tshwane University of Technology

Faculty of Information and Communication Technology

Faculty Committee of Research Ethics

15 March 2021

Ref #: FCRE/ICT/2021/03/001
Name: SM Mamabolo
Student #: 209050587

Ms SM Mamabolo
c/o Dr Olalekan S Ogunleye
Department of Informatics
Faculty of Information and Communication Technology
Tshwane University of Technology

Dear Ms Mamabolo

Decision: Provisional Approval

Name:	SM Mamabolo
Proposal Title:	Persuasive Technology Health Self-monitoring Model for Patients with Chronic Lifestyle Diseases in South Africa
Qualification:	Master of Computing: Informatics
Supervisor:	Dr Olalekan S Ogunleye
Co Supervisor:	Ms RC Mogase

Thank you for submitting project documents for review by the Faculty Research Ethics Committee of ICT (FCRE-ICT), Tshwane University of Technology (TUT). In reviewing the documents, the comments and notes below are tabled for your consideration, attention and/or notification:

Research Proposal

- Strategies for the selection of organizations/hospitals to participate in the study should be indicated, including how the organizations/hospitals will be selected, how many will be selected per province, and how it was calculated.

- The researcher mentions 2 sampling methods, non-probability method (judgemental), then later mentions inclusive sampling as a sampling method to be used. Do the sampling methods complement each other?

Checklist of submitting data collection instruments

- The supervisor's initials are outstanding.
- Electronic initials are not accepted.

Ethics Checklist

- The supervisor's initials are outstanding.
- Electronic initials are not accepted.

Permission Letter

- The researcher should obtain permission from parents/guardians as participants can potentially be younger than 18 as stated in the questionnaire that participants 20 years and below should complete the questionnaire. **After** receiving final approval from FCRE/REC, and after obtaining the permission letter, the letter must be forwarded to the FCRE secretary, Ms. Stewart, for filing purposes. **Data collection can then be permitted.**

The Faculty Committee for Research Ethics (FCRE) of the Faculty of Information and Communication Technology of the Tshwane University of Technology, reviewed the documents for your Application of Ethics Clearance for your research study at its meeting on 9 March 2021. Provisional Approval has been granted for the study. ***Note that***: ***Data collection can only commence after Final Approval has been granted by the Committee***. Submit your revised documents based on the comments and suggestions by the Committee to the FCRE Secretariat for review for the Final Approval. **This Provisional Approval letter is valid for 3 months only; failure to which will result in the re-submission of your Application for fresh consideration.**

C Du (Dr)
Chairperson: Faculty Committee of Research Ethics
[FCRE ICT Ref# 2021=03=001=MamaboloSM]