A FRAMEWORK FOR IMPLEMENTATION OF SMART CARD TECHNOLOGY IN PUBLIC HEALTHCARE

by

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DEDICATION

This dissertation is dedicated to the Almighty God and my parents, Prof S.J. and Mrs M.L. Malungana. Not forgetting my brother J.M. Malungana and sister Dr R. Setino, who both provided physical and supernatural support for my academic ascent.

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ABSTRACT

The proliferation of information and communication technology (ICT) in numerous public administration sectors has accelerated the transition of government departments from traditional work into work that is highly dependent on ICT. Smart Card Technology (SCT) has intrinsic benefits for a range of industries, including telecommunications, finance, transportation and the public sector in the areas of security, authentication and multi-application capabilities. Medical mistakes still occur often in public healthcare, which results in poor service. As a result, manual file systems cannot be depended upon or used and prescription errors resulting from misinformation or inconsistency regarding the dosage, allergies and interactions must be resolved. This study seeks to develop a framework for implementing SCT in public healthcare.

The key factors for the application of SCT were enhanced in this study by using a conceptual framework based on the Healthcare Unified Theory of Acceptance of User Technology Model (HUTAUT) (2018), DeLone and McLean IS Success Model (2003) and Diffusion of Innovation theory (DOI) (2003). To achieve its goals, the study adopted a quantitative research methodology. Respondents were selected using the convenience sample technique. In the Steve Biko Academic Hospital, Tshwane District Hospital, Kalafong Tertiary Hospital and Pretoria West District Hospital in South Africa's Gauteng area, 406 provided healthcare professionals self-administered questionnaires. *Statistical Package for Social Sciences (SPSS)* version 26 was used for data analysis, and both descriptive and inferential statistics were applied in this study. It was decided to validate both the model and the instrument using exploratory factor analysis (EFA). Moreover, structural equation modelling (SEM) and confirmatory factor analysis (CFA) was applied.

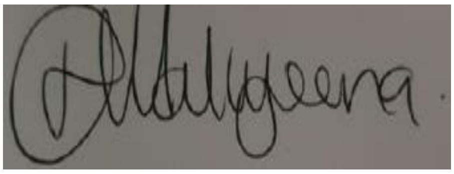
The quantitative study's findings identified several elements that must be considered when making decisions for SCT to be implemented in South African public hospitals. Seven hypotheses were found to be supported by the investigation, including those covering behavioural intention (H5), system use (H8), information quality (H9), communication (H12), compatibility (H13) and trialability (H14). The performance expectancy hypothesis (H2), on the other hand, was not supported because of its low reliability. Five hypotheses, however, that dealt with effort expectancy (H1), social impact (H3), facilitating conditions (H4), user pleasure (H7) and user attitude (H6) were not, for this rationale, validated in this study. These results indicated that the Department of Health and other stakeholders' choice to apply SCT in public healthcare is significantly influenced by behavioural intention, system quality, system use, information quality, compatibility, communication and trialability.

This study explores SCT's potential application in public healthcare. In addition, the Department of Health should increase the usage of SCT in public hospitals throughout all provinces where healthcare reforms are urgently required. This could be addressed by healthcare professionals within public healthcare by using elements for the implementation of SCT acquired from the study. The study intends to assist with the implementation of smart card technology, which would increase and improve the standard of healthcare service delivery in South African public hospitals.

Keywords: Smart card technology; healthcare professionals; implementation; technology; healthcare; confirmatory factor analysis; structural equation modelling.

DECLARATION

I declare that this study**, A FRAMEWORK FOR IMPLEMENTATION OF SMART CARD TECHNOLOGY IN PUBLIC HEALTHCARE**, is my work and that all the sources that I have used or quoted have been indicated and acknowledged using complete references. I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.



22 March 2023

Signature   Date

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List of Abbreviations

4IR	-	Fourth Industrial Revolution
3D	-	Three dimensional
AI	-	Artificial Intelligence
AIDS	-	Acquired Immunodeficiency Syndrome
ATM	-	Automated Teller Machine
ANC	-	Antenatal Care
CDSS	-	Clinical Decision Support System
CBHI	-	Community-based Health Insurance
COVID-19	-	Coronavirus Disease 2019
DEMATEL	-	Decision-making trial and evaluation laboratory
DoH	-	Department of Health
DOI	-	Diffusion Innovation Theory
DACAR	-	Data Capture and Auto Identification Reference
DRG	-	Diagnosis-Related Groups
EMR	-	Electronic Medical Records
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
EHS	-	Electronic Healthcare System
HER	-	Electronic Health Records
HIT	-	Health Information Technology
HUTAUT	-	Healthcare Unified Theory of Acceptance of User Technology
HIS	-	Health Information Systems
HIS	-	Health Insurance System
HCP	-	Healthcare Providers
HIPPA	-	Health Insurance Portability and Accountability Act
HIV	-	Human Immunodeficiency Virus
HTTP	-	Hypertext Transfer Protocol
hNET	-	Health Network
hAOP	-	Health Portal
ICT	-	Information Communication Technology
IoT	-	Internet of Things
IATA	-	International Air Transportation Association
IS	-	Information Systems
IPHRS	-	Integrated Patient Health Record System

IR	-	Industrial Revolution
MVC	-	Model View and Controller
NHRC	-	National Health Research Council
NFC	-	Near Field Communication
NHI	-	National Health Insurance Bill
PIN	-	Personal Identification Number
PCA	-	Principal Component Analysis
PACS	-	Picture Archiving and Communication Systems
PHI	-	Protected Health Information
PCEHR	-	Personally Controlled eHealth Records
PHR	-	Personal Health Record
ROM	-	Read-Only Memory
RAM	-	Random Access Memory
RFID	-	Radio Frequency Identification
SC-TIF	-	Smart Card Technology Implementation Framework
SA	-	South Africa
SASSA	-	South African Social Security Agency
SCT	-	Smart Card Technology
SC	-	Smart Card
SGI	-	Silicon Graphics
SIA	-	Secure Identity Alliance
SEM	-	Structural Equation Modeling
SPSS	-	Statistical Package for Social Scientists
TAM	-	Technology Acceptance Model
TRA	-	Theory of Reasoned Action
TPB	-	Theory of Planned Behaviour
TIR	-	Third Industrial Revolution
UP	-	University of Pretoria
UTAUT	-	Unified Theory of Acceptance of User Technology
UNISA	-	University of South Africa
WHO	-	World Health Organisation
WSN	-	Wireless Sensor Networks

The study used the **HARVARD** referencing style in the thesis.

Terms and Definitions

Smart card (SC)

A smart card has an embedded integrated circuit to safeguard a microcontroller, which is comparable to a memory chip alone. This technology is widely utilised in healthcare institutions, tertiary institutions and the retail sector (Taherdoost, 2017).

Smart Card Technology (SCT)

Smart cards offer a high level of security and privacy protection while storing sensitive data, such as healthcare information (Act, 2013). To safeguard private data and provide quick, secure transactions, smart card technology is also being used in other applications, such as healthcare records.

National Health Insurance (NHI) Bill

New legislation known as the National Health Insurance (NHI) Bill requires health insurance and shields South Africans from the escalating cost of medical care. It may be managed by the public sector, private sector or a combination of the two. The government confirmed that the main goals of NHI are to address the difficulties in providing high-quality public healthcare and the prohibitive costs of private healthcare.

Fourth Industrial Revolution (4IR)

This term is used to describe how the lines separating the physical, digital and biological worlds are becoming increasingly obscured. It combines developments in technology including genetic engineering, 3D printing, quantum computing, block chains, the Internet of Things (IoT) and artificial intelligence (AI).

Privacy and security

In implementing a smart card system, which is a frequent necessity for hyperspace, privace and security necessitate large data processing (Liu, Weng, Wan, Yue, Song & Vasilakos, 2017). The smart card has security features that should be applied to IoT healthcare systems quite urgently, including for authentication, authorisation and secure communication (Karthigaiveni & Indrani, 2019).

PUBLICATIONS FROM THE STUDY

Malungana, L. & Motsi, L. (2022). A Structural Equation Model for implementation of Smart Card Technology in public healthcare. In 2022. *ACIST- Conference Proceedings* at Malawi University.

Malungana, L. & Motsi, L. (2022). Adoption for the implementation of Smart Card Technology in public healthcare. *The Journal for Transdisciplinary Research in Southern Africa.*

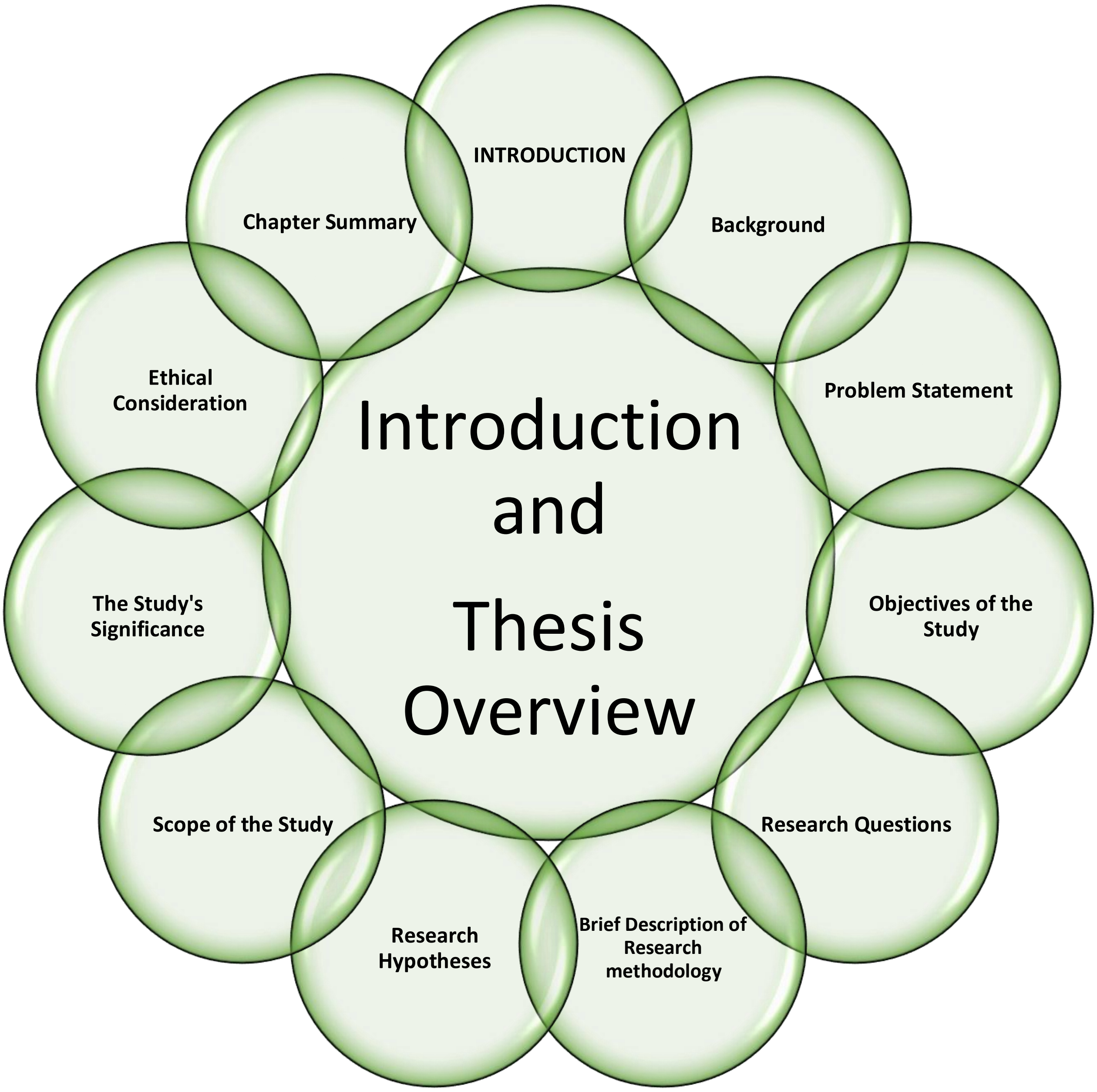
Malungana, L. & Motsi, L. (2022). Critical success factors for adoption of Smart Card Technology in South African public hospitals. *South African Journal of Information Management*.

Under Review

Malungana, L. & Motsi, L. (2022). Impact of knowledge factors towards the implementation of smart card technology in public healthcare. *Africa's Public Service Delivery & Performance Review.*

Malungana, L. & Motsi, L. (2022). Structural equations model to analyse the critical variables related to smart card technology adoption in South African public healthcare. *South African Journal of Science and Technology.*

CHAPTER 1
INTRODUCTION AND THESIS OVERVIEW



1.1 Introduction

Developments in South Africa's public health system have resulted in the rapid application of technology in a variety of fields in the public health sector. Information and communication technologies (ICTs) have been used in healthcare as new developments to alleviate the burden of the delivery of affordable patient healthcare (World Health Organization, 2012; Sezgin & Özkan-Yıldırım, 2016). As a result, the eHealth strategy is posing a serious threat to the South African healthcare system (Dehling & Sunyaev, 2014). The South African government recently passed the National Health Insurance Bill (NHI), which aims to improve the quality of healthcare (National Department of Health, 2019). Emerging developments like the Internet of Things (IoT) and the Fourth Industrial Revolution (4IR) are helping to accelerate the use of smart card technology (SCT) in the healthcare sector (Peters, 2017).

Studies conducted in various developing countries have reported that the use of ICTs in healthcare facilities leads to better healthcare delivery (Mechael, 2009; Mugo & Nzuki, 2014; Agarwal, Perry, Long & Labrique, 2014; Arkorful, Shuliang, Muhideen, Basiru & Hammond, 2020). Furthermore, the idea of having a complete medical record on smart card-based technology has been studied for some years (Smart Card Alliance, 2012). More than a decade ago, countries like Hungary, France & Spain developed computer systems that could store medical histories on a smart card (SC) (Hussain, Ariyachandra & Frolick, 2016). The United States of America, on the other hand, has yet to implement the use of smart card technology on a nationwide scale.

Kihuba, Gathara, Mwinga, Mulaku, Mogoa, Nyamai & English (2014) discovered that data being entered manually at Nairobi hospitals were prone to human mistakes. In addition, there was a pressing need for IoT adoption to address issues like these. Poor record-keeping creates unnecessary delays for patients (Adebayo & Ofoegbu, 2014). Patients' folders are mislaid or are misplaced from time to time and instead of informing the patient, healthcare professionals (nurses) simply let the patient wait. In a worst-case scenario, the patient's medical history is lost, which can lead to additional issues, including wrong diagnoses and in rare cases, death (Sethia, Gupta & Saran, 2019). According to Wahaballa, Kurauchi, Yamamoto and Schmöcker (2017), smart cards provide cost independence and reliability. Zeadallya and Bellob (2021) believe that South Africa has the potential for improving the delivery of healthcare services while also enhancing efficiency and lowering the costs of manual systems currently in use.

According to Albahli, Khan and Qamar (2020), countries such as Saudi Arabia are using smart cards in healthcare to improve their healthcare. However, healthcare technologies remain a problem in developing countries such as Ethiopia, Malawi, Zambia, Zimbabwe and Swaziland, resulting in poor healthcare delivery (Nyasulu & Chawinga, 2018). In South Africa, more scholarly research is still required to address smart card technology in the provision of healthcare services to patients for the benefits of healthcare professionals (nurses) (Botha, Botha & Herselman, 2014). As a result, a new study for developing a framework for SCT in public healthcare for professionals should be undertaken. Furthermore, the importance of strengthening security, traceability and healthcare professionals' previous history or recorded activities, as well as the quality of service provided by the healthcare delivery system, should be acknowledged. This study addresses a research gap in the implementation of smart card technology (SCT) in healthcare in South Africa.

Many frameworks are utilised for studies in the field of information systems. Due to the size and complexity of some IT processes, these frameworks can be helpful. Service delivery runs the risk of becoming random and unreliable without a set of operating principles, records and governance standards. Therefore, this study adopts the use of a conceptual framework based on the healthcare unified theory of acceptance of user technology model (HUTAUT) (2018), the DeLone & McLean IS success model (D&M) (2003) and the diffusion of innovation theory (DOI) (2003). The relevant interventions are proposed, explaining and enhancing crucial factors for the implementation of smart card technology.

1.2 Background

In South Africa, it is required under the constitution to provide high-quality medical treatment (Stuckler, Basu & Mckee, 2011). As a result, the government implemented numerous programmes to improve healthcare, efficiency, safety, quality of delivery and access for all users (Mogashoa & Pelser, 2014). Moreover, major changes in health policy and legislation have been implemented to ensure compliance in delivering quality healthcare (Moyakhe, 2014). Despite the government’s efforts to enhance the quality of healthcare service delivery, the media and the public continue to criticise the level of healthcare services provided in South Africa. Further reports by the Department of Health (2012) revealed that services in public health institutions were still falling short of fundamental care requirements and patient expectations (Department of Health, 2012). In addition, the public has lost faith in provisions made by the Department of Health to improve the delivery of healthcare (Zubane, 2011). According to Koelble and Siddle (2014), the South African healthcare system has been demolished and is in desperate need of repair.

Many of the problems in the South African healthcare system can be traced back to the Apartheid period (1948–1993), during which the healthcare system was highly fragmented, with discriminatory regulations for four different racial groups (Black, Mixed-race, Indian and White) (Johnson, Berzins, Baker, Melling & Thompson, 2018). To make this situation worse, the Apartheid regime created ten *Bantustans* (so-called ethnic homelands), in which Africans were forced to live. There was a health department in each of them, as well as professional groups (Maphumulo, Bhengu & Curationis, 2019). Due to a lack of funding, the delivery of the healthcare system deteriorated and impoverished populations were disproportionately affected (Maphumulo, Bhengu & Curationis, 2019). Since the 1994 elections, enormous efforts have been made to improve the quality of healthcare delivery in South Africa, although the public has highlighted various concerns about public institutions. Healthcare professionals are frequently cited in the media as being unable to provide timely and efficient healthcare services, in part due to poor records administration (Katuu, 2015). As a result of the inability to recover documents or the loss of medical files, patients must wait for long periods to be helped. In such instances, healthcare professionals are unable to assist patients.

Despite their value, medical records are frequently mismanaged, preventing healthcare professionals from accessing information regarding earlier diagnoses, treatments and prescriptions. In addition, these medical records can be permanently lost if they are not properly managed. For example, patients' lives are impacted by missing records or incomplete files. Newspapers reported that the Polokwane Hospital in Limpopo was unable to "produce medical documents for one of the chronic cervical cancer patients" (Maponya, 2013). Ineffective record management is a global issue, not only in South Africa. According to the Department of Health and Human Services (2006), one in every seven files in healthcare institutions in the United States is misplaced.

Furthermore, medical records are significant in hospitals because they are required for the verification of background information (Marutha & Ngoepe, 2017). Medical errors can be avoided if clinicians have access to and the competence to apply clinical informatics successfully (Babalola, Idowu, Ademolu, Olukunle & Rahman, 2020; Ushie, Salami, Jegede & Oyetunde, 2013). In addition, it is estimated that as many as 44,000 to 98,000 patients die annually due to the wrong diagnosis in the United State of America. In Nigeria, it has been reported that 13% to 43% of the instances where strokes are misdiagnosed are because of a lack of access to and use of clinical informatics tools. Similarly, 40% of medical doctors in South Africa have admitted to making medical errors because of a lack of access to and use of clinical informatics in the administration of drugs to patients (Babalola et al., 2020; Ushie et al., 2013).

Information and communication technology (ICT) strategies appear to be one of the vital core elements in operations and improving healthcare delivery throughout the world. In addition, ICT is a tool for delivering quality products and for decision-making and maintaining customer loyalty for many organisations (Mbizi, 2021). Over the last four decades, the trend of patients becoming empowered to take a more active part in their health has increased (Dahm, Georgiou, Herkes, Brown, Li, Lindeman, Horvath, Jones, Legg, Li, Greenfield & Westbrook, 2018; Moll, Rexhepi, Cajander, Grünloh, Huvila, Hägglund, Myreteg, Scandurra & Åhlfeldt, 2018). Patients' access to medical records are being advocated for, with legal backing, to make this right a reality (Davis Giardina, Menon, Parrish, Sittig, & Singh, 2014; DesRoches, Leveille, Bell, Dong, Elmore, Fernandez, Harcourt, Fitzgerald, Payne, Stametz, Delbanco & Walker, 2020). In addition, patients want access to their medical records (Delbanco & Gerteis, 2018). Access to personal information contained in medical records leads to a perceived increase in knowledge about the clinical conditions and enhances the sense of control of care (Woods, Schwartz, Tueper, Press, Nazi, Turvey & Nichol, 2013). Narrative research by Wibe, Hellese, Slaughter and Eksterdt (2011) describes respondents using health records as a means of supplementing their subjective experiences of illness with a biomedical description to enhance and complete their understanding of the disease. Smart card technology (SCT) in healthcare could help to minimise waiting periods and complaints received by DoH from patients about the service rendered by healthcare professionals (Yarbrough & Smith, 2007). Whereas complaints seem to be valid to patients and society in general, the role of healthcare professionals may not be clear due to healthcare professionals' daily workload since they must adopt new technologies.

Bandyopadhyay and Sen (2018) highlight that SCT should be linked to the back-end system to resolve technological problems and improve patient access to healthcare. Several challenges may exist, requiring the proper use of technology while continuously monitoring and evaluating healthcare professionals' compliance with the new technology, to efficiently deliver healthcare services (Nilsen, Stendal & Gullslett, 2020). In most countries where the implementation of smart cards has been successful, there has been interaction relationship management between the decision-makers and users (Albugami & Ahmed, 2015). Management is also required to encourage the full cooperation of the parties involved through the development of an enabling theoretical framework, for the benefit of both the patients and healthcare professionals in South Africa.

1.3 Problem Statement

The implementation of multiple information systems within public healthcare has turned into an issue that affects efficiency and efficacy, according to Hussain, Ariyachandra and Frolick (2016). When implementing technology in various sectors, several variables must be considered. To fulfil patients' and healthcare professionals' demands, healthcare information systems should be implemented (Marufu & Maboe, 2017). For instance, the eHealth@Joburg electronic health record system has been implemented in the City of Johannesburg and has more than 500 000 registered patients. This implementation was guided by the eHealth strategy. Yet, complaints about healthcare service delivery are occurring more frequently because the South African Department of Health is postponing the implementation of smart card technology across the country. As a result, the Department of Health in South Africa presides over experienced healthcare professionals who continue to deliver services to patients inadequately.

SCT is one example of an eHealth initiative that has successfully used technology to speed up the delivery of healthcare in the past (WHO, 2013). Regrettably, due to infrastructure-related difficulties, certain urban and rural communities have difficulties in adopting eHealth technologies (Nilsen, Stendal & Gullslett, 2020). For instance, China effectively implemented smart health by emphasising medicine accessibility, infrastructure and the expertise of other healthcare professionals (Dornan, Pinyopornpanish, Jiraporncharoen, Hashmi, Dejkriengkraikul & Angkurawaranon, 2019).

Hung, Tsai and Chuang (2014) suggest that the standard of services provided by healthcare professionals(nurses) affects the delivery of basic healthcare. Therefore, public hospitals and clinics continue to suffer from a lack of medical knowledge and drugs, which could impede the implementation of SCT. In order to practice as a healthcare professional (nurse) in South Africa, one is required to register with the South African Nursing Council after receiving a diploma or degree.

Studies undertaken by Ahuja, Hanlon, Chisholm, Semrau, Gurung, Abdulmalik, Mugisha, Mntambo, Kigozi, Petersen, Shidhaye, Upadhaya, Lund, Evans-Lunko, Thornicroft, Gureje and Gordons (2019) highlight that the cost of implementing healthcare technology in some low- and middle-income countries is often prohibitive. This requires significant finance for technology implementation. Unfortunately, data storage and retrieval methods in certain countries are primitive (Kushniruk, Bates, Bainbridge, Househ & Borycki, 2013). Nevertheless, various healthcare facilities evidently offer the delivery of excellent healthcare (Renuka, Kumari & Li, 2019). Health information technology offers numerous benefits, while at the same time possessing many drawbacks, such as a lack of transparency in the management of prescription errors. Errors with patients' medication documentation have become a major source of adverse drug reactions, which need to be upscaled through technology (Bayoud, Waheedi, Lemay & Awad, 2018). Therefore, SCT is vital because it saves time compared to traditional paper files and allows high-quality healthcare to be accessed (Tadros, Barbini & Kaur, 2021). Replacing manual files that have been lost, stolen or misplaced is often a significant challenge.

One of the six fast-track priorities for clinical control of information and quality care of health services identified by the Department of Health in 2012 was patient safety (Magaqa, 2012). In addition, the 2019–2024 National Digital Health Strategy for South Africa was developed in cooperation with other governmental agencies. Its goals are to fortify governance frameworks for digital health, build solid, integrated platforms for the creation of information systems and create the requisite broadband network infrastructure (National Department of Health, 2019). Therefore, the goal of this study is to offer a theoretical framework for the implementation of smart card technology (SCT) in South African public healthcare.

1.4 Objectives of the Study

The objective of this study is to design a framework for implementing smart card technology in South African public healthcare. The following sub-objectives address the main objective of the study:

- **Research Objective 1 (RO1)**: To determine variables and related factors that affect the adoption of the SCT implementation in public healthcare.
- **Research Objective 3 (RO2**): To develop accurate information quality which influences the SCT implementation in public healthcare.
- **Research Objective 3 (RO3):** To identify variables used to develop a conceptual framework for the implementation of SCT in public healthcare.

1.5 Research Questions

Based on the study's background and problem statement, this study seeks to answer the following main research question:

How can a framework be developed for the SCT's implementation in South Africa's public healthcare?

The following are the sub-research questions:

- **Research Question 1 (RQ1):** What are the variables and related factors that affect the adoption of SCT implementation in public healthcare?
- **Research Question 2 (RQ2):** How can accurate information influence the quality of SCT implementation in public healthcare?
- **Research Question 3(RQ3):** What are the identifiable variables used to develop a conceptual framework for the implementation of SCT in public healthcare?

1.6 Brief Description of Research Methodology

This study aims to develop a framework for the implementation of smart card technology in public healthcare. The study is based on healthcare professionals working in the Tshwane District, which is part of the City of Tshwane Metropolitan. These healthcare professionals work in a range of disciplines including emergency, neonatal, midwifery, paediatrics, surgery and other specialities.

The research on the implementation of smart card technology in public healthcare was conducted using a deductive approach. According to the SCT principle, smart cards with higher performance and capacity are often used in the medical field of technology (Kumar, Dayanidhi & Vignesh, 2016). Therefore, SCT is seen as a portable device with integrated circuits that allow for greater data storage and processing. These cards are crucial to an eRecording system because they assist with personal information identification, health-related data storage and health-related record sharing. Furthermore, the recording unit is used to load extra data in addition to capturing a patient's personal information. The main advantage of this technology is increasing accuracy, which allows for better focus in healthcare, as well as its cost-effectiveness, increased productivity and reduced time consumption.

The study's respondents were healthcare professionals working at the four selected hospitals. The healthcare professional population also included all medical students from the University of Pretoria who were based at the respective teaching hospitals. In terms of the study's sample size, 150 healthcare professionals were chosen from each of the four hospitals and a convenience sampling method was applied for the study.

Questionnaires were administered to collect data from respondents for the study's quantitative component. The quantitative data were evaluated using the *AMOS 26* with the structural equation model (SEM) and the *Statistical Package for Social Sciences (SPSS)* Version 26. After reliability and validity testing, Cronbach's alpha score was more than 0.7, suggesting that all of the data submitted and examined were reliable.

1.7 Research Hypotheses

The research hypotheses for the study is detailed in the final chapter of this study as follows:

H1 Effort Expectancy is expected to have a positive effect on the implementation of SCT in healthcare.

H2 Performance Expectancy (PE) is expected to have a positive effect on the implementation of SCT in healthcare.

H3 Social Influence has a positive effect on the implementation of SCT in healthcare.

H4 Facilitating Conditions is expected to have a positive effect on the implementation of SCT in healthcare.

H5 Behavioural Intention is expected to have a positive effect on the implementation of SCT in healthcare.

H6 User Attitude has a positive effect on the implementation of SCT in healthcare.

H7 User Satisfaction is expected to have a positive effect on the implementation of SCT in healthcare.

H8 System Use has a positive influence on smart card technology implementation in healthcare.

H9 Information Quality is expected to have a positive influence on the implementation of SCT in healthcare.

H10 Systems Quality has a positive effect on the implementation of SCT in healthcare.

H11 Service Quality is expected to have a positive effect on the implementation of SCT in healthcare.

H12 Communication has a positive effect on the implementation of SCT in healthcare.

H13 Compatibility has a positive effect on the implementation of SCT in healthcare.

H14 Trialability has a positive effect on the implementation of SCT in healthcare.

H15 The implementation of smart card technology has a positive influence on healthcare.

1.8 Scope of the Study

This study was conducted in the Gauteng Province of South Africa, in Tshwane District hospitals. The province is home to a variety of academic, district as well as municipal clinics. The emphasis of this study was on health professionals who were employed at the four selected hospitals. Hospital personnel were constantly busy because of the constant stream of patients into hospitals.

Therefore, it was practically impossible to engage them to fill out a questionnaire at the workplace due to issues such as the Coronavirus Disease 2019 (Covid-19) pandemic. Thus, the data collection in this study was structured and used a self-administered questionnaire for the identified hospital personnel. The researcher chose a sample size from the target population that was large enough to be representative of the entire population of study subjects on her initiative. The convenience sampling technique was scientific to the extent of statistical randomisation in the sample frame so that outcomes were not compromised.

Due to the COVID-19 pandemic, there were measures in place that allowed the researcher to take a different approach to data collection. In addition, questionnaires were placed in a box with clear instructions for the ward's management. Communication was maintained continually through telephonic conversations, which aided healthcare professionals (nurses) who had difficulty answering the questions.

Finally, from a total of 31 hospitals in Gauteng province, the study was limited to only four. Within Tshwane, however, there are seven hospitals, including one academic hospital (Steve Biko Academic Hospital), two district hospitals (Pretoria West Hospital and Tshwane District Hospital), and one tertiary hospital (Kalafong Hospital).

1.9 The Study's Significance

As part of the current research, the researcher intends to develop a framework for implementing SCT in South Africa's public health system. This study examines the drawbacks, advantages and effects of applying SCT in a public healthcare facility in South Africa. Few studies have assessed the application of SCT on a large scale in the South African context; hence, this study is the first of its kind. Furthermore, the study explores the influence of electronic health records (EHR) on medical records in the South African public healthcare system from a different perspective, paving the way for future research into large-scale smart card adoption in the country, as well as other developing countries (Steininger, Stiglbauer, Baumgartner & Engleder, 2014). In addition, it contributes to the limited understanding of the deployment and implementation of electronic health records in developing countries (Sood, Nwabueze, Mbarika, Prakash, Chatterjee, Ray & Mishra, 2008).

"Healthcare professionals are entitled to making decisions regarding the usage of the technologies." According to Olteanu, Cernian, Stamatescu, Mateescu, Vladescu, Ropot, Plesca, Togan, Sgarciu, Carstoiu, Saru, Anghel and Oana (2012), specialists, pharmacists, paramedics and other healthcare professionals have reaped significant benefits from using the smart card in recent years. However, healthcare professionals assist patients with admission, checking blood types and temperatures. Nilsen et al. (2020) argue that healthcare technology projects would only succeed if the patient is maintained at the centre and sociocultural/behavioural, organisational, financial, political and technical restrictions are addressed with the goal of patient empowerment. However, it should be considered that SCT users are often healthcare professionals, which could obstruct SCT implementation attempts due to their lack of experience and knowledge of the technology (Dos Santos Brito, Da Silva Costa, Garcia & De Lemos Meira, 2014).

1.10 Ethical Considerations

The University of South Africa granted permission to conduct this research involving humans. The researcher also requested approval from the Department of Health to conduct research in four particular hospitals. Several ethical issues, including the confidentiality of the requisite patient data were taken into account to prevent the research from jeopardising patients' right to privacy. This study took steps to protect respondents' privacy by ensuring that their answers to the questionnaire were as anonymous as feasible. Creswell (2013) contends that to protect respondents, researchers must be mindful of their rights, keep moral considerations under control and maintain the integrity of the data they gather. Additionally, questions with an ethical component must be pertinent to the current research study and, if necessary, confirmed.

Leedy, Paul and Ormrod (2010) argue that before any research study commences, the researcher has the responsibility to facilitate carefully checked ethical factors that can have an impact on respondents. Above all, it necessitated the categorisation of ethics in the following manner: respondent concerns, debriefing respondents, the right to privacy and being honest with colleagues.

1.11 Study Chapter Outline

This research study is structured as follows:

Chapter One: This chapter included background serves as an introduction to the field of information systems for the sake of this research. After, a problem statement is presented, the research problem thereafter, the research objectives, and then the research questions. The definitions of key terminologies as implied in the context of this thesis are listed. The intended contribution and delineation of the research as well as the ethical considerations for the study were established.

Chapter Two: An in-depth review of the existing literature is presented. It includes a detailed review of related literature on Smart Card technology implementation. The eHealth strategy and the national government framework was discussed. Also, the chapter discussed the challenges and benefits of Smart Cards, and legislations that affect Smart Card Technology in the health sector.

Chapter Three: Discussions regarding the selection of appropriate theories were conducted in this chapter. Two important levels of implementation theories were discussed: technology acceptance at individual and organizational levels respectively. At the individual level, the Healthcare Unified Theory of Acceptance of User Technology Model (HUTAUT) was discussed. At the organizational level theories, diffusion of innovation (DOI), DeLone and McLean information systems (D&M IS) Success Model, and Stakeholder theory were critically reviewed for relevance and applicability to this study. The main outcome of this chapter is the selection and adoption of the HUTAUT, D&M IS Success Model and DOI as the most appropriate theories for this research study.

Chapter Four: This chapter represents the research design applied to this study. It provided an overview of the research approach which included philosophical assumptions and methodology that was used to carry out the study. It described the data collection processes and methods as well as the data analysis technique.

Chapter Five: Presentation and Data Analysis. All the research questions will be fully addressed in this chapter where the presentation of data will be fully discussed to get the meaning of the data collected.

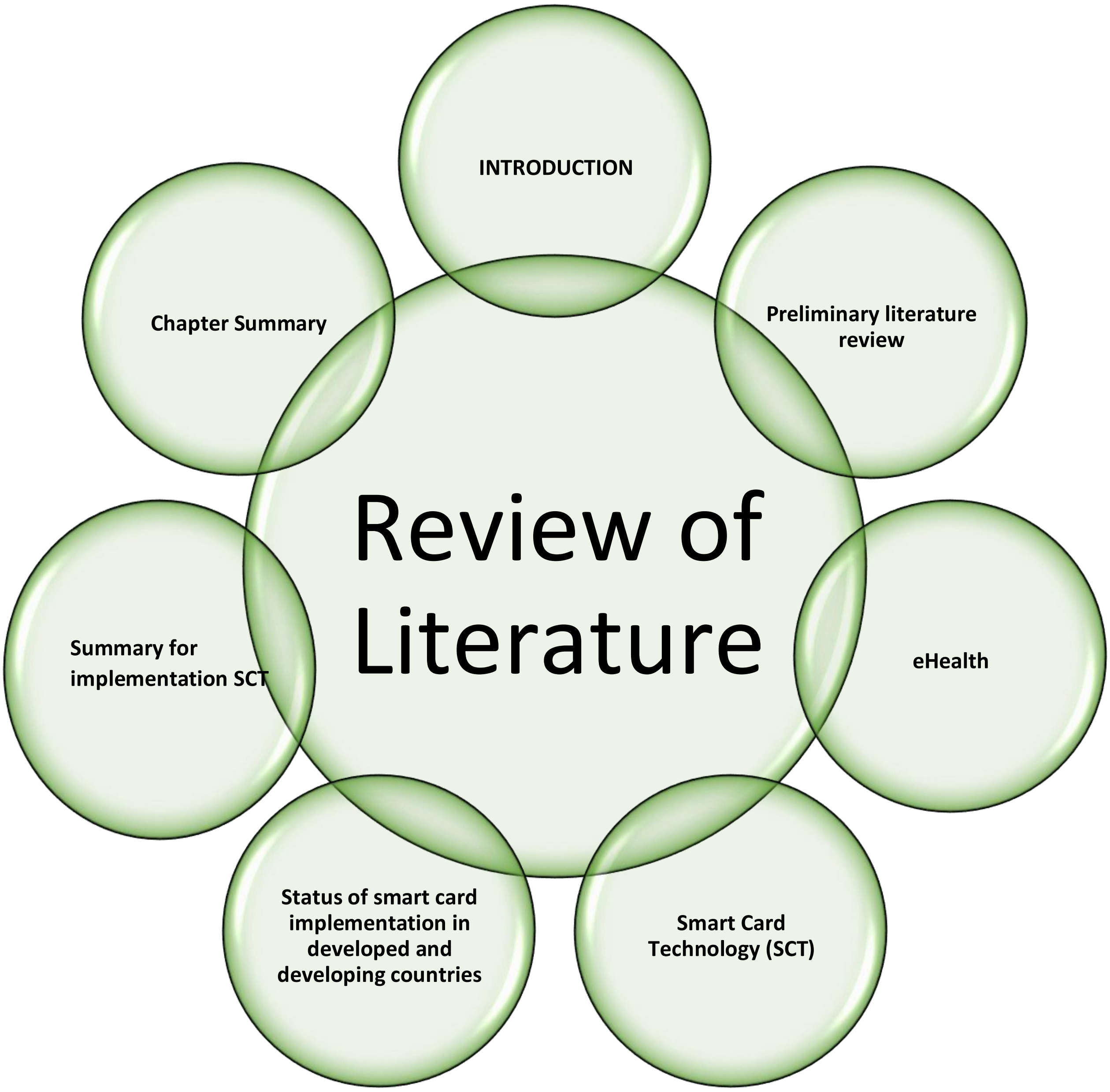
Chapter Six: This chapter outlines the discussion and conclusion based on the research objectives and findings. Also, an aftermath reflection on the research process as well as the limitations will be stated, followed by possible research areas in the future to conclude the thesis.

1.12 Chapter Summary

The introductory chapter served as a research summary of the study, highlighting important factors that were introduced in the research emphasis that was followed for the study. The chapter also included an introduction to the study, a background, a problem statement, research objectives and research questions addressing the study chapters. The next chapter provides a full, detailed review of the relevant literature.

CHAPTER 2

REVIEW OF LITERATURE



2.1 Introduction

This chapter focuses on eHealth in general, smart card technology (SCT) in public health and theoretical foundations for how health organisations make adoption decisions. In addition, the chapter elaborates on eHealth and SCT adoption and its implementation in both developed and developing countries.

2.2 Preliminary Literature Review

The goal of this study is to develop a theoretical foundation for the implementation of SCT in South African public healthcare. The research identified the technology implementation gap for the usability of smart card technology and mapped selected studies that could shed light on the healthcare industry. The research was guided by three main themes: (1) Performance, (2) Technological challenges and (3) Usage issues. The other focus area was the contributing factors towards the SCT implementation such as the Fourth Industrial Revolution (4IR) approach and the Internet of Things (IoT). The Department of Health cannot dismiss 4IR's participation or role in developing a framework (Bianchi & Labory, 2018). A framework serves as a guideline for the implementation of any information systems within the industry, in addition to its economic impact (Ahmad & Omar, 2016). It is important to take advantage of risks associated with technology during deployment and to keep the present business trends going (Nisand, Allaert, Brézillon, Isphording & Roeslin, 2003). As highlighted in Table 2.1 of the study, the research goals below are linked to the research questions that were posed in Chapter 1 of the study.

Table 2. 1: Research Goals (Source: Own)

Research Goal 1	To determine the efficiency of smart card technology in delivering healthcare services when implemented.
Research Goal 2	To address the interoperability issues for successful smart card technology implementation.
Research Goal 3	To understand the management of smart card technology for public healthcare.
Research Goal 4	To identify challenges that have an impact on the implementation of smart card technology in public healthcare.

Research Goal 5	Based on the above sub-research objectives, a conceptual framework for the implementation of smart card technology is developed in the healthcare sector.

Patients cannot see their records in a file, manual card or any other stored environment except during the process of exchanging healthcare professionals. Most importantly, there is a misconception regarding the use of technology in healthcare by these professionals. Such misconceptions are the validation of records and a suitable budget for procuring these technology systems. The benefits of SCT implementation should make information visible and patients' records stored on a smart card that contains all recorded data (Kumar, 2014). In addition, to deal with global standards and evolving trends, the contribution of the World Health Organisation (WHO) standards regarding the implementation of technologies in healthcare, cannot be overlooked (Ivanovi & Rakovi, 2019). The main purpose of information systems is to identify technological implementations that can function together without failing to produce reliable information systems (Wu & Hadzic, 2008). Thus, electronic healthcare systems (EHS), health information systems (HIS) and health insurance systems (HIS) are identified under the smart card technology concept. SCT must benefit healthcare professionals and patients (Kaneyasu & Akiyama, 2012). There is a clear indication of how a framework can be implemented to benefit public healthcare in South Africa. Generally, different identifiers (names) within the healthcare sector exist for different reasons; hence, the confusion about what the actual objective of SCT is. For this reason, a novel approach must be developed by using a smart card framework that provides evident benefits to healthcare professionals.

Search Literature Review Items

- Smart card technology
- Theoretical frameworks used
- Electronic health record
- Challenges within healthcare
- eHealth strategy implementation

2.2.1 Inclusion: Systematic Literature Review

The study's inclusion criteria were relevant to the implementation of SCT. The study included keywords such as smart card, technology, public healthcare, privacy and security, as stated in Figure 2.1, detailing the search layer. The study used keywords such as 'SCT', 'healthcare' and 'healthcare professionals' in searching in some of the journals listed in Table 2.2. However, some literature was searched from different databases such as *Scopus*, *IEEE*, *Science Direct*, *Taylor and Francis Online* journals and *Ebscohost* journals.

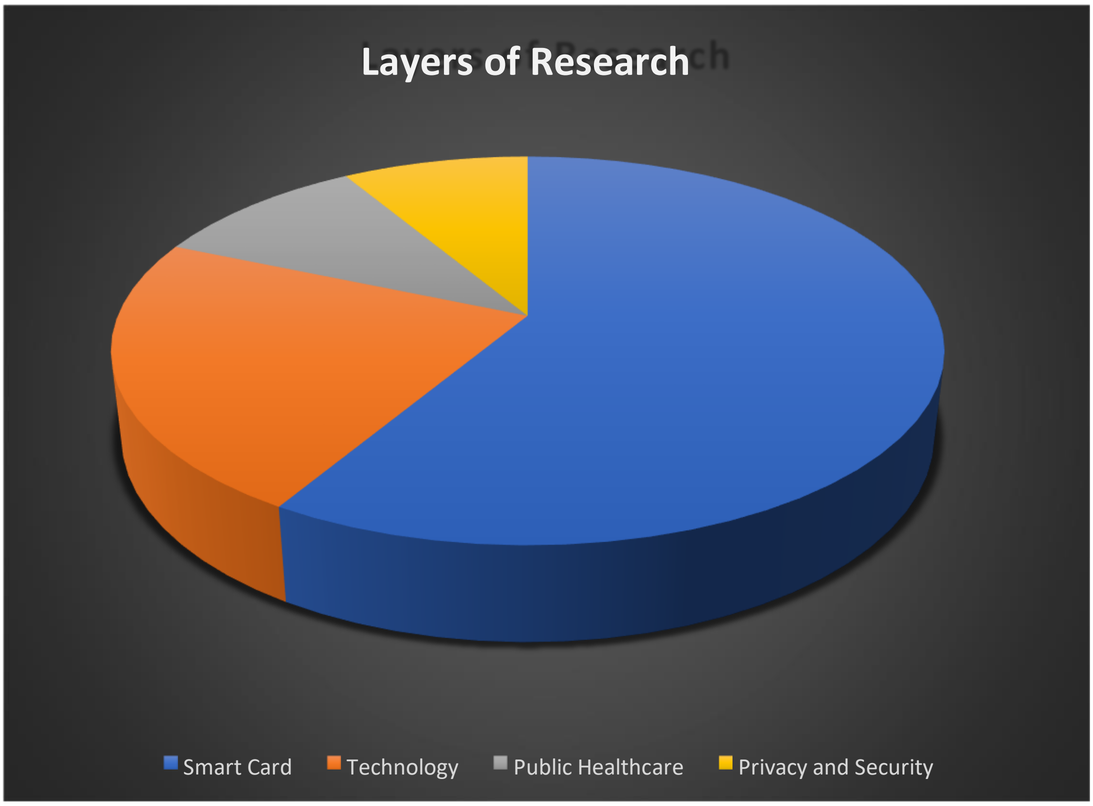


Figure 2. 1:Details of the search layer (Source: Own)

Table 2. 2: Inclusion criteria for journals (Source: Own)

Relevant journals based on the study. (2012–2019)	• Science, Technology, and Energy Policy [White Paper] Competition • 2018 6th International Conference on Information and Communication Technology, ICO • ICT 2018 • *IJETSR* • European Communications in Computer and Information Science Conference on Information Warfare and Security, ECCWS • *Journal of Information Security and Applications* • *International Journal of Medical Informatics*

	• *Journal of Information Security and Applications* • *Computers and Electrical Engineering* • *Sustainability* (Switzerland)

	• H 2014 IEEE 3rd Global Conference on Consumer Electronics, GCCE 2014 human-centric Computing and Information Sciences • *Journal of Cleaner Production* • *Pervasive and Mobile Computing* • *Information Sciences* • *Consumer-Driven Technologies in Healthcare* • *Smart Health* • *Journal of Information Security and Applications* • IST-Africa • *Proc. of 2013 3rd Int. Conf. on Instrumentation, Communications, Information Technology and Biomedical Engineering: Science and Technol. for the Improvement of Health, Safety, and Environ.*, ICICI-BME 2013 • *2016 Proceedings of the Conference on Information Systems Applied Research* • 2018 International Conference on Smart City and Emerging Technology, ICSCET 2018 • *Information* • *Procedia Engineering* • *Journal of Communications and Information Sciences*

	• Smart Card Alliance Security of Things 2016 Conference to Highlight Need for Security, Privacy, and Authentication in IoT

Previous years (1999–2011)	• Science, Technology, and Energy Policy [White Paper] Competition • *International Journal of Computer Applications in Technology* • *Computer Networks* • *MASEUM Journal of Computing* • *Computer Methods and Programs in Biomedicine* • *International Journal of Computer Science Issues* (2011) 8(1) 217–225 • *Proceedings. 36th Annual 2002 International Carnahan Conference on Security Technology* • *Zeitschrift fur Arztliche Fortbildung und Qualitatssicherung* (2001) 95(9) 642–646 • 14th Pacific Asia Conference on Information Systems (PACIS 2010) • *International Journal of Medical Informatics*
Scientific databases	• *Emerald* • *IEEE Xplore Digital Library* • *Wiley library* • *EBSCO* • *Cochrane library* • *Taylor and Francis Online Journals*
(Highly cited) academic textbooks	• *Smart Cards Applications in the Healthcare System* • *Effective use of smart cards* • *Smart Card Alliance*

Non–academic books	• *Electronic Healthcare Model Based on Smart Card for Saudi Medical Centres* • *Effective use of smart cards* • *Smart Cities in the new service economy: Building platforms for smart services.*

To find the relevant contribution to the defined search objectives in this study, a novel approach was utilised to search the abovementioned journals from 1999 to 2011, to look backwards at the study's progress. The first search words like SCT were dominant; however, it was discovered that the most prevalent search words for the study which are addressed in the report are seldom found, such as "Health Information Systems" or "Electronic Records Management" were all terms used to refer to the same problem. Although several authors considered smart cards to be suitable for healthcare technology, it seemed unclear how smart card technology would be implemented in the healthcare sector. Recent research revealed that the term ‘smart’ is taken from a phrase used to designate smart cities in Europe and several Asian countries (Van Zoonen, 2016; Trencher & Karvonen, 2019; Ahmad, Khujamatov, Akhmedov, Bajuri, Ahmad, Ali & Ahmadian, 2022). The term ‘smart’ was used more in the context of the patient than in the context of healthcare providers (HCP). During the title search in the cited journals, however, special emphasis was placed on keywords that indicated whether a management framework in public healthcare should be covered by the study.

2.2.2 Sources: Literature Review

There are various forms of literature reviews to apply to any study (Cronin, Ryan & Coughlan, 2008). The most common subject areas in relevant studies are valuable for summarising and synthesising. This study's main objective was to synthesise the literature using a narrative style review rather than a conventional one. According to Okoli and Schabram (2010), literature reviews are conducted for different purposes in research. A literature review is often conducted for theoretical purposes, i.e., to provide a theoretical foundation. In an article, Trattne, Hvam, Forza and Hansen (2019) describe the words ‘literature review’ as an operative definition of a systematic literature review, which is explicitly employed.

Okoli and Schabram (2010) refer to a literature review as a stand-alone task that can be completed with varying levels of rigour, ranging from minimal to extensive. According to Hart (2018), an author employs the following three types of literature review processes, drawn from the classification of secondary sources by Herselman (2011), as highlighted in Figure 2.2

- Primary sources are original material on which other research was based, including original written works: poems, diaries, court records, interviews, surveys, original research/fieldwork and research published in scholarly/academic journals.
- Secondary sources describe or analyse primary sources, including reference material: dictionaries, encyclopedias, textbooks, books and articles that interpret, review or synthesise original research/fieldwork.
- Tertiary sources are used to organise and locate secondary and primary sources:
    - Indexes provide citations that fully identify the work of information for the author, the title of a book, article or journal, publisher, publication date, volume, issue number and page numbers.
    - Abstracts summarise the primary or secondary sources.
    - Databases are based on online indexes that usually include abstracts for each primary or secondary resource and may also include a digital copy of the resource.

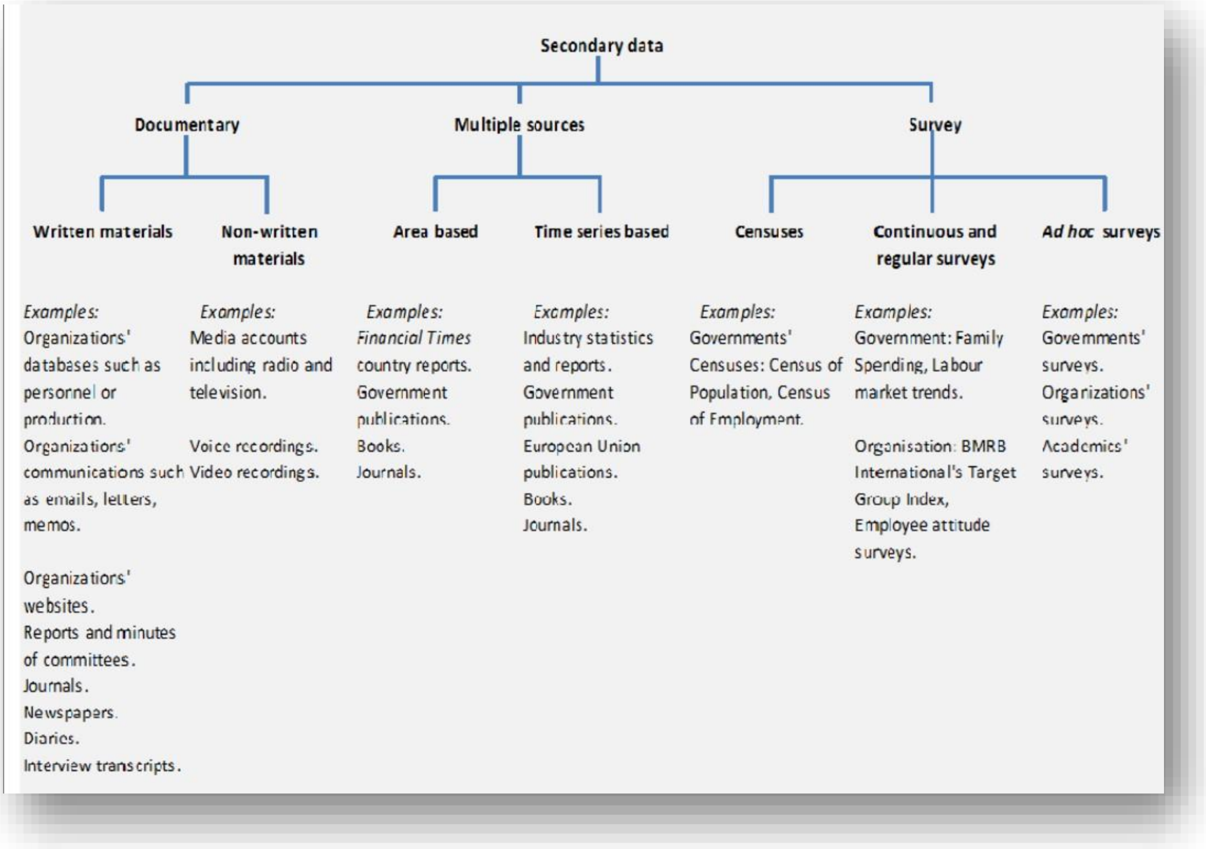


Figure 2. 2: Classification of secondary sources

(Source: Herselman, 2011)

2.3 eHealth

The World Health Organisation (WHO) defines eHealth as the use of information communication technologies (ICTs) for healthcare (World Health Organization, 2013). To meet expanding healthcare difficulties and challenges, eHealth solutions are being deployed all over the world (Ilorah, Mokwena & Ditsa, 2017). In their study, Yeh, Lo, Wu, Yang and Liaw (2012) indicate that the effective use of medical information management systems and the academic community has immediately responded by focusing on the development of eHealth care services.

Alberts, Fogwill, Botha and Chetty (2014) argue that eHealth makes it possible to employ technology for tracking diseases, educating healthcare professionals, performing medical research and monitoring public health. Lau and Kuziemsky (2016) argue that eHealth is an evolving field in the interaction of medical informatics, public health, business, health services, information delivered or enhanced through the internet and related technologies. Given the challenges that some countries had in deploying smart card technology, it may be necessary to engage with a variety of interfaces employing security measures. The advent of mobile technology has rendered plastic smart cards useless in the healthcare industry, threatening to do the same for credit/debit smart cards in the commercial sector (Ivanovi & Rakovi, 2019). Whereas benefits can be easily recognised in the management of patient data, eHealth offers the capacity to provide integrated applications and data in areas like patient diagnostic and treatment support. Patients were impacted by remote patient data collection, education and awareness campaigns, remote patient monitoring, monitoring of disease epidemic breakouts and adherence to evidence-based therapy and healthcare (Nhavoto & Grönlund, 2014).

The file system is eroding; therefore, technology is gradually considered to be in demand. As a result, technology allows the healthcare sector to implement the use of smart card technology devices. By employing terminals or computer systems to obtain data, these technologies provide improved interoperability and mobility advantages. Moreover, thanks to smartphones and tablets, technology has evolved from the first to the third generation of electronic health systems. Yet, 'plug-and-play' data ecosystems were created to hasten the uptake of smart personal health devices (Sezgin & Zkan-Yildirim, 2016). eHealth was first introduced in 2000 by the World Health Organisation (2013) and has been widely used since its inception. Because several interconnected technical, social and organisational aspects must be considered, implementing eHealth technology has proven difficult (Cresswell & Sheikh, 2013).

Much knowledge can be gained from the application of technology such as SCT along with the implementation of eHealth in different countries in the world like Canada, Australia, the United States and Europe, according to Lau and Kuziemsky (2016). According to Mugo and Nzuki (2014), eHealth is one of the solutions for healthcare facilities and is utilised by both patients and healthcare staff. The focus should be based on improving healthcare quality by increasing collaboration across governmental sectors. As a result, the implementation of technologies for the implementation of healthcare is highlighted in eHealth. The next section explores smart card technology in depth. Moreover, eHealth technology must be managed for clinical decision support systems, intelligent, responsive infrastructure and equipment that has made it possible to deliver safe and high-quality healthcare (Zayyad & Toycan, 2018). One of the eHealth technologies this study investigated was SCT.

2.4 Smart Card Technology (SCT)

A smart card comprises an embedded integrated circuit, a secure microcontroller or comparable intelligence and internal memory, or a single memory chip with no other functions (Ray, Dash & Kumar, 2020). Smart card technology is depicted in Figure 2.3. According to Yeh, Lo, Wu, Yang, and Liaw (2012), SCT is employed as a tool for authentication procedures. Furthermore, it features a built-in computer chip memory or a microprocessor which allows it to process or store data.

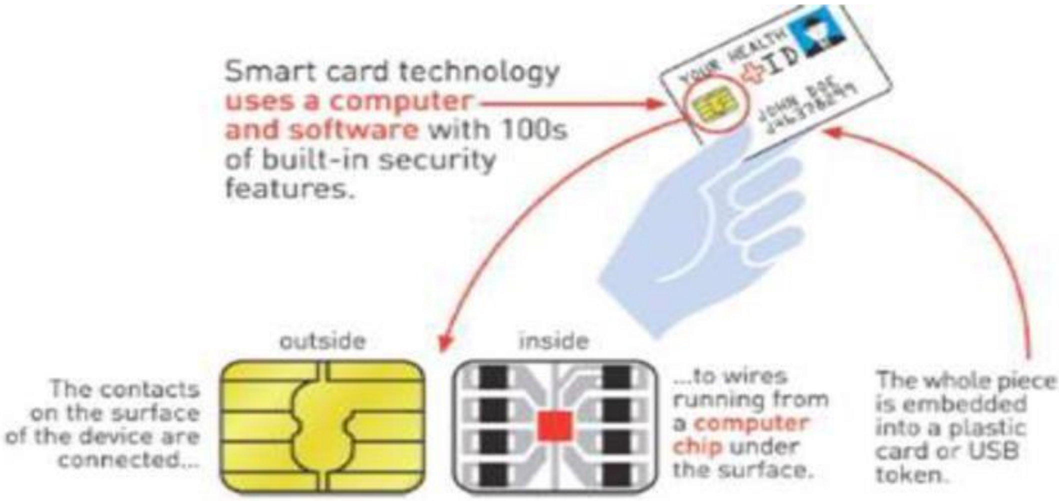


Figure 2. 3: Smart card technology (Source: Alliance, 2016)

For instance, Germany chose the electronic health card as the core of its eHealth infrastructure (Wirtz, Mory & Ullrich, 2012). Barbosa, Takako and Sadok (2020) assert that interacting with both human users and other systems presents difficulties. Yet, the lack of data support and confidentiality results in network device authenticity control. Doctors would need to demonstrate their proficiency with the technology for eHealth to be deployed in Zimbabwe, according to Furusa and Coleman (2018). Due to the need for hardware and software during treatment, doctors in public hospitals have been mandated to learn how to use eHealth technology.

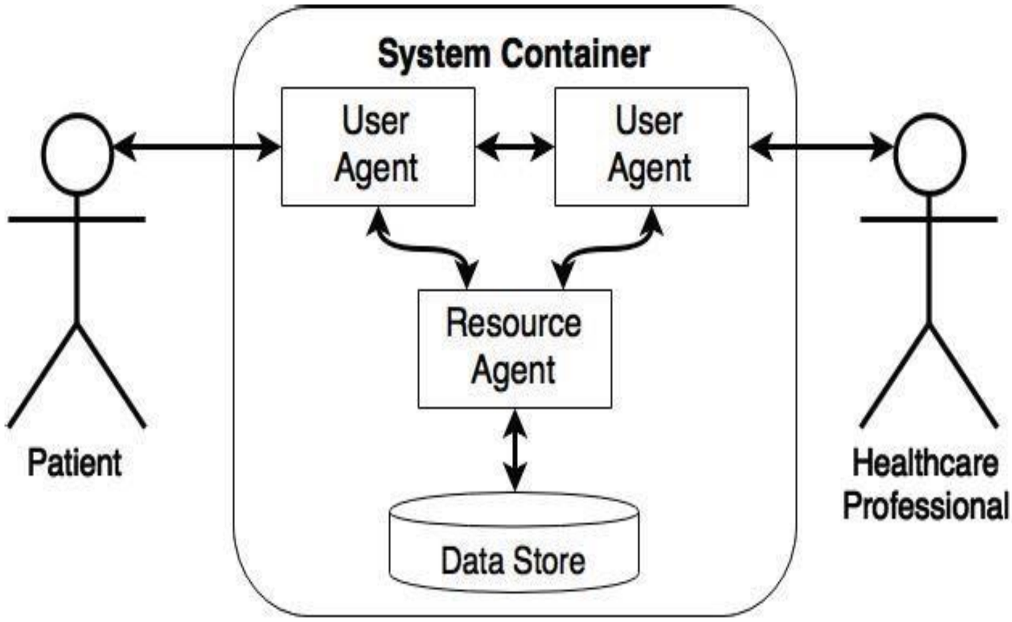


Figure 2. 4: System overview (Source: Shakshuki, Reid & Sheltami, 2015)

Shakshuki, Reid and Sheltami (2015) highlight two types of user agents found within the system visualisation, namely user agents and resource agents. However, a user agent requires the management of health data and responding to the healthcare professional user agent requests, as addressed in Figure 2.4. The main purpose of the resource agent is to improve the authentication process between the user agent and achieve the patient's health data for long-term storage. Chan (2000) pointed out that the Hypertext Transfer Protocol (HTTP) can be used as the basic protocol to access information on the smart card. Silicon Graphics (SGI), for example, promotes the usage of current standard web browsers as the common client user interface. Lastly, for healthcare applications to be considered, all medical records should be fully available in a smart card application. Thus, simply explained, the smart card is used in a device that is equivalent to the size of a credit card, to deliver the database with mobility into a person's pocket (Elefant, 2017).

2.4.1 Architecture for Smart Card Technology

The Health Insurance Portability and Accountability Act (HIPPA) of 1996 is a United States federal law signed into law by (then) President Bill Clinton. The health information system's (HIS) main goals were to modernise the flow of data in healthcare, clarify how personal data held by the healthcare and health insurance industries should be secured from fraud and theft, and eliminate health insurance coverage restrictions. The HIS is equivalent to SCT architecture, which was built to provide three-factor authentication, allowing it to access encrypted protected health information (PHI), thereby enabling HIPPA compliance. This allows the embedded chip to store, retrieve and securely exchange data with card readers and other systems (Howell, Abdelhamid, Sharman & Das, 2016). SCT also communicates with mobile devices such as smartphones, computers and tablets that use Near Field Communication (NFC).

Moreover, the three-tier architecture, which is the most common software architecture for typical client-server applications, divides applications into three logical and physical computer tiers (Sethia, Gupta & Saran 2019). The three-tier architecture allows the client to connect directly to the database and server to run queries. Instead of the dependency, an extra control structure for handling queries is implemented. An integrated circuit comprising a microcontroller chip or only a memory chip with non-programmable logic is known as a smart card (Keliris, Kolias & Nikita, 2013). The main document that provides specifications for contact smart card physical properties is ISO/IEC 7816 (Ivanovic & Rakovic, 2019). Similarly, ISO/IEC 14443 and ISO/IEC 15693 also define standards for contactless smart cards.

The operating system for smart cards is kept in the read-only memory of the chip (ROM). For each application, the operating system is utilised as well as the available RAM and EEPROM for the implementation and execution of the standard pre-programmed instruction set (Keliris et al., 2013). SCT, as shown in Figure 2.5, is a hardware and software tool (Alam & Ali, 2016). The hardware for SCT consists of a reader and a chip. In healthcare, professionals are the main users of the SCT tool. Therefore, the healthcare professional has a terminal that is used to access medical information (Kawthankar, Ansari, Joshi & D'Mote, 2018). Kadasi and Tunali (2006) indicate that smart cards contain client software components that may depend entirely on the database server and associated databases.

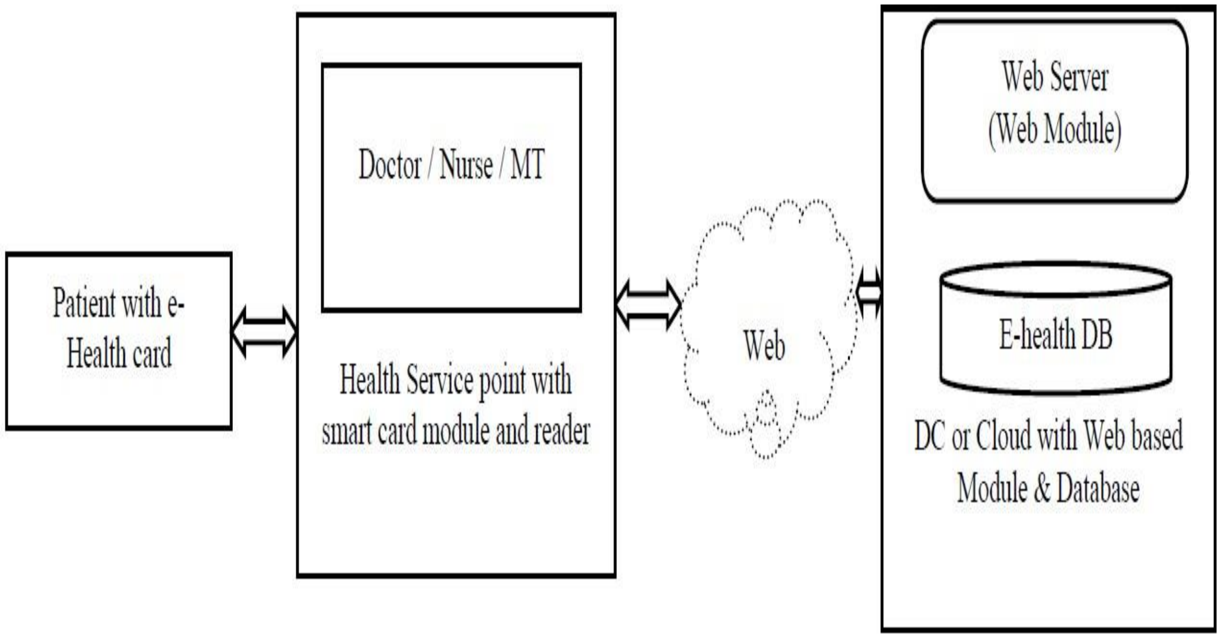


Figure 2. 5: The basic eHealth architecture (Source: Alam & Ali, 2016)

The Model View Controller (MVC) is regarded as a software design pattern for creating user interfaces, among some of its uses. In the MVC architecture, view components are connected with the device data model via a controller mechanism (Kardas & Tunali, 2006). Thus, user interfaces such as forms, and associated dialogs are found as an independent relational database stored in the SCT data model.

As shown in Figure 2.6, SCT can do the following:

a) *The registration process* - The central administration is responsible for performing the verification and registration processes of all healthcare institutions.
b) *The login process* - Due to the central database, healthcare professionals at each healthcare institution obtain passwords during the registration process. The passwords and the login ID can be used to login into the eHealth system.
c) *Patient administration* - Any healthcare facility could allow the authentication of a patient by his eHealth card through a smart card module, admit the patient as well as assign a doctor to them through this process.
d) *Prescriptions* are used to maintain prescriptions electronically and information flow from the primary care of the healthcare professionals.
e) *Patients' bookings* - Patients are booked and see information regarding booking according to their needs for a specific healthcare professional, depending on their problems.

f) *Laboratory requests and results* - The information is used as a process flow between the nurses and laboratories.

g) *Reimbursements* - The information flow from general practitioners (GP) to public insurance for reimbursements.

h) *Check the pathology report process* - The healthcare professional could check the patient's pathology test report and forward it to the medical technologist. After that, using the 'File Encryption Process' reports can easily be transferred from a temporary directory to the 'patient's online directory' in encrypted form and the patient's pathology can be updated.

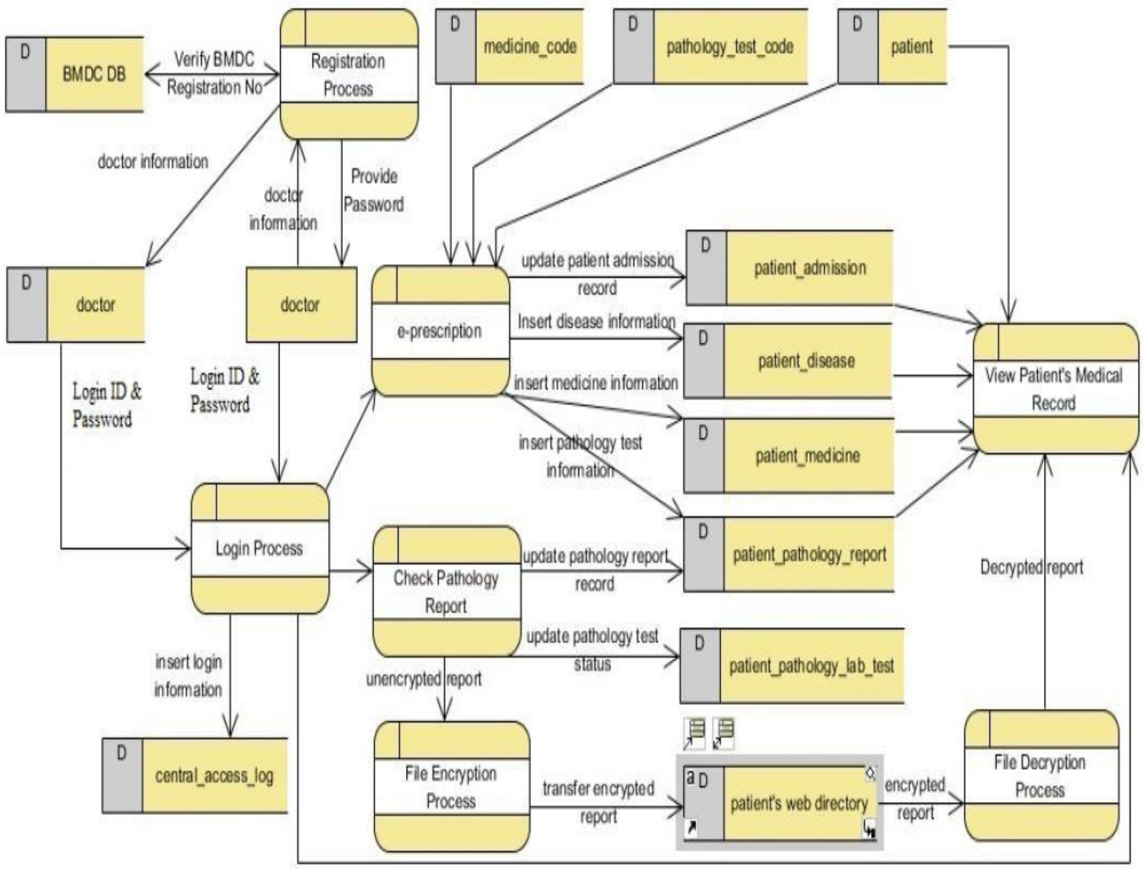


Figure 2. 6: Healthcare professionals' entity (Source: Alam & Ali, 2016)

2.4.2 Advantages of SCT

SCTs are intended to provide the following benefits:

a) *Access to Information* - One of the utmost important functionalities of SCT is being easy to access and the useability of information and data that leads to implementation (Kardas & Tunali, 2006). Patient data, that are manually recorded in a patient's file cannot be easily monitored, according to Wright, O'Mahony and Cilliers (2017). healthcare professionals use the cryptographic approach for monitoring and evaluating data.

b) *Documentation* – The importance of documentation is regarded as a return on investment. Intangible benefits of the SCT include increased quality and patient care, patient safety, more effective patient data tracking, improved documentation and greater auditing of accessed information. Pankomera and van Greunen (2018) add that documentation assists with tracking the previous history of a patient during the implementation of eHealth.

c) *Processing of records* - Provides an opportunity for healthcare professionals to speedily process records and appointment scheduling as well as reduce turnaround time. Asghar, Baig, Rusello, Lee, Ullah and Dobbie (2017) highlight the potential advantages of SCT, including promoting the ease of conducting health-related routines among healthcare professionals.

d) *Decision-making* - Improved decision-making reduces healthcare costs. Some difficulties encountered during the implementation of SCT include the reinforcement of privacy and the security of data. According to Fan, Lo, Buchanan, Ekonomou, Th¨ummler, Uthmani, Lawson, Sharif and Sheridan (2012) in a study conducted for the Data Capture and Auto Identification Reference (DACAR), the use of digital technologies in healthcare is ideal for decision-making.

e) *Record-keeping* - The adoption and usage of SCT by healthcare professionals such as nurses are meant to (among other things) ease the tasks of record-keeping of patients' information including the filing, storage and sequence of medication (Wu, Zhao, Xu, Wang, Niu, Zhang, Zhi, Zhu, & Meng, 2020). In achieving the use of SCT for nurses, the eHealth strategy has become one of the most promising platforms.

f) *Automation* - In the past, health information systems in South Africa were characterised by a lack of coordination, the preponderance of manual systems and a lack of automation, with interoperability between systems where automation exists. As a result, the South African government has sought to address issues such as pharmaceutical supply, skill scarcity and broader healthcare concerns (National Department of Health, 2019).

g) *Data capturing* - SCT is used in healthcare to assist with data processing. Most healthcare professionals regard data technology as a tool to evaluate quality on a systematic and large scale. SCT has many capabilities and is more focused on capturing and sharing patient data.

h) *Communication with healthcare professionals* - The goal of transforming traditional healthcare into smart healthcare is to improve patients' access to information and make healthcare professionals' jobs simpler (Renuka, Kumari & Li, 2019). However, due to security and integrity concerns, the transition is difficult. As a result, communication facilitates the handling of patients' health records and privacy via authorisation assessment and authentication schemes.

i) *Impact on education* - SCT has capabilities for storing educational content in the form of illustrating health messages and videos, which is helpful to target audiences (Spies & Muwanguzi, 2014). Educational content is restricted to computers, giving healthcare providers the ability to limit the amount of information directed at the patient.

j) *Workarounds* - Data collection resulted in the exchange of patient information to be significant purposes for the SCT. Doctors' workarounds, on the other hand, are seen as compromising the integrity of technology use (Daker-White, Hays, McSharry, Giles, Cheraghi-Sohi, Rhodes & Sanders, 2015).

2.4.3 Disadvantages of SCT

Shortfalls are inevitable with any technology. The following are some disadvantages associated with SCT.

a) *Lost smart card* -The most significant disadvantage of SCT is based on the loss of privacy and information which remain a concern regarding the accessibility of information by unauthorised parties (criminals) who can readily gain access (Howell et al., 2016).

b) *Privacy* - SCT information is accessible to third parties without the cardholder's permission, leaving the healthcare professional or owner at risk (Madhusudhan & Hegde, 2017).

c) *Non-repudiation* - Data are shared from its origin and the information is readily denied by the user.

d) *Authentication* - The user should be identified during this procedure. The technique establishes a person's identity when healthcare providers are unable to identify the card's legitimate carrier.

e) *Expensive readers* - Since the provision of SCT involves the processing of sensitive medical data, the replacement of expensive readers attracts extra attention (Dehling & Sunyaev, 2014).

f) *The smart card is small and lightweight* – As a result, they are susceptible to being forgotten or lost because of known or unknowable activities. The owner has to undergo a drawn-out procedure at the police station to acquire an affidavit. The owner would then apply for a new SC, but occasionally, data would not have been backed up.

The next subsection addresses the Fourth Industrial Revolution (4IR) concept and smart card technology.

2.4.4 The Fourth Industrial Revolution and Smart Card Technology

Previously, the Industrial Revolution (IR) was regarded as a way to achieve outcomes through opposition to change. The term Third Industrial Revolution (TIR) is related to the processing, storage and production of energy as a result of variables like automation and the usage of computers and electronic equipment (Blom & Uwizeyimana, 2020).

The Fourth Industrial Revolution (4IR) has shaped and reshaped the way people live, work and interact while using technology. ICT has made enormous breakthroughs in increasing healthcare access, efficiency and quality (Aceto, Persico & Pescap, 2018). Peters (2017) notes that the Fourth Industrial Revolution is a concept focused on automated cognition in healthcare. The 4IR's capacity to automate tasks like healthcare practitioners' use of SCT in care delivery is one of its strongest characteristics. The Fourth Industrial Revolution (4IR) encompasses the emergence of several key digital phenomena, including the Internet of Things, artificial intelligence, big data and virtual reality (Mulrean, 2020).

The Internet of Things (IoT) is a network of physical items that are integrated with sensors, software and other technologies to connect and exchange data with other devices and systems through the internet. According to Raja (2016), IoT devices automatically gather and share data, allowing new data streams to be captured, evaluated and recorded faster and more accurately. Hamidi (2019) highlights the challenges faced by the IoT such as technological shortcomings, which entail connectivity, security issues and compatibility issues.

Besides IoT, blockchain is an additional technology for sharing information (Reyna, Mart´ın, Chen, Soler & Manuel D´ıaz, 2018). Gupta and Quamara (2018) note that it is important to understand the IoT's underlying architecture and the elements involved in meeting its requirements (Gupta & Quamara, 2018). As a result, the security architecture of the Internet of Things (IoT) is provided with a taxonomy for critical technologies like radio frequency identification (RFID) and wireless sensor networks (WSN), which are key enablers of the IoT. RFID technology has proven to be reliable, secure and far superior in healthcare (Saunila, Nasiri, Ukko & Rantala, 2019). The implementation of RFID technology streamlined the necessary modules and automated the patient and healthcare professional identification process.

According to Davenport and Kalakota (2019), a prominent category of applications for artificial intelligence comprises administrative tasks for healthcare personnel, suggestions for therapeutic and diagnostic procedures, and patient retention and compliance. To keep their clients' healthy lifestyle information up to date, most South African medical aid firms use big data analytics and artificial intelligence capabilities (Mulrean, 2020). In India, medical records contain medical history; hospital management systems have been developed to convert manual searches and file access into electronic medical records to solve manual methods (Hertin & Al-Sanjary, 2018). For moving away from manual processes, the study proposes the utilisation of computer-based software to design hospital management records.

According to Parasol (2019), data are transforming across industries, including the healthcare industry. As a result, structured data or any sort of information are machine-readable due to the consistent structure that allows it to function properly. The data are translated and processed to be 'sanitised' and are used by healthcare providers. Data manipulation has become increasingly crucial as the amount of data consumed and stored grows. Huge volumes of data are stored for healthcare in general. In India, data are collected through numerous sensors on the IoT, which has resulted in a large influx of data (Mani & Chouk, 2018). Consequently, even if datasets are not fully utilised in healthcare, they are being used in other industries like universities, businesses and the gas and petroleum industries (Hussein, 2020). SCT is an IoT device that was developed and implemented to protect patient and healthcare professional data (Rupani & Doshi, 2019). The next subsection addresses the implementation of SCT in developed and developing countries.

2.5 Status of Smart Card Implementation in Developed and Developing Countries

The Secure Identity Alliance (SIA) was seen as committed to encouraging global economic growth and prosperity through fostering the establishment of trustworthy digital identities as well as the widespread adoption of secure eServices. The alliance brought together public, private and nongovernmental organisations to promote international collaboration on digital identity challenges, the topics of data security, citizen privacy, identity and authentication. In developed countries such as Belgium, Estonia, Finland, France, the Republic of Korea and Singapore, the adoption of digital identification has enhanced the efficiency of public services (Geteloma, Ayo & Goddy-Wurlu, 2019).

The rapid growth of information systems has been observed in most developing countries such as Kenya, Ethiopia, Rwanda, Malawi and many other African countries.

2.5.1 Implementation in Developed Countries

The implementation of SCT solutions in the banking sector required security services to have cryptographic techniques. Customers in the banking sector experienced e-banking issues, according to a survey done in Punjab's Ludhiana area in April 2019 (Singh, 2021). Customers appeared to have problems with e-banking services due to a lack of understanding, a poor network, a lack of infrastructure, an inconvenient location, ATM card misuse and account opening difficulties. According to Singh (2021), improving e-banking services requires methods such as consumer education, seminars/meetings, sufficient network and infrastructure facilities, online shopping, proper functioning and ATM installation, among others. The use of e-cash requires secure payment through safeguards and the settlement of credit and debit claims (Sharma, 2017). Multipurpose smart cards have been utilised for transit systems between government agencies and their users in the way they are used for transportation (Cheng & Chen, 2016). However, user perspectives proved useful for smart cards in the transit system and focused on the new product adoption model (Figure 2.7). For SC usage, consumers intended to use the construct in the transit model. This study considered the use of structural equation modelling (SEM).

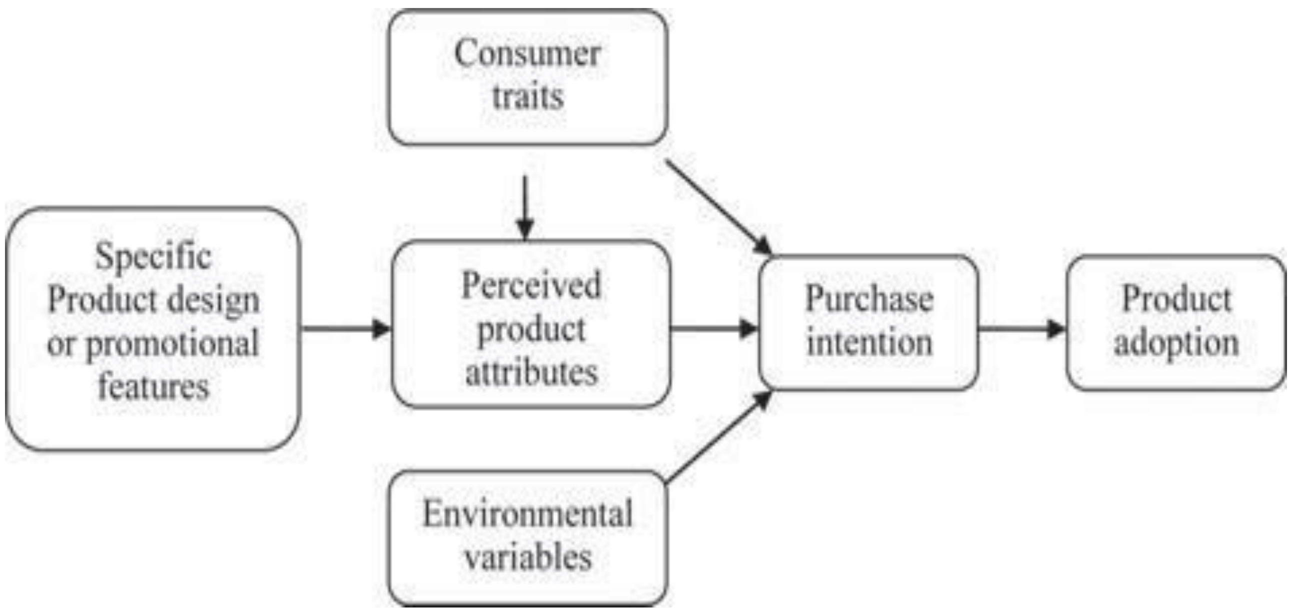


Figure 2. 7: New product adoption model (Source: Holak, 1998)

Radhakrishna, Goud, Kasthuri, Waghmare and Raj (2014) conducted a study on the use of SCT and its benefits in healthcare. The pilot study used the dual portability model, demonstrating the concept's utility. Scientists argue that embedded information systems are less important for today's planning and governance in developed countries. SC adoption rates are, however, higher in other developing nations than in South Africa, according to surveys (Valle-Cruz, Sandoval-Almazan & Gil-Garcia, 2016). Due to a lack of training, low awareness and poor support from top management, Rao, Katyal, Singh, Samarth, Bergkvist, Kancharla, Wagstaff, Netuveli and Renton (2014) estimate that more than 80% of private spending goes to the implementation of healthcare technology.

In a study undertaken in Australia, Cripps, Standing and Prijatelj (2012) found that in healthcare, management used the smart card to electronically retain patient records. Australia lagged in terms of eHealth implementation. SCT was first used in 1995 to transmit medical history and backup patient data. Furthermore, the European Union supported many eHealth pilot programmes, including DiaBcard, Card Link and Netlink; however, Australian Health was not included. In the Australian study context, SCT is considered in the light that not all data are secure and trustworthy for successful implementation (Cripps, 2012). Furthermore, Personally Controlled eHealth Records (PCEHR) should be patented for privacy and security reasons. The lack of ID cards or a small number of systems that are not integrated with the smart card is a current gap in Australia. A complex healthcare system is also noted as a flaw, which raises concerns about chip cards' applicability.

Slovenian research on smart card implementation reflects different levels of success (Stanimirovic, 2019). Consequently, SCT is regarded as effective for managing patient records, security screening and prescription monitoring; it is limited in terms of interoperability, security planning and scalability. According to Stanimirovic (2019), the Slovenian project took longer than expected, posing several developmental and implementation issues. The National Health Plan for 2008–2013, as well as the information strategy for the Slovenian health system between 2005 and 2010, assert that all activities in the Slovenian health system's informatisation are geared toward achieving eHealth. To synchronise contactless card data with a central database and generate reports, the central processing system should run automatically on all terminals.

Basic infrastructure, including Diagnosis Related Groups (DRG), Electronic Health Records (EHR), E-Prescription as well as the improvement of SC features in healthcare is extensively highlighted. General practitioners (GPs) prescribe drugs, prosthetic devices as well as organ and tissue donations for transplants. As a result, the eHealth functions have been effectively deployed and smart cards allow users to remotely access health data via Personal Health Records (PHR). Secondly, well-designed eHealth services could provide access to relevant data and information. This engenders better-supported decision-making at all levels of healthcare administration and management (Stanimirovic, 2019), as shown in Figure 2.8. The planned infrastructure of eHealth in Slovenia was Health Network (hNET), a health portal (hAOP) and EHR. The following section discusses SCT implementation in developing countries.

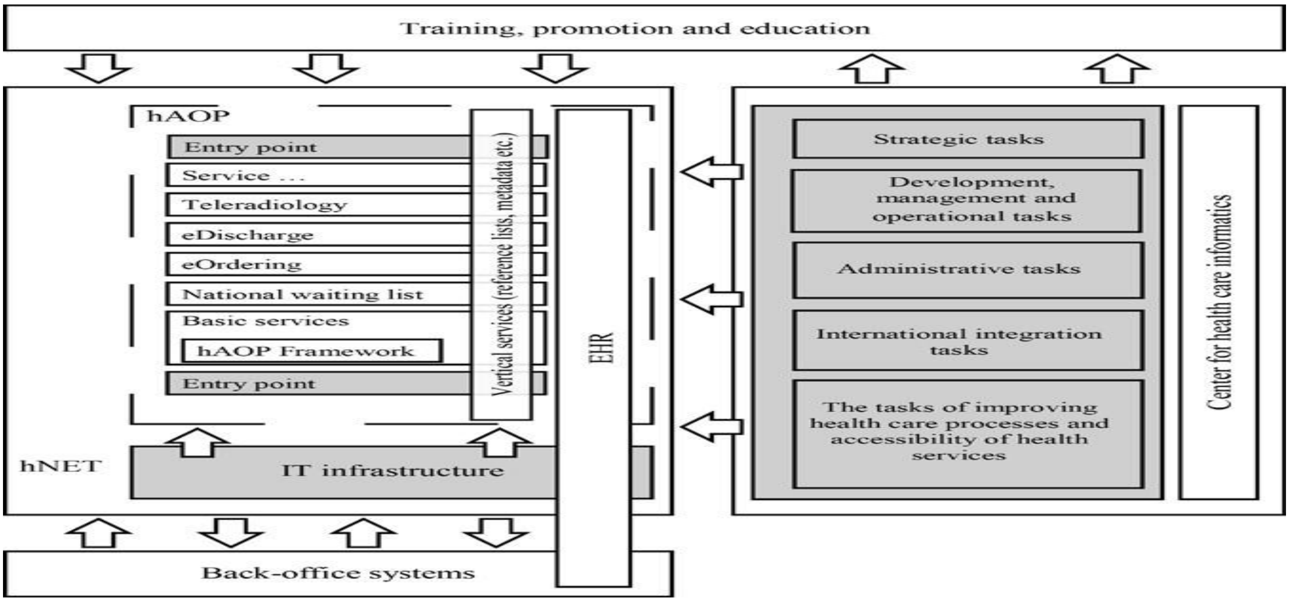


Figure 2. 8: The planned infrastructure of eHealth in Slovenia (Source: Stanimirovic, 2019)

2.5.2 Implementation in Developing Countries

The Ministry of Health in India continues to spend more on primary healthcare since this is a national responsibility. Joshi and Islam (2018) confirm that the inability to adopt health technology leads to a discrepancy between India's rural and urban districts. For that reason, the Indian government is spending more money on technology instead of dealing with the core cause, namely infrastructural problems. In this instance, technological readiness for the implementation of projects should be assumed to address challenges to avoid fruitless expenditure by the government. A few other researchers have examined how adoption characteristics may affect opportunities to provide high-quality healthcare with SCT, either directly or indirectly. Although the issue of implementing SCT is of global importance, the absence of suitable infrastructure is a concern to consider. The difference between private and public healthcare is identified by comparing a country's economic differences (Radhakrishna et al., 2014).

Pell, Menaca, Were, Afrah, Chatio, Taylor, Hamel, Hodgson, Tagbor, Kalilani, Ouma and Pool (2013) found that women believed health workers' recommendations and claimed that they followed their directions, notwithstanding the messages and referrals they received. Women's attitudes toward prenatal follow-up (ANC) appointments have been captured in a protocol developed by software developers. In addition, women were forced to attend their ANC sessions by scheduling. Furthermore, the communication protocol was seen to assist women and health workers in receiving reminder messages.

In Rwanda, Eric (2016), assessed the need for the improvement of community-based health insurance (CBHI) membership management systems. Eric (2016) states that the CBHI system has challenges due to a lack of information exchange system capabilities. Leading to a shortage of information systems, beneficiaries were subjected to fraud, duplication and unnecessary travel. The research also investigated the technological capabilities that were used to support and equip (finance) existing CBHI systems. To improve the system's performance, refinements were required and analysed. The study included an impact assessment; however, it solely benefited the academic field. Another study in Rwanda on distributed medical record systems employing wearable devices discovered that progress was being made in that regard (Hakizimana & Wannous, 2018). In another study on Rwanda's integrated patient health record system, Willy, Paracha, Hisato and Vianney (2014) validate the prospects of smart card-based eHealth networks (IPHRS).

Fanta, Pretorius & Erasmus (2019) evaluated the implementation of smart care systems for healthcare in Ethiopia. The researchers addressed challenges and failures in implementing eHealth delivery systems and the lack of scale-up beyond pilot phases. eHealth systems have been successfully implemented in Ethiopia, despite the challenges faced by other developing countries, according to the report. Electronic medical record systems were also determined to be sustainable in Addis Ababa's ten hospitals. Smart care systems have been combined with a variety of electronic medical healthcare systems and models utilised in various healthcare facilities. In the field of eHealth, these models covered technological, social, economic and organisational preparedness. As a result, that study concluded that a conceptual framework for eHealth implementation that covers economic, social and organisational challenges is required. According to Fanta, Pretorius & Erasmus (2019), the framework has resulted in top management committing to support Ethiopia's smart care system, which has an organisational readiness rate of 80% in all hospitals. Interoperability remains one of the main issues in enabling healthcare in Ethiopia, according to a literature analysis by Tedla and Omer (2011). In the absence of interoperability standards, data exchange technologies and prototypes cannot assist in solving problems.

Botswana had a population of 2,249,104 people in 2018, according to Ncube, Mars and Scott (2019), with 45 per cent of the population living in rural areas. In addition, the country has the highest HIV/AIDS prevalence in Africa, with a population density of four people per km^2, a low doctor-to-patient ratio (3.8/10,000) and the lowest doctor-to-patient ratio in Africa. The integration of technology in Botswana requires high costs for healthcare systems. Successful implementation of SCT in Botswana requires sufficient information (Ivala, 2013). In some cases, databases are accessed from different terminals located in healthcare facilities to improve performance. Patient data may be necessary for situations where there is no network connection, such as when a patient is not registered, and medical practitioners have to collect data manually.

Machacha, Kanjadza and Kumari (2017) found that Botswana had adopted health information systems (HIS) and electronic medical records (EMR). The sample for the study was selected from three large hospitals in Gaborone, where questionnaires were distributed and EMR-related interviews with healthcare professionals were conducted. The study found that discrepancies in healthcare system implementation existed because of capacity and infrastructure issues. Consequently, these discrepancies in the healthcare system have caused Integrated Platform Management System (IPMS) to be fully operational. Additionally, the adoption rate is low, ranging from 10% to 15% in certain cases and 20%, 30%, 40%, 50% and 60% or more in others—but never 100% (Machacha et al., 2017). As a result, citizens might freely migrate in and out of Nigeria unless SCT is used properly and appropriately for ID cards (Olabode, 2011). Indeed, policies and frameworks are an important factor in ensuring the implementation of SCT (Kruszynska-Fischbach, Sysko-Romanczuk, Napiórkowski, Napiórkowska & Kozakiewicz, 2022). The next section discusses SCT implementation, specifically in South Africa.

2.5.3 Implementation of Smart Card Technology in South Africa

User awareness and acceptance of smart cards and fingerprint-based access management to medical information systems were investigated by Maeko and Van Der Haar (2018) through in-depth research at Johannesburg's Charlotte Maxeke Academic Hospital. That study employed an interpretative research methodology to collect data for the best implementation of multimodal access control systems in the hospital. Maeko and Van Der Haar (2018) sent surveys to hospital employees with access to patient records. Seventy-nine per cent of the respondents said they had never attended a security awareness or training session. To address awareness and acceptability difficulties, a framework was developed that extended the unified theory of acceptance of user technology (UTAUT) model. The origins of the UTAUT model are a blend of aspects from many different models like the technology acceptance model (TAM) and diffusion of innovation theory and were taken into consideration. Rogers' diffusion of innovation (DOI) theory has been applied to highlight concerns that may be useful to others attempting to disperse innovation in healthcare settings (Leggott, Martin, Sklar, Helitzer, Rosett, Crandall, Vagh & Mercer, 2016).

According to Rogers (2003), diffusion is the process of the invention being disseminated through time and among members of a social system through certain channels. DOI allows organisational change to be presented as a process that thrives in micro-level social contexts (Barrett & Stephens, 2017). A study by Saarikko, Westergren and Jonsson (2020) that used theories for adoption found that innovation is critical for IT adoption, particularly the technology acceptance model (TAM). Due to its simplicity, the UTAUT model for the South African healthcare system was later renamed the healthcare unified of acceptance of user technology (HUTAUT) (Maeko & Van Der Haar, 2018). The study focused on how user attitudes, beliefs and personal knowledge influence access control technology acceptance and use.

Mthethwa (2016) highlights the improved smart card for the South African Social Security Agency (SASSA). The researcher further states that South Africa pays out over R16,900,000 in social grant awards each month. These grants are distributed to grant recipients through a third-party business. However, there are problems with grant payments such as cases of impersonation, which have resulted in money being handed out to people who are not entitled to it. Helpful examples can be taken from industrialised countries like Japan, which have implemented healthcare systems such as biometric systems for the adoption of SCT in South Africa. These types of systems allow the owner of the card to be the only one to use the card through a personal identification number (PIN) authentication process.

The Gauteng provincial legislature piloted SCT in hospitals in 2008 and the former Premier (Minister Shilowa) announced through the former Minister of Health that SCT would be implemented not only in hospitals but also in clinics. According to Mahlong (2009), the SCT implementation in Gauteng sought to provide health cards with embedded smart chips that could hold patient details. The benefits of the SCT implementation include increased accuracy of stored information, faster check-in times and a streamlined process for moving patients between clinics or hospitals. However, all contracts in Gauteng were reviewed, including the SCT implementation project (Mahlong, 2009). The focus turned to AIDS and HIV/AIDS initiatives with former minister Trevor Manuel, head of the National Planning Commission, later confirming the adequacy of SCT implementation due to its low cost (Maphumulo, 2009). Based on newspaper articles, many challenges were associated with the SCT implementation in Gauteng, as detailed below.

2.5.3.1 The Cost of Smart Card Technology Implementation

Fernandez-Alemn, Carrión Señor, Lozoya and Toval (2015) point out that infrastructure and other smart card-related devices are critical for the delivery of quality healthcare. According to Omotosho and Emuoyibofarhe (2011), the most important cost benefits of technology deployment are pricing performance, bandwidth, internet, imaging technologies and data processing. According to Vermesan and Friess (2022), improved patient life safety is another essential component in deployment, requiring more control and monitoring through existing infrastructures. As a result, using SCT would make the transfer of patient data complete and more cost-effective (Tsay, Williamson & Im, 2012).

2.5.3.2 Management Strategies and Technology

Technology has proven to be a driving force in delivering quality public healthcare to citizens (Sun & Medaglia, 2019); hence, the role of management cannot be underestimated (Siau, Southard & Hong, 2002). Management strategies include people, processes and technology (Bai, Wang & Su, 2020). Change management is based on public health best practices such as nursing homes, medication administration and patient control. Innovative technologies like SCT in healthcare require an adoption process for full user participation, accessibility, acceptance and ease of use.

2.5.3.3 Data Management of the Smart Card by Healthcare Professionals

Healthcare organisations all over the world realised the value of investing in information technology as a cost-effective approach to providing high-quality care by enabling rapid data retrieval and management (Ojo & Popoola, 2015). Traditional paper-based health information systems can be replaced by portable electronic means, according to studies. In addition, the introduction of digital technology potentially cuts costs and enhances the timely delivery of healthcare (Dai, Hu, Wan, Chen & Wang, 2016).

2.5.3.4 Privacy and Security of Data Management in Healthcare

Privacy and security are closely related to confidentiality (Hussain, Ariychandra & Frolick, 2016). Healthcare technology involves sharing, transmission and archiving of sensitive and personal information. As a result, prioritising privacy and data security appears to be critical features of any new technology, both during development and implementation (Sajedi & Yaghobi, 2020). In healthcare, the sensitivity of patient information drives data sharing (Hodson, 2019).

Privacy and security received a lot of attention during the creation of a healthcare smart card system (Alliance, 2003). In addition, security is a concern in Japan, India, Germany, the United States, China and the United Kingdom (Hussain et al., 2016). Table 2.3 identified scholars who have set SCT technology challenges.

Table 2. 3: Smart Card Technology Challenges (Source: Own)

Smart Card Technology Challenges	**Explanation**	**Literature**
Error detection	In terms of data management, error detection can be controlled for providing reliable delivery of digital data.	(Bamford-wade et al., 2020; Aceto, Persico & Pescapé, 2018; Kushniruk et al., 2013; Mshali,

		Lemlouma, Moloney & Magoni, 2018)
Interoperability issues	SCT can cause interoperability barriers and record consistency for healthcare professionals.	(Vaona, Banzi, Kh, Rigon, Cereda, Pecoraro, Tramacere & Moja, 2018; McCabe, McCann & Am, 2017)
Authentication problems	SCT is difficult to copy as encryption and authentication efforts increase, such as the use of a PIN or biometric factors to make it impossible to use a stolen card.	(Khalil, Bell, Chambers, Sheikh & Avery, 2017; Inglis, Clark, Dierckx & Cleland, 2015)
Non-adherence to policies	Policies and procedures are important for hospitals.	(Drahota, Ward, Mackenzie, Stores, Higgins, Gal & Tp, 2012; Kaner, Beyer, Garnett, Crane, Brown, Muirhead, Redmore, O'Donnell, Newham, De Vocht & Hickman, 2017)
Performance	Two actors affect the delivery of healthcare and the management of patients: Caregivers working in healthcare organisations or pathways, and managers who can make organisational changes to care processes.	(Sethia, Gupta & Saran, 2019; Radhakrishnan & Muniyandi, 2022; Akram, Markantonakis & Sauveron, 2016; Mshali et al., 2018; Yeh, 2017; Hamadouche & Lanet, 2013)

The following subsection discusses the adoption of the smart card in a general detailed summary of this chapter.

2.6 Summary for Implementation of Smart Card Technology

Technological adoption and implementation science goes hand-in-hand; they cannot be separated. Technology implementation discusses the treatments and factors that assisted in promoting evidence-based practice, while technology adoption concentrates on how end users utilise technology (Schoville & Title, 2015). The implementation of electronic health records (HER) is far more difficult and is affected by a range of internal factors, according to research findings by Sadoughi, Khodaveisi and Ahmadi (2019). Thus, the decision to adopt and implement systems like the HER is taken with the knowledge of healthcare policymakers and managers. The probability of using a smart card is significantly impacted by the adoption of SCT in the healthcare industry and mistakes, societal pressure and illness orientation (Howell, Smith, Sharman & Abdelhamid, 2016). The Badan Penyelenggara Jaminan Sosial Kesehatan (BPJS Kesehatan) with SC and SC readers was used by the Health Authority of Indonesia to deliver universal healthcare to its people. Other health information technology (HIT) variables were behavioural intent to utilise the clinical decision support system (CDSS), the expectancy of achievement, the expectancy of exertion and social impact. Performance expectations and effort expectations have a significant impact on attitude, according to the decision-making trial and evaluation laboratory (DEMATEL) analysis and the impact is more significant for attitude than for behaviour (Lai, 2017). On the other hand, certain elements, such as the quality of the information in the health sector remained poor, especially at the district and health institutions' peripheral levels, which in Ethiopia, are responsible for the majority of the operational management tasks (Shiferaw, Zegeye, Assefa & Yenit, 2017).

According to a study by Mahajan, Verma and Pahuja (2014) published in Dataquest (March 2000), there were going to be 28 million shipments of smart cards (microprocessors and memory) in the US. The International Air Transportation Association (IATA) created the initial magnetic stripe cards in the 1970s (Mahajan, Verma & Pahuja, 2014). The distribution of brochures and flyers that assist individuals in meeting their essential health needs is a sign of the growth of eHealth (Adian & Budiarto). In Nigeria, the eHealth card has been introduced; it accepts input from an application and outputs information. Yet, because of the high patient populations in hospitals, healthcare providers continue to provide care using paper records, which presents numerous difficulties for the smart ID card (Adebayo & Ofoegbu, 2014). To receive better healthcare services, a smart card specifically needs each patient to verify (Alam & Ali, 2016). The ratings for personal duties matched the user's perception. The section below discusses the summary results of the implementation of the SCT.

This study outlines that the Department of Health is required to create plans and activities for appropriate SCT implementation goals in public healthcare, such as patient socialisation and for healthcare professionals to use SCT. A study on the effects of ICT-based smart city services advised policymakers to consider innovation and technology (Yeh, 2017). In addition, the creation of technology adoption models and theories based on an assessment of the literature concerning the potential use of cutting-edge single-platform e-payment technology is essential (Lai, 2017). The decision to adopt these models and theories serves as a driving force behind the adoption of technologies in the healthcare industry.

The unified theory of acceptance and use of technology (UTAUT) is one of the theories embraced as part of the E-ZWICH (an electronic payment system used in Ghana) for Ghana's transition to a cashless economy. However, for the benefit of the study, user acceptance and adoption could be used to determine whether an IT project is effective (Taherdoost, 2018). Tao, Shao, Wang, Yan and Qu (2020) describe user acceptance as "a potential user's predilection for personally using a specific system" whereas Venkatesh et al. (2004) propose that it is a "first decision made by the individual to interact with the technology" (Venkatesh et al., 2004). Additionally, according to Venkatesh et al. (2004), individual users only choose to adopt a certain technology after using it first-hand. Therefore, people must adopt the new technology widely for smart card technology to operate well. Ajzen (1991), Davis (1989) and Davis et al. (1989) are a few researchers who investigated the theoretical frameworks illuminating the adoption of IT and information systems (IS) (1995).

The Department of Health needs to ascertain how its new smart card technology might be embraced and used by healthcare professionals in the most effective way possible, given the growing interest in delivering public healthcare. One definition of how a new system gets adopted considers the "entire mental process" that any user goes through between learning about an innovation and opting to utilise it (Mabasa, 2022). The DoH policies for encouraging the uptake of technology by healthcare professionals must consider the transition from one step to the next along the journey of becoming aware of the new technology. Thus, it seems appropriate to conclude that implementing new technology is the key to securing the universal acceptance of novel ways to provide public services.
Performance efficiency, effort efficiency and social impact influence people’s behavioural intentions to use a cashless system (Addai & Arthur, 2020). In addition, the study addressed the disparity regarding the applicability of the UTAUT model to a central cashless system acceptance and usage. Another significant point is that the literature has investigated how and when technology can be made

available to healthcare professionals (Petrakaki, Klecun & Cornford, 2016). In this study, these models and theories were utilised as a conceptual lens to investigate how the healthcare environment both physical and social can enable informal interactions. Previously, researchers have tested the adoption of technology in healthcare using different theories and models. Table 2.4 presents a summary of studies using theories in public healthcare.

Table 2. 4: Summary of studies using the theories in public healthcare (Source: Own)

Theory	**Constructs**	**Descriptions**	**Level of User Analysis**	**References**
HUTAUT	Behavioural Intention	HUTAUT enables researchers to analyse variables affecting users' intentions when using smart card technology. Using HUTAUT facilitates the creation and use of information devices in the healthcare sector, promoting patient awareness of SCT.	Healthcare Professionals	(Maeko & Van Der Haar, 2018)
	System Use	Attitudes change in response to social influences, which, in turn, are affected by the opinions or suggestions expressed by healthcare professionals. For example, the source credibility of a message is a critical determinant in influencing one's attitude toward a certain behaviour. Healthcare professionals will accept the use of SCT as prudent if this message comes from an influential/important persuader. Moreover, they may develop a	Healthcare professionals	(Hung, Tsai & Chuang, 2014)

		positive attitude if the behaviour is recommended or advocated for by colleagues who are important to them.		
DeLone McLean	Information Quality	In healthcare, information quality is ranked higher around independent variables like content, correctness, format and distinctiveness. Information quality must contain accuracy, gathered usage convenience, documentation, system process speed, education and interface characteristics.	Patients and Healthcare Professionals	(Sebetci, 2018)
	Service Quality	The patients are more satisfied with the healthcare professionals in the provision of consultation, services fees and admission processes, which falls under the category of health service quality.	Patients	(Abbasi-Moghaddam, Zarei, Bagherzadeh, Dargahi & Farrokhi, 2019)
DOI	Communication	During the implementation of technology, innovation is diffused over a short period. Healthcare professionals can communicate across their social networks to attain a certain level of consensus by sharing information through specific routes.	Public Healthcare professionals	(Lien, & Jiang, 2017)
	Compatibility	The extent to which the meaning and values ascribed to the intervention by those involved	Public Healthcare professionals	(Damschroder, Aron, Keith,

		match up with their norms, beliefs and perceptions of risks and requirements, as well as the degree to which the intervention fits into pre-existing workflows and systems. Implementation is likely to be more successful, the more people perceive agreement between the meaning they give the intervention and the meaning given by top management. For instance, while leadership is driven by the prospect of better patient outcomes, providers may view such intervention as a threat to their autonomy.		Kirsh, Alexander & Lowery, 2009)
	Trialability	Trialability is the measure to which an innovation can be tested out on a small scale. Trialability takes into account the observability construct visibility and outcome demonstrability. The effects of using new technology are tangible, including its communicability and observability, as explained by visibility related to other users of the system in the organisation.	Healthcare professionals	(Moghavvemi, Hakimia & Tengk Feissal, 2012)

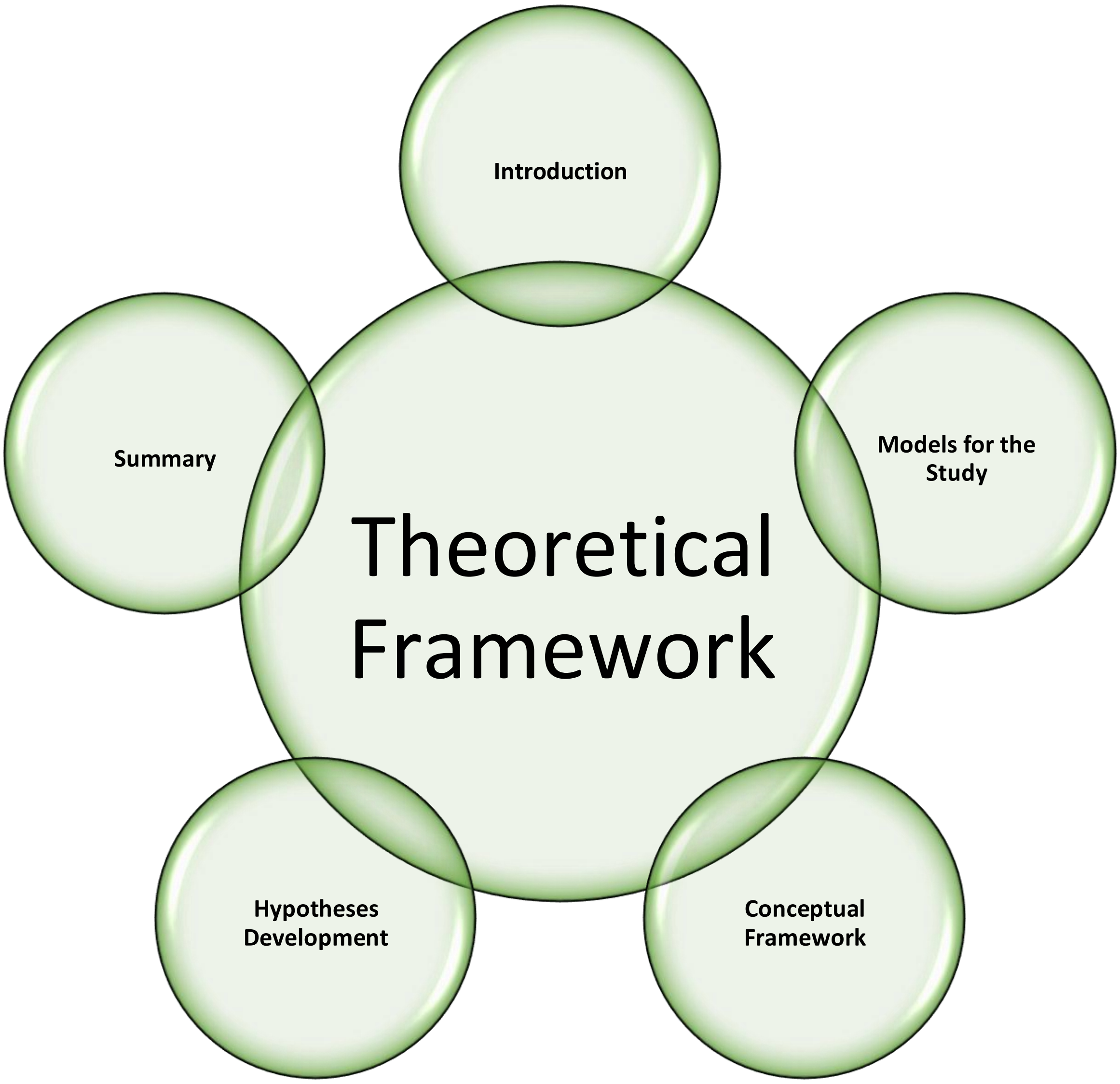
The DeLone & McLean IS success model (2003), the healthcare unified theory of acceptance of user technology model (HUTAUT) (2018) and the diffusion of innovation theory (DOI) are the three models that were specifically chosen for this study (2003). The seven significant accepted variables for these models are useful because this study considers all three theories and the model thus appeared to be comprehensive compared to the implementation of smart card technology. Moreover, these theories were chosen because the present study is explanatory research. Zuiderwijk, Chen and Salem, (2021) explain that explanatory research is highly recommended for technology implementation studies.

2.7 Chapter Summary

The literature review clarified the description of the architectural elements of the smart card and the related theories that were applied in this study. Understanding the smart card, management strategies for usage, interoperability, privacy, security and data management were all discussed. The review also focused on the implementation of smart card technology (SCT), which addresses the use of health information systems in developed and developing countries. In addition, the review highlighted how implementation challenges can be addressed. Furthermore, most of the theoretical evidence suggests that developed countries struggle to implement new technology. For the benefit of the study, the next chapter presents a detailed theoretical framework for the SCT.

CHAPTER 3

THEORETICAL AND CONCEPTUAL FRAMEWORK



3.1 Introduction

This study intends to develop a conceptual underpinning for SCT implementation in the South African public health system. As a result, the primary goal of this chapter is to establish the conceptual framework's foundation. The subsequent subsection discusses several models and theories, including the healthcare unified theory of acceptance of user technology model (HUTAUT) (2018), the DeLone & McLean IS success model (2003) and the diffusion of innovation theory (DOI).

These theories have been tested for information systems (IS) in the introduction of various technologies within and outside healthcare. Therefore, models assist in understanding through a detailed background of each model and its strengths and weaknesses. Chapter 5 describes how the proposed conceptual framework was tested and validated for assisting the study in identifying the key factors influencing SCT implementation in the South African healthcare sector.

3.2 Models for the Study

- This study provides different contexts and methods to measure different variables against different models. In addition, each of these three models is considered separately; they present a fragmented picture of the factors influencing SCT implementation in public healthcare. However, when the theories are integrated, they provide a considerably more significant and interesting perspective on the phenomenon. The potential user of any given SCT would doubtlessly assess the possible benefits and losses before going through the various steps described in the sequential model (Aubert & Hamel, 2001). Along the way, they would be subjected to pressure from individuals inside and outside the organisation. The HUTAUT model (2018), the DeLone & McLean IS success model (2003), and the diffusion of innovation theory (2003) were all adopted and used in this study. In addition, the following variables for the study were incorporated, including insights from each to provide a more comprehensive view of all the variables influencing the implementation of SCT. Below are the elements of the conceptual framework depicted in Figure 3.4:
- Independent variables: Implementation of smart card technology.
- Dependent variables: Performance expectancy and effort expectancy, social influence, facilitating conditions, user attitude, information quality, service quality, system use, system quality, communication, compatibility and communication.
- Moderating variables: Behavioural intention and User satisfaction.

Information and communication technology (ICT) has major advantages as regards making health information public, even if the implementation does not go as planned. Furthermore, the design, installation and usage of such systems can be complex, posing challenges that were not anticipated (Weeks, 2014). Nevertheless, according to Brooke-Sumner, Petersen-Williams, Kruger, Mahomed and Myers (2019), strategies can be established to address limitations like technical, participatory management, communication and community engagement skills, program monitoring as well as eliminating and assessing skills. Non-technical skills such as modelling positive attitudes, recognising personal personalities, influencing innovative views, influencing the organisational climate and building trust relationships have been identified. As a result, managers have incorporated service innovation into daily practice. Hence, a framework of technical and non-technical skills that managers need for facilitating the adoption of health innovation is needed. Future efforts to build managerial capacity toward implementing health innovation should target these competencies. Considering this, the following section presents some of the common human models that have been used and applied in the implementation of technology. These models and frameworks aided the researcher in identifying the factors that influenced the research goal and in designing a survey to assess the insight and readiness for technology implementation and awareness by healthcare professionals (Sadoughi, Khodaveisi & Ahmadi, 2019).

3.2.1 Healthcare Unified Theory of Acceptance of User Technology Model (HUTAUT)

Several models and hypotheses of how technology adoption works exist, some of which have been used in the healthcare industry (Sharifian, Askarian, Nematolahi & Farhadi, 2014). The healthcare unified theory of acceptance of user technology (HUTAUT) model seeks to comprehend why consumers accept or reject a technology, as well as how healthcare technology design might increase user adoption. Maeko and Van der Haar (2018) developed the HUTAUT to promote user participation and acceptability in public healthcare. Venkatesh, Morris, Davis and Davis developed the UTAUT or unified theory of acceptance and use of technology (2003). The UTAUT uses seven models or theories that combine elements and constructs from all seven models, as shown in Table 3.1.

Table 3. 1: Detailed UTAUT model (Source: Own)

Theory	**Developed by**	**Explanation**
Theory of reasoned action (TRA)	Ajzen and Fishbein (1977)	TRA was devised according to which behavioural intention is determined by the attitude towards behaviour and by the subjective norm in the close environment.
Technology acceptance model (TAM)	Davis (1986)	TAM predicts the acceptance and use of information technology, especially 'on the job'. This model shows the influence of perceived usefulness and perceived ease of use on the behavioural intention to use technology and on the attitude towards using it. The latter determines behavioural intention as well.
Motivational model (MM)	Bagozzi and Warshaw (1992)	MM explains how extrinsic and intrinsic motivation can be used to understand new technology acceptance and use.
Theory of planned behaviour (TPB)	Fishben and Alzen (1975)	TPB explains the determinants of computer acceptance that are general and capable of explaining user behaviour across a broad range of end-user computing technologies and user populations.
Model of PC utilisation (MPCU)	Thompson, Higgins and Howell (1991)	The MPCU six-core constructs affect PC utilisation: job fit, the complexity of the innovation, long-term consequences, effect towards use, social factors and facilitating conditions.
Diffusion of innovation theory (DOI)	Rogers (1995)	DOI consists of five elements of innovation that influence the acceptance behaviour of an individual: relative advantage, ease of use, image, visibility and compatibility, resulting in demonstrating and volunteering the use.
Social cognitive theory (SCT)	Bandura (1986).	SCT suggests a reciprocal influence of environmental factors, personal factors (self-efficacy, affect, anxiety, etc.) and behaviour.

The UTAUT explains 70% of the variance intended to use technology and about 50% of the variance for technology use (Vanneste, Vermeulen & Declercq, 2013). For this reason, the UTAUT model becomes relevant for understanding the technology and system acceptance of the SCT. Table 4 details that UTAUT and related models focus on one step in the implementation process, namely the acceptance of the technology. However, implementation is a continuum, not a static one-time event. The UTAUT model was used to analyse physicians' behavioural intention to adopt and useability of health information systems (HIS) in Cameroon by Bawack and Kala Kamdjoug (2018). For this reason, the UTAUT gained significance in predicting technological adoption.

This study noted that UTAUT theory became relevant in the field of information systems (IS) because it states that four key constructs, namely performance expectancy (PE), effort expectancy (EE), facilitating conditions (FC) and social influence (SI) are direct determinants of usage intention and behaviour (Dang, Zhang, Brown & Chen, 2020). Gender, age, experience and voluntary use are also considered to have a moderating effect, according to UTAUT (Sallehudin, Bakar & Ismail, 2020). The UTAUT model has been applied to different technologies in different environments and is one of the most cited theories in IS research (Jewer, 2018).

Dwivedi, Rana and Williams (2011) identified the limitations of the UTAUT model in terms of behavioural intention, such as not representing the external factors that can influence behavioural performance. As a result, the healthcare unified theory of acceptance of user technologies (HUTAUT) model was developed, based on a study of user awareness and the acceptance of smart cards and biometric technology in healthcare (Maeko & Van Der Haar, 2018). The HUTAUT model has been tested as a new model in healthcare and has added value to understanding the many phases of technology implementation in healthcare, as shown in Figure 3.1 of this study. The HUTAUT framework relies on good skills and user interaction to achieve a successful technology deployment, which is a barrier to implementation in a hospital (Maeko & Van Der Haar, 2018).

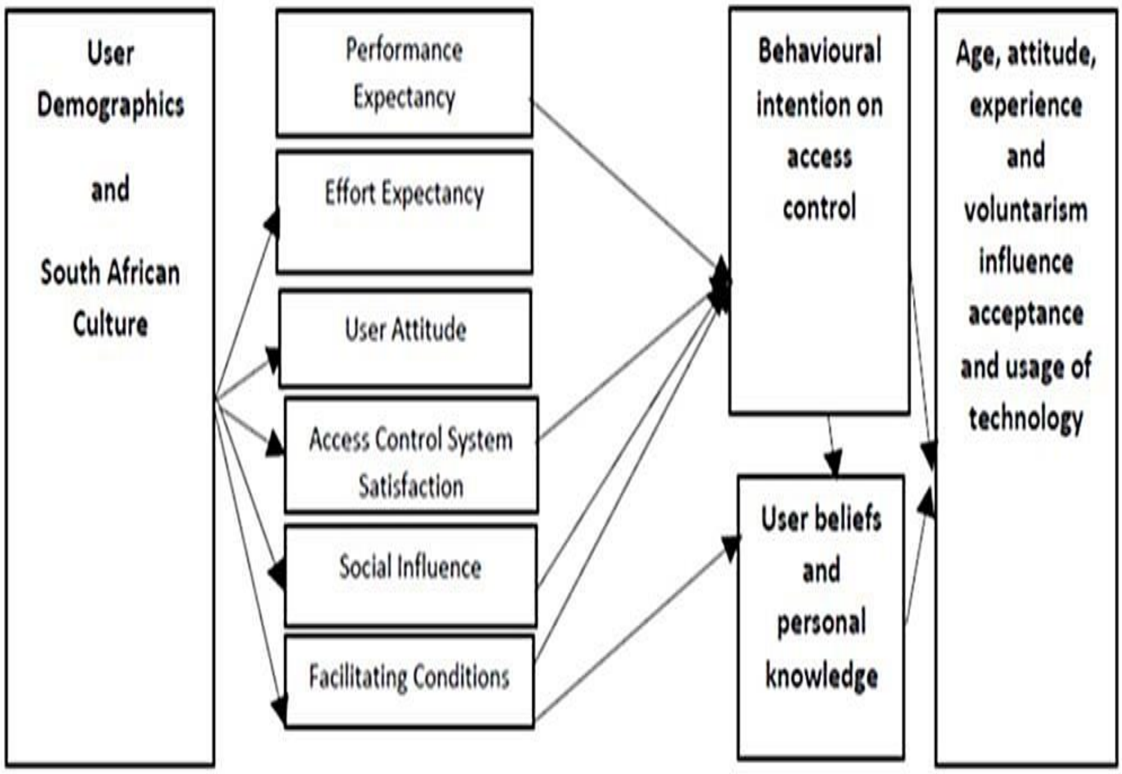


Figure 3. 1: Healthcare unified theory of acceptance of user technology (HUTAUT) model

(Source: Maeko & Van Der Haar, 2018)

Mshali et al. (2018) highlight that it is imperative to design systems from the perspective of technology evolution, system requirements, system design and modelling. In this study, the HUTAUT model is utilised to establish a framework for adopting SCT in public health. However, effort expectancy, performance expectancy, social influence and supportive condition were adopted from the HUTAUT model to act as independent variables within the conceptual model developed in Figure 3.4 below, to influence the implementation of healthcare technologies. The four constructs are discussed in detail, in Section 3.5.1.

3.2.2 Delone and Mclean IS Success Model

An assessment of information systems (IS) success is critical to an organisation's understanding of the value and effectiveness of IS investment and management. Delone and McLean (1992, 2002, 2003) proposed an influential framework for studying innovation adoption success. Their model is widely accepted among IS researchers (Bharati & Chaudhury, 2004; Wang, 2008). It was first presented in 1992 and updated in 2002 and 2003. The most recent iteration of the model consists of six dimensions: IT information quality, system quality, service quality, use, user satisfaction and net benefits. Delone & McLean suggest that system quality, information quality and service quality affect user satisfaction. In turn, both use and user satisfaction are direct antecedents of net benefits, which can be evaluated from individual and organisational impact. The model was modified by Delone & McLean in 2003 to include service efficiency and replace individual effect and organisational benefit with net benefit (Erlirianto, Ali & Herdiyanti, 2015). In addition, the DeLone & McLean IS model presents various characteristics of information system success, including information, system, service quality, (intention to) use, user satisfaction and net benefit.

The efficiency of the DeLone & McLean IS model in SCT was assessed using more general metrics such as device response time and downtime. In this study, another construct was omitted because behavioural intention is the intention to use the system, i.e., it signifies the same intent. As a result, constructs like user satisfaction, which has a strong relationship with the DeLone & McLean's IS model, were adopted from the HOT-fit model. However, the net benefit was not considered for the study because the intention to use the SCT had already been identified (Shim & Jo, 2020).

Information and system quality, net benefits to individuals, organisations and society influence user satisfaction, information and system quality (Jeyaraj, 2020). As a result, theories and models like the HOT-fit model use technology to describe or anticipate user behaviour (Aldholay et al., 2018). The DeLone & McLean model, as shown in Figure 3.2 below, remains in effect; however, it lacks the deeper aspect of technology in terms of sociotechnical sensitivity (Booth, 2012a).

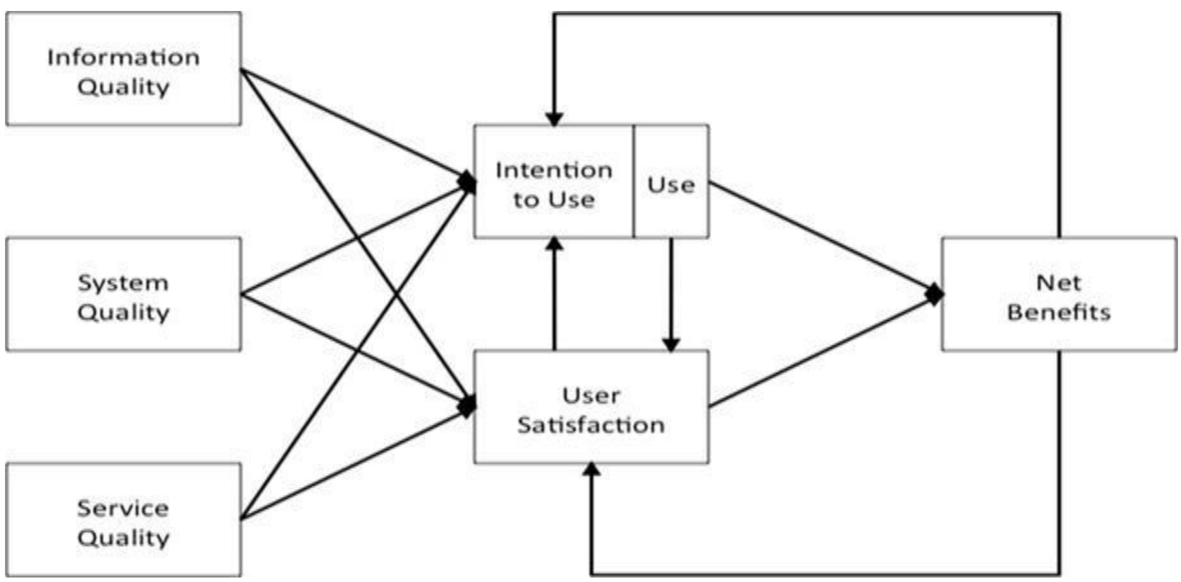


Figure 3. 2: Delone & McLean IS success model

(Source: DeLone and McLean [2002; 2003])

One of the strengths of the DeLone & McLean IS model is that the system quality of the technology relates to its technical aspects, while the quality of service relates to the overall support of the technology users. Reliability and responsiveness of technology are important for implementation (Shim & Jo, 2020). Petter, DeLone and McLean (2013) cited and identified several independent variables relevant to IS success in their integrative research study. These results helped the researchers to understand how different factors contribute to an organisation's success. The DeLone & McLean IS model also identified success factors such as healthcare professionals, workgroups and many others by accounting for benefits at different levels of study. The DeLone and McLean model can be adapted to different areas of healthcare because of its methodological flexibility (Bossen, Jensen & Udsen, 2013). The outcome variables used to evaluate an IS performance model include the relative importance of information quality, user satisfaction and system quality for post-installation success (Hsu, Yen & Chung, 2015). This study assumes that healthcare professionals have already developed expertise in utilising the manual filing of patient notes on paper; therefore, it could also be assumed that performance should not be a concern when SCT is used (Bossen, Jensen & Udsen, 2013).

Azeemi, Lewis and Tryfonas (2013) state that technologies in healthcare are limited because of investigations on non-technical performance which focus on the attitudes, satisfaction and performance of users. The effectiveness of information systems (IS) is explored in this research by investigating the relationships between IS success variables. Accordingly, multiple variables were used to validate correlations, leading to the development of success assessment models. For instance, users cannot record patient information or perform other tasks related to healthcare. The overall 'effectiveness' or 'success' constructs of a given ICT should be viewed in the context of the larger DeLone and McLean IS model (Mardiana, Tjakraatmadja & Aprianingsih, 2015). Other effectiveness variables not directly measured in individual research are excluded by the DM Model (Booth, 2012). Therefore, during postimplementation, the intention to use SCT in healthcare would benefit healthcare professionals. The DeLone and McLean IS success model was used by Othman and Hayajneh (2015) to assess the effectiveness of electronic health record implementation in Jordan. The findings showed that all internal perspectives proposed by the two integrated models have strongly influenced the success case of *Hakeem* in Jordan. There is also a relationship between the perspectives that affect each other and are reflected in the EHR's success. Finally, the research proposes an integrated EHR model that could be used in assessing the success of any EHR implementation. The diffusion of innovation theory is discussed in Section 3.2.3 of this chapter.

3.2.3 Diffusion of Innovation (DOI) Theory

Everett Rogers (1962) established the DOI which became one of the oldest theories in the field of information systems (IS). DOI has been applied in numerous fields of study like communication, development studies, knowledge management and healthcare. The decision to implement the DOI theory involves a variety of factors, including whether or not to use technology such as SCT. Therefore, implementation focuses on methods of variable interventions and promotes variables such as end-user acceptance (Birken, Powell, Shea, Haines, Kirk, Leeman, Rohweder, Damschroder & Presseau, 2017). Schoville and Title (2015) find that healthcare technology is used to facilitate early discharge, suggesting that healthcare facilities have purchased and implemented evidence-based technology. However, individuals and organisations cited by Doyle, Garrett and Currie (2014) confirmed that the DOI theory could be used in this study to transfer the reported implementation process to health technology. Rogers (1995) proposes five stages (Table 3.2) that can be found in the diffusion of innovation theory, categorised as follows:

Table 3. 2: Five stages of the diffusion of innovation theory (Source: Rogers,1995)

Knowledge	Healthcare professionals must be made aware of the implementation of SCT as potential users to understand how innovation operates. Awareness campaigns and roadshows can help with changes in perceptions about implementation (Kovalik & Kuo, 2012). Knowledge has been decentralised to the interplay between various perspectives and knowledge sources.
Persuasion	There must be user involvement of potential users who form opinions about innovation. The users pass through the persuasion phase, which weighs the desirable, direct and anticipated consequences with the undesirable, indirect and unanticipated consequences to form favourable or unfavourable attitudes towards the innovation (Mamun, 2018).
Confirmation	Confirmation is based on seeking reinforcement for decision-makers' decisions (Dobbins, Ciliska, Cockerill, Barnsley & DiCenso, 2002).

Decision	Management decides for potential users to decide on either adoption or rejection of the SCT. Social forces impact the adoption of decisions (Pick & Sarkar, 2016). The duplication of systems is taken into consideration to avoid purchasing readily available systems.
Implementation	Implementation occurs when the user starts using SCT. Success or failure depends on the implementation of an innovation system since it has supportive factors like software planning and support, as well as a relationship between innovation with policy implementation and administration (Tsay, Williamson & Im, 2012).

The relevance of DOI in the study of social learning includes behaviour change, information sharing and network connections (Wu, 2016). Diffusion of innovation is a theory that explains how, why and how quickly new technologies and ideas spread across cultures (Balta-Ozkan, Davidson, Bicket & Whitmarsh, 2013). Enz (2012) further notes that DOI innovates by inventing something new and cooperating with it. According to Rogers (2003), diffusion, as suggested in Figure 3.3, is based on relative chance. There are five types of adopters trying new products, including innovators, early adopters, early majority, late majority and laggards. Rogers further adds that DOl has an aspect of implementation within the individual phase.

It also involves knowledge, belief, decision and confirmation; with five characteristics of innovations that influence a person's decision to accept or reject an innovation. These are: i) relative advantage, ii) compatibility, iii) complexity, iv) trialability and v) observability. During the implementation phase, developing policies that include maintaining patient confidentiality, professional etiquette and infection control are useful (Doyle, Garrett & Currie, 2014). DOI is defined as the social process of communicating a new concept to members of a community over time (Nemutanzhela & Iyamu, 2011). Furthermore, according to Rogers (2003), DOI is an idea, practice or object perceived by a person as new and communicated through specific channels over time among members of social systems.

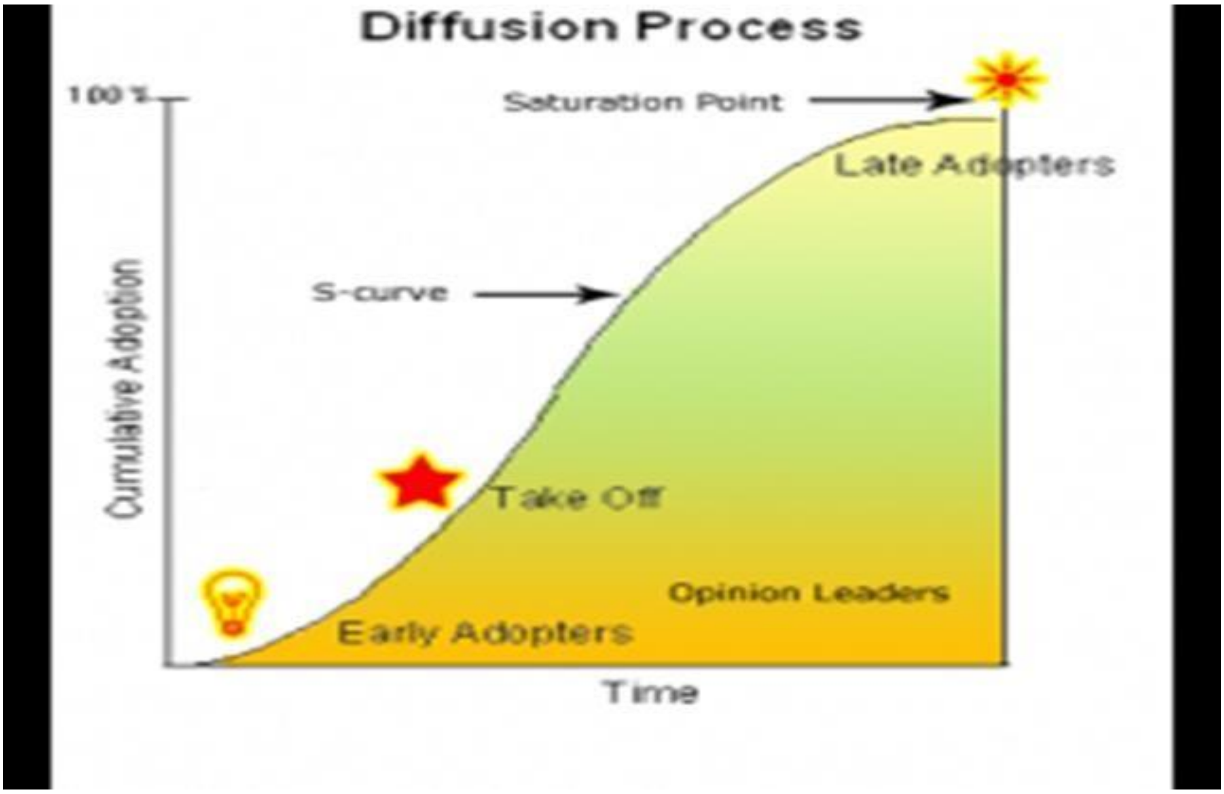


Figure 3. 3: Diffusion of innovation theory (Source: Rogers, 2003)

The study's strength was based on the ability to determine how, why and how quickly new ideas and technology were spread across civilizations (Balta-Ozkan, Davidson, Bicket & Whitmarsh, 2013). Roger’s seminal work addressed factors that increase penetration rate, including relative advantage, trialability and observability (Hayes et al., 2015). Furthermore, DOI allowed innovation to be based on both the creation of something new and its coproduction (Paskaleva & Cooper,2018). Diffusion is common in social learning, behaviour change, information sharing and network connections (Wu, 2016). Doyle, Garett and Currie (2014) indicated that in 52 conducted studies, the implementation varied and the challenges of integrating the mobile devices lack administrative support and time for student training. This result has a positive contribution to the current study since certain constructs such as communication and time are strongly affected, which requires a strategic plan to support the implementation of a framework as was the case with mobile devices.

The diffusion process involved communication between change agents to persuade a person or organisation and an adoption unit to innovate across social systems. In the DOI theory, communication dominates as a channel in which information about innovations such as the SCT is shared. For healthcare professionals, modern communication methods (such as email) are not highly recommended (Soroka & Jacovi, 2004).

DOI theory is relevant to this study since it focuses on invention, citing current principles, prior knowledge and user needs as compatibility. According to Rogers (1995), compatibility is the second aspect of the DOI, relating to how well an innovation is perceived to be consistent with shared principles, attitudes, experiences and needs. The degree to which an innovation is thought to be consistent with potential users' current beliefs, experiences and desires is known as compatibility (Roger, 2003). An innovation can be tested on an experimental basis without adding unnecessary work or costs; it can be implemented gradually while still providing significant benefits and numerous mechanisms, such as free downloads, trial versions, prototypes and so on allow users to quickly try the technology before planning. The degree to which an invention lends itself to small-scale testing is called trialability.

Rogers not only emphasised the creation of new ideas or innovations but focuses on how ideas are disseminated through individuals. The degree to which the SCT is compatible with nurses' work habits or desires is referred to as compatibility (Hung, Tsai & Chuang, 2014). The theoretical innovation attributes, attitudes, individual beliefs and communication about innovation that the individual receives from the social environment are the fundamental constructs for the decision-making process. As shown in Figure 3.3, Rogers explained the S-shaped adoption curve as the initial phase. The illustration depicts how innovations spread slowly as more people adopt them and then expand swiftly until reaching the saturation point. Communication is not considered by Mani and Chouk (2018), Davis' technology acceptance model (1989) or the UTAUT by Venkatesh et al. (2003). However, in this study, the limitation of insufficient information when introducing an idea or innovation may impede dissemination. For example, healthcare professionals may provide information to the public that only citizens may use SCT.

Lack of communication between the general public and healthcare professionals resulted in a lack of understanding. Hence, the inclusion of the communication constructs into the model is required for providing feedback to the users of the system. Mani and Chouk (2018) indicate that the adoption and diffusion approach explains how innovation can spread across an organisation. In addition, DOI theory depicts enduring interest in the subject and the general acceptance by scholars of depicting the S-curve. The dissemination of innovations and general acceptance of Rogers' typology by scholars of adoption categories, e.g., 'innovators' vs. 'laggards' (Saarikko, Westergren & Jonsson, 2020). Rogers highlights the adopter as a focal point for decision-making and action; as expected, not only in purchasing of systems but also in the implementation process. The DOI theory has found a special application by not limiting attention to implementing decisions. As a result, DOI is a unified theory that adequately explains the state of innovation in terms of external and internal elements, often known as social systems.

3.3 Conceptual Framework

The main research question of the study is:

How can a framework be developed for the SCT's implementation in South Africa's public healthcare?

The conceptual framework is defined as an abstract model that brings together many related theories and views relevant to the field of study or practice (Pisano, 2015). Masenya and Ngulube (2020) add that to produce a preservation model that can be used, a study requires the use of many ideas and models. For the benefit of this study, the healthcare unified theory of user acceptance (HUTAUT) (Maeko & Van der Haar, 2018), the Delone & McLean IS success model (2003) and the diffusion of innovation theory (Rogers, 2003) was identified as underpinning theoretical frameworks. Figure 3.4 depicts the conceptual model for this research. In the context of this study, the independent variables in this study were expected to be sustained factors that lead to positive user behavioural intention. Constructs such as behavioural intention and user satisfaction were used as mediating factors. A schematic view of this model is shown in Figure 3.4.

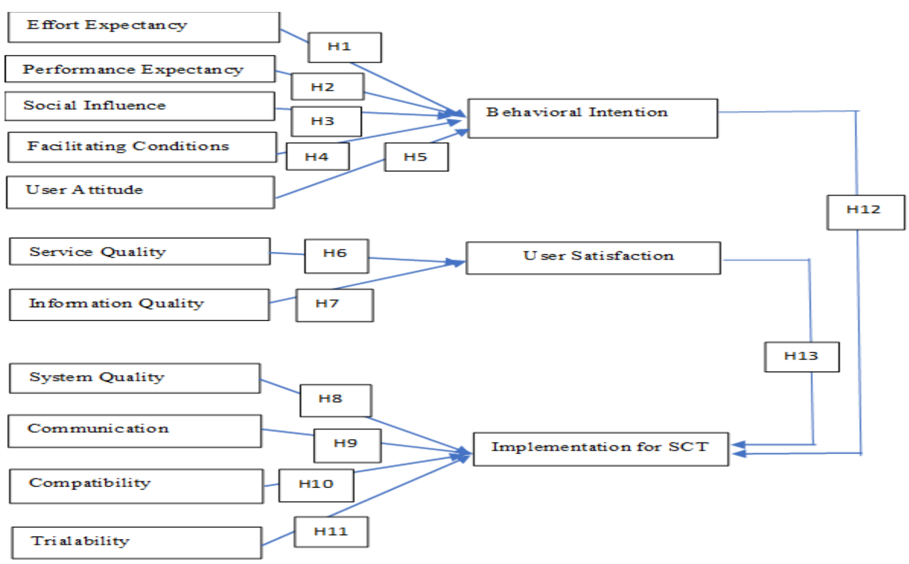


Figure 3. 4: The conceptual framework for SCT (Source: Own)

3.4 Hypotheses Development

To understand the association between the constructs in the conceptual model, several hypotheses were formulated to develop a conceptual framework for the implementation of smart card technology in South Africa's public healthcare sector. Based on the research conceptual framework as shown in Figure 3.4, 15 hypotheses were deduced.

3.4.1 HUTAUT Model Constructs

Five constructs were adopted from HUTAUT for the proposed conceptual framework illustrated in Figure 3.4. These constructs are expectancy, performance expectancy, social influence as well as facilitating conditions and serve as independent variables.

3.4.1.1 Effort Expectancy (EE)

Effort Expectancy (EE) is the extent to which using a system is effortless. Ease of use is key to influencing perceptions of the utility of innovation and is important from both a mandatory and voluntary point of view. The technology's complexity also plays a significant part in this construct and is frequently influenced by people due to the technology's complexity and requirements. Furthermore, EE is explained by respondents’ gender and experience (Jewer, 2018). In health-related areas, it has been shown that technologies with a low expected effort have a higher intention to use them. Effort expectancy is significant for implementation in the early stages when it becomes insignificant over time. Management has high expectations of technology that will be fully exploited once it has been implemented. Technology adoption and utilisation are at the forefront of health research. Healthcare professionals would also accept SCT if is implemented as highlighted by Davis (1989), Venkatesh et al. (2003) and (Teo, 2013). Therefore, the following hypothesis is proposed:

H1 Effort Expectancy has a positive effect on the implementation of SCT in healthcare.

3.4.1.2 Performance Expectancy (PE)

Performance expectancy (PE) refers to extent to which an individual believes that use of a technology would benefit healthcare professionals to achieve improvements in job performance. Thus far, performance expectation has been used to describe the technical context, while subjective standards and funding conditions have been used to define the implementation context (Teo, 2013). The performance of information systems in both voluntary and mandatory settings is the determining factor for technology implementation, according to the study by Venkatesh et al. (2003). Thus, the following hypothesis is proposed:

H2 Performance Expectancy (PE) has a positive effect on the implementation of SCT in healthcare.

3.4.1.3 Social Influence (SI)

The degree to which a person believes that people should use a new system is known as a social influence (SI) (Sallehudin, Bakar, Ismail, Razak, Baker & Fadzil, 2020). Social influence leads the healthcare professional who intends to quit during an early stage of technology adoption due to work pressure (Sun, Zhang & Zhang, 2011). Furthermore, user behaviour towards acceptance of implementation in healthcare was modified (Kamal, Shafiq & Kakria, 2020). Individual perceptions of social pressure to accept or not accept are related to both optional and mandatory situations as well as the social influencer, the subjective standard (Ni, Yang & Kong, 2020). As a result, the social influenced constructs directly impact the implementation of SCT for healthcare professionals. This construct tends to make the organisation believe in the importance of SCT. When measuring BI, which has a direct bearing on the implementation of SCT, social impact carries more weight to ensure implementation effectiveness. The supporting conditions are another construct that represents an independent variable. The construct is an independent variable that directly influences the BI for the implementation of SCT (Almuraqab & Jasimuddin, 2017). Social influence has a significant impact on technology implementation (Lwoga & Komba, 2015). Therefore, the following hypothesis is proposed:

H3 Social Influence has a positive effect on the implementation of SCT in healthcare.

3.4.1.4 Facilitating Conditions

Facilitating conditions (FC) are the extent to which people can use the new technology without undue restrictions (Kamal, Shafiq & Kakria, 2020). The impact of these conditions on actual usage was greatest among older workers and those with more experience (Kamal, Shafiq & Kakria, 2020); the degree to which healthcare professionals believe management fully supports the implementation of technology. Furthermore, people believe that SCT adoption in public health is fully supported. The organisational and technological infrastructures that support the system are facilitating conditions (Arman & Hartati, 2016). Age and experience in the healthcare environment are influenced by facilitating conditions. Therefore, the following hypothesis is proposed:

H4 Facilitating Conditions are expected to have a positive effect on the behavioural intention to implement SCT in healthcare.

3.4.1.5 Behavioural Intention (BI)

Behavioural intention (BI) relates to a desire or purpose and is a direct determinant of actual usage (Kiwanuka, 2015). The HUTAUT model considers factors that influence BI and technology usage behaviour. Performance expectancy, effort expectancy and social influence are all affected by the BI to use of technology, whereas the BI and supporting conditions determine the usage of technology. Behavioural performance, effort expectancy, social influence and enabling conditions affect the BI found in the HUTAUT model. Users (healthcare professionals) can effectively influence the importance of SCT by deciding between BI and implementation (Thomas, 2016). To influence BI, a mediating variable of motivation is needed that facilitates the process of implementing SCT (Arman & Hartati, 2016). This means that HUTAUT's three constructs are the most important predictors of BI for implementing and using technology, with the expectation of performance being the strongest predictor. The BI construct was also derived from the UTAUT model since the BI is the major estimator of actual SCT usage and the willingness of actual SCT usage by health professionals, which is crucial for implementation. Thus, the hypothesis is proposed:

H5 Behavioural Intention is expected to have a positive effect on the implementation of SCT in healthcare.

3.4.2 Delone and McLean IS success Model Constructs

In this study, independent variables were based on the adoption of SCT technology; three constructs from the D&M IS success model were adopted: service quality, system quality and information quality. Furthermore, information and communication technology (ICT) in this study is a term that refers to the various tools and techniques used by healthcare professionals to provide quality healthcare delivery to citizens. A framework helps organisations to find the right balance between these components and achieve optimal results. The D&M IS success model considers system utilisation and user satisfaction in the human dimension, while the organisational dimension focuses on the environment's structure. It is best for the community to incorporate the human, organisational and technology contexts to facilitate proper implementation within the identified context. It is for this reason that healthcare professionals regard user satisfaction as being difficult.

In this study, Figure 3.2 depicts the benefits of the D&M IS success model as factors that influence new technology adoption (Sallehudin, Satar, Bakar, Baker, Yahya & Fadzil, 2019). According to Sibuea, Napitupulu and Condrobimo (2017), information quality is measured by the usefulness of the content provided. Information qualities have a positive impact on user satisfaction with SCT technology. Information quality is related to the technical aspect of DOI theory which, in turn, it can be seen relating to patient communication (Makovhololo, 2018). It also emphasises the importance of information quality when implementing systems in the healthcare sector. The system usage construct was identified as one of the important implementation factors where system quality, system utility and system performance cannot be compromised in healthcare (Yusof et al., 2008). The usefulness of the system is measured by the inherent features based on the system's performance and user interface. System quality is influenced by the variability of issues such as the availability of ICT to support health professionals (Belanche-Gracia, Casal-Ario & Prez-Rueda, 2015). Information quality underpins all the constructs identified in this study; system quality is used to assess the quality of an information technology system (Nulhusna, Sandhyaduhita, Hidayanto & Phusavat, 2017). Furthermore, information quality is applied to measure a system's output (Wu & Hadzic, 2008). According to the aforementioned literature, using the four identified constructs has a significant impact on SCT implementation.

3.4.2.1 User Attitude

User attitude is the only construct borrowed from the HOT-Fit model. This construct has a direct bearing on the behavioural intention that influences the implementation of SCT (Halic, Ahn & De, 2015). Overall, the user attitude construct helps the D&M IS success model in determining how user perceptions, values and personal experiences influence access control technology adoption and usage (Maeko & Van Der Haar, 2018). A study by Yusof, Papazafeiropoulou, Paul and Stergioulas (2008) found that the key factors influencing system acceptance are the right user attitude, skills, environment and communication. Useability, system flexibility, information relevance and organisational culture are all criteria that can be used to assess technology fitness (Ahmadi, Ibrahim & Nilashi, 2015). Therefore, user attitude is success in implementing a health information system, which is attributed to its human–technology fit. This simply means that the implementation of SCT can serve as an example of how attitudes and knowledge can be key factors in the successful use of a system (Grol, Bosch, Hulscher, Eccles & Wensing, 2007). It shows how healthcare professionals can be persuaded to use the system despite having limited knowledge and experience in using it. To examine the relationship between user attitude and the implementation of SCT in healthcare, the following hypothesis is proposed:

H6 User Attitude has a positive effect on the implementation of SCT in healthcare.

3.4.2.2 User Satisfaction

User satisfaction is referred to as the general use of technology, as reflected in contentment and enjoyment, and software and decision satisfaction (Lau & Kuziemsky, 2016). Therefore, user satisfaction is subjective since it depends on the respondents and systems. Some studies measure satisfaction based on ease-of-use and others on attitudes towards IS. As a result, user satisfaction is defined as the total rating of the user's experience with the system as well as the system's potential influence. Therefore, the intention to use information is related to the level of satisfaction with that information. This relationship is also related to the level of satisfaction with their future use of information systems (Puspita, Supriyantoro & Hasyim, 2020). However, for the benefit of this study, user satisfaction is a mediating variable to measure human aptitude in an organisation (Yusof, Paul & Stergioulas, 2006). User satisfaction from the D&M IS success model is used as the mediating variable for the implementation of SCT. Furthermore, user satisfaction is defined as the degree to which a user finds a device useful and wants to use it again (Aldholay et al., 2018). The D&M IS success model framework sets the guidelines provided to determine the area of improvement during implementation to ensure higher user satisfaction (Bac, 2020). The following hypothesis is proposed:

H7 User Satisfaction has a positive effect on the implementation of SCT in healthcare.

3.4.2.3 System Use

Any healthcare facility should be able to provide intelligent search capabilities, quick and multi-site access and the capacity to digitally merge data fragments housed in geographically distributed databases by implementing the system (Acquah-Swanzy, 2015). Healthcare organisations must strive to improve the quality of their care. Technology features such as hardware, software and data are used to fulfil user obligations (Sombat, Chaiyasoonthorn & Chaveesuk, 2018). Technology can be influenced by its design as well as other factors such as its characteristics. Smart card technology entices healthcare professionals to use them for tasks like recording and patient, laboratory, x-ray and pharmacy information. Every healthcare facility should be able to provide intelligent search capabilities, immediate and multi-site access and the capacity to digitally merge data pieces held in geographically distributed databases by utilising a single system (Acquah-Swanzy, 2015). Healthcare organisations must strive to improve the quality of healthcare. Technology features such as hardware, software and data are used to fulfil user obligations (Sombat, Chaiyasoonthorn & Chaveesuk, 2018). User adoption and use of technology can be influenced by system design as well as other factors such as technical features. The following hypothesis proposes:

H8 System use has a positive influence on smart card technology implementation in healthcare.

3.4.2.4 Information Quality

Information quality is a measure of how well the information is presented to a healthcare professional. It also indicates how well the information is formatted and presented. The Department of Health sets guidelines for devices which guide the private and public sectors in installing a computerised system to improve the quality of healthcare. It can be argued that SCT should enable hospitals and clinics to seamlessly integrate business processes. In a proper HIS implementation, information quality refers to the integration of several factors such as human, organisational and technical factors (Kilsdonk, Peute & Jaspers, 2017). The following hypothesis is proposed:

H9 Information quality has a Positive Effect on the Implementation of SCT in healthcare.

3.4.2.5 System Quality

System quality designates the component of an IS dimension and thus summarises various measures of the system itself. As a result, system quality is thought to play a role in convenience, technological flexibility, system correctness, response time and usability (Lau & Kuziemsky, 2016). In addition, system quality is referred to as the technical aspects of HIT and includes three categories of measures related to system functionality, performance and security. The functionality includes the type and level of existing SCT functions, for example, order entry with decision support for reminders and alerts. Performance includes the technical behaviour of SCT in terms of accessibility, reliability and response time. However, system quality capacity is commonly viewed concerning the system's security element, which protects the integrity of the information or data collected and ensures correct authorisation. The following hypothesis proposes:

H10 Systems quality has a positive effect on the implementation of SCT in healthcare.

3.4.2.6 Service Quality

Service quality was defined in this study as the overall support provided to the service provider, whether the service is provided in-house or by a third party (Mardani et al., 2019). SCT can be used to identify the various factors that influence a healthcare professional's experience to measure usage. It is used to assess service quality and identify inconsistent and problematic service processes (Halvorsrud, Kvale & Flstad, 2016). In this study, service quality is seen to have a significant impact on user satisfaction. Therefore, the concept of service quality is a framework for evaluating the quality of health professionals' information and communication technology (ICT) services (Hsu, Yen & Chung, 2015). The following hypothesis proposes:

H11 Service Quality has a positive effect on user satisfaction to implement SCT in healthcare.

3.4.3 Diffusion of Innovation Theory Constructs

The concept of innovation and diffusion is explained by the different independent variables identified in the model (Emani, Yamin, Peters, Karson, Lipsitz, Wald, Williams & Bates, 2012). These variables explain the different stages of innovation and diffusion processes. In this study of the implementation of SCT, three DOI constructs were used: communication, compatibility and trialability.

3.4.1.1 Communication

According to Rogers (2003), diffusion of innovation theory (DOI) defines communication as an innovation that uses specific channels between members of social systems. Communication channels play an important role in technology implementation in this context and healthcare professionals are engaged in the implementation. Christopoulou (2013) emphasises that communication is a scheme used by humans and technology to interact. User acceptance is a prerequisite for the successful implementation of hospital information systems (HIS). Increasing investment in information technology by international healthcare organisations has made user adoption an important issue in technology implementation and management. Therefore, implementation embraces the flexibility of the system designers; tasks should be communicated to the developers after the communication has been passed to the system users. Healthcare professionals must ensure that communication concerns such as awareness and feedback sessions are resolved effectively throughout implementation (Jansson et al., 2019). The following hypothesis proposes:

H12 Communication has a positive effect on the implementation of SCT in healthcare.

3.4.1.2 Compatibility

Rogers (2003) describes compatibility as the specified level of certainty that an idea is in line with potential consumers' existing beliefs and needs. Hayes et al. (2015) further argue that the ability to accommodate individual preferences is suggested to make innovations more easily applicable. People are more likely to adopt an innovation if its goals and ideals coincide with their current work practices, according to this theory. Data security, storage capacity, data consistency, access authorisation, data ownership, device usability and data protection are all concerns that need to be addressed early in the implementation process (Cripps, Standing & Prijatelj, 2012). According to Sadoughi, Khodaveisi and Ahmadi (2019), issues related to developing consistency and safety reliability pose challenges for SCT implementation. Rogers (2003) also sees compatibility as a critical aspect of new product launches such as SCT.

In this study, under Rogers (2003), a new system is compatible or incompatible with the beliefs and values of its users. Trialability takes place in the persuasion phase within the DOI theory. A study conducted by Neo and Calvert (2012) found that the ability to innovate stems from people adopting technology. *Facebook* is a social networking platform that allows users to connect with friends, co-workers and strangers online by creating free profiles. Integrating *Facebook* is simple and inexpensive. While all nine public libraries were examined, implementing *Facebook* was both inexpensive and simple. The data also revealed that there was a window of opportunity that could have greatly facilitated the decision-making process. Therefore, the trialability of DOI takes place during implementation as it relates to the innovation that is only tested in a limited way (Alemneh & Hastings, 2010). Hence, the following hypothesis is proposed:

H13 Compatibility has a positive effect on the implementation of SCT in healthcare.

3.4.1.3 Trialability

In this study, trialability is viewed as the degree to which health professionals provide services to patients from time to time. In the relationship between innovation acceptance and trialability, health professionals' attitudes can play a mediating role (Mohammadi, Poursaberi & Salahshoor 2018). The implementation of technology in healthcare is for data storage and is a wearable device that keeps all personal data for smart health (Cresswell & Sheikh, 2013). Tsai and Chang (2016) further explain that the success or failure of an innovation system is determined by factors such as software planning and support, as well as the relationship between innovation and policy implementation and administration. The following hypothesis proposes:

H14 Trialability has a positive effect on the implementation of SCT in healthcare.

3.4.1.4 Implementation of Smart Card Technology

Several implementation techniques have been used, however, challenges in integrating mobile devices include a lack of administrative support and a lack of time or funding for teacher and student training. Overall, the use of mobile devices appears to bring benefits to nursing students; however, research is limited (Doyle, Garrett & Currie, 2014). Guidelines for theory selection can encourage implementation scientists to use theories and discourage underuse, use theories sensibly and discourage superficial use and be aware of the strengths, weaknesses and appropriateness of the theories they select to prevent abuse (Birken et al., 2017). Smart cards are used in information technologies as portable integrated devices with data storage and data processing capabilities. As in other areas, the use of smart cards in healthcare systems has become popular due to their increased capacity and performance. Their efficient use with easy and fast data access possibilities leads to particularly widespread implementation in security systems (Kardas & Tunali, 2006). Contributing to the design and implementation of such studies provides system designers with useful information.

The PACS implementation was based on the vendor's ability to meet a list of requirements in desirable features, system availability, ease of use and professional training programs defined by stakeholders like radiologists, PACS administrators, radiologists and others (Abbas & Singh, 2019). The result would allow health management, users and providers to anticipate potential challenges during implementation that would later mitigate its negative impact. In this study, inadequate infrastructure were power outages, a lack of stable power supplies and inadequate networks installed by the healthcare facility as some of their top infrastructure-related challenges during PACS implementation. Based on the literature reviewed, the following hypothesis is proposed:

H15 Implementation of smart card technology has a positive influence on healthcare.

3.5 Chapter Summary

This chapter addressed three theoretical frameworks that underpin this study. The following frameworks and models were identified for this study as being useful for the implementation of SCT in the South African healthcare sector: the healthcare unified theory of user acceptance (Maeko & Van der Haar, 2018) (HUTAUT), Delone & McLean IS success model (2003) and diffusion of innovation theory (DOI) (Rogers, 2003). Based on the conceptual model developed, the hypothetical relationships between constructs were explained. In the next chapter, the detailed research methodology is discussed.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

This chapter addressed three theoretical frameworks that underpin this study. The following
The main goal of this chapter is to introduce the research methodology which ensured that the research problem was addressed and was appropriate for achieving the research goals and verification of the hypotheses. As a result, the first section of this chapter covers the various research philosophies, techniques and strategies accessible before selecting and justifying the most relevant philosophies for this study. Secondly, the chapter covers a review and discussion of the many research methodologies available as well as the selection of the most suitable method for this study. Finally, the questionnaire formulation and data collection process are described. The ethical considerations and pilot research findings are presented. Data analysis and ethical issues are described by Saunders, Lewis and Thornhill (2009) in this chapter. The research onion in Figure 4.1 describes the different decisions taken in the study to develop a research methodology. The research onion is influenced by the theory or paradigm on which the study is based (Saunders, Lewis & Thornhill, 2009). In any scientific activity, the outer layer of the research onion is the most important since it sets the data collection strategies and processing procedures. The research paradigm that guided this study is detailed in the following section.

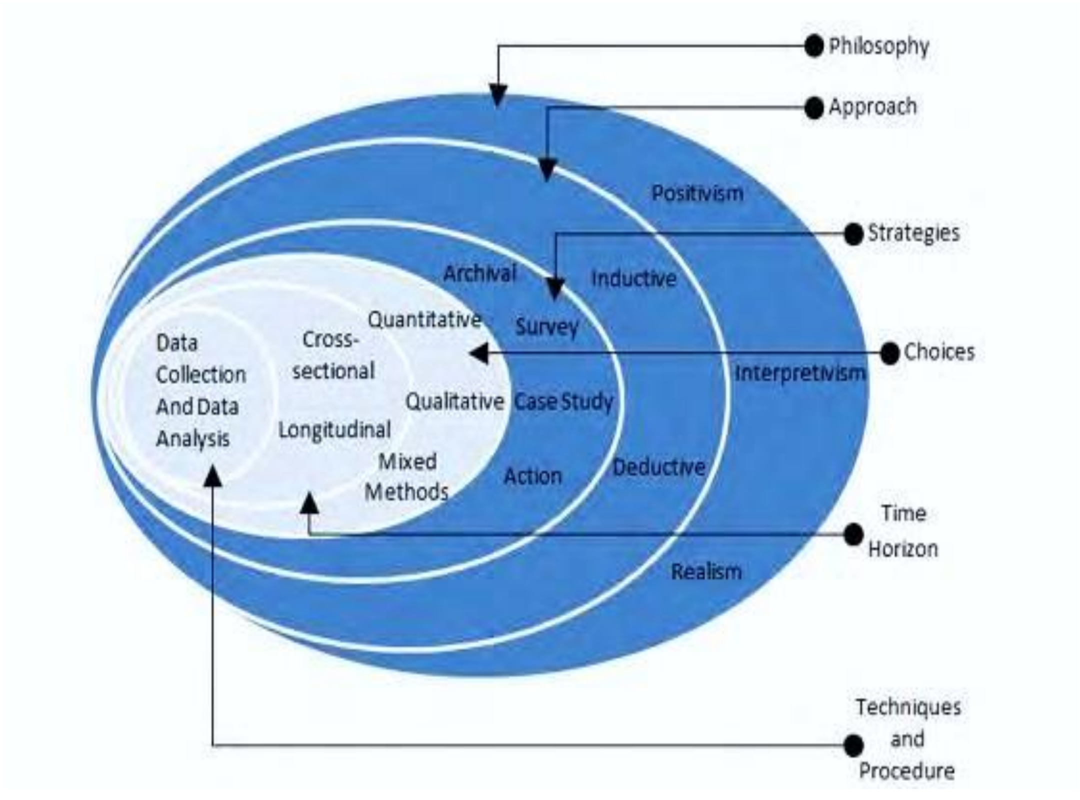


Figure 4. 1: Research Onion (Source: Saunders, Lewis & Thornhill, 2009)

4.2 Study Selection Area

The Tshwane Health District is located in the northern part of Gauteng Province and shares the same geographic boundaries as the Tshwane Metropolitan Municipality. The district is divided into eight healthcare sub-districts that align with the metro's administrative demarcation. For this study, the selected respondents were only selected from Steve Biko Academic Hospital as it specialises in many different medical fields. Kalafong Tertiary Hospital takes care of specific regions as highlighted in Figure 4.2, which is divided into regions and Tshwane District Hospital and Pretoria West District Hospital provide healthcare services to Tshwane Central District and the surrounding townships. The questionnaires were generally filled out by healthcare professionals from the emergency, midwifery, pediatric, neonatal, surgical and other departments. It was important to guide healthcare professionals through the questionnaires for them to understand what questions needed to be answered regarding the implementation of SCT in public healthcare.

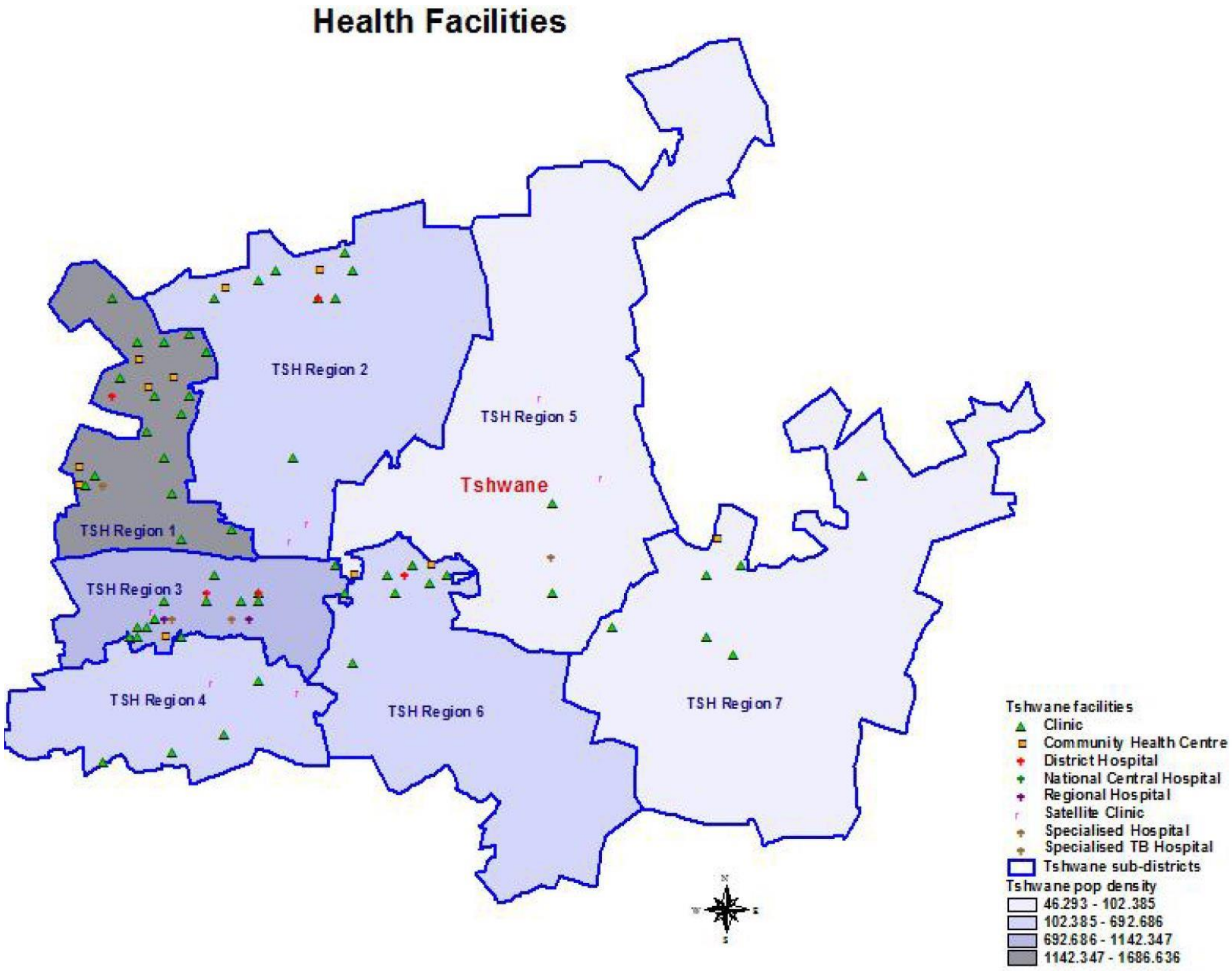


Figure 4. 2: Tshwane District Health Facilities

(Source: Department of Health, 2022)

4.3 Research Philosophies

In this study, different research philosophies were discussed, based on the analysed data collected to be used. The philosophical viewpoint that guides and explains research activity is critical (Creswell, 2018). Philosophy is defined as the study of the nature and meaning of the universe and human life (Deshpande, 2019). Researchers' beliefs about how data is a phenomenon and should be obtained, analysed and applied are called research philosophy. The researcher in this study agrees with Converse (2012) who believes that no researcher may enter the area without a clear understanding of the paradigms that influence and guide her/his research. Creswell (2013) supports that research-philosophical views are those of an individual worldview.

Saunders, Lewis and Thornhill (2012) state that research philosophy is used because it aids the researcher in adopting their beliefs about how they see the world. Research paradigm interpretations are intricately related to the researcher's worldview, which influences how research is conducted (Christ, 2014). Some application areas can be used to implement standard procedures or stimulate particular work that is consistent with current paradigms (Dix, 2017). In this chapter, the paradigm that was used to develop a framework for implementing SCT in public healthcare that is both adaptable and scalable is described, taking advantage of the most recent technologies (McAllister, El-Tawab & Heydari, 2017). The research paradigm adopted in the study played a role in the following:

- It assisted the researcher in developing theories and models that permit healthcare professionals to solve issues.
- It also aided with the establishment of various tools such as methodology and data collection for researchers to solve issues.
- Finally, it provided principles, methods and procedures to be considered when phenomena appeared.

Considering the significance of information systems in business, the same model may be applied to any healthcare technology implementation (Ivanovi & Rakovi, 2019). Paradigms are utilised to illuminate research challenges rather than as a completion aid in this study. Understanding the philosophy is also important since social science research can only be properly interpreted if the decisions that affect the research outcomes are clear. Philosophical concepts include analytical thinking, a cognitive process, insight and self-knowledge, which are all utilised to gain insights into reality as well as to plan, conduct, evaluate and interpret research and its findings. Put differently, science's realistic approach is its epistemological procedures. It deals with what is or should be regarded as adequate knowledge and is aimed at ontological knowledge (knowledge about the nature of reality) (Pruzan & Pruzan, 2016).

Saunders, Lewis and Thornhill's (2009) described epistemology deals with all aspects of the validity, scope and methods of acquiring knowledge, such as a) what constitutes asserted or measured knowledge; b) how reality is to be interpreted in whatever meaning and c) how knowledge should be explored using the best tools to solve the problem. In terms of the research's epistemological perspective, a health professional may understand that the SCT training should be implemented because the decision was made by the Ministry of Health management. As a result, epistemology in the study influences how the researcher may design the work to discover knowledge. Examining the concept of epistemology and its impact on research design can be done by considering the relationship between a subject and an object. Bond, Pope, Retief and Morrison-Saunders (2018) assume that objectivist epistemology is the reality that exists only independently or outside of the individual mind. However, objectivistic research is useful because it offers reliability (consistency of the results obtained) and external validity (applicability of the results to other contexts).

Ontology examines the nature of reality, according to Saunders et al. (2012). The ontology for this study was based on the fact that if SCT is implemented in public healthcare and thus, healthcare professionals would be able to use it. Within the three common areas, ontology is more interested in what reality is. There is only one reality or truth (singularity); there are various realities or truths (independent or perceived as reality is molded) and reality is continually questioned and interpreted. Ontology believes that there is only one reality (Saunders, Lewis & Thornhill, 2009). Ashley and Boyd (2006) state that relativistic ontology is based on the idea that truth is created by human imagination and that there is no such thing as a single actual reality. Truth, on the other hand, is relative to how people perceive it at a particular time and place.

4.4 Research Paradigm

Defining the philosophical stance that drives research becomes crucial; according to Creswell (2014), it guides and justifies research activities. Al-Ababneh (2020) states that the researcher's beliefs on how data phenomenon should be acquired, analysed and applied should be applied. Researchers should not enter the field without a thorough awareness of the paradigms that inform and guide their research. Creswell (2014) emphasises research paradigm relating to an individual's worldview.

4.4.1 Positivism

Positivism holds that social events and meanings occur independently of social actors or through confronted external facts that we seldom reach or influence (Awa, Ukoha & Igwe, 2017). This study followed the positivist research paradigm, with hypotheses to be tested and theories to be developed, based on the various applicable theories identified. Many of positivism's key concepts, such as ontological realism is advocated positivism, including the application of a scientific process and the quest for empirical fact. According to Awa, Ukoha and Igwe (2017), in information systems research, positivism must contain evidence of quantifiable variables, formal statements, hypothesis testing and inference drawing. Mukherji and Albon (2018) argue that a positive attitude leads to a systematic and scientific approach to research, which lends itself to quantitative methodologies.

Therefore, a quantitative approach, based on statistical and mathematical techniques that identify facts and causal relationships was used. Various data patterns are considered when collecting data. It also involves creating a hypothesis and generating theories that can be confirmed by studies. This confirmation approach begins with a hypothesis regarding the occurrence of a specific phenomenon and then builds a predictive model based on the theory. The researcher then performs empirical research and investigation to put the argument to the test and determine if the evidence backs it up, establishing the causal theory. The theories that underpin this study were discussed in Chapter 3. The main advantage of positivism in this study is that it makes managing the study sample easier. Interpretivism is discussed in the following subsection.

4.4.2 Interpretivism

Interpretivism argues that to understand discrepancies between people in their positions as social actors, the researcher must first understand those positions (Saunders et al., 2012). Interpretivism assumes that all knowledge is a matter of interpretation. This emphasises the distinction between conducting research among humans and conducting research on artefacts such as medicines and computers. The researcher must proceed empathically after the interpretive theory. Truth and our understanding of it, according to interpretivism, are social products that cannot be understood without the involvement of social actors (including academics) who construct and make sense of them. Using the interpretivism paradigm, it may be determined that relying on the subjective interpretations of the respondents is the best way to investigate social order. Multiple respondents can be interviewed and differences between their responses are explained utilising their subjective viewpoints (Bhattacherjee, 2012). Qualitative research employs interpretivism. The method is notable for using long descriptions to extract context, with an emphasis on deciding what is there, not how many. There are two well-known forms of interpretivism: critical theory and constructivism. It is exploratory, intending to discover trends in study data to understand and clarify them better (Saunders et al., 2012). According to critical theory, the truth can be grasped from a historical perspective, with the questioner and the questioned being interactively related to the point where the questioner's and important others' beliefs impact the analysis, resulting in value-mediated outcomes. Constructivism holds that there is no single truth and that understanding it requires viewing it as a collection of different and intangible mental constructions that are social and experienced as well as local and distinctive (Constantinides & Slavova, 2020).

4.4.3 Critical Realism

In the natural and social sciences, critical realism offers an ontology that may conceptualise reality, assist thinking, and direct empirical research. It acknowledges the complexity of reality and the agency and influence of structural variables on human conduct. At this time, it has transitioned from the natural sciences to social theory and finds use in a variety of social science fields. Therefore, it holds the fundamental argument that social scientists work on a similar project and necessitates a unique set of methodological instruments to be used (Neergard & Ulhoi, 2007). As a result, a large portion of the increase in critical realism become important in qualitative research methodologies and appears to have been sparked by first-hand experience in the field. The next section discusses the research approach.

4.5 Research Approach

There are many ways to classify the research approach, this section illustrates some of the basic ways of separating research.

4.5.1 Quantitative Approach

The quantitative approach was used in this study since it addresses the procedures of inquiry, whereas research methods are concerned with how the data were acquired and analysed. Quantitative research is described as "an approach for testing objective theories by analysing the relationship among variables" (Creswell, 2018). This study is explanatory. Hence, deductive reasoning was theoretically applied, and the researcher first established some relationships between concepts before forming supporting hypotheses. In addition, this was narrowed down to more specific hypotheses. The hypotheses were tested with the available data. Finally, the tests revealed whether or not the hypotheses were supported. The deductive method is more theory-based and builds on already created categories and codes derived from past studies. In addition, the deductive approach focuses on specific testing issues. Quantitative research can also be used to evaluate existing theories with new data, determine a theory's limits/limitations or determine the conditions under which a theory applies (Giguère, Légaré, Grimshaw, Turcotte, Fiander, Grudniewicz, Makosso-Kallyth, Wolf, Farmer & Gagnon, 2015). The study was conducted under a deductive approach, based on the four theories stated in the preceding chapter.

In addition, researchers used a survey-questionnaire instrument previously used in standard data collection methods in quantitative studies. The positivist research approach focuses on the formulation of propositions and hypotheses through supported theories and previous work (Karamat et al., 2019). Unlike qualitative research, which has a limited number of observations, quantitative research was used to address the generalisation challenge in this study. Commonalities were used within the quantitative approach.

- The core concern is to describe and account for regularities in social behaviour.
- Patterns of behaviour can be separated into variables and are represented by numbers.
- Explanations are expressed as associations (usually statistical) between variables, ideally in a form that the prediction of outcomes from known regularities.
- Social phenomena are explored through systematic, repeated and controlled measurements.

- The quantitative approach assumes that social processes exist outside of individual actors' comprehension, constrain individual actions and are accessible to the researcher's prior theoretical knowledge.

4.5.2 Qualitative Approach

Qualitative researchers use an almost opposite approach which is interpretive, using observations as a starting point and looking for reasons for observed behaviour (Williamson & Johanson, 2017). In this study, qualitative could not be used as it generally aims to gain insight and understanding into how people perceive the environment, both as individuals and communities. The inductive approach focuses on research in an organisation and thorough investigation through various research methods, aiming to generate theory from research (Zikmund et al., 2012). The problem with inductive is determining how many observations and questions to ask (Eger & Hjerm, 2022). The exploratory approach is used in qualitative research for the inductive approach, which depends on observations to answer research questions.

Qualitative research has many characteristics. These characteristics include first; the development of questions and processes; second, the collection of data connected to respondents; third, inductive data analysis from specific to broad themes and finally, the researchers' interpretation of the data. Interviews, case studies and literature reviews are common data collection methods in qualitative studies. Creswell (2013) describes the following designs as traditional qualitative research methodologies, citing literature and greater visibility of this sort of methodology in the 1990s and early 21st century.

- Narrative analysis is when a researcher uses a narrative chronology to retell the knowledge gathered through investigation from the lives and stories of the respondents who are the data sources.
- The researcher describes the experiences of individuals about a phenomenon as defined by respondents in phenomenological research.

4.6 Research Design

In this section, the overall method adopted to combine the many components of the study coherently and logically, to guarantee that the researcher can effectively solve the research problem is referred to as the research design. It forms the blueprint for collecting, measuring and analysing data. An explanatory research approach is followed in this study, it generates an understanding of a framework for the implementation of SCT. Research design follows a roadmap for various research operations, allowing the researcher to produce the most knowledge with the least amount of work, time, and money. Creswell (2017) notes that investigative strategies were associated with quantitative research and so were consequently invoked in the post-positivist worldview and restricted mainly to psychology. Research design is also a set of decisions that come together to develop a strategy for answering research questions and testing hypotheses. Choosing a data collection method is covered by research design, data analysis, data collection, sampling, scaling and procedures.

In this study, survey research provided a quantitative or numerical description of a population's trends, attitudes, or opinions by examining a sample of that population. Therefore, cross-sectional data collection was applied to the study. The rationale for using cross-sectional data collection was that it is based on structured questionnaires and was specifically designed for healthcare professionals (Fowler, 2008). Sophisticated structural equation models with causal pathways and identification of the combined strength of multiple variables are also included in the designs (Creswell, 2018).

A study's architectural backbone is its research architecture (Çelik et al., 2018). This is because the research design aids the researcher in “planning, structuring, and executing” the study to maximise the “validity of the findings” (Poutanen, Soliman & Sthle, 2016). The research challenges, aims and how the research design aligns with relevant data sources, research methodologies, sampling methods, the findings' reliability and validity are all fundamental factors in research design (Halvorsrud, Kvale & Flstad, 2016).

Case study, action research and archiving are incorporated into research designs (Saunders et al., 2012). An empirical study of a single entity to discover its primary characteristics and generalise in a real-world environment is known as a case study analysis (Mehmood et al., 2017). To acquire data for case study research, a combination of interviews, observation and documentation analysis is used. Within a culture of practice, action research involves a practical approach to a specific research question. According to Saunders, Lewis & Thornhill (2012) addressed two types of surveys: cross-sectional and longitudinal. This study followed a *cross-sectional survey* since the survey was sent out at a specific time interval. This was to allow the healthcare professionals time to respond to the survey for four weeks during the COVID-19 pandemic period.

Surveys are the most widely used research methods in social science because they may be used to investigate everything from attitudes and intentions to motives and behaviours (Joshi, Goel & Garg, 2019). To measure objective facts, survey research conforms to the positivist philosophical paradigm and is capable of making the most accurate predictions about the existence of a given situation or population characteristics (Scapin et al., 2018). The survey research design allows for a numerical explanation of the population's viewpoint by monitoring a sample of the population (Creswell, 2013). For this study, the survey research design was used because it might have provided quantitative data from a broad demographic group that is typical of a larger population, allowing hypotheses to be tested (Leedy, Paul & Ormrod, 2010).

Based on the above, this research followed the quantitative approach which is justified for the following reasons.

i. In this research, the identified theories surrounding the problem concerning the implementation of smart card technology were identified.
ii. At the methodology level, the hypothesis is formulated to explain observations.
iii. The level of methodology in this study allowed quantitative research methods to be used, based on research questions and data collection methods. Several variables were used in this study for the researcher to identify causal relationships between them and measure each variable separately. As a result, numerical data needed to be analysed using statistical analysis techniques.
iv. The research paradigm used in this study was the positivist paradigm, which began by creating a set of tested hypotheses.
v. For epistemology, since the researcher was isolated from the previous research context, this research was objectivist. As a result, a neutral observation was conducted to avoid researcher bias.

This study aimed to test and validate the proposed hypotheses. The researcher followed the positivist paradigm and quantitative method. The deductive approach also implies that quantitative research must be tested against theories. In contrast, qualitative research relies on inductive reasoning to generate new theories. Therefore, this study formulated various theories and hypotheses that are validated to confirm that the results can be generalised to the population. In this study, the quantitative model is adopted using a questionnaire-based approach. The following are the fundamentals of this survey which will be discussed next: the development of the questionnaire, a pilot study and a study sample.

4.7 Questionnaire Development

In this study, the research targeted a larger group of selected healthcare professionals using a structured questionnaire (El-Yafouri & Klieb, 2014). There is no conventional technique to develop a questionnaire, but a useful questionnaire can be created by selecting a suitable question style, designing the questions, and piloting and modifying the questionnaire. Therefore, this method was chosen because it is less expensive, takes less time and can provide qualitative information with a larger sample size. As a result, the generated questionnaire was used to gather opinions on SCT implementation in public healthcare.

In addition, the study used a closed question style, which allowed for answer-based adjustment to be selected. Rowley (2014) argued that this style of questionnaire was chosen since it is easy to answer and can be completed in a short time. The questionnaire was divided into three sections (Appendix 4).

- The first part of the questionnaire focused on the demographic information within the hospital. The respondents were required to answer four questions related to gender, age group, department in which the healthcare professionals are working, and the highest educational qualification obtained for the field of work.
- The second part of the questionnaire mainly focused on technology, internet usage and interaction with smart card technology. In this section, the respondents were required to answer the interaction with the SCT in other areas within healthcare, the rating or understanding of computer literacy was measured too and the level of interest in if the SCT can be implemented, whether or not it requires knowledge.
- The third part contained the 90 items used to study the factors influencing smart card technology usage in Table 4.1. This section used the constructs drawn from the existing

theories such as HUTAUT, D&M IS success model and DOI within variables and some added variables were also found in the study:

Table 4.1:Constructs theories (Source: Own)

Theory	Constructs
Healthcare unified theory of acceptance of user technology model (HUTAUT) (2018)	Effort Expectancy Performance Expectancy Social Influence Facilitating Conditions Behavioural Intention
DeLone & McLean IS success model (2003)	User attitude Service quality Information quality User satisfaction System quality
Diffusion of innovation (DOI)theory (2003)	Communication Compatibility Trialability

In this study, a form of numerical scaling was used for all items that were measured. The Likert scale-type question is probably the most widely used response scale in surveys and is often used to measure attitudes and other factors. Likert scales are the best designs when using self-administered surveys for data collection. The Likert scale is an interval scale that seeks to find out from respondents the indication if they agree or disagree with a particular issue by rating a series of statements in measuring the state of mind on a particular issue (Puspita, Supriyantoro & Hasyim, 2020). Pallant (2013) added that coding increases the statistical method to be used for a study to be managed. In this study, a five-point Likert scale ranging from “strongly agree” to “strongly disagree” was used for all measurement points. In this study, structural equation modeling (SEM) was applied for analysis.

4.8 Questionnaire

The original questionnaire was in English and was edited by a professional editor to ensure the consistency of the content of the questions.

4.8.1 Pilot Study

The pilot study was conducted based on the revised questionnaire. Conducting a pilot study is an important step in the research process. The goal of a pilot study is to see if a strategy used in a larger study is feasible (Onifade, Jewell & Adedeji, 2013). According to Radhakrishna et al. (2014), the pilot study is unique in that it examines the use of tools that are readily available for use. Therefore, it considered technologies that are easy to implement, using open-source development tools to address health information storage and portability issues in a resource-constrained setting.

The pilot study was in the form of a questionnaire that helped in the training of the data collectors/supervisors, supportive supervision and the clarification of the study respondents on the study objectives as activities to ensure data quality (Asemahagn, 2017). According to Creswell (2017), these plans for survey pilot testing or field testing are reviewed and a rationale is provided. Therefore, the importance of pilot testing determines the detailed content and validity of the instrument and provides a first assessment of the internal consistency of the items. Building on this, evidence of improvement in questions, format and instructions is found.

For the benefit of the study, questionnaires were hand-delivered and later collected. In addition, the questionnaires were distributed to 50 healthcare professionals to test their understanding of smart card technology. It was noted that of the 90 items generated in Section C of the questionnaire, the five-point scale (Likert) was used to rate the items in the questionnaire. On the pilot-tested questionnaire, respondents were asked to rate the importance and relevance of each variable on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The five-point Likert scale was used instead of a seven-point scale because it has been reported that respondents tend to avoid the two extreme points. For this reason, the seven-point scale is less useful in social science research (Radhakrishna et al., 2014). The data from the pilot study was carefully examined and the comments from the pilots were used to develop the main questionnaire.

4.8.2 Pilot Survey Testing

The survey instrument was put into practice with the help of 50 (Fifty healthcare professionals) the University of Pretoria working at Steve Biko Academic hospital who were targeted based on the fact that they are considered student nurses (healthcare professionals) completing the questionnaire.

Saunders, Lewis and Thornhill (2012) and Creswell (2017) state that the purpose of the pilot survey test was to achieve the following goals:

1. To establish respondent comprehension based on the questionnaire's instructions.
2. To provide data for conducting preliminary tests to ensure that the suggested analysis is feasible.
3. To ensure that the researcher and the responders have the same interpretation of the questions' wording.
4. To ensure that the questions being asked are valid.
5. To establish the reliability of the questions.
6. To ensure that the researcher and the responders have the same comprehension of the questions' language.

4.8.3 Sample Population

The study was conducted at Gauteng hospitals, namely, Steve Biko Academic Hospital, Pretoria West District Hospital, Tshwane District Hospital and Kalafong Tertiary Hospital. Given the number of hospitals and the various departments within each hospital, a larger sample size of health professionals was expected for this study. A research population is defined as a group of people who have similar characteristics. Saunders, Lewis and Thornhill (2009) state that any research can adopt the use of a unit of analysis by using the main units and sub-units for each healthcare professional who participated in the study (Stockemer, 2019). The current study's unit of analysis comprised healthcare professionals in the Tshwane district in Gauteng province.

As indicated in Table 4.2, this study included a large number of healthcare professionals from several departments including emergency, midwifery, pediatric, neonatal, surgical and other departments such as medical care and cancer. The research focuses on the implementation of smart card technology in public health. Therefore, the target participants for this study consisted of healthcare professionals who interacted with the SCT in other areas such as collecting data for patient records, clinical, laboratory, radiology, pharmacy and administration.

Table 4. 2: Unit of Analysis (Source: Own)

Main Units	Sub – Units
Hospitals	Emergency Midwifery Pediatric Neonatal Surgical Others (medical care and oncology)

4.8.4 Sample Size Estimation

Convenience sampling, a non-probability sampling method, is the most frequently employed sampling technique in psychology (Etikan, Musa & Alkassim, 2016). Convenience sampling gathers information from anyone willing to participate in a study, is most approachable, or is otherwise easily reachable by the researcher (Scholtz, 2021). The convenience sampling for this study will include medical healthcare professionals who will be able to complete the questionnaires while working in various departments or units within the identified hospital. One of the advantages of convenience sampling is the capturing of samples and placing them near a location such as the hospitals, for example, convenience sampling becomes a relevant technique for gathering samples (Stratton, 2021).

Convenience sampling depends on the subjects who will participate in this study. These medical healthcare professionals who will be able to complete the questionnaires while working in various departments or units within the specific hospital will be included in the convenience sampling. However, in this study, the purpose of using convenience sampling allows the selection of units randomly. This study is also guided by the selected quantitative research design approach.

Convenience sampling was chosen because collecting data during the COVID-19 pandemic was challenging. the rules established by the government to halt the spread of the coronavirus in South Africa. The researcher's ability to visit participants and hospitals in person is constrained by these rules. Due to the difficulty in recruiting respondents due to the environment's peculiarities, convenience sampling was used to select only healthcare professionals from various departments with no criteria for inclusion. Table 4.3 shows the number of healthcare professionals who participated in this study.

Table 4. 3: Healthcare professionals per hospital samples (Source: Own)

Hospitals	**Males**	**Females**	**Total**	**Percentage**
Steve Biko Academic Hospital	43	103	146	36%
Pretoria West Hospital	12	67	79	19.4%
Kalafong Tertiary Hospital	28	39	67	16.5%
Tshwane District Hospital	18	96	114	28.%

4.8.5 Potential Population

The population is a term that refers to a specific group of people or entities that the study focuses on (Belayneh, Woldie, Berhanu & Tamiru, 2017). Most researchers agree that the number of health professionals is not growing fast enough to meet the needs of the large study population (Golant, 2017). The overall population in the four hospitals (Steve Biko Academic Hospital, Pretoria West Hospital, Tshwane District Hospital and Kalafong Tertiary Hospital) for this study was 1,438 healthcare professionals. The population consisted of healthcare professionals from various departments such as emergency, midwifery, pediatric, neonatal, surgical and other departments drawn from Gauteng's three hospitals and one academic hospital.

The researcher was permitted by the University of Pretoria to administer surveys to healthcare professionals at Steve Biko Academic Hospital. Because of its large potential for specialisation in numerous fields of healthcare, the hospital was chosen for the study. In addition, access data, research locations and population groups were chosen, namely, the four Gauteng hospitals that serve the municipality's regions: the Steve Biko Hospital, Pretoria West Hospital, Kalafong Tertiary Hospital and Tshwane District Hospital. However, in addition to the Tshwane District Hospital serving the community in the local city of Pretoria, a hospital serving the local community in the city of Tshwane was chosen to measure the difference. According to Pati, Harvey and Cason (2008), the researcher must be adaptable to accommodate design modifications. Hospitals were given restrictions by the World Health Organisation and the National Department of Health in South Africa that prevented the researcher from collecting more data than was expected.

Gauteng was among the highest provinces hit by the Coronavirus Disease 2019 (Covid-19) pandemic. Accessibility remained an issue for data collection. Table 4.4 shows how the departmental sample size was broken down by domain and division within each domain. User segmentation for accessible technical solutions, according to Aceto, Persico and Pescap (2018), consists of dividing the population (preferably per service or group of linked services) into more or less homogeneous, mutually exclusive subsets of users. Ludvigsson, Almqvist, Bonamy, Ljung, Michaëlsson, Neovius, Stephansson and Ye (2016) confirm that the study population consists of all individuals who make up the population. Research can be customised to any design employing population study parameters. The study's sample contained nurses (healthcare professionals) rather than the general population if the researcher is only interested in the qualifications of healthcare professionals working in a single hospital. Therefore, the researcher's scope of work had to be confined to what was feasible (Lapierre, Li, Kwan, Greenhaus, DiRenzo & Shao, 2018). This requires the research to be valid, that all limitations are considered and that as much data as possible must be collected. The next section of the chapter deals with data analysis.

Table 4. 4: Departmental Sample Size (Source: Own)

Departments	**Steve Biko Academic Hospital**	**Kalafong Tertiary Hospital**	**Pretoria West Hospital**	**Tshwane District Hospital**	**Total**
Emergency	37	18	15	12	82
Midwifery	55	38	18	17	128
Paediatric	14	13	9	7	43
Neonatal	6	7	2	5	20
Surgical	59	43	14	16	132
Others (oncology and medical)	1	0	0	0	1
Total	172	119	58	57	406

4.9 Data Analysis

Quantitative analysis is used to determine the strength of correlations between various components in the context of an event. The predictions of a theory are used in this procedure to see whether the hypothesis is viable. The greatest strength of quantitative analysis lies in providing repeatable evidence that supports the theoretical prediction. Furthermore, quantitative analysis can detect minor associations which would be undetected by human data analysis. The questionnaire data were collected, analysed and validated with *SPSS* (v26). The variables were then defined and labelled. In addition, before using SPSS, the data were imported into *Microsoft Excel* to check for errors (Esewe, 2018). For complex statistical data analysis, *SPSS* (*Statistical Package for the Social Sciences*) is utilised by a multitude of academics. The *SPSS* software package was developed for the management and statistical analysis of social science data.

Respondents from the listed hospitals in the Tshwane district completed all questions. Variables and relationships were adopted for statistical techniques in the study using *SPSS* software. For the benefit of data analysis, exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modeling (SEM) was used for factor analysis as well as path analysis (Bandalos & Finney, 2018; Maguraushe, 2021). The following subsections describe the strategies followed during the analysis phase.

4.9.1 Data Collection Techniques

In this study, the data collection techniques were in the form of a questionnaire. A statistics software package was used to measure and summarise the different variables. This study used *SPSS* software to analyse the quantitative data. To support the quantitative study's findings, constructs from the developed conceptual framework were coded. This section describes the steps the researcher took to administer and test the survey (Bhattacherjee, 2012). It also provides information on how this study was conducted. In preparation for the data-collecting process, the researcher visited university hospitals to obtain research approval from the Gauteng Department of Health for the selected Pretoria West Hospital and Tshwane District Hospital (Appendix 3). Due to the difficulty of the COVID-19 epidemic, the secretaries at the hospitals made appropriate arrangements on behalf of the researcher to meet with the different heads of departments. All questionnaires received were sanitised as a precaution before leaving the hospitals and being captured by the researcher. The detailed survey questionnaires are outlined in the following sections of the study. Once approved, the researcher was referred to the University of Pretoria (Appendix 2).

4.9.2 Data Collection Method

The required information was obtained using a quantitative methodological approach. In this study, data collection primarily focused on three levels: respondent's demographics, technology use, SCT interaction and the final category which examined factors impacting SCT use. Therefore, the data were collected using structured questionnaires. To develop the questionnaire, the reviewed literature, as well as the conceptual framework, were used. In addition, related studies were searched for the theoretical background of HUTAUT, D&M IS success model and DOI as highlighted in Chapter 3.

In this study, the primary questionnaire survey was conducted during the COVID-19 pandemic from June 2020 to August 2022 with the above target sample of respondents. Due to the high prevalence of infection, COVID-19 healthcare professionals have been at significant risk of infection. Of the 589 questionnaires distributed and collected from team members, 406 were received after follow-up. In this study, 50 questionnaires were rejected because they were incomplete. Due to the high admission rate of COVID-19-related illnesses in hospitals, time constraints and exhaustion, the healthcare professionals couldn't complete all the questionnaires. The data were analysed using structural equation modeling since a total of 406 were suitable for the analysis.

4.9.3 Quantitative Analysis

Data were analysed using exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modeling (SEM) as discussed below.

4.9.3.1 Descriptive Analysis

Descriptive analysis is research that describes the results of a variety of tests (Creswell, 2014). These descriptive statistics are used to present respondents with data related to smart card technology usage and demographic profiles in this study. In addition, descriptive statistics was discussed before advanced analyses which included regression testing, factor analysis and structural equation modeling. In this study, descriptive analysis was based on the internet experience, education level, gender and age were all significant criteria in determining whether or not health professionals in various departments at the four hospitals would employ smart card technology. The impact of participant demographics on the adoption of smart card technology in public health was investigated in this study.

4.9.3.2 Exploratory Factor Analysis

Examining a set of factors and trying to determine what the respondent is saying is an exploratory factor analysis technique. Confirmatory factor analysis is a method that is combined to evaluate a hypothesis (Arman & Hartati, 2016). This study used the exploratory factor analysis technique to analyse the dimensions of different constructs. Subsequently, confirmatory factor analysis was performed to test and confirm the relationships between the observed factors (Zikmund, Babin & Griffin, 2012). Exploratory factor analysis (EFA) analyses a limited set of factors, using a large number of variables. The goal is to get a smaller set of factors that can be used to extract valuable information from the data. EFA is a set of tools used to select items in a large group and examined the relationships between them. It is also commonly used to analyse the relationships between the different variables without prior hypotheses (D'Ambra, Wilson & Akter, 2013). The first step in EFA is extraction, followed by rotation as the second step.

The rotation's purpose is to identify the components that influence the creation of the EFA. Principal component analysis (PCA) is one of the most widely used extraction methods. In this study, due to several uncontrollable items, the PCA method was used, which is only used for six items. Its popularity is attributed to its reliable assessment of various variables (Yeh, 2017). The rotation of EFA, which allows for an interpretable representation of loading patterns, follows the first phase. The orthogonal and oblique approaches to rotation are the most common. Furthermore, the former assumes that the extracted factors are unrelated, whereas the latter assumes they are connected. Several research studies have combined the two methodologies (Shim & Jo, 2020; Aboelmaged & Hashem, 2018; Celik et al., 2018). This research used the orthogonal model and principal component analysis to perform factor analysis. The model is more advantageous than oblique rotation in terms of generalisability and reproducibility. Confirmed factor analysis was performed using structural equation models, as seen in the next section.

4.9.3.3 Confirmatory Factor Analysis

This study used confirmatory factor analysis (CFA) which revealed that different technology attitudes have a significantly positive impact on people's performance and usage (Shim & Jo, 2020). Luqman, Abdullah and Ghapar (2011) investigated if there were correlations between variables that are compatible with the proposed component structure in a CFA. EFA has determined that the number of fractions and loads can be found in the data. CFA statistics provide information on how the researcher has the theoretical specification of the factors that correspond to the reality of CFA as a method that allows the researcher to validate or reject the same given theory (Luqman et al., 2011). For that reason, CFA becomes a sophisticated technique compared to EFA, usually used in advanced stages of research. In the literature, CFA is then performed by structural equation modeling as indicated in the next section.

4.9.3.4 Structural Equation Modeling

For this study, structural equation modeling (SEM) was used to evaluate the research model. IBM *SPSS Amos* is an enterprise software package that supports the SEM technique, a widely used method for analysing data. This approach involves the study of covariance structures or causal modeling.
SEM is sometimes considered to be difficult to use and learn but that is incorrect. Its simplicity makes it ideal for data analysis. The advent of statistical methods (SEM) opens the door for people not trained in statistics to solve problems that previously required the services of specialists (Teo et al., 2014). Since its inception, *Amos* has focused on making it easy to use. Its graphical interface allows the basic principles of SEM to be conveyed (Wu & Chen, 2017).

Amos' path diagrams help in the visualisation of models and provide a clear representation of the various steps involved in numerical model analysis (Dhagarra, Goswami & Kumar, 2020). Structural equation modeling aims to explain and verify the relationships between different latent variables. In addition, SEM analysis approaches have been employed for academic study in several IS disciplines (Al-Rahmi, Yahaya, Aldraiweesh, Alamri, Aljarboa, Alturki & Aljeraiwi, 2019; Wu & Chen, 2017). The relationship between constructs and latent variables was measured using SEM (depending on how SCT was implemented) and (independent variables which are effort expectancy, performance expectancy, communication, compatibility, user satisfaction, system quality and information quality).

Latent variables are factors that can't be measured directly but are frequently employed in research. The SEM model aims to find causal relationships between different variables. A model could be presented as an equation or as a path diagram. The second step of the SEM is to indicate whether the model has identified the unique numerical solution for each parameter found (Teo et al., 2014). Population parameters are estimated, and model identification is performed. The next step is to check the model fit. The goal of model fit testing is to determine whether or not the model is good.

Component-based and covariance-based SEM are the two forms of analysis found in SEM. The most popular is covariance based on the literature with much available software such as *Amos, SSEPATH, EQS* and *LISREL*. The available sample size is the most important difference between covariance-based SEM and PLS. SEM requires more than 200 respondents (Lock, 2015). PLS, on the other hand, tries to explain the suggested model with high variance (R2) and considers significant t-values between constructs.

While the covariance-based SEM applies to the entire population, the PLS has a different purpose (Shim & Jo, 2020b). This is because it predicts the relationship between latent variables and how they interact. This study used *SmartPLS* (Aldholay, Isaac, Abdullah & Ramayah, 2018)—which is free for non-commercial users—to evaluate the model proposed by the partial least squares-based SEM. The partial least squares path model is discussed in the following subsection.

4.9.3.5 Partial Least Square Path Model

A partial least square path (PLS) model is used as the measurement model and a model describing the PLS path model is created. In addition, the measurement model specifies the indicators of each construct and allows the researcher to access the validity constructs. A structural model is also developed to reflect the relationships between the latent variables. Therefore, convergent and discriminant validity is checked to validate the measurement model. Convergent validity is proved by calculating factor loadings, composite reliability and average variance extracted values (AVE) (Shim & Jo, 2020). Discriminant validity is demonstrated by calculating the square root of the AVE values for each construct. For qualified discriminant validity, the square root of the AVE values for each latent variable in the model should be higher than the correlation of each latent variable pair. Furthermore, the structural model is evaluated with significant path coefficients and R^2 (variance) of latent variables.

4.10 Ethical Issues

In a research study, unforeseen concerns and risks, changes in the research plan, or any harm (social, psychological, physical or legal) were reported to the Research Ethics Committee before ethics clearance was granted (Creswell, 2018). Several ethical issues were addressed in this study. A well-supported thesis is the result of ethically gathered and scientifically accurate data (Magaqa, 2012). The researcher applied for ethical approval from the Ethics Committee of the University of South Africa (UNISA). The research ethics committee was responsible for approving the researcher's study as part of the approval procedure (Saunders et al., 2012; Ilorah, Mokwena & Ditsa, 2017).

The participants were informed of the concerns around human involvement in this study. Therefore, most issues were addressed before approval, such as the study methodologies and risks, allowing respondents to answer questions without fear. Practice-based research, on the other hand, raises several ethical concerns because of the researcher's unique position within the practice (Costley & Fulton, 2018).

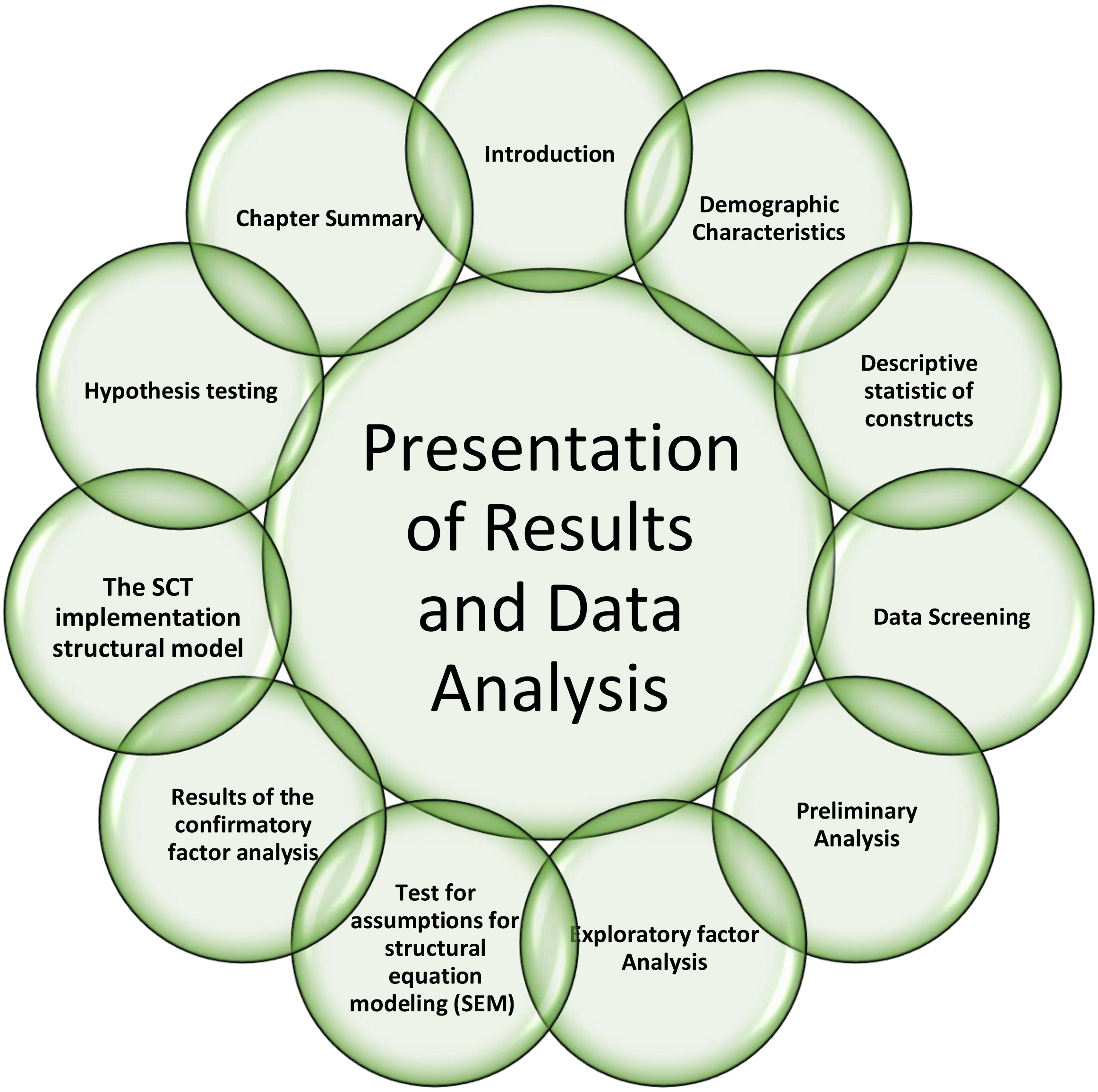
Information about human health is often collected through surveys and other forms of electronic data collection. To deliver high-quality and reliable data, this procedure necessitates the application of ethical considerations and values. The study was approved by three main institutions such as the University of South Africa. Permission to collect data for research was granted. Considerations were made for ethical approval to ensure that the study was properly conducted. The importance of voluntary participation in the study was emphasised to all healthcare professionals in this study. Second, due to the high admissions of patients with COVID-19-related illnesses, the survey included consent items such as work stress. Healthcare professionals were also expected to complete the study's questionnaire without being distracted or stressed. Finally, the respondents were advised that their responses would be kept confidential and their request for anonymity would be honored. Respondents were informed that the survey results are supposed to be shared with the NHRC and would be saved in the databanks as a future research resource. Furthermore, the hard copy of the entire research study obtained would be retained and protected using a password, which is managed by the University of South Africa.

4.11 Chapter Summary

This chapter explained in detail how the quantitative research study was conducted. The quantitative research and the positivist paradigm which had been adopted for this study were discussed. This chapter also addressed the literature that demonstrates validity and dependability. In addition, the conceptual model developed in the previous chapter was addressed as well as the quantitative methods. Furthermore, the ethical implications of the hospital's data collection were addressed. The next chapter provides a detailed presentation of the results and data analysis.

CHAPTER 5

PRESENTATION OF RESULTS AND DATA ANALYSIS



5.1 Introduction

The researcher described the study's research methods in the previous chapter. The methodology was deployed, and the data were captured using the *Statistical Package for the Social Sciences* (*SPSS*). This study aimed to develop a framework for the implementation of smart card technology (SCT) in healthcare. The data were analysed, and the results are presented in this chapter. The previous chapter discussed the survey questionnaire that had been used to collect quantitative data to test the research model developed in this thesis.

This study employed a quantitative research strategy that included a survey method. The questionnaire was divided into sections to make it easier for respondents (healthcare professionals) to understand and respond to the statement items in the questionnaire. The Likert scale with six items of possible responses from *Strongly Agree* to *Strongly Disagree* was employed in this study. The survey was conducted at Steve Biko Academic Hospital, Pretoria West Hospital, Tshwane District Hospital and Kalafong Tertiary Hospital from January to June 2021. Initially, the administration issued 465 survey questionnaires to the four hospitals. Fifty questionnaires were returned as unusable due to inaccurate responses. A total of 406 questionnaires were completed and analysed in this study.

The researcher provided a detailed analysis of how data were collected using survey questionnaires. The researcher used Cronbach's alpha to test the instrument's reliability after screening the data. A discussion and the conclusion of the data are fully addressed in Chapter 6. The analysis of the chapter is mainly focused on structural equation modeling. The results of the demographics of healthcare professionals are displayed using graphs and bar charts. The normalcy test and statistical descriptive analysis are also discussed in this chapter.

5.2 Demographic Characteristics

Gender, age, department and level of education were among the demographic variables included in the survey questionnaire. The frequency statistics of these factors were extracted in the study and the results are as follows.

5.2.1 Gender

The gender representation in terms of frequency is shown in Figure 5.1 which highlights the level of respondents in terms of gender-based participation. The figure shows that the females have the highest percentage of 63% while the males obtained the lowest variance of 37%.

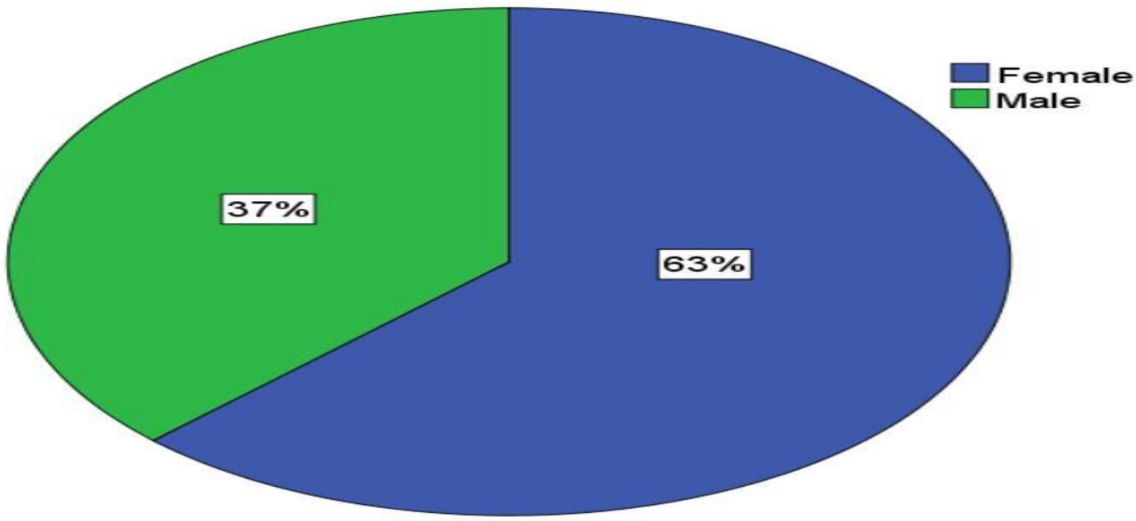


Figure 5. 1: Frequency of gender

5.2.2 Age Group

The study investigated the age category to which a respondent belongs. The options available for respondents to choose from were: Below 25 years, between 25 and 30 years, between 31 and 40 years, between 41 and 50 years and above 50 years. The percentage representation of each age category is shown in Figure 5.2. The figure shows that the age category with the highest representation is 31 to 40 years with a total of 53% of the sample, followed by the age category 25 to 30 with a total representation of 33%. In this study, a sample total of 8% of the respondents belonged to the age category 41 to 50 years, while the following age categories: below 25 and above 50 years have an equal representation of 3%.

Generally, the majority of the respondents are middle-aged, which is the age category that previous studies have classified as the technology age category (30–50). Therefore, the researcher anticipated that the perceptions from individuals about SCT gathered by this study provided insightful conclusions due to the perceptions of most respondents who were technophobic.

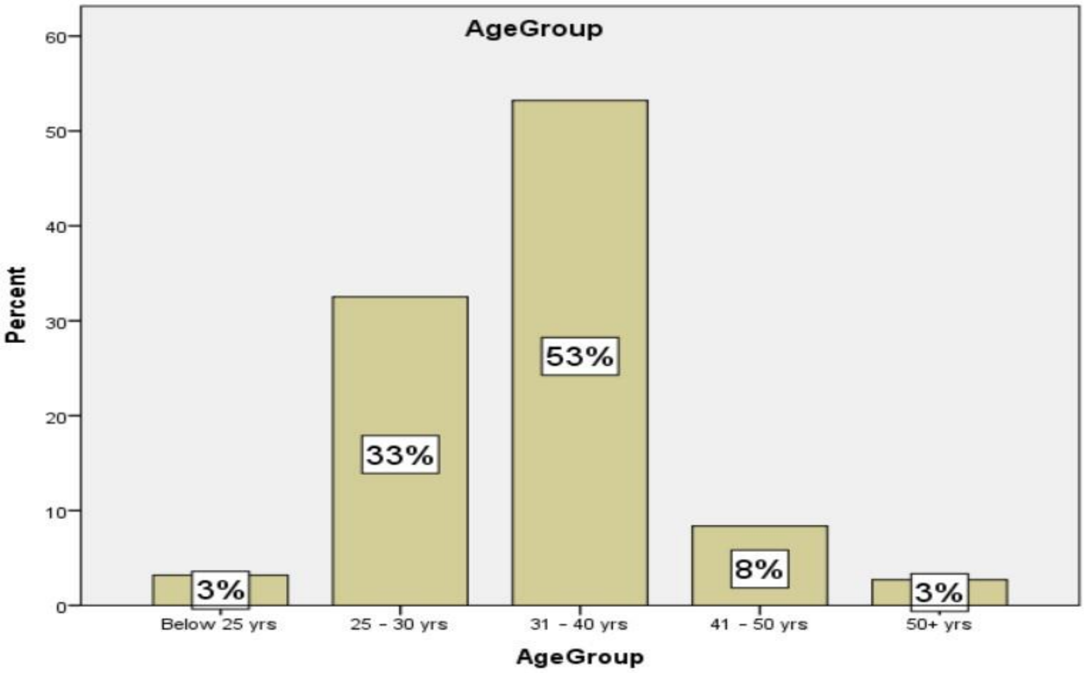


Figure 5. 2: Frequency of age group

5.2.3 Respondents' Level for Departments

Respondents were asked to specify the department they work in. The results as summarised in Table 5.1 indicate that 32.5% of the respondents work in the surgical department, which is the most represented. This was followed by the midwifery department with a total of 31.5% of the sample. Emergency and pediatric departments have a representation of 20.2% and 10.6%, respectively. The least represented departments are the neonatal and other departments that were not explicitly mentioned in the questionnaire, each with 4.9% and 0.2%, respectively.

Table 5. 1: Department frequency distributions

Department	Frequency	Percentage
Emergency	82	20.2%
Midwifery	128	31.5%
Paediatric	43	10.6%
Neonatal	20	4.9%
Surgical	132	32.5%
Others	1	0.2%
Total	406	100%

5.2.4 Level of Education

The level of education was measured according to the highest qualification within the department. The different levels of education available for respondents to choose from were below Grade 12, diploma, degree, postgraduate and other qualifications. The level of education frequency is summarised in Table 5.2.

Table 5. 2: Level of education

Education level	Frequency	Per cent
Grade 12 or below	19	4.7%
Diploma	132	32.5%
Degree	213	52.5%
Postgraduate	38	9.4%
Other Qualifications	4	1.0%
Total	406	100%

The majority of the respondents (52.5%) held a degree, followed by 32.5% with a diploma. Those with a postgraduate qualification were 9.4% of the total sample used in this study, while 4.7% of the respondents had a Grade 12 qualification, at most. A negligible percentage (1.0%) of the sample had other qualifications. It can be concluded that the majority of respondents had attained a minimum level of education to the level from which they could understand developing technologies such as SCT.

5.2.5 Frequency of Knowledge Factors

This study investigated the technology, internet usage and interaction of smart card technology. The questions included the following:

- What has been your experience with smart card technology in other sectors of healthcare?
- How would I rate my degree of computer literacy?
- If smart card technology is introduced, what would my technological expertise have to be?

Table 5.3: Summarises of the frequency data for questions.

Factor	Items	Frequency	Per cent
SCT Interactions	Patient Data	100	24.6%
	Clinical Data	84	20.7%
	Laboratory Data	53	13.1%
	Radiology Data	73	18.0%
	Pharmacy Data	44	10.8%
	Administration Data	52	12.8%
Computer Literacy Level	Little	117	28.8%
	Fair	51	12.6%
	Good	99	24.4%
	Very Good	20	4.9%
	Excellent	119	29.3%
SCT Knowledge	Little	251	61.8%
	Fair	10	2.5%
	Good	136	33.5%
	Very Good	9	2.2%

In terms of SCT interactions, the findings in Table 5.3 reveal that the respondents had experienced or used SCT in some way. In addition, 24.6% of the respondents had used it for patient data, while 20.7%

had used SCT for the collection of clinical data. Radiology data had been used by 18% of respondents, followed by SCT in the laboratory and administration data by 13.1% and 12.8% of the sample, respectively. Finally, 10.8% of the respondents indicated that SCT was being used at the pharmacy.

To further understand the knowledge about SCT that respondents possessed, the study requested the respondents to rate their knowledge of SCT. Table 5.3 shows that despite having dealt with SCT elsewhere, a large percentage of respondents (61.8%) had little knowledge of SCT. This is followed by 33% who had good knowledge of SCT. A total of 2.2% and 2.5% had a very good and fair knowledge of SCT. In terms of computer literacy, 29.3% of respondents had excellent computer abilities, while 28.8% had little computer knowledge. A total of 24.4% had good computer knowledge and 12.6% with fair knowledge and 4.9 % with very good knowledge, respectively.

These results are encouraging because they are inclusive, showing that 61.8 per cent of participants and 2.5 per cent had a good understanding of SCT. Hence, the level of understanding benefits the implementation of SCT in public healthcare. As a result, the perspectives acquired from all respondents in this study would contribute to the establishment of an adequate framework for SCT implementation in healthcare institutions.

The following section provides descriptive statistics for the constructs theorised to play a role in SCT implementation in healthcare institutions.

5.3 Descriptive Statistics of Constructs

Using descriptive statistics, the researcher investigated and analysed a summary of information on the distribution and central tendency of continuous variables. The influence factors for SCT usage used descriptive statistics which included the mean, minimum, maximum and skewness values that were used in analysis. It also considered the distribution of the data collected. The middle of the available range is represented by the mean value. Skewness is a measure of asymmetry in a set of statistical data from the normal distribution (Pallant, 2020). Skewness is classified into two types: negative and positive (Pallant, 2020). Table 5.4 below summarises the results of the descriptive statistics extracted through *SPSS*.

Table 5. 3: Construct Descriptive Statistics

Construct	Minimum	Maximum	Mean	Skewness
Effort Expectancy	2	5	4	-0.540
Performance Expectancy	2	5	4	0.308
Social Influence	2	5	4	-0.282
Facilitating Conditions	2	5	4	-0.196
Behavioural Intention	2	5	4	-0.222
User Attitude	2	5	4	-0.477
Service Quality	2	5	4	-0.003
System Use	2	5	4	-0.156
Information Quality	2	5	4	-0.250
User Satisfaction	2	5	4	-0.162
System Quality	1	5	4	-0.015
Communication	2	5	4	0.001
Compatibility	2	5	4	-0.113
Trialability	2	5	4	-0.056
SCT Implementation	2	5	4	-0.213

The results show that all factors except system quality has a minimum of two (2), which represents disagreement. This suggests that while system quality was the only element with at least one respondent *strongly disagreeing* regarding its importance in the implementation of SCT in healthcare institutions, none of the respondents *strongly disagreed* with the rest of the questions. In terms of maximum value, all factors had a maximum value of five (5), which indicates that they *strongly agree*. This means that all factors had at least one respondent who *strongly agreed* with the role that these factors play in the implementation of SCT. These minimum and maximum statistics indicate that the majority of respondents *agreed* or *strongly agreed* with the questions about the role of each factor in the implementation of SCT; however, the mean and skewness statistics must be interpreted to be more confident in this conclusion.

Table 5.4 shows that the mean value for all the factors is four (4), a value that represents *agree*. This suggests that for an average of four (4) to be obtained, the majority of the respondents *agreed* and *strongly agreed* with the questions asked about the role of each factor in the implementation of SCT in healthcare institutions. To further cement this conclusion, skewness statistics were analysed, and the results showed that, except for performance expectancy and communication, all factors in Table 5.4 have a negative skewness score, indicating that the majority of their data points are aligned to the right side of the mean value (the side with *agree* and *strongly agree*). This means that for these factors, the majority of the respondents agreed and strongly agreed with the questions about the role they played in the implementation of SCT in healthcare institutions. Communication and service quality have low positive and negative skewness values of 0.001 and -0.003, respectively, which are nearly nil, suggesting that there is a balance between respondents who *agree* or *strongly agree* and those who *disagree* or *strongly disagree*. Furthermore, there could be more respondents who were neutral to the questions asked about the role of communication and service quality toward the implementation of SCT. Performance expectancy has a high positive skewness value of 0.308, meaning that most respondents *disagreed* and *strongly disagreed* with the questions on its role in the implementation of SCT in healthcare institutions.

Negative skewness was highest for effort expectancy (-0.54), followed by user attitude, social influence, information quality, behavioural intention and SCT implementation (-0.477, -0.282, 0.250, -0.222, and -0.213, respectively). The least negative skewness values are -0.015 and -0.056, respectively, for system quality and trialability. In summary, respondents *agreed* or *strongly agreed* that the factors investigated in this study played a role in the implementation of SCT in healthcare institutions. The next section details structural equation modeling, which intends to explain the relationship among various hypothesised relationships.

5.4 Data Screening

Two types of screening were conducted: responses screening (which included checking for missing data and unengaged responses) and variable screening.

Twenty-three (23) responses were removed from the dataset due to missing data. The missing data were more than a third of the responses that were supposed to be provided; hence, it was appropriate to remove them. Sixteen (16) other incomplete responses were identified but since they had only one or two missing values, they were replaced with the median (Singh & Sharma, 2016).

Unengaged responses were checked. Furthermore, unengaged replies refer to circumstances in which respondents only tick a set number or a majority of the questions in the questionnaire (Ahmed, 2017). Thirty-six (26) responses were removed due to unengaged responses. The standard deviation of the responses was checked according to the rows to check for unengaged responses. All rows with standard deviations less than 0.5 were removed (Gaskin, 2021). The response rate is comparable to that of other public hospitals studies, such as those by Ashish, Gurung, Kinney, Sunny, Moinuddin, Basnet, Paudel, Bhattarai, Subedi, Shrestha and Lawn (2020), Salleh, Zakaria and Abdullah (2016) and Lake, Narva, Holland, Smith, Cramer, Rosenbaum, French, Clark and Rogowski (2022).

Bryne's (2013) skewness and kurtosis methods were used to determine the data's normality. The variables' normality is acceptable when the skewness and kurtosis fall between -2 and +2 (Norman & Streiner, 2008; Byrne, 2010). Items that violated the assumption of normality were removed (EE1, EE3, PE1, PE6, SI2, SI6, FC5, BI5, SQ1, CP5, TR2 and IM3). Table 5.5 represents the normality test of all items before the removal. The highlighted items fall within the acceptable skewness and kurtosis range. The removed items were not used in further analyses.

Table 5. 4: Normality Test

Item	**Cases**	**Mean**	**Median**	**Mode**	**Std. Deviation**	**Skewness**	**Std. Error of Skewness**	**Kurtosis**	**Std. Error of Kurtosis**	**Min**	**Max**
EE1	406	4.2562	4.0000	4.00	0.80025	-1.424	0.121	3.305	0.242	1.00	5.00
EE2	406	4.1207	5.0000	5.00	1.11896	-1.069	0.121	-0.158	0.242	1.00	5.00
EE3	406	4.1478	4.0000	4.00	0.66876	-1.225	0.121	4.511	0.242	1.00	5.00
EE4	406	4.1724	4.0000	4.00	0.83138	-1.057	0.121	0.894	0.242	2.00	5.00
EE5	406	4.0640	4.0000	5.00	1.03558	-0.987	0.121	-0.176	0.242	2.00	5.00
EE6	406	4.4507	5.0000	5.00	0.64121	-1.029	0.121	1.223	0.242	2.00	5.00
PE1	406	4.1798	4.0000	4.00	0.60015	-0.643	0.121	2.127	0.242	2.00	5.00
PE2	406	4.3966	5.0000	5.00	0.70825	-0.866	0.121	-0.055	0.242	2.00	5.00
PE3	406	4.1158	4.0000	4.00	0.75940	-0.367	0.121	-0.685	0.242	2.00	5.00
PE4	406	4.3473	4.0000	5.00	0.69216	-0.809	0.121	0.329	0.242	2.00	5.00
PE5	406	4.0911	4.0000	4.00	0.67335	-0.159	0.121	-0.622	0.242	2.00	5.00
PE6	406	4.5493	5.0000	5.00	0.64505	-1.571	0.121	3.381	0.242	1.00	5.00
SI1	406	3.6897	4.0000	4.00	0.76481	-0.540	0.121	0.424	0.242	1.00	5.00
SI2	406	4.4704	5.0000	5.00	0.72885	-1.454	0.121	2.469	0.242	1.00	5.00
SI3	406	3.7167	4.0000	4.00	0.94075	-0.409	0.121	-0.679	0.242	2.00	5.00
SI4	406	4.2808	4.0000	4.00	0.70271	-0.926	0.121	1.708	0.242	1.00	5.00

Item	Cases	Mean	Median	Mode	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Min	Max
SI5	406	4.2118	4.0000	4.00	0.83412	-1.158	0.121	1.124	0.242	2.00	5.00
SI6	406	4.3916	4.0000	4.00	0.65684	-1.144	0.121	2.893	0.242	1.00	5.00
FC1	406	3.3005	4.0000	4.00	1.06498	-0.931	0.121	0.314	0.242	1.00	5.00
FC2	406	3.5025	4.0000	4.00	1.13039	-0.161	0.121	-1.349	0.242	1.00	5.00
FC3	406	3.5394	4.0000	4.00	1.25597	-0.867	0.121	-0.136	0.242	1.00	5.00
FC4	406	4.347	4.000	5.0	0.7536	-1.053	0.121	0.978	0.242	1.0	5.0
FC5	406	4.0517	4.0000	4.00	0.69905	-0.768	0.121	2.033	0.242	1.00	5.00
FC6	406	3.7906	4.0000	4.00	1.05550	-0.650	0.121	-0.778	0.242	2.00	5.00
BI1	406	3.4704	4.0000	4.00	1.14519	-1.181	0.121	0.237	0.242	1.00	5.00
BI2	406	4.0567	4.0000	5.00	1.10185	-1.326	0.121	1.360	0.242	1.00	5.00
BI3	406	3.9384	4.0000	4.00	1.09484	-1.352	0.121	1.310	0.242	1.00	5.00
BI4	406	4.1355	4.0000	5.00	0.95781	-0.935	0.121	-0.089	0.242	2.00	5.00
BI5	406	3.9581	4.0000	4.00	0.73078	-1.118	0.121	2.085	0.242	1.00	5.00
BI6	406	4.1232	4.0000	4.00	0.88867	-0.944	0.121	0.386	0.242	1.00	5.00
UA1	406	3.8300	4.0000	4.00	0.90714	-0.934	0.121	0.263	0.242	1.00	5.00
UA2	406	3.9532	4.0000	5.00	1.04245	-0.629	0.121	-0.761	0.242	1.00	5.00
UA3	406	3.6182	4.0000	4.00	1.28411	-0.925	0.121	-0.283	0.242	1.00	5.00
UA4	406	3.8448	4.0000	4.00	1.11911	-1.093	0.121	0.563	0.242	1.00	5.00

Item	Cases	Mean	Median	Mode	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Min	Max
UA5	406	3.7340	4.0000	4.00	1.21236	-0.865	0.121	-0.299	0.242	1.00	5.00
UA6	406	4.1724	4.0000	4.00	0.75348	-0.818	0.121	0.880	0.242	1.00	5.00
SQ1	406	4.0394	4.0000	4.00	0.56953	-0.719	0.121	4.009	0.242	1.00	5.00
SQ2	406	4.2611	4.0000	5.00	0.91399	-1.242	0.121	0.859	0.242	1.00	5.00
SQ3	406	4.1281	4.0000	4.00	0.91805	-0.949	0.121	0.145	0.242	2.00	5.00
SQ4	406	4.0197	4.0000	4.00	1.03021	-0.897	0.121	-0.263	0.242	1.00	5.00
SQ5	406	3.5123	4.0000	4.00	0.83952	-0.366	0.121	-0.432	0.242	1.00	5.00
SQ6	406	4.0640	4.0000	4.00	0.84376	-1.039	0.121	1.009	0.242	1.00	5.00
SU1	406	3.7783	4.0000	4.00	0.90000	-0.692	0.121	-0.189	0.242	2.00	5.00
SU2	406	4.0739	4.0000	4.00	0.87176	-0.840	0.121	0.285	0.242	1.00	5.00
SU3	406	4.1897	4.0000	4.00	0.86123	-1.121	0.121	0.862	0.242	2.00	5.00
SU4	406	3.9581	4.0000	4.00	1.00159	-0.849	0.121	-0.221	0.242	1.00	5.00
SU5	406	3.8941	4.0000	4.00	0.95897	-0.783	0.121	-0.160	0.242	1.00	5.00
SU6	406	4.3719	4.0000	4.00	0.63409	-0.619	0.121	-0.005	0.242	2.00	5.00
IQ1	406	3.9680	4.0000	4.00	0.83235	-0.792	0.121	0.506	0.242	1.00	5.00
IQ2	406	4.3596	4.5000	5.00	0.73619	-0.943	0.121	0.570	0.242	1.00	5.00
IQ3	406	3.9581	4.0000	4.00	0.85532	-0.705	0.121	0.181	0.242	1.00	5.00
IQ4	406	4.2167	4.0000	4.00	0.72508	-0.629	0.121	0.267	0.242	1.00	5.00

Item	Cases	Mean	Median	Mode	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Min	Max
IQ5	406	4.0099	4.0000	4.00	0.81946	-0.938	0.121	1.068	0.242	1.00	5.00
IQ6	406	3.9581	4.0000	4.00	0.86394	-0.727	0.121	0.073	0.242	2.00	5.00
US1	406	3.9655	4.0000	4.00	0.57846	-0.384	0.121	1.250	0.242	2.00	5.00
US2	406	3.9631	4.0000	5.00	1.18264	-0.702	0.121	-1.069	0.242	2.00	5.00
US3	406	4.0468	4.0000	4.00	0.58396	-0.379	0.121	1.350	0.242	2.00	5.00
US4	406	4.1798	4.0000	5.00	0.93475	-1.058	0.121	0.353	0.242	1.00	5.00
US5	406	4.0616	4.0000	4.00	0.82171	-1.081	0.121	1.421	0.242	1.00	5.00
US6	406	4.0936	4.0000	4.00	0.85843	-1.193	0.121	1.427	0.242	1.00	5.00
SYQ1	406	3.5739	4.0000	4.00	1.04855	-0.487	0.121	-0.620	0.242	1.00	5.00
SYQ2	406	3.1182	3.0000	2.00	1.16780	0.077	0.121	-0.958	0.242	1.00	5.00
SYQ3	406	3.6281	4.0000	4.00	1.00718	-0.500	0.121	-0.528	0.242	1.00	5.00
SYQ4	406	3.4704	4.0000	4.00	1.19582	-0.457	0.121	-0.811	0.242	1.00	5.00
SYQ5	406	3.5739	4.0000	4.00	1.12358	-0.868	0.121	0.049	0.242	1.00	5.00
SYQ6	406	4.0911	4.0000	4.00	0.75625	-0.910	0.121	1.523	0.242	1.00	5.00
C1	406	3.6502	4.0000	4.00	0.86970	-0.570	0.121	-0.352	0.242	2.00	5.00
C2	406	4.1059	4.0000	4.00	0.91685	-0.945	0.121	0.348	0.242	1.00	5.00
C3	406	3.8571	4.0000	4.00	0.97337	-0.727	0.121	-0.313	0.242	1.00	5.00
C4	406	4.0123	4.0000	4.00	0.86772	-0.821	0.121	0.334	0.242	1.00	5.00

Item	Cases	Mean	Median	Mode	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Min	Max
C5	406	3.9581	4.0000	4.00	0.90033	-0.672	0.121	-0.214	0.242	2.00	5.00
C6	406	3.7906	4.0000	4.00	1.08776	-1.265	0.121	1.081	0.242	1.00	5.00
CP1	406	3.8227	4.0000	4.00	0.70838	-0.905	0.121	1.170	0.242	2.00	5.00
CP2	406	3.8744	4.0000	5.00	1.22181	-0.983	0.121	0.026	0.242	1.00	5.00
CP3	406	4.2020	4.0000	4.00	0.67300	-0.704	0.121	1.330	0.242	1.00	5.00
CP4	406	3.8768	4.0000	4.00	1.01573	-0.646	0.121	-0.594	0.242	1.00	5.00
CP5	406	4.1724	4.0000	4.00	0.62840	-0.688	0.121	2.161	0.242	1.00	5.00
CP6	406	4.0690	4.0000	4.00	0.98139	-1.005	0.121	0.075	0.242	2.00	5.00
TR1	406	3.6207	4.0000	4.00	0.95269	-0.624	0.121	-0.655	0.242	2.00	5.00
TR2	406	4.1897	4.0000	5.00	1.05690	-1.659	0.121	2.560	0.242	1.00	5.00
TR3	406	4.0887	4.0000	4.00	0.85895	-0.923	0.121	0.456	0.242	2.00	5.00
TR4	406	4.0714	4.0000	4.00	0.83877	-0.817	0.121	0.308	0.242	2.00	5.00
TR5	406	4.0271	4.0000	4.00	0.82657	-0.921	0.121	0.706	0.242	2.00	5.00
TR6	406	4.1995	4.0000	4.00	0.87042	-1.143	0.121	0.957	0.242	1.00	5.00
IM1	406	3.8079	4.0000	4.00	0.90950	-0.877	0.121	0.225	0.242	1.00	5.00
IM2	406	4.2414	4.0000	5.00	0.89766	-1.091	0.121	0.411	0.242	2.00	5.00
IM3	406	4.2167	4.0000	4.00	0.58989	-0.674	0.121	2.933	0.242	1.00	5.00

Item	Cases	Mean	Median	Mode	Std. Deviation	Skewness	Std. Error of Skewness	Kurtosis	Std. Error of Kurtosis	Min	Max
IM4	406	4.0665	4.0000	4.00	0.82732	-0.361	0.121	-0.746	0.242	1.00	5.00
IM5	406	3.8892	4.0000	4.00	0.94283	-0.879	0.121	0.069	0.242	1.00	5.00
IM6	406	4.2635	4.0000	4.00	0.81771	-1.228	0.121	1.357	0.242	2.00	5.00

5.5 Preliminary Analysis

5.5.1 Reliability Analysis

The degree of approximation of repeated measurements under the same conditions is referred to as scale reliability. It is used to assess scale consistency and stability and can change over time and between respondents. External and internal reliability are both included in the term reliability. The former refers to the consistency of the constituents in the scale's items, while the latter pertains to interrater and inter-rater reliability. At this stage, the internal consistency of the scale items was assessed. Lucas, Tucker, Grosse and Norouzi (2019) state the acceptable reliability coefficient is above 0.700. In this section, the reliability of all the scales is presented. To demonstrate the reason for the removal of some scales and even a variable chronologically. In this section, the item-total statistics tables are presented including the prevailing reliability coefficient and the final after some items were removed.

5.5.1.1 Reliability of the Effort Expectancy Scale

Table 5. 5: Item-total statistics (Effort Expectancy)

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's alpha if Item Deleted**
EE2	12.6872	2.176	0.517	0.001
EE4	12.6355	3.837	0.186	0.431
EE5	12.7438	2.428	0.506	0.045
EE6	12.3571	5.252	-0.180	0.739
Current reliability (α) = 0.443				
Decision: Reliability (α) after removing EE6 = 0.739				

The effort expectancy scale was measured by six items. Due to unengaged and missing responses, the first and third attempts were removed. The reliability of effort expectancy was 0.443. Item EE6 was removed since the item-total correlation was negative. Its removal increased the reliability of the scale to 0.739.

5.5.1.2 Reliability of the Performance Expectancy Scale

Table 5. 6: Item-total statistics (Performance Expectancy)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
PE2	12.5542	1.295	0.079	-.249a
PE3	12.8350	1.936	-0.279	0.389
PE4	12.6034	1.302	0.090	-.265a
PE5	12.8596	1.326	0.093	-.262a
Current reliability (α) = -0.061				
Decision: to remove the variable completely				

The performance expectancy scale was removed because all the items were found not to hold well with any other. Low correlations (all below 0.100) show that the scale is not internally consistent. It was, therefore, appropriate to remove the scale at this stage of the analysis.

5.5.1.3 Reliability of the Social Influence Scale

Table 5. 7: Item-total statistics (Social Influence)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
SI1	12.2094	2.546	0.596	0.278
SI3	12.1823	2.149	0.562	0.262
SI4	11.6182	4.069	0.008	0.702
SI5	11.6872	3.065	0.282	0.539
Current reliability (α) = 0.560				
Decision: Reliability (α) after removing EE6 = 0.702				

It was decided to remove SI4 because it had a very low correlation with the total set of items. Its correlation was 0.008. The scale's reliability increased from 0.560 to an acceptable level of 0.702 once it had been removed.

5.5.1.4 Reliability of The Scale for Facilitating Condition

Table 5. 8: Item-total statistics (Facilitating Conditions)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
FC1	15.1798	8.548	0.540	0.626
FC2	14.9778	7.128	0.769	0.511
FC3	14.9409	6.999	0.672	0.553
FC4	14.1330	14.328	-0.324	0.858
FC6	14.6897	7.805	0.700	0.555
Current reliability (α) = 0.707				
Decision: Reliability (α) after removing FC4 = 0.858				

The FC scale which already had one item (FC5) removed due to missing values had acceptable reliability of 0.707. Nonetheless, one item (FC4) had to be removed because it had a negative item–total correlation. This suggests that the item had a negative relationship with the entire scale.

5.5.1.5 Reliability of the Behavioral Intention Scale

Table 5. 9: Item-total statistics (Behavioural Intention)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
BI1	16.2537	6.531	0.643	0.492
BI2	15.6675	7.264	0.527	0.559
BI3	15.7857	7.413	0.502	0.572
BI4	15.5887	8.865	0.320	0.654
BI6	15.6010	10.181	0.112	0.725
Current reliability (α) = 0.665				
Decision: Reliability (α) after removing BI6 = 0.725				

The BI scale had a reliability of 0.665 and needed to be improved. It was found that after removing BI6 which had a low correlation, the reliability would move up to 0.725, hence it was removed.

5.5.1.6 Reliability of the User Attitude Scale

Table 5. 10: Item-total statistics (User Attitude)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
UA1	19.3227	12.777	0.478	0.661
UA2	19.1995	14.555	0.133	0.755
UA3	19.5345	9.820	0.650	0.588
UA4	19.3079	11.349	0.544	0.634
UA5	19.4187	10.560	0.593	0.613
UA6	18.9803	14.597	0.267	0.712
Current reliability (α) = 0.708				
Decision: Reliability (α) after removing UA2 and UA 6 = 0.725				

The UA scale had a total number of six items. The reliability was 0.708 after running the reliability analysis. Although this scale is acceptable, it was prudent to remove UA2 and UA6 since their item-total correlations were quite low.

5.5.1.7 Reliability of the Service Quality Scale

Table 5. 11: Item-total statistics (Service Quality)

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's alpha if Item Deleted**
SQ2	15.7241	5.252	0.534	0.490
SQ3	15.8571	5.180	0.551	0.480
SQ4	15.9655	5.707	0.316	0.610
SQ5	16.4729	7.934	-0.066	0.753
SQ6	15.9212	5.060	0.673	0.426
Current reliability (α) = 0.626				
Decision: Reliability (α) after removing SQ5 = 0.753				

The reliability analysis of the SQ scale was also conducted. The reliability of the scale was 0.626. The SQ5 scale was deleted since it had a negative correlation with the overall scale, bringing the scale reliability to 0.753.

5.5.1.8 Reliability of the System Use Scale

Table 5. 12: Item-total statistics (System Use)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
SU1	20.4877	5.263	0.429	0.341
SU2	20.1921	5.504	0.387	0.370
SU3	20.0764	7.113	-0.002	0.566
SU4	20.3079	5.379	0.315	0.406
SU5	20.3719	4.911	0.474	0.304
SU6	19.8941	7.848	-0.114	0.576
Current reliability (α) = 0.491				
Decision: Reliability (α) after removing SU2, SU3 and SU6 = 0.714				

The SU scale had quite a low level of reliability (0.491). After observing the low and negative item-total correlations of SU6, SU3 and SU2, they were removed. Therefore, the final scale reliability was 0.714.

5.5.1.9 Reliability of the Information Quality Scale

Table 5. 13: Item-total statistics (Information Quality)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
IQ1	20.5025	5.683	0.444	0.542
IQ2	20.1108	6.780	0.212	0.629
IQ3	20.5123	5.312	0.531	0.502
IQ4	20.2537	7.237	0.096	0.665
IQ5	20.4606	5.217	0.600	0.474
IQ6	20.5123	6.226	0.270	0.615
Current reliability (α) = 0.623				

Decision: Reliability (α) after removing IQ4 and IQ2 = 0.717

None of the items of the IQ scale were removed at the first stage but at the stage of reliability checks, IQ2 and IQ4 were removed to improve the reliability. The final reliability was 0.717 which is acceptable.

5.5.1.10 Reliability of the User Satisfaction Scale

Table 5. 14: Item-total statistics (User Satisfaction)

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's alpha if Item Deleted**
US1	20.3448	7.772	0.271	0.603
US2	20.3473	4.686	0.565	0.460
US3	20.2635	7.883	0.230	0.613
US4	20.1305	6.578	0.319	0.587
US5	20.2488	7.649	0.144	0.648
US6	20.2167	5.711	0.617	0.457
Current reliability (α) = 0.648				
Decision: Reliability (α) after removing US1, US3 and US5 = 0.709				

The reliability of the US scale was 0.648. However, after the US5, US3 and then US1 had been removed, the dependability increased to 0.709. The removal was done independently and after each removal, the reliability was checked.

5.5.1.11 Reliability of the System Quality Scale

Table 5. 15: Item-total statistics (System Quality)

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's alpha if Item Deleted**
SYQ1	17.8818	12.949	0.221	0.705
SYQ2	18.3374	10.876	0.451	0.632

SYQ3	17.8276	11.234	0.513	0.613
SYQ4	17.9852	11.081	0.402	0.651
SYQ5	17.8818	10.905	0.478	0.622
SYQ6	17.3645	12.558	0.482	0.636
Current reliability (α) = 0.685				
Decision: Reliability (α) after removing SYQ1 = 0.705				

The reliability of the SYQ scale was improved after the SYQ1 had been removed. Thereafter, the final dependability was 0.705.

5.5.1.12 Reliability of the Communication Scale

Table 5. 16: Item-total statistics (Communication)

	Scale Mean if Item Deleted	**Scale Variance if Item Deleted**	**Corrected Item-Total Correlation**	**Cronbach's alpha if Item Deleted**
C1	19.7241	7.242	0.647	0.467
C2	19.2685	8.755	0.263	0.615
C3	19.5172	7.949	0.388	0.567
C4	19.3621	11.027	-0.131	0.736
C5	19.4163	7.814	0.477	0.533
C6	19.5837	6.604	0.579	0.472
Current reliability (α) = 0.624				
Decision: Reliability (α) after removing C4 = 0.736				

The communication scale recorded a reliability of 0.736 after the C4 variable had been removed because it was found to inversely relate with the rest of the items.

5.5.1.13 Reliability of the Compatibility Scale

Table 5. 17: Item-total statistics (Compatibility)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
CP1	16.0222	7.385	0.355	0.622
CP2	15.9704	5.782	0.337	0.653
CP3	15.6429	8.551	0.063	0.711
CP4	15.9680	5.369	0.606	0.486
CP6	15.7759	5.113	0.716	0.426
Current reliability (α) = 0.650				
Decision: Reliability (α) after removing CP3 = 0.711				

The CP scale recorded initial reliability of 0.650. Item CP3 had a very low item-total correlation of 0.063, hence it was removed. The reliability increased to 0.711 as a result of this action.

5.5.1.14 Reliability of the Trialability Scale

Table 5. 18: Item-total statistics (Trialability)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's alpha if Item Deleted
TR1	16.4877	6.784	0.458	0.692
TR2	15.9187	5.749	0.611	0.625
TR4	16.0369	6.742	0.578	0.648
TR5	16.0813	8.312	0.203	0.774
TR6	15.9089	6.473	0.617	0.631
Current reliability (α) = 0.727				
Decision: Maintain all five (5) items at this stage				

All remaining five items on the TR scale were retained because at this stage, the reliability of the scale was acceptable.

5.5.1.15 Reliability of the Implementation Scale

Table 5. 19: Item-Total Statistics (Implementation)

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
IM1	16.4606	5.711	0.610	0.622
IM2	16.0271	6.708	0.360	0.723
IM4	16.2020	7.505	0.221	0.766
IM5	16.3793	5.456	0.646	0.604

IM6	16.0049	6.064	0.610	0.628
Current reliability (α) = 0.723				
Decision: Maintain all five items at this stage				

All items in the IM scale, apart from IM3 which had already been removed due to unengaged responses, were maintained at this stage. Even though IM4 showed a low correlation with the entire scale, it was maintained at this point because further analysis may necessitate item removal. At this stage, the following fifty-six (56) items qualify for the exploratory factor analysis: EE2, EE4, EE5, SI1, SI3, SI5, FC1, FC2, FC3, FC6, BI1, BI2, BI3, BI4, UA1, UA3, UA4, UA5, SQ2, SQ3, SQ4, SQ6, SU1, SU4, SU5, IQ1, IQ3, IQ5, IQ6, US2, US4, US6, SYQ2, SYQ3, SYQ4, SYQ5, SYQ6, C1, C2, C3, C5, C6, CP1, CP2, CP4, CP6, TR1, TR2, TR4, TR5, TR6, IM1, IM2, IM4, IM5 and IM6.

5.6 Exploratory Factor Analysis (EFA)

Factor analysis is a method of modeling the covariation among a set of observed variables as a function of one or more latent constructs (Bandolos & Finney, 2019). Factor analysis is used for determining the nature of the latent constructs that underpin the variables of interest (Bandolos & Finney, 2019). Chattopadhyay (2018) explains that factor analysis seeks to identify underlying variables or factors, that explain the pattern of correlations within a set of observed variables or construct items. One common goal of factor analysis is to produce a small number of factors that can be used to replace a much larger number of variables (Comrey & Lee, 2016). Factor analysis is a data reduction technique that aims to find a small number of factors that account for the majority of the variance seen in a large number of manifest variables (Mukherjee, Sinha & Chattopadhyay, 2018). This means that at the end of factor analysis the researcher would be left with variables that explain most of the variance while those that explain the least variance are discarded.

The study extracted factors using the principal components analysis (PCA) method. PCA's goal is to find a sequence of orthogonal factors that represent the directions of the greatest variance (Liu et al., 2016). PCA was used because it can form uncorrelated linear combinations of the observed variables. It can also be employed when a correlation matrix is unique to obtain the initial factor solution. As a factor rotation method, a direct Oblimin method was used because the literature suggested some theoretical grounds that imply that the factors in this study are related or correlated during theory development. The study chose to display the coefficients in order of size and suppress coefficients with absolute values less than 0.4. In this study, the following output was extracted and explained: correlation matrix, Kaiser-Meyer-Olkin and Bartlett's test, Factor Extraction and Rotated Pattern Matrix.

EFA was conducted using maximum likelihood with Promax rotation to determine if the items loaded well on the variables and correlated adequately. To estimate the unique variance among items and the correlation between factors, maximum likelihood estimation was used. Following Pallant (2016), a goodness of fit test for the factor solution Promax was chosen due to the large dataset (n=406) and the fact that it can account for correlated factors. The fourteen-factor pattern matrix (Table 5.24) below shows the outcome of the factor analysis. Before the factor analysis, Bartlett's test of sphericity and Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was assessed. The results revealed a KMO of 0.949 and Bartlet's test is significant at α=0.000 with a Chi-square of 20225.791, indicating the suitability of conducting exploratory factor analysis (Kaiser, 1974). Items that did not show high loadings were removed (EE4, IQ6, SYQ4 and SYQ5).

5.6.1 Correlation Matrix

The correlation matrix was the first to be interpreted since the correlation matrix tables generated were too huge to display because there were so many components evaluated in this study. The questionnaire contained 55 total questions (factors) and the study chose to focus on correlations rather than the determinant statistic. Furthermore, the correlation matrix revealed that the highest correlation coefficient, 0.773, was found between BI1 and FC1. The rest of the coefficients were less than 0.773. The correlation matrix's determinant was found to be 0.713E-23, which is less than the required value of 0. 00001. This implies that there may be a problem of multicollinearity with the data used in this study.

5.6.2 Kaiser–Meyer–Olkin and Bartlett's Tests

The Kaiser–Meyer–Olkin (KMO) and Bartlett's tests were the second results of the PCA factor analysis. The KMO statistic ranges from nil (0) to one (1). The value of KMO should be close to one rather than nil for factor analysis to be effective. A value close to one indicates that correlation patterns are relatively compact, implying that factor analysis should yield distinct and reliable factors. Kaiser (1974) suggests that values greater than 0.5 be accepted. Furthermore, values between 0.5 and 0.7 are considered mediocre, values between 0.7 and 0.8 are considered very good, values between 0.8 and 0.9 are very good, and values greater than 0.9 are considered superb (Dhagarra, Goswami & Kumar, 2020).

The KMO statistic value for the data used in this study was 0.949, as shown in Table 5.21. The researcher can be confident that factor analysis is acceptable for this data because the value is in the superb range.

Table 5. 20: KMO and Bartlett's test

Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		0.949
Bartlett's Test of Sphericity	Approx. Chi-Square	20225.791
	df	1485
	Sig.	**0.000**

5.6.3 Communalities

Communalities explain how items are related to the variables. Pallant (2010) suggests that an item's communality values of less than .3 should be removed. The communality figures are between 0.716 and 0.864, as shown in Table 5.22.

Table 5. 21: Communalities

	Initial	**Extraction**
EE2	1.000	0.783
EE4	1.000	0.768
EE5	1.000	0.779
SI1	1.000	0.794
SI3	1.000	0.784
SI5	1.000	0.757
FC1	1.000	0.809
FC2	1.000	0.762
FC3	1.000	0.844
FC6	1.000	0.836
BI1	1.000	0.861
BI2	1.000	0.795
BI3	1.000	0.830
BI4	1.000	0.721
UA1	1.000	0.793
UA3	1.000	0.829
UA4	1.000	0.777
UA5	1.000	0.838
SQ2	1.000	0.771
SQ3	1.000	0.754
SQ4	1.000	0.763
SQ6	1.000	0.749
SU1	1.000	0.823
SU4	1.000	0.756
SU5	1.000	0.803
IQ1	1.000	0.775
IQ3	1.000	0.749
IQ5	1.000	0.840
IQ6	1.000	0.720
US2	1.000	0.831
US4	1.000	0.795

US6	1.000	0.753
SYQ2	1.000	0.854
SYQ3	1.000	0.810
SYQ4	1.000	0.852
SYQ5	1.000	0.851
SYQ6	1.000	0.864
C1	1.000	0.716
C2	1.000	0.837
C3	1.000	0.804
C5	1.000	0.817
C6	1.000	0.813
CP1	1.000	0.814
CP2	1.000	0.796
CP4	1.000	0.740
CP6	1.000	0.822
TR1	1.000	0.823
TR2	1.000	0.745
TR4	1.000	0.844
TR5	1.000	0.806
TR6	1.000	0.785
IM1	1.000	0.796
IM2	1.000	0.742
IM5	1.000	0.789
IM6	1.000	0.756
Extraction Method: Maximum Likelihood.		

5.6.4 Factor Extraction

The total variance explained output is the third output from *SPSS*. This output displays the Eigenvalues associated with each linear component (factor) before and after rotation. *SPSS* had 55 linear components in the dataset before extraction. Furthermore, this means that Factor 1 accounts for 31.7% of the overall variance. *SPSS* was instructed to only show factors with an Eigenvalue greater than one (1) and these were five (5) factors in total. However, four factors had an Eigenvalue value greater than two (2). This is suggestive of problems with divergence. Thus, more work had to be done on the data to achieve the uniqueness of the variables. In addition, further removal of items was done. Table 5.23 shows the Eigenvalues in terms of the percentage of variance explained. This means that Factor 1 explains 31.7% of the total variance. The cumulative percentage column shows the total percentage of variance explained by the current factor and the factors that came before it.

Table 5.23 shows that Factors 1 to 14 explain 79.492% of the total variance.

Table 5. 22: Total Variance Explained

Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.452	31.730	31.730	17.452	31.730	31.730
2	8.645	15.719	47.449	8.645	15.719	47.449
3	5.483	9.968	57.417	5.483	9.968	57.417
4	4.133	7.515	64.933	4.133	7.515	64.933
5	1.873	3.405	68.338	1.873	3.405	68.338
6	0.903	1.641	69.979	0.903	1.641	69.979
7	0.803	1.461	71.440	0.803	1.461	71.440
8	0.793	1.441	72.881	0.793	1.441	72.881
9	0.692	1.258	74.139	0.692	1.258	74.139
10	0.668	1.214	75.353	0.668	1.214	75.353
11	0.593	1.078	76.431	0.593	1.078	76.431
12	0.589	1.070	77.502	0.589	1.070	77.502
13	0.552	1.004	78.506	0.552	1.004	78.506
14	0.543	0.986	79.492	0.543	0.986	79.492
15	0.529	0.961	80.453			
16	0.523	0.952	81.405			

17	0.498	0.906	82.311			
18	0.481	0.875	83.186			
19	0.469	0.852	84.038			
20	0.442	0.804	84.842			
21	0.433	0.787	85.629			
22	0.425	0.773	86.403			
23	0.401	0.730	87.132			
24	0.384	0.699	87.831			
25	0.358	0.651	88.482			
26	0.354	0.643	89.126			
27	0.341	0.621	89.747			
28	0.319	0.580	90.326			
29	0.318	0.578	90.904			
30	0.301	0.547	91.451			
31	0.290	0.527	91.978			
32	0.279	0.507	92.485			
33	0.274	0.498	92.983			
34	0.262	0.476	93.459			
35	0.253	0.460	93.918			
36	0.246	0.447	94.365			
37	0.236	0.430	94.795			
38	0.235	0.428	95.223			
39	0.223	0.406	95.629			
40	0.209	0.381	96.010			
41	0.200	0.364	96.373			
42	0.193	0.351	96.725			
43	0.183	0.333	97.057			
44	0.175	0.318	97.376			
45	0.171	0.312	97.687			
46	0.167	0.303	97.991			
47	0.158	0.288	98.278			
48	0.145	0.264	98.542			

49	0.140	0.254	98.797			
50	0.127	0.230	99.027			
51	0.122	0.221	99.248			
52	0.110	0.200	99.448			
53	0.104	0.189	99.637			
54	0.100	0.183	99.820			
55	0.099	0.180	100.000			
Extraction method: Principal component analysis.						

5.6.5 Rotated Pattern Matrix

The rotated pattern matrix table shown in Table 5.24 is the final and most important output to be explained. The rotated pattern matrix provides factor loadings for each variable onto each factor, allowing for a summary of the factors to consider or eliminate for future analysis. To purify the measurement items, a minimum factor loading of 0.4 was used as a criterion (Hair et al., 2008; Clossey, Hu, Gillen, Rosky, Zinn & Bolger, 2019). Furthermore, all item loadings greater than 0.3 represent a level commonly regarded as significant. Therefore, factors with factor loadings of less than 0.4 were excluded from the output, resulting in gaps in the table. In addition, it resulted in the output being sorted or arranged according to the size of the factor loadings. Factors were considered to belong to a component that had the highest loading, for example, IQ6 loaded on both components four (4) and component ten (10); however, its highest loading was on component ten. IQ6 was considered to have belonged to component ten. In the process of further data analysis, the highlighted items were removed.

Table 5. 23: Pattern Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
EE5	0.854													
EE2	0.805													
EE4														
SI5		0.415												
SI3		0.836												
SI1		0.785												
FC6			0.814											
FC5			0.336											
FC3			0.858											
FC2			0.804											
FC1			0.647											
BI5				0.537										
BI3				0.838										
BI2				0.717										
BI1				0.796										
UA5					0.812									

UA4					0.509									
UA3					0.639									
UA1					0.773									
SQ6						0.771								
SQ4						0.451								
SQ3						0.743								
SQ2						0.701								
SU1							0.792							
SU4							0.708							
SU5							0.557							
IQ1								0.610						
IQ3								0.772						
IQ5								0.709						
US2									0.685					
US4									0.584					
US6									0.790					
IQ6				0.562					0.508					
SYQ2										0.294				

SYQ3										0.344				
SYQ6										0.376				
SYQ4						0.320				0.371				
SYQ5														
C1											0.761			
C2														
C3											0.434			
C5											0.634			
C6											0.824			
CP1												0.451		
CP2												0.551		
CP4												0.714		
CP6												0.872		
TR1													0.610	
TR2													0.768	
TR3														
TR4													0.684	
TR5														

TR6													0.701	
IM1														0.840
IM2														0.380
IM3														0.330
IM5														0.801
IM6														0.651

5.7 Test for Assumptions on Structural Equation Modeling (SEM)

Some assumptions had to be examined before using the SEM in this study. This section examines the assumptions to determine whether structural equation modeling and the paired sample t-test, which were the most commonly used analytic methods in this study, were suitable. The assumptions were multivariate normality, multicollinearity, sample size, positive definiteness and univariate normality.

5.7.1 Multivariate Normality

Linear regression was used to test for multivariate normality, with the ID serving as the independent variable and the remaining elements serving as dependent variables. Thereafter, the Mahalanobis distance check was conducted to see if there were any outliers. No case fell below the expected probability level of .001. As a result, no case was ruled out from any further analysis. The Mahalanobis distance considers if there is an outlier after the aggregation of all the items for each case. The analysis of Mardia's coefficient in *AMOS* was used to further investigate multivariate normality. To check for Mardia’s coefficient, according to Yuan, Bentler and Zhang (2005), “in practice, values > 5.00 are indicative of data that are non-normally distributed. In this application, the z-statistic of 26.194 (Refer to Table 5.25) is highly suggestive of nonnormality in the sample” (as cited in (Rogne, Bryne, Johansen & Fossen, 2016). However, as posited by Pallant (2010), a dataset exceeding 30 has a high likelihood of non-normality.

Table 5. 24: Assessment of normality

Variable	Min	Max	Skew	C.R.	Kurtosis	C.R.
IM6	2	5	-1.212	-9.98	1.282	5.278
IM5	1	5	-0.877	-7.225	0.062	0.255
IM3	1	5	-0.67	-5.515	2.89	11.902
IM2	2	5	-1.09	-8.979	0.398	1.639
IM1	1	5	-0.877	-7.22	0.217	0.894
TR6	1	5	-1.139	-9.378	0.937	3.859

TR4	2	5	-0.814	-6.704	0.297	1.222
TR2	1	5	-1.653	-13.615	2.524	10.393
TR1	2	5	-0.625	-5.149	-0.655	-2.699
CP6	2	5	-1.002	-8.253	0.066	0.272
CP4	1	5	-0.646	-5.324	-0.599	-2.468
CP2	1	5	-0.981	-8.08	0.019	0.078
CP1	2	5	-0.904	-7.446	1.153	4.746
C6	1	5	-1.263	-10.405	1.065	4.386
C5	2	5	-0.672	-5.535	-0.225	-0.927
C3	1	5	-0.727	-5.985	-0.323	-1.329
C1	2	5	-0.571	-4.706	-0.356	-1.466
US6	1	5	-1.189	-9.794	1.404	5.782
US4	1	5	-1.054	-8.679	0.34	1.399
US2	2	5	-0.703	-5.794	-1.065	-4.386
IQ5	1	5	-0.935	-7.704	1.038	4.273
IQ3	1	5	-0.704	-5.797	0.162	0.669
IQ1	1	5	-0.79	-6.508	0.493	2.032
SU5	1	5	-0.782	-6.438	-0.171	-0.704
SU4	1	5	-0.849	-6.991	-0.229	-0.943
SU1	2	5	-0.692	-5.702	-0.193	-0.796
SQ2	1	5	-1.237	-10.185	0.838	3.452
SQ3	2	5	-0.946	-7.79	0.135	0.556
SQ4	1	5	-0.895	-7.371	-0.268	-1.105

SQ6	1	5	-1.036	-8.53	0.991	4.079
UA1	1	5	-0.931	-7.664	0.245	1.01
UA3	1	5	-0.924	-7.609	-0.29	-1.193
UA4	1	5	-1.091	-8.987	0.552	2.271
UA5	1	5	-0.864	-7.12	-0.302	-1.243
BI1	1	5	-1.18	-9.722	0.229	0.945
BI2	1	5	-1.324	-10.901	1.336	5.501
BI3	1	5	-1.349	-11.112	1.285	5.29
BI5	1	5	-1.11	-9.143	2.033	8.37
FC1	1	5	-0.931	-7.669	0.303	1.247
FC2	1	5	-0.163	-1.346	-1.348	-5.55
FC3	1	5	-0.867	-7.144	-0.141	-0.582
FC5	1	5	-0.766	-6.307	2.005	8.255
FC6	2	5	-0.65	-5.351	-0.78	-3.213
SI1	1	5	-0.541	-4.455	0.412	1.697
SI3	2	5	-0.41	-3.376	-0.68	-2.798
SI5	2	5	-1.153	-9.499	1.101	4.534
EE2	1	5	-1.068	-8.797	-0.163	-0.672
EE5	2	5	-0.984	-8.101	-0.182	-0.75
Multivariate					129.377	**26.194**

5.7.2 Multicollinearity

To check for multicollinearity, the same regression output was examined. In the collinearity statistics under the coefficients table, the tolerance and variance inflation factors (VIF) were screened for figures <.01 and >10, respectively. The assumption of multicollinearity was satisfied because none of the tolerance figures were less than .01 and the VIF was more than 10 (Menard, 2002).

Table 5. 25: Coefficients

Model				**Standardised Coefficients**	**T**	**Sig.**	**Collinearity Statistics**	
				Beta			Tolerance	VIF
1	(Constant)	101.593	66.270		1.533	0.126		
	EE2	6.927	6.353	0.066	1.090	0.276	0.279	3.581
	EE5	11.376	7.518	0.100	1.513	0.131	0.233	4.294
	SI1	-8.614	8.807	-0.056	-0.978	0.329	0.311	3.214
	SI3	26.286	7.786	0.211	3.376	0.001	0.263	3.801
	SI5	2.129	7.822	0.015	0.272	0.786	0.332	3.016
	FC1	19.140	8.118	0.174	2.358	0.019	0.189	5.296
	FC2	3.900	6.613	0.038	0.590	0.556	0.253	3.959
	FC3	16.502	7.581	0.177	2.177	0.030	0.156	6.423
	FC5	-22.201	7.034	-0.132	-3.156	0.002	0.584	1.713
	FC6	6.517	8.015	0.059	0.813	0.417	0.197	5.070
	BI1	10.349	8.080	0.101	1.281	0.201	0.165	6.067
	BI2	-7.166	6.142	-0.067	-1.167	0.244	0.308	3.244
	BI3	-7.671	8.053	-0.072	-0.952	0.342	0.182	5.508
	BI5	-6.887	8.617	-0.043	-0.799	0.425	0.356	2.809
	UA1	-12.636	9.104	-0.098	-1.388	0.166	0.207	4.832
	UA3	0.728	6.671	0.008	0.109	0.913	0.192	5.200
	UA4	-8.818	6.028	-0.084	-1.463	0.144	0.310	3.224
	UA5	12.169	7.569	0.126	1.608	0.109	0.168	5.966
	SQ2	7.738	6.943	0.060	1.115	0.266	0.351	2.853

	SQ3	-21.321	7.689	-0.167	-2.773	0.006	0.283	3.530
	SQ4	-7.391	6.611	-0.065	-1.118	0.264	0.304	3.286
	SQ6	0.904	7.632	0.006	0.118	0.906	0.340	2.938
	SU1	-9.396	9.001	-0.072	-1.044	0.297	0.215	4.649
	SU4	3.135	7.032	0.027	0.446	0.656	0.285	3.515
	SU5	24.652	6.962	0.201	3.541	0.000	0.317	3.158
	IQ1	4.499	8.627	0.032	0.521	0.602	0.274	3.653
	IQ3	7.193	7.489	0.052	0.960	0.337	0.344	2.907
	IQ5	-18.493	7.460	-0.129	-2.479	0.014	0.378	2.648
	US2	15.869	6.461	0.160	2.456	0.015	0.242	4.137
	US4	3.047	6.521	0.024	0.467	0.641	0.380	2.632
	US5	-12.392	7.079	-0.087	-1.751	0.081	0.417	2.397
	SYQ2	0.962	4.425	0.010	0.217	0.828	0.529	1.892
	SYQ3	-7.585	6.636	-0.065	-1.143	0.254	0.316	3.165
	SYQ4	7.363	6.744	0.075	1.092	0.276	0.217	4.608
	SYQ6	-7.448	6.974	-0.048	-1.068	0.286	0.507	1.971
	C1	-3.670	7.879	-0.027	-0.466	0.642	0.301	3.327
	C3	3.511	6.485	0.029	0.541	0.589	0.354	2.823
	C5	4.679	6.791	0.036	0.689	0.491	0.378	2.649
	C6	2.738	7.282	0.025	0.376	0.707	0.225	4.445
	CP1	-1.944	8.940	-0.012	-0.217	0.828	0.352	2.841
	CP2	8.947	6.047	0.093	1.480	0.140	0.259	3.867
	CP4	-13.824	6.096	-0.120	-2.268	0.024	0.368	2.717
	CP6	18.280	8.186	0.153	2.233	0.026	0.219	4.573
	TR1	5.104	8.212	0.041	0.622	0.535	0.231	4.337
	TR2	14.935	6.641	0.135	2.249	0.025	0.287	3.490
	TR4	8.658	7.063	0.062	1.226	0.221	0.402	2.487
	TR6	-11.353	7.211	-0.084	-1.574	0.116	0.358	2.791
	IM1	3.700	8.772	0.029	0.422	0.673	0.222	4.509
	IM2	5.644	6.522	0.043	0.865	0.387	0.412	2.429
	IM3	-14.727	7.988	-0.074	-1.844	0.066	0.636	1.573

	IM5	-7.803	8.056	-0.063	-0.969	0.333	0.245	4.088
	IM6	-19.703	8.290	-0.137	-2.377	0.018	0.307	3.256
a. Dependent Variable: ID								

5.7.3 Sample size

An internet calculator was utilised to determine the proper sample size for structural equation modeling (SEM) (Zewdie, Nigusie, Wolde, Mazengia, Belaineh, Habtie & Kassa, 2022). After calculation, the minimum sample size generated was 104. The sample size for SEM for all three studies is appropriate because the 406 cases greatly exceed the minimum number of cases needed.

5.7.4 Positive definiteness

Factor analysis was used to ensure that the assumption of positive definiteness was not violated. Under the correlation matrix table 5.26, the determinant value should not be equal to nil. The observed determinant was not equal to nil (0.713^{-23}), therefore, the assumption of positive definiteness was not violated for the study.

5.7.5 Univariate Normality

The variables were analysed in *SPSS* for significance using the Shapiro–Wilk test to determine univariate normality. If the significance value is <.05, then, we accept the null hypothesis that the data ID is significantly different from a normal distribution (Shapiro & Wilk, 1965; Park, 2015). All of the variables in the study were above the .05 cut-off mark (Pallant, 2010).

5.8 Results of the Confirmatory Factor Analysis

5.8.1 Factor Loadings and Critical Ratios

AMOS 23.0 was additionally used to perform confirmatory factor analysis using maximum likelihood estimation. This is to confirm the components or variables concluded after the exploratory factor analysis. Factor loadings with critical ratios (CR) greater than 1.96, according to Arbuckle (2010), are significant at the 0.5 level and show a reasonable fit to the data. The CFA indicated that the critical ratios are significant because they are all above 1.96. The CFA results are shown in Figure 5.3, which shows the factor loadings and their corresponding ratios.

5.8.2 Initial CFA Model

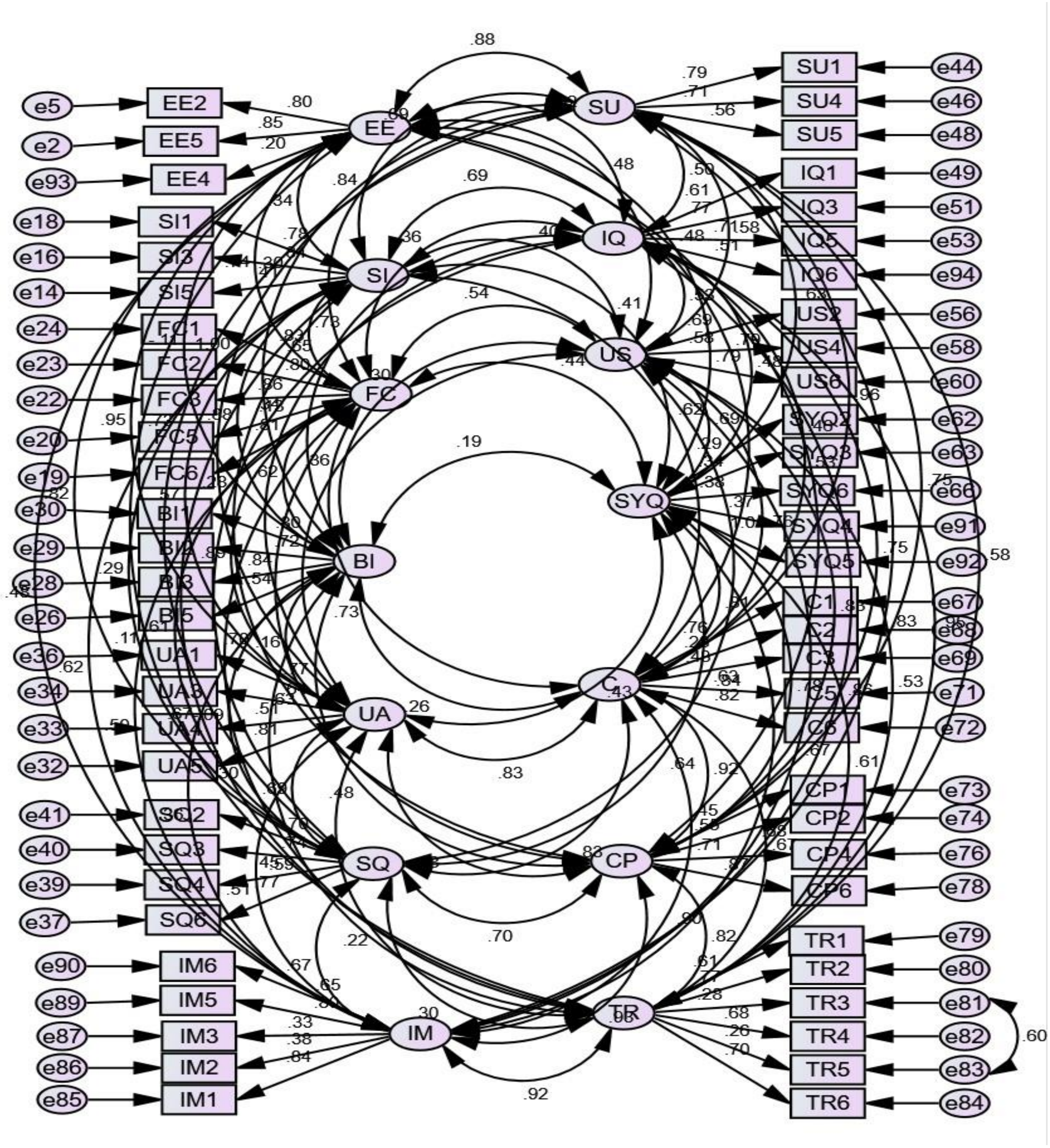


Figure 5. 3: Initial CFA model

The initial CFA showed several anomalies. First, some variables had factor loadings below 0.300. Table 5.27 presents the factor loadings and the significance levels due. It was also necessary to present the table due to the clustered nature of the model. Due to the anomalies, the highlighted items were eliminated from further analysis.

Table 5. 26: Factor loadings and significance of initial CFA

			Estimate	**Standardised Estimate (Factor loadings)**	**S.E.**	**C.R.**	**P**
EE5	<---	EE	1.000	0.854			
EE2	<---	EE	1.019	0.805	0.050	20.251	***
SI5	<---	SI	0.576	0.415	0.069	8.317	***
SI3	<---	SI	1.310	0.836	0.070	18.676	***
SI1	<---	SI	1.000	0.785			
FC6	<---	FC	1.000	0.814			
FC5	<---	FC	0.273	0.336	0.040	6.906	***
FC3	<---	FC	1.252	0.858	0.058	21.434	***
FC2	<---	FC	1.058	0.804	0.054	19.437	***
FC1	<---	FC	0.801	0.647	0.055	14.499	***
BI5	<---	BI	1.000	0.537			
BI3	<---	BI	2.336	0.838	0.200	11.664	***
BI2	<---	BI	2.011	0.717	0.187	10.739	***
BI1	<---	BI	2.319	0.796	0.204	11.366	***
UA5	<---	UA	1.000	0.812			
UA4	<---	UA	0.578	0.509	0.053	10.980	***
UA3	<---	UA	0.835	0.639	0.058	14.415	***
UA1	<---	UA	0.714	0.773	0.039	18.525	***
SQ6	<---	SQ	1.000	0.771			
SQ4	<---	SQ	0.714	0.451	0.079	9.079	***
SQ3	<---	SQ	1.049	0.743	0.066	15.849	***
SQ2	<---	SQ	0.985	0.701	0.067	14.805	***
SU1	<---	SU	1.000	0.792			
SU4	<---	SU	0.997	0.708	0.062	16.180	***
SU5	<---	SU	0.751	0.557	0.062	12.147	***
IQ1	<---	IQ	1.000	0.610			
IQ3	<---	IQ	1.302	0.772	0.103	12.662	***

IQ5	<---	IQ	1.145	0.709	0.096	11.908	***
US2	<---	US	1.000	0.685			
US4	<---	US	0.673	0.584	0.063	10.696	***
US6	<---	US	0.836	0.790	0.060	14.006	***
SYQ2	<---	SYQ	1.000	0.294			
SYQ3	<---	SYQ	1.009	0.344	0.211	4.787	***
SYQ6	<---	SYQ	0.828	0.376	0.166	4.982	***
C1	<---	C	1.157	0.761	0.085	13.614	***
C2	<---	C	0.453	0.283	0.081	5.618	***
C3	<---	C	0.739	0.434	0.088	8.400	***
C5	<---	C	1.000	0.634			
C6	<---	C	1.567	0.824	0.108	14.470	***
CP1	<---	CP	1.000	0.451			
CP2	<---	CP	2.109	0.551	0.267	7.886	***
CP4	<---	CP	2.275	0.714	0.256	8.894	***
CP6	<---	CP	2.679	0.872	0.281	9.540	***
TR1	<---	TR	1.000	0.610			
TR2	<---	TR	1.398	0.768	0.110	12.741	***
TR3	<---	TR	0.415	0.280	0.077	5.381	***
TR4	<---	TR	0.988	0.684	0.084	11.704	***
TR5	<---	TR	0.373	0.262	0.074	5.036	***
TR6	<---	TR	1.051	0.701	0.088	11.926	***
IM1	<---	IM	1.000	0.840			
IM2	<---	IM	0.447	0.380	0.057	7.906	***
IM3	<---	IM	0.255	0.330	0.038	6.792	***
IM5	<---	IM	0.988	0.801	0.049	20.128	***
IM6	<---	IM	0.698	0.651	0.047	14.922	***
SYQ4	<---	SYQ	1.293	0.371	0.261	4.954	***
SYQ5	<---	SYQ	3.298	1.008	0.551	5.986	***
EE4	<---	EE	0.191	0.203	0.047	4.022	***
IQ6	<---	IQ	0.864	0.508	0.095	9.134	***

5.8.3 Final CFA

After the removal had been done, the final CFA model was run. The model showed acceptable indices: x2= 4.490, df = 3; chi sq/df = 3.163; P = 0.122; GFI = 0.955; AGFI = 0.905; CFI = 0.976; RMSEA = 0.43; PCLOSE = 0.316. The final CFA model presents 47 items and 13 variables. This demonstrates the thoroughness of the iterative process. It is important to note that the EE variable was left with two items, however, due to its theoretical significance and the content validity of the two items, it was decided that the variable is maintained. It should be noted that the factor loadings in the final CFA model were greater than 0.400 (Table 5.28).

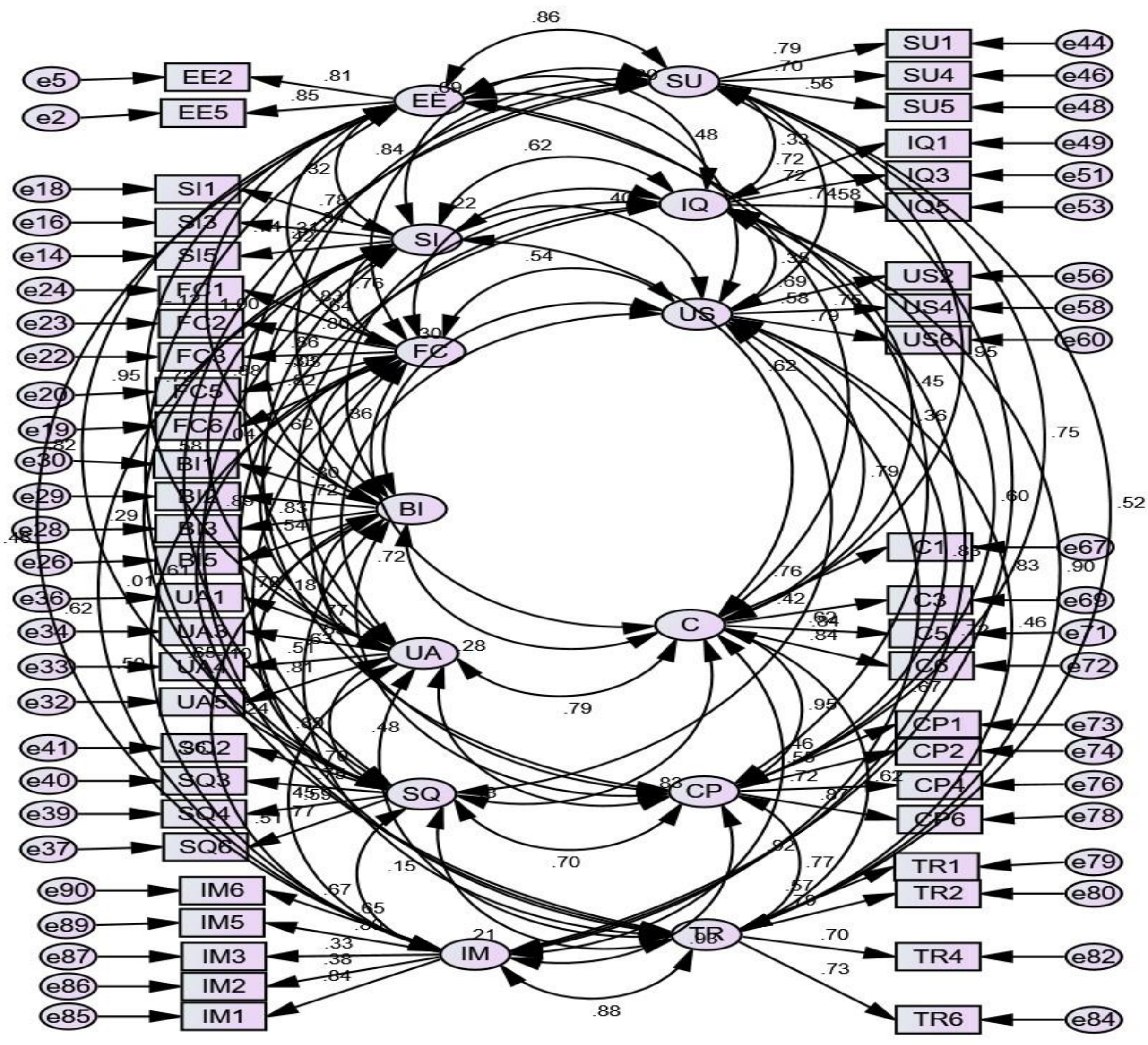


Figure 5. 4: Final CFA model

Table 5. 27: Factor loadings and significance of final CFA

			Estimate	**Standardised Estimate (Factor loadings)**	**S.E.**	**C.R.**	**P**
EE5	<---	EE	1.000	0.846			
EE2	<---	EE	1.031	0.807	0.051	20.158	***
SI5	<---	SI	0.577	0.415	0.069	8.326	***
SI3	<---	SI	1.311	0.836	0.070	18.679	***
SI1	<---	SI	1.000	0.785			
FC6	<---	FC	1.000	0.818			
FC5	<---	FC	0.269	0.333	0.039	6.855	***
FC3	<---	FC	1.248	0.859	0.058	21.688	***
FC2	<---	FC	1.052	0.803	0.054	19.538	***
FC1	<---	FC	0.791	0.642	0.055	14.431	***
BI5	<---	BI	1.000	0.539			
BI3	<---	BI	2.313	0.834	0.197	11.734	***
BI2	<---	BI	1.996	0.715	0.185	10.806	***
BI1	<---	BI	2.319	0.800	0.202	11.489	***
UA5	<---	UA	1.000	0.809			
UA4	<---	UA	0.583	0.511	0.053	10.994	***
UA3	<---	UA	0.849	0.648	0.058	14.584	***
UA1	<---	UA	0.712	0.768	0.039	18.228	***
SQ6	<---	SQ	1.000	0.768			
SQ4	<---	SQ	0.715	0.450	0.079	9.042	***
SQ3	<---	SQ	1.058	0.747	0.067	15.886	***
SQ2	<---	SQ	0.985	0.699	0.067	14.686	***
SU1	<---	SU	1.000	0.794			
SU4	<---	SU	0.987	0.704	0.061	16.069	***
SU5	<---	SU	0.754	0.561	0.062	12.259	***
IQ1	<---	IQ	1.000	0.724			
IQ3	<---	IQ	1.024	0.720	0.072	14.129	***

IQ5	<---	IQ	1.002	0.735	0.069	14.443	***
US2	<---	US	1.000	0.686			
US4	<---	US	0.671	0.583	0.063	10.675	***
US6	<---	US	0.834	0.789	0.060	13.988	***
C1	<---	C	1.181	0.757	0.091	12.989	***
C3	<---	C	0.740	0.423	0.092	8.018	***
C5	<---	C	1.000	0.618			
C6	<---	C	1.637	0.839	0.117	13.982	***
CP1	<---	CP	1.000	0.464			
CP2	<---	CP	2.027	0.545	0.253	8.000	***
CP4	<---	CP	2.217	0.716	0.242	9.147	***
CP6	<---	CP	2.592	0.868	0.264	9.828	***
TR1	<---	TR	1.000	0.566			
TR2	<---	TR	1.550	0.791	0.132	11.754	***
TR4	<---	TR	1.093	0.703	0.100	10.941	***
TR6	<---	TR	1.172	0.726	0.105	11.164	***
IM1	<---	IM	1.000	0.841			
IM2	<---	IM	0.444	0.378	0.057	7.840	***
IM3	<---	IM	0.257	0.333	0.038	6.837	***
IM5	<---	IM	0.988	0.802	0.049	20.151	***
IM6	<---	IM	0.694	0.647	0.047	14.794	***
*** = p<0.0001							

IM, information matrix; EE, effort expectancy; PE, performance expectancy; SI, social influence; FC, facilitating conditions; BI, behavioural intention; UA, user attitude; US, user satisfaction; SU, system use; IQ, information quality; SQ, system quality. C, communication; CP, compatibility; TR, trialability; SE, standard error; CR, construct reliability, †, Hypothesis dropped because of low reliability.

Gaskin's (2021) stats tool pack was used to find the average variance extracted (AVE) to test for convergent validity (CV). The standardised regression table and the correlations from the CFA output in IBM *AMOS* were copied and pasted into the 'ValidityMaster' in the stats tool pack. Table 5.29 shows that the AVEs range from 0.515 to 0.696, indicating that all values are above the 0.50 levels recommended by Fornell and Larcker (1981), which implies that the measurement model's convergent validity has been confirmed.

The square root of the AVE (on the diagonal in Table 5.29) was compared to all inter-factor correlations to see if it had discriminant validity. Composite reliability (CR) was calculated for each construct. In every case, the CR was greater than the minimum threshold of 0.70 set by Hair et al. (2010).

Table 5. 28: CFA Table

	CR	AVE	MaxR(H)	TR	EE	SI	FC	BI	UA	SQ	SU	IQ	US	C	CP	IM
TR	0.792	0.692	0.809	**0.701**												
EE	0.812	0.683	0.814	0.011	**0.827**											
SI	0.733	0.696	0.805	0.645	0.321	**0.704**										
FC	0.831	0.515	0.882	0.237	0.742	0.631	**0.718**									
BI	0.817	0.534	0.847	0.586	-0.123	0.679	0.624	**0.731**								
UA	0.783	0.681	0.815	0.154	0.949	0.578	0.592	0.175	**0.694**							
SQ	0.767	0.660	0.796	0.213	0.821	0.290	0.609	-0.096	0.688	**0.678**						
SU	0.731	0.680	0.759	0.519	0.861	0.690	0.545	0.313	0.598	0.626	**0.693**					
IQ	0.770	0.528	0.770	0.696	-0.202	0.620	0.215	0.760	-0.033	0.044	0.331	**0.726**				
US	0.730	0.678	0.753	0.458	0.478	0.402	0.536	0.304	0.359	0.707	0.582	0.347	**0.691**			
C	0.763	0.659	0.820	0.616	0.747	0.623	0.621	0.283	0.790	0.628	0.949	0.359	0.687	**0.678**		
CP	0.752	0.645	0.828	0.671	0.446	0.701	0.629	0.480	0.477	0.502	0.651	0.602	0.527	0.647	**0.667**	
IM	0.752	0.605	0.839	0.677	0.456	0.621	0.498	0.356	0.508	0.673	0.527	0.615	0.613	0.617	0.531	**0.636**

NB: All correlation is significant at the 0.001 level (2-tailed).

x2= 9.490, df = 3; chi sq/df = 3.163; P = 0.122; GFI = 0.955; AGFI = 0.905; CFI = 0.976; RMSEA = 0.43; PCLOSE = 0.316.

5.9 The SCT implementation structural model

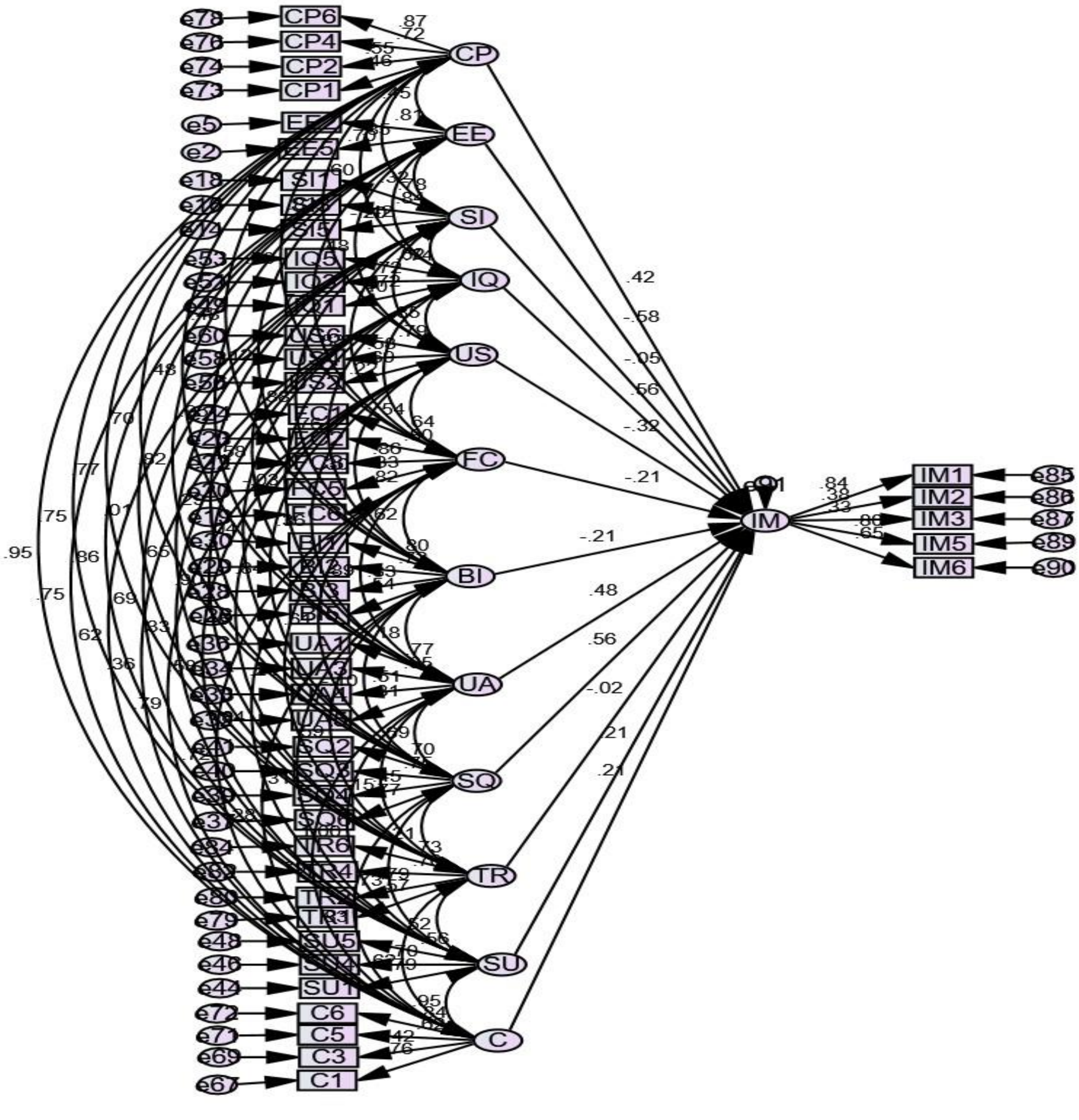


Figure 5. 5: SCT implementation structural model

The relationships between constructs were investigated following the development of the structural model. The summary extract from the *AMOS* output for the standardised significance levels obtained after running the structural model is shown in Table 5.30. These levels depict the hypothesised relationships between the latent variables that comprise the underlying causal structure of SCT implementation. Hair et al. (2006) suggested using a 1.96 threshold for the critical ratio values to establish the relevance of the hypothesised relationship (CR). This means that for a hypothesis to be significant or supported, its constructs must have a critical ratio value greater than 1.96 otherwise, the hypothesis is rejected. Table 5.30 shows the results of the hypotheses testing.

Table 5. 29: Hypotheses testing

Hypothesis		**Path**		**Standardised Estimate**	**S.E.**	**C.R.**	**P**	**Decision**
H1	IM	<---	EE	-0.575	0.025	0.174	0.862	Unsupported
H2	IM	<---	PE	*Hypothesis dropped due to low reliability*				
H3	IM	<---	SI	-0.054	0.032	0.148	0.882	Unsupported
H4	IM	<---	FC	-0.208	0.023	0.203	0.840	Unsupported
H5	IM	<---	BI	-0.209	0.063	-5.287	***	Supported
H6	IM	<---	UA	0.480	0.019	0.331	0.741	Unsupported
H7	IM	<---	US	-0.317	0.028	0.078	0.937	Unsupported
H8	IM	<---	SU	0.209	0.029	5.363	***	Supported
H9	IM	<---	IQ	0.557	0.047	8.883	***	Supported
H10	IM	<---	SQ	0.562	0.032	6.436	***	Supported
H11	IM	<---	C	0.211	0.046	7.538	***	Supported
H12	IM	<---	CP	0.419	0.081	6.021	***	Supported
H13	IM	<---	TR	-0.020	0.090	7.437	***	Supported
*** = p<0.001								

5.10 Hypothesis Testing

Seven of the thirteen (13) hypotheses were supported by the model as shown in (Figure 5.5 and Table 5.30). The first hypothesis (H1) was not supported. This suggests that effort expectancy does not have a significant impact on the implementation of SCT (β = -0.575, p =0.862, R^2 = 0.75). The second hypothesis (H2) was dropped due to low reliability. The third and fourth hypotheses (Social influence and facilitating conditions effect on the implementation of SCT) were not supported (β = -0.054, p =0.882, R^2 = 0.75 and β = -208, p =0.840, R^2 = 0.75, respectively).

Hypothesis 5, which states that Behavioral Intention has a significant impact on the implementation of SCT, was supported (β = -0.209, $p<0.001$, R^2 = 0.75) suggesting an inverse relationship between the two variables. Hypotheses 6 and 7 (User Attitude and User Satisfaction effect on implementation of SCT) were not supported (β = 0.480, p=0.741, R^2 = 0.75 and β = -0.317, p=937, R^2 = 0.75), respectively.

All of the hypotheses from eight (8) to thirteen (13) were supported. It was found that System Use (β = 0.209, $p<0.001$, R^2 = 0.75), Information Quality (β = 0.557, $p<0.001$, R^2 = 0.75), Service Quality (β = 0.562, $p<0.001$, R^2 = 0.75), Communication (β = 0.211, $p<0.001$, R^2 = 0.75), Compatibility (β = 0.419, $p<0.001$, R^2 = 0.75) and Trialability (β = -0.020, $p<0.001$, R^2 = 0.75) variables had a significant impact on Implementation of SCT. However, it should be noted that trialability had a negative impact on SCT implementation.

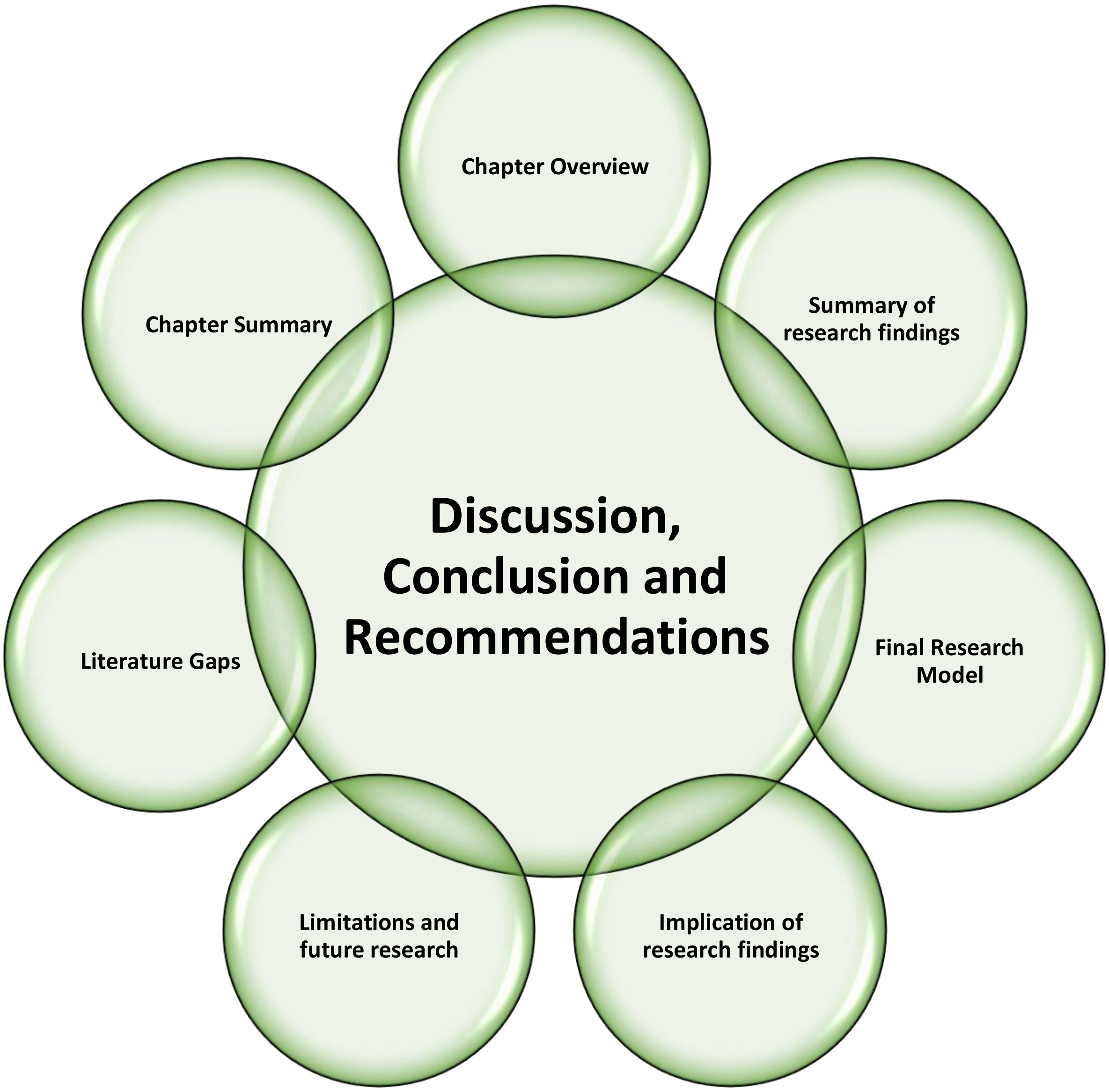
5.11 Chapter Summary

The quantitative analysis results and findings were discussed in this chapter. The data were analysed to establish the most important factors that contributed to the development of a framework for implementing smart card technology in public healthcare. This chapter also presented the study's findings, which were based on the descriptive data statistics of the data collected. The mean, median, mode, standard deviation and variance of the data are presented in descriptive statistics. Structural equation modeling was also used to analyse the data.

The structural equation modelling (SEM) results show that the data fit the model. In summary, the findings show that Behavioural Intention, System Use, Information Quality, Service Quality, Communication, Compatibility and Trialability affect the implementation of SCT. The following chapter is the final chapter, containing the discussion and conclusions of the study, as well as recommendations for future research.

CHAPTER 6

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS



6.1 Chapter Overview

The interpretation of the research findings in relation to the critical success of developing a framework for the implementation of smart card technology in public healthcare in four selected South African hospitals in the Gauteng Province (Tshwane District) was discussed in the previous chapter. The main aim of the research was to develop a framework for implementing smart card technology (SCT) in South African public healthcare.

The following sub-objectives were identified for the study:

1. To determine variables and related factors that affect the adoption of the SCT implementation in public healthcare.
2. To develop accurate information quality which influences the SCT implementation in public healthcare.
3. To identify the elements that went into creating a theoretical framework for the implementation of SCT in public healthcare.

This study used a quantitative research approach to collect data and analyse it. The primary analysis was done using *SPSS 26* for the descriptive analysis. *SPSS* and *AMOS* were also used for the analysis of the structural equation model and other inferential statistics. The demographics of the participants were analysed using descriptive statistics and frequency tables. The data were screened, and a construct reliability analysis was conducted. Exploratory and confirmatory factor analyses were used to validate the measurement instrument (Bandolos & Finney, 2018). Finally, each research hypothesis was tested using the structural equation model. The purpose of using the structural equation model was to test for the relationship existing between each construct and to ascertain the statistical model of the defined hypotheses.

In this chapter, the summary of the major findings of each research question and the discussions are presented. Additionally, the chapter explicitly presents the implications for each research finding based on policy, practice and theory. In conclusion, the study presents recommendations for policymakers and healthcare professionals in South Africa, based on the major findings.

6.2 Summary of Research Findings

The summary of the study as well as the conclusions concerning the research objectives and research questions are discussed in this section. For this study, four primary research objectives were formulated to address the research gaps identified in the study's research objectives. The findings generated by the research objectives served as the framework for determining the theoretical, practical and policy implications of the study.

6.2.1 Research Objective 1

To determine variables and related factors that affect the adoption of the SCT implementation in within public healthcare.

6.2.1.1 Summary of Research Findings

The research question to address Research Objective 1 is:
What are the variables and related factors that affect the adoption of SCT implementation within public healthcare?

Hence, to answer Research Question 1, inferential statistics based on the structural equation model were applied. According to the findings in this study, behavioural intention, system use, information quality, service quality, communication, compatibility and trialability all influence the implementation of SCT in public healthcare. The following are the findings that resulted from Research Objective 1:

1. Behavioural Intention has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $R^2 = 0.75$ and $\beta = -0.209$.
2. System Use has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = 0.209$, and $R^2 = 0.75$.
3. Information Quality has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = 0.557$ and $R^2 = 0.75$.

4. Service Quality has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = 0.562$ and $R^2 = 0.75$.
5. Communication has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = 0.211$ and $R^2 = 0.75$.
6. Compatibility has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = 0.419$ and $R^2 = 0.75$.
7. Trialability has a significant impact on the implementation of smart card technology in public healthcare with the significant value of $p<0.001$, $\beta = -0.020$ and $R^2 = 0.75$.

The next sections discuss the implications of the aforesaid research findings for Research Objective 1:

6.2.1.2 Practical Implications

The findings of this study revealed that Behavioural Intention (BI), System Use and Communication have practical implications for the use of smart card technology in public healthcare. Kiwanuka (2015) highlights that an individual's desire or purpose for using a system has a direct impact on its actual use. Thus, the findings support those of Kiwanuka (2015) who claimed that management cannot impose system usability on healthcare professionals who are not practically oriented toward system use unless they have a sincere desire to do so.

In addition, the system has implications for the implementation of SCT in public healthcare. The rationale for this component is that technology features like hardware, software and data are traditional technical tools that are utilised in healthcare organisations to carry out normal duties (Sombat, Chaiyasoonthorn & Chaveesuk, 2018). The way a system uses technology can be influenced by its design as well as other factors like the technology's qualities. Smart card technology's features tempt healthcare professionals to adopt it for tasks such as admissions, patient data, laboratory, radiography and pharmacy data. This study found that healthcare institutions can provide intelligent search features and instantaneous and multi-location access through the usage of smart card technology. The ability to digitally connect data fragments kept in geographically dispersed databases would provide healthcare institutions with simple access to this information, according to the literature (Acquah-Swanzy, 2015).

Communication is a classical instrument for implementing effective system use. Hence, system developers, management and all stakeholders of the system being used must gain clear information on system usage. Clear and concise communication using modern communication technologies (such as email, *WhatsApp*, SMS, smart notice boards, etc.) are highly recommended tools for healthcare professionals within the healthcare industry to disseminate information easily and more conveniently (Soroka & Jacovi, 2004). As a result, there is a higher level of dependency on communication within healthcare for successful implementation. Christopoulou (2013) supports this by stating that communication is a technique employed by humans and technology to interact. In addition, the implementation of SCT encompasses the flexibility of the system developers to communicate without any form of ambiguity to the system users to harness the ease of use of the technology (Christopoulou, 2013; Jansson, San Martin, Johnson & Nilsson, 2019).

6.2.1.3 Theoretical Implication

Upon careful study of the research findings, it was discovered that behavioural intention, communication, compatibility and trialability have a positive influence on the implementation of SCT. In line with these findings, it can be deduced that they have direct theoretical implications as indicated in the studies of the following theories:

- Behavioural intention supports the healthcare unified theory of acceptance of user technology model (HUTAUT) as propounded by Maeko and Van Der Haar (2018).
- System use supports the DeLone & McLean (2003) IS success model.
- Communication, compatibility and trialability support the diffusion of innovation theory (DOI) by Rogers (2003).

The HUTAUT model by Maeko and Van Der Haar (2018) states that BI influences the use of technology. The BI construct as used in the UTAUT model (as HUTAUT is derived from UTAUT theory) serves as the mediating construct that is significant for the implementation of SCT. Furthermore, BI is the main estimator of the actual use of SCT and it shows the willingness of the healthcare professional's actual use. Interestingly, the research found that BI has a considerable impact on SCT in public healthcare, with a significant value of 0.01

indicating that it is a valid construct in the HUTAUT model. As a result, there are increased expectations for SCT implementation such as behavioural intent and dedication to employing technology to enhance the conditions for smart card technology implementation (Chan, 2000).

System use is an integral component of the implementation of SCT in public healthcare and has been thoroughly used in studies by the Delone & McLean (1992; 2003) IS success model. System use is also thought to have a significant impact on SCT in public healthcare because it helps to simplify healthcare operational procedures. It also features advanced search capabilities, multi-location access and the ability to digitally combine data bits from many databases throughout the globe (Acquah-Swanzy, 2015).

In sum, the findings point to Communication, Compatibility and Trialability as critical components of Rogers' (2003) diffusion of innovation theory, in line with technological implementation and usage. Communication, compatibility and trialability are all important elements in SCT implementation in public healthcare, with significant values (p0.01). This affirmation supports the theoretical viewpoint of Rogers' diffusion of innovation model. In the DOI theory, communication dominates as a channel in which information regarding innovation such as the SCT is being shared through modern media. According to Rogers (2003), compatibility is determined by the amount of confidence that is reliable with existing principles and anticipated users' requirements. The findings of this study are similar to that of Hayes et al. (2015) and Rogers (2003) who found that compatibility can accommodate individual preferences, making innovation more adaptable in public healthcare institutions, using SCT systems. This study strengthens the concept and theory that aids healthcare professionals to adopt innovative strategies, goals and values compatible with their existing work practices.

As a result, early on in the implementation process, benefits such as data protection, storage capacity, data consistency, access authorisation, data ownership, device usability and privacy issues become apparent (Cripps, Standing & Prijatelj, 2012). Moreover, the findings from this study resonate with Rogers' (2003) DOI theory and compatibility is the key determinant for new product launches such as the SCT in public healthcare institutions.

Furthermore, as Rogers (2003) states, trialability—or a system's ability to be trialed or tested before making concrete decisions is an essential factor for technology implementation. The study’s findings confirmed that trialability has a major impact on SCT implementation, which is consistent with research by Rogers (2003) and Mohammadi, Poursaberi and Salahshoor (2018). The findings on the significance of trialability in SCT implementation support the findings by Cresswell and Sheikh (2013) who establish that trialability in DOI addresses the implementation of technology in healthcare from data inputs, data storage and data processes on portable devices and servers to keep personal data for smart health. Similarly, the conclusions of this study are similar to those by Tsai and Chang (2016) who find that a system’s success or failure is solely determined by how it is implemented. This includes software development and planning, policy implementation and administration.

6.2.1.4 Policy Implication

A collection of management policies, business processes and benchmarks for enhancing a company's environmental performance is known as an environmental management system (Angeles, 2014). Infrastructure, privacy and security issues must all be addressed while making effective decisions to maintain healthcare performance. The Department of Health would not be able to decide regarding the implementation of SCT without first informing healthcare professionals about the technology. Furthermore, healthcare professionals are socially conditioned to respond in various ways as a result of the people around them (Howell et al., 2016). According to the literature, technology has a direct impact on the extensive use of performance construct adopted in HUTAUT, which has a direct impact on the implementation of smart card technology.

6.2.2 Research Objective 2

To develop accurate information quality which influences the SCT implementation in public healthcare.

6.2.2.1 Summary of Research Findings

The research question to address Research Objective 2 is:

How can accurate information and service quality influence SCT implementation in public healthcare?

To answer the second research question of the study, inferential statistics, based on the structural equation model were also applied. It was discovered that:

1. Information Quality has a significant impact on the implementation of smart card technology in public healthcare with a significant value of $p<0.001$, $\beta = 0.557$ and $R^2 = 0.75$.
2. Service Quality has a significant impact on the implementation of smart card technology in public healthcare with a significant value of $p<0.001$, $\beta = 0.562$ and $R^2 = 0.75$

The following section discussed the implications of the research findings from Research Objective 2:

6.2.2.2 Policy Implications

The study's findings revealed that the quality of service and information had a significant impact on the adoption of SCT in healthcare. Furthermore, in this study, the findings suggest that ensuring service and information quality in public healthcare would require the implementation of stringent policies to ensure the effective and efficient usage of SCT.

Mardani, Hooker, Ozkul, Yifan, Nilashi, Sabzi and Fei (2019) affirm that regardless of whether a service is supplied by internal agencies or outsourced to third parties, policies and procedures should direct the service provider. Service quality, according to Hsu, Yen and Chung (2015) enables the evaluation of the quality of ICT services provided by healthcare professionals. As a result, the necessity of service quality in the application of SCT in public healthcare, particularly when dealing with crucial health information of patients, has been highlighted. Consequently, adequate regulations are required to manage healthcare providers' operational mandates and service quality, to enhance the use of smart card technologies (De Regt, Cats, Van Oort & Van Lint, 2017).

Based on the findings, the researcher concludes that an absolute quality of the information in the system is required for successful smart card implementation in public healthcare. Kilsdonk, Peute and Jaspers (2017) assert that the idea of information quality is the integration of various components including human, organisational and technical variables that provide a series of information in the system. Furthermore, based on the background of the study (see Section 1.2), the Department of Health must develop a clear policy guide. In addition, that would assist both the private and public sectors in using computerised technology in their various environments while maintaining a high degree of data quality.

6.2.3 Research Objective 3

To identify variables used to develop a conceptual framework for the implementation of SCT in public healthcare.

6.2.3.1 Summary of Research Findings

The research question to address Research Objective 3 is:

What are the identifiable variables used to develop a conceptual framework for the implementation of SCT in public healthcare?

The researcher performed inferential statistics based on the structural equation model to test all the factors that supported and had a significant, continuous effect towards the implementation of smart card technology in the public healthcare sector. Behavioural Intention, System Usage, Information Quality, Service Quality, Communication, Compatibility and Trialability were identified as critical factors in the implementation of SCT in public healthcare in South Africa. These findings are also in line with those of (Kiwanuka, 2015; Sombat, Chaiyasoonthorn & Chaveesuk, 2018; Acquah-Swanzy, 2015; Jansson et al., 2019) who conducted studies on the factors that support the use of smart card technology in public healthcare.

The researcher strongly believes that the findings in these studies confirm the previous studies by Maeko and Van Der Haar (2018) on the implementation of the healthcare unified theory of acceptance of user technology model (HUTAUT) and the DeLone and McLean (2003) IS success model on effective system use. Notwithstanding the abovementioned researchers' work, it was determined that their studies and the findings derived from those studies are in accordance. The researcher believes that communication, compatibility and trialability support the diffusion of innovation theory (DOI), as established by Rogers (2003) and Hayes et al. (2015).

Furthermore, the implications of the identified factors posed practical, policy and theoretical viewpoints in this study, to gain a better knowledge of the challenges surrounding the application of smart card technology in healthcare. This study's results indicate that certain aspects such as behavioural intention, user attitude, system use, user satisfaction communication, trialability and compatibility variables have a significant role in the implementation of SCT. In addition, as a result of the study's conclusions, there would be greater planning, saving and inclusion of all parties involved in order to introduce technologies that would not fail but would save money within the public healthcare delivery sector. These are the constructs that were concluded for the final research framework for the implementation of smart card technology in public healthcare: Behavioural Intention, System Usage, Information Quality, System Quality, Communication, Compatibility and Trialability

6.3 Final Research Model

In this section, the researcher provides thoughtful consideration to integrating all of the variables that support the implementation of smart card technologies into a framework. In this research, findings derived from the literature review and the conceptual framework added more weight to the study. The research model (Figure 5.5) was derived from Chapter 5, finalised and based on the research's findings. This study discovered that the hypotheses (behavioural intention, system quality system usage, information quality, communication and trialability) were supported for the implantation of SCT in public healthcare. Finally, the quantitative study that revealed the application of SCT in public healthcare was, therefore, used to further expand the final SCT implementation framework, as shown below (Figure 6.1).

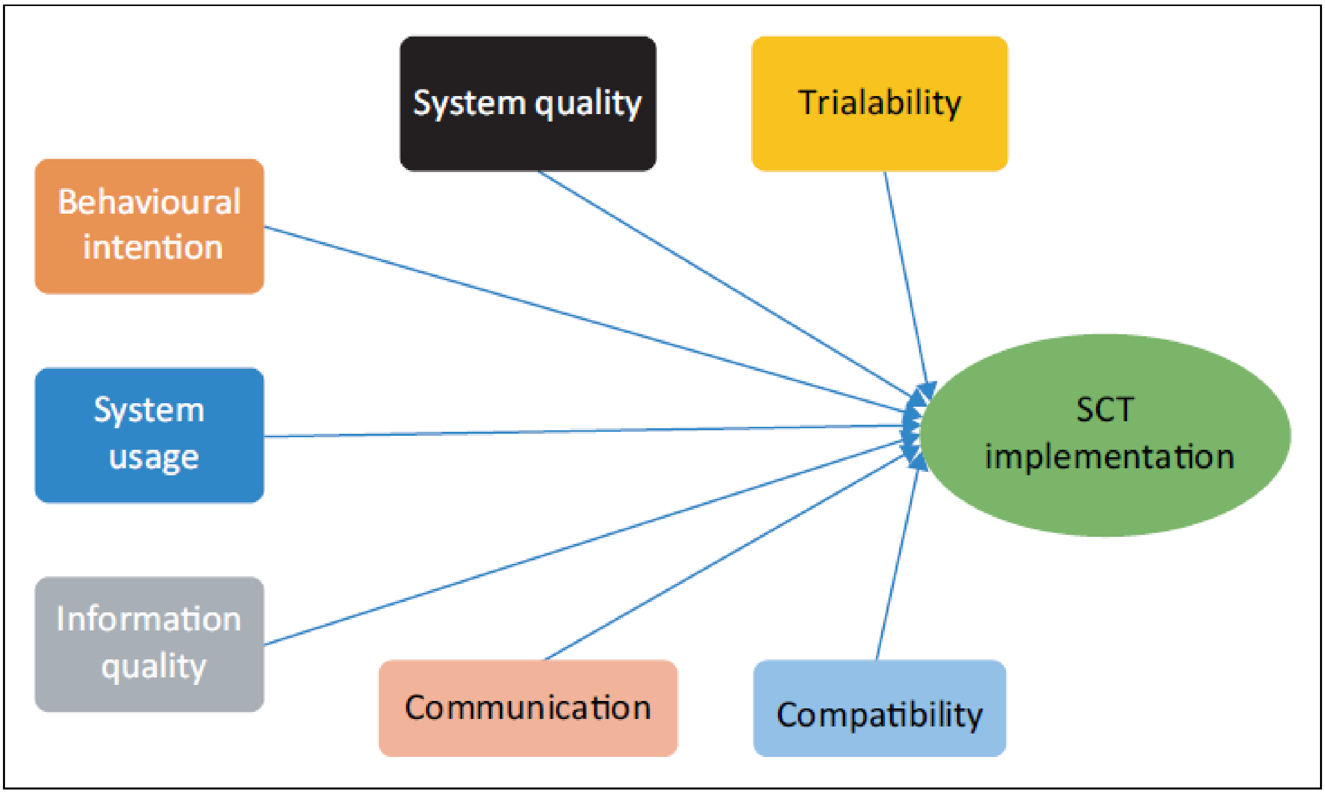


Figure 6. 1: Final SCT implementation framework (Source: Own)

6.4 Implications of the Research Findings

6.4.1 Theoretical Implications of the Research Findings

The findings from the study's third research objective provide a theoretical contribution to the literature regarding the usage of smart card technology in public healthcare. The study was based on three identified models and theories: The healthcare unified theory of acceptance of user technology model (HUTAUT) (2018), the DeLone & McLean IS success model (2003) and the diffusion of innovation theory (DOI) (2003). These theories and models are built on the existent literature on information systems implementation, which the findings of studies equally affirm has a significant positive effect on SCT implementation in South African public health services.

The HUTAUT was developed by Maeko and Van der Haar (2018) to influence user awareness and technology acceptance in healthcare. The unified theory of acceptance and use of technology (UTAUT) was developed by Venkatesh, Morris, Davis and Davis (2003). In this study, variables have been identified for the HUTAUT model. The developed SCT framework adds new insights to the literature on technology integration in healthcare practices. The researcher's knowledge and understanding of the developed framework were tested and used vividly confirms to other studies (Maeko & Van der Haar, 2018).

Interestingly, the research exposed several insignificant factors like effort expectancy, performance expectancy, social influence and facilitating condition (as indicated in the HUTAUT model) as non-relevant factors for SCT implementation in the South African context of public healthcare.

The Delone & McLean IS success model was used in this study to clarify how users acquire information system consistency. The D&M IS success model incorporates many characteristics such as system quality, information quality, use, user satisfaction, individual impact and organisational effect, according to the findings of this study. In the context of this research, the model was expanded to include other factors like behavioural intention and user satisfaction as mediating variables. This model for SCT includes independent variables based on user attitude, information quality, system quality and service quality according to the findings. However as stated in Chapter 5, system quality was discarded for the study due to its outcome, which showed strong disagreement regarding implementation. Therefore, this study adds to the body of knowledge through an in-depth understanding of the D&M IS success model, by examining the factors of implementation.

This study further contributes to the field of information systems (IS) and implementation innovation by introducing a new model, the diffusion of innovation theory, which expands SCT implementation through specific constructs. The concept of innovation and diffusion is explained by the various independent variables that are identified in the model. These variables help to explain the various stages of innovation and diffusion processes. The research studied the model extensively which identified the following constructs from the DOI theory for adding contribution to the study as communication, compatibility and trialability.

During the literature review, the researcher found that not much research had been conducted into the implementation of smart card technology. Henceforth, identified theories and models added more contributions to the implementation subject for any particular system or technology. As a result, this study fills a knowledge gap and adds to the body of knowledge on technology installation, particularly in the context of healthcare information systems.

6.4.2 Practical Contribution

The practical objective of this study was to bring about a better understanding of the related issues concerning the implementation of smart card technology in healthcare. This study's results indicate that certain aspects such as behavioural intention, user attitude, system use, user satisfaction communication, trialability and compatibility variables play a significant role in the implementation of SCT. Therefore, the findings may aid in identifying other factors to understand what influences the implementation of these technologies in healthcare more, in particular, for healthcare professionals. As a result, there would be better planning, saving and inclusion of all parties involved to develop technologies that would save money for the government.

6.5 Limitations and Future Research

6.5.1 Research Limitations

This study expands the knowledge regarding a framework for the implementation of smart card technology in public healthcare. The development of this framework was detailed and reliable due to the validated variables in the study. As a consequence of robust statistical techniques such as the SEM applied in the study, the data analysis was appropriate. However, this study has attended to many issues through the desired sample of a questionnaire-based survey. Some limitations should be considered while understanding the findings of the study, such as a limited population due to the finite number of healthcare professionals that could be found within one district.

Another limitation of this study was the difficulty in reaching out to healthcare professionals due to Coronavirus Disease 2019 (Covid-19) related illnesses that surfaced during the data collection period. It was equally difficult to compare this research to previous studies conducted in the healthcare sector. For example, most studies focused solely on patients but when a study on the smart card was conducted, more emphasis was placed on its functionalities like privacy and security. Privacy and security issues were also fully addressed in the study, using the identified theories and models. Nonetheless, these emphasise the study's uniqueness in this part of the world.

Three other limitations of this research are as follows:

1. Research population: The population in this research comprised only healthcare professionals. Therefore, it is important to emphasise results that can be generalised for policy recommendations in the framework for the implementation of technologies like the smart card. The government would be able to determine why healthcare professionals and patients are not interested in using SCT in healthcare and the lessons learnt could be improved upon further.
2. Methodology: The study exclusively employed quantitative methodology; this approach was used for several reasons; the study was conducted during the COVID-19 pandemic; some difficulty was experienced since healthcare professionals were committed to saving the lives of patients in South Africa. Therefore, this research can bring further insight into the findings concerning those factors in particular.
3. Geographical scope: The research was conducted at four hospitals in the Tshwane District: Steve Biko Academic Hospital serves Gauteng and Mpumalanga, Kalafong Hospital is a tertiary hospital that handles all of Tshwane's regional issues and Tshwane District Hospital and Pretoria West Hospital are two district hospitals. This is because all of the hospitals are in the city centre of Pretoria, improving the researcher's distribution and collection of survey questionnaires in the research areas.

6.5.2 Future Research

A study undertaken by FTI Consulting (2019) states that there are five barriers (as discussed in Chapter 2) to the implementation of healthcare technology, like smart card implementation in South African public healthcare. These barriers (e.g., user resistance) are contingent on senior management's support. As a result, there is an averseness to moving towards new ways of doing things, which is a serious problem among many healthcare professionals. Poor government decisions, like a lack of political interest and employment insecurity, remain an issue and more extensive research incorporating these aspects is required. This could suggest that future studies on the implementation of healthcare technology such as SCT should be explored. Furthermore, while this study incorporated significant variables, further studies might emphasise variables like levels of resistance to technology implementation on the African context.

Change management may be linked to resistance to technology adoption, in particular. In addition, a mixed-method approach could be employed to thoroughly investigate research aspects in order to fully understand the problem. Although the focus of this research was on the usage of smart cards in healthcare in South Africa, other researchers could use the developed conceptual model and that might also provide a strong theoretical platform for future studies on smart card adoption in other areas, based on the African context.

However, because of the admissions system, for example, in private healthcare it has become similar to that of public healthcare, this study does not exclude the implementation of SCT in private healthcare. Therefore, lessons can be drawn from both institutions of healthcare to best implement healthcare technologies. Another recommendation is that future studies include a comparison between healthcare professionals and patients in developed and developing countries. Smart cards are not new, they have long been used in the banking industry. Future research should incorporate the findings of this study in other industries that experience difficulties in implementing new technology. Seven out of thirteen hypotheses were found to be supported in the data collected for a framework for the implementation of SCT. The first hypothesis (H1) was not supported. This suggests that effort expectancy has no significant influence on SCT implementation (= -0.575, p =0.862, R2 = 0.75). The second hypothesis (H2) was discarded due to low reliability; hence it was tested in this study. Both the third (H3) and fourth hypotheses (H4) (Social influence and facilitating conditions effect on the implementation of SCT) were not supported (β = -0.054, p =0.882, R2 = 0.75 and β = -208, p =0.840, R2 = 0.75, respectively). Hypothesis (H5) which suggests that behavioural intent has a significant impact on SCT implementation was supported (β = -0.209, p<0.001, R2 = 0.75). In addition, implying that the two variables have an inverse relationship in addition, hypotheses (H6) and (H7) (User Attitude and User Satisfaction effect on implementation of SCT) were not supported (β = 0.480, p=0.741, R2 = 0.75 and β = -0.317, p=937, R2 = 0.75), respectively. Hypotheses (H8) to (H13) were all supported. It was found that System Use (β = 0.209, p<0.001, R2 = 0.75), Information Quality (β = 0.557, p<0.001, R2 = 0.75), Service Quality (β = 0.562, p<0.001, R2 = 0.75), Communication (β = 0.211, p<0.001, R2 = 0.75), Compatibility

($\beta = 0.419$, $p<0.001$, $R2 = 0.75$) and Trialability ($\beta = -0.020$, $p<0.001$, $R2 = 0.75$) variables had a significant impact on the implementation of SCT.

According to the findings of this study, trialability impacts the implementation of SCT negatively. Furthermore, factors impacting the implementation of SCT in public healthcare have been thoroughly investigated, therefore, the use of structural equation modeling (SEM) for study analysis has gained extra interest. Furthermore, the research model considered applying the SEM to bring robustness to the statistical technique. This study has further explored other areas where the SEM is applied. As a result, SEM is no longer limited to dealing with complex research challenges in traditional research topics. However, it can also be a helpful tool for construction academics and technicians to assess the acceptance, usage and success of newly developed technologies (Xiong, Skitmore & Xia, 2015).

6.6 Literature Gaps

Keliris, Kolias and Nikita (2013) define a smart card as an integrated circuit containing a microcontroller chip or just a memory chip with non-programmable logic. In their study, Barbosa, Takako and Sadok (2020) found problems with integrating SCT with human users and other systems. This study's findings reveal that a lack of data support and secrecy leads to network device authentication control, which addresses some of the issues with implementing SCT in public healthcare. The findings of this study corroborate those of Dealing and Sunyaev, (2014), Howell et al. (2016), Madhusudhan and Hegde (2017) and Furusa and Coleman (2017).

Some studies have also identified barrier factors in the implementation of healthcare technology such as error detection, performance, non-adherence & authentication issues (Drahota et al., 2012; Kushniruk et al., 2013; Inglis et al., 2015; McCabe, McCann & Am, 2017; Grewal, Kazeem, Pappas, Majeed & Car, 2012; Efs et al., 2017; Akram, Markantonakis & Sauveron, 2016; Yeh, 2017; Mshali et al., 2018; Vaona et al., 2018; Sethia, Gupta & Saran, 2019; Radhakrishnan & Karuppiah, 2019; Bamford-Wade et al., 2020).

Findings from these studies identified the following:

- *If error detection is not regulated, it can lead to doctors becoming misinformed while diagnosing a patient's ailment by delivering reliable digital data.*
- *Inconsistent data across the network is a major source of concern, particularly for healthcare IT suppliers who serve large health networks. Providers keep different bits of data in multiple, often disparate locations and health IT professionals waste countless hours looking for them.*
- *Attempts at encryption and authentication, such as using a PIN to make it more difficult to use a stolen card, have exacerbated authentication problems. No one can readily reproduce information from a smart card without authorisation. In public healthcare, the information technology department would need to select dedicated healthcare specialists in each department to issue smart card technology with past patient information, treated diseases, and any other health-related information.*

Previous research by Fernández-Alemán et al. (2015), Omotosho and Emuoyibofarhe (2011), Tsai, Williamson and Im (2012) as well as others has shown that infrastructure and other smart card-related equipment are critical for providing high-quality healthcare at a low cost of implementation. Aquino et al. (2018) and Bai, Wang and Su (2020) added strategies that allow planning changes based on best practices within public healthcare services. Such planning includes nursing homes, medication management and patient control; these strategies allow changes based on best practices within public healthcare services like nursing homes, medication management and patient control.

6.7 Chapter Summary

The findings of this study focused on the important success elements that led to the development of a framework for smart card technology application in public healthcare in South Africa. Overall, the modified HUTAUT model, the D&M IS success model and the DOI theory were used as underpinning theories for this study and subsequently, the proposed framework was evaluated and validated using structural equation modeling. The study's conclusions are supported by a literature review.

In this study, the mean, median, mode, standard deviation and variance of the data were presented using descriptive statistics. Descriptive statistics were utilised to investigate respondents' ages, gender, education levels and work experience. Graphs and pie charts were used to present these variables. Finally, structural equation modeling was applied to the data. The performance expectancy hypothesis (H2) was dropped due to its low reliability (see Table 5.7) in the previous chapter. As a result, the study's five hypotheses: Effort Expectancy (H1), Social Influence (H3), Facilitating Conditions (H4), User Attitude (H6) & User Satisfaction (H7) were not supported.

The framework for the implementation of smart card technology in public healthcare in South Africa as shown in (Figure 6.1) was then developed by combining all of the accepted hypotheses: Behavioural Intention (H5), System Use (H8), Information Quality (H9), Service Quality (H10), Communication (H11), Compatibility (H12) and Trialability (H13). Further research is needed to expand this study into private healthcare and to investigate the impact of the constructs that were removed from it.

This last part of the study summarised each chapter of the study; Table 6.1 below summarises the research objectives, questions and chapters.

Table 6. 1: Summary of Chapter(s) in which Research Questions/Objectives were answered (Source: Own)

Research Objectives	**Research Questions**	**Chapter(s) in which Research Question/Objective was answered**
(RO1): To determine variables and related factors that affect the adoption of the SCT implementation in public healthcare.	**(RQ1):** What are the variables and related factors that affect the adoption of SCT implementation in public healthcare?	**Chapter 2:** Part of the chapter for the literature review fairly addressed the adoption used for the implementation of technology in healthcare. **Chapter 3:** Different hypotheses were fully explained which

		contributed to the implementation of smart card technology.
(RO2): To develop accurate information quality which influences the SCT implementation in public healthcare.	(**RQ2**): How can accurate information influence the quality of SCT implementation in public healthcare?	**Chapter 3:** The accuracy of the collection of information has been identified in Chapter 3 for all constructs. **Chapter 5:** Interpreted all the accepted hypotheses for the study and analysed detailed information regarding SCT implementation

(RO3): To determine the variables used to develop a conceptual framework for the implementation of SCT in public healthcare.	**(RQ3):** What are the identifiable variables used to develop a conceptual framework for the implementation of SCT in public healthcare?	**Chapter 2:** The previous literature has been gathered similar to the studies. **Chapter 3:** The chapter fully addressed all the accepted and not accepted variables according to the theories used Chapter **4:** The research methodology used was related to the data collection process used Chapter **5:** This chapter interpreted the results derived from the data collected and was analysed and interpreted in detail. **Chapter 6:** Addressed all the summary chapters which produced the final research model.

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APPENDIX 1: Ethical Clearance

UNISA university of south africa

UNISA-CAES HEALTH RESEARCH ETHICS COMMITTEE

Date: 03/04/2020

Dear Ms Malungana

NHREC Registration # : REC-170616-051
REC Reference # : 2020/CAES_HREC/081
Name : Ms L Malungana
Student #: 33904464

Decision: Ethics Approval from 02/04/2020 to completion

Researcher(s): Ms L Malungana
Lario.lalie@gmail.com

Supervisor (s): Dr C Dongmo
dongmc@unisa.ac.za

Dr L Motsi
motsil@unisa.ac.za

Working title of research:

A framework for implementation of smart card technology in public healthcare

Qualification: PhD Information Systems

Thank you for the application for research ethics clearance by the Unisa-CAES Health Research Ethics Committee for the above mentioned research. Ethics approval is granted until the completion of the project, **subject to submission of the relevant permission letters and yearly progress reports. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report has been submitted.**

Due date for progress report: 31 March 2021

Please note the points below for further action:

1. The researcher must obtain permission from the relevant provincial Department of Health before data collection may commence. Furthermore, permission must also be obtained from the targeted hospitals before any staff may be approached. The permission letters must be submitted to the committee as they are obtained.

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2. It seems that the researcher will only target nurses, and no patients or doctors? What is the motivation for this sample selection?

*The **low risk application** was **reviewed** by the UNISA-CAES Health Research Ethics Committee on 02 April 2020 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the Committee.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
7. No field work activities may continue after the expiry date. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

*The reference number **2020/CAES_HREC/081** should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

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Yours sincerely,

Prof MA Antwi

Chair of UNISA-CAES Health REC

E-mail: antwima@unisa.ac.za

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Prof SR Magano

Acting Executive Dean : CAES

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APPENDIX 2: APPROVAL OF RESEARCH

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Office of the Registrar

2020-07-03

Ms Lario Malungana
School of Computing
College of Science, Engineering & Technology
UNIVERSITY OF SOUTH AFRICA

Email: LarioM@tshwane.gov.za

Dear Ms Malungana

APPROVAL OF RESEARCH

The UP Survey Coordinating Committee has noted your PhD research project titled "Framework for Implementation of Smart Card Technology in Public Healthcare" to be conducted at Steve Biko and Kalafong Hospital.

We have no objection to the proposed research taking place in accordance with the research proposal submitted.

Kind regards

Prof CMA Nicholson
REGISTRAR
CHAIRPERSON: SURVEY COORDINATING COMMITTEE

Rectorate, Room 4-23, 4th floor, Administration Building, Hatfield Campus
University of Pretoria, Private Bag X20
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Kantoor van die Registrateur
Ofisi ya Mmušakarolo

APPENDIX 3: APPROVAL OF RESEARCH

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

STEVE BIKO ACADEMIC HOSPITAL

Enquiries: Dr JS Mangwane
Tel No: +2712 3452018
Fax No: +2712 354 2151
E-mail: joseph.mangwane@gauteng.gov.za

For attention: Lario Malungana

NHRD Ref Number: GP_202004_020

Re: REQUEST FOR PERMISION TO CONDUCT RESEARCH AT STEVE BIKO ACADEMIC HOSPITAL

TITLE: A framework for implementation of Smart Card Technology in Public Healthcare

Permission is hereby granted for the above-mentioned research to be conducted at Steve Biko Academic Hospital.
This is done in accordance to the "Promotion of access to information act No 2 of 2000".
Please note that in addition to receiving approval from Hospital Research Committee, the researcher is expected to seek permission from all relevant department.
Furthermore, collection of data and consent for participation remain the responsibility of the researcher.
The hospital will not incur extra cost as a result of the research being conducted within the hospital.
You are also required to submit your final report or summary of your findings and recommendations to the office of the CEO.

Approved

Comment: ______________________

Date: 2020-07-08

Dr. J S. Mangwane
Manager: Medical Service

APPENDIX 4: QUESTIONNAIRE

UNISA university of south africa

Dear Respondent

You are invited to participate in this research. The objective of this survey is to conceptualize a framework that will facilitate the effective implementation of this survey is part of a study that seeks to identify factors that are necessary to a Framework for the implementation of Smart Card Technology (SCT) in public healthcare. Develop a contextualized framework. This is purely academic work for the fulfillment of a Post-Doctoral Degree Research in Information Systems. The research title is:

A Framework for Implementation of Smart Card Technology in public healthcare

Participation in this study is voluntary. If you do not wish to participate, simply discard the questionnaire. All responses will be completely anonymous and will be presented as summaries of the findings. Your name will **not** appear anywhere on the survey and is not requested for that case. Completing and returning the questionnaire constitutes your consent to participate and you are kindly appreciated.

Answering this questionnaire will only take 10-15 minutes of your time. Your corporation is highly appreciated and will contribute to the success of this study.

Thank you for your participation.

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PLEASE, MAKE A TICK √ OR A CROSS x IN THE CELL CORRESPONDING TO YOUR CHOICE

SECTION A: RESPONDENT'S DEMOGRAPHICS

1. What is your gender?

Female		Male	

2. What is your age group?

Below 25 yrs		25 – 30 yrs		31 – 40 yrs		41 – 50 yrs		50+ yrs	

3. Indicated the department you belong to:

Emergency		Midwifery		Paediatric		Neonatal		Surgical		Others	

4. What is your highest educational qualification?

Grade 12 or below		Diploma		Degree		Postgraduate		Others	

SECTION B: TECHNOLOGY, INTERNET USAGE AND INTERACTION

5. What is your interaction with Smart Card Technology in other areas within healthcare?

Patient Data	Clinical Data	Laboratory Data	Radiology Data	Pharmacy Data	Administration Data

6. I would rate my computer literacy level as:

Do not use		Fair		Good		Very Good		Excellent	

7. If the smart card is implemented, my knowledge of the technology will be.

Do not use		Fair		Good		Very Good		Excellent	

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SECTION C: **INFLUENCING FACTORS FOR SMART CARD TECHNOLOGY USAGE**

Using a rating scale of 1 to 5, please indicate your level of disagreement/agreement with the Following statements:

	Effort Expectancy (HUTAUT)	1 Strongly disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1.	My interaction with the SCT would likely be clear and understandable.					
2	I believe it would be easy for me to become skillful at using the SCT					
3	I believe I would find the SCT easy to use.					
4	Learning to operate the SCT is easy for me.					
5	The smart card is not technically complicated					
6	I can delete the previous history in the smart card					
	Performance Expectancy (HUTAUT)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	Management measurement of staff performance					
2	I believe the smart card is user friendly					
3	There is a high-speed internet service which will enable the implementation of SCT					
4	Technical issues are addressed within 24 hours					
5	Systems already integrated					
6	The viability of user systems manuals will improve system performance					
	Social Influence (HUTAUT)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1.	Healthcare professionals who are important should use the SCT to update the information					
2	Healthcare professionals think they understand the use of the SCT					
3	I think healthcare professionals will use the SCT					
4	Using the SCT will influence the usage of technology in healthcare					
5	SCT usage improves the image out there for healthcare professionals					
6	SCT usage improves the quality of work provided to patients					
	Facilitating Conditions (HUTAUT)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	ICT departments are available to aid healthcare professionals with the SCT					

3	In case the system downtime is there a backup plan to assist the healthcare professionals					
4	Are all connectivity issues fully addressed for SCT usage					
5	Does the hospital have available resources to access training for SCT usage					
6	Are there enough working tools to assist healthcare professionals with the usage of SCT					
	Behavioural Intention (HUTAUT)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	I think other doctors can use the smart card					
2	I will keep using the SCT					
3	I believe other hospitals can use the smart card					
4	I others excited too about using the smart card					
5	I am aware of the easy ways in using the SCT					
6	I am willing to use SCT if the features are easy					
	User Attitude D&M)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	I will use smart card technology if the system is not difficult to use.					
2	Healthcare Professionals understand the SCT better					
3	Learning to operate the smart card technology					
4	Performing tasks is straightforward					
5	Correction of errors					
6	The patient's history is available and visible					
	Service Quality (D&M)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	The response time offered by ICT is available					
2	Does the ICT department keep the users/healthcare professionals informed of downtime					
3	ICT is willing to solve problems related to connectivity					
4	There is enough knowledge and understanding of SCT					
5	Available for convenient hours such as 24 hours					
6	Sufficient resources to assist healthcare professionals all the time					
	System Use (D&M)	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	SCT is easy to use					
2	SCT is easy to be found on the website					
3	I find it easy to get any information related to healthcare					
4	Using SCT does not require a lot of effort					

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5	The SCT does not frustrate my work					
6	SCT is easily situated on the website					
Information Quality (D&M)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	Information loaded in the SCT is accurate					
2	SCT information is reliable and useful for reporting					
3	Patients provide relevant quality information to be loaded in SCT					
4	SCT is easy to understand					
5	The information provided in the SCT is easy to be used by other healthcare professionals					
6	The information loaded into the SCT meets the requirements for healthcare					
User Satisfaction (D&M)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	The overall quality of SCT is better					
2	I prefer assessing healthcare information using the SCT.					
3	I prefer accessing information loaded in the SCT for assistance.					
4	Using SCT to obtain patient information is adequate for healthcare assistance					
5	I will continue using SCT in healthcare.					
6	My overall expectation with the SCT is helpful					
System Quality (D&M)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	The Department of health support the SCT					
2	The Department of Health website advertised the SCT to the public for easy to learn					
3	I find it easy to access the SCT					
4	Using the Department of Health website does not require a lot of effort					
5	Using the Department of Health website is not often frustrating					
6	The Department of Health is easy to use					
Communication (DOI)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1.	I believe all communication processes for Smart cards are available to improve information delivery services.					

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2.	I believe regular training through seminars; open days enhances the easier implementation of smart technology and hence improves healthcare service delivery.					
3.	I believe top management's commitment to staff development will enable SCT implementation					
4	I believe regular training through seminars; open days enhances the easier implementation of smart technology and hence improves healthcare service delivery.					
5	I feel before the implementation of SCT, users must receive sufficient computer literacy and other IT-related communication					
6	I understand that fair communication is addressed with all healthcare Professionals					
Compatibility (DOI)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	I believe management's decision will implement smart technology will influence staff to use technology					
2	I believe all l systems managers should be involved in the implementation of smart card technology.					
3	I expect Stakeholder engagements to address issues					
4	I believe management must listen to all the healthcare professional's thoughts and feelings about the smart card technology					
5	I believe All issues regarding the smart card decisions have been settled and the provision of wide solutions is in place.					
6	I believe Decision making an impact on smart card usage for healthcare professionals					
Trialability (DOI)		**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	I believe the experience of using the SCT will be exciting					
2	If implemented, I want to be the first one to use the Smart Card technology					
3	I am aware of the limited time regarding operational learning					

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3	I am aware of the limited time regarding operational learning					
4	I believe the adoption of smart cards will be very easy					
5	I will attend the trial sessions to understand how the system works					
6	I understand that smart card technology is an innovation					
	Implementation of Smart Card Technology	**1 Strongly disagree**	**2 Disagree**	**3 Neutral**	**4 Agree**	**5 Strongly Agree**
1	I believe the implementation of Smart card technology in healthcare requires all bodies					
2	I am aware of communication awareness of smart card usage					
3	I believe user satisfaction is measured by smart card					
4	I believe smart card implementation will improve the quality of healthcare					
5	I am aware that documentation will not be lost after the smart card implementation					
6	I am aware previous patient's history is available					

Thank you for your participation!

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