INVESTIGATION OF THE VIABILITY OF AN INTEGRATED CLOUD-BASED ELECTRONIC MEDICAL RECORD FOR HEALTH CLINICS IN FREE STATE, SOUTH AFRICA

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DECLARATION OF INDEPENDENT WORK

I, NOMABHONGO MASANA, identity number and student number , do hereby declare that this research project submitted to the Central University of Technology, Free State for the Degree MASTER OF INFORMATION TECHNOLOGY, is my own independent work; and complies with the Code of Academic Integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State; and has not been submitted before to any institution by myself or any other person in fulfilment (or partial fulfilment) of the requirements for the attainment of any qualification

SIGNATURE OF STUDENT

18 February 2019

DATE

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ABSTRACT

The use of paper-based medical records leads to gaps in patient healthcare. Paper-based records are prone to challenges such as lack of real-time access to patient data, and inability to share and exchange medical data among different health institutions. A solution to address most of the challenges associated with paper-based medical records is to have an information system, such as an Electronic Medical Record (EMR) system. EMRs have proven to be more complete and quicker to access as opposed to paper records.

Although EMRs may help resolve some of the problems with paper-based medical records, if the EMR systems are not linked or integrated, the problem of real-time accessibility and exchange of patient data remains unresolved. This leads to challenges in monitoring a patient's health progress and providing continuity of care.

The emerging cloud-computing model, which leverages the Internet to allow the sharing of IT resources as online services, may offer a cost-effective solution of integrating diverse EMR systems. It can serve as an electronic medical record storage centre which simplifies the complexities with EMR exchange methods between different systems and saves the equipment setup expenses for smaller healthcare facilities. In addition, cloud computing may improve healthcare services and benefit medical research.

Despite the benefits offered by cloud computing, the adoption of cloud computing in the healthcare industry is the slowest compared to other industries. Further, adopting cloud computing involves many factors which require rigorous evaluation prior to introducing the new computing model to an organization. Very few empirical studies have focused on exploring factors influencing the adoption of cloud computing, especially in the public health sector.

This study aimed to investigate the viability of an integrated cloud-based EMR system by exploring factors which influence the intent to adopt cloud computing at public healthcare facilities in the Free State province, South Africa. Through a review of literature on existing studies on the adoption of cloud computing and the Technology-Organization-Environment (TOE) framework, TOE factors were identified and adopted to suit the study's context. The study carried out a quantitative cross-sectional research by collecting data using a questionnaire which was surveyed to a sample of five principal network controllers from all districts of the Free State and 31 public healthcare facilities in the Free State (FS), South

Africa. The data collected was analyzed using SPSS version 19. The study's hypotheses were tested by conducting a Spearman's Coefficient Correlation.

Results of the study revealed that most of the public healthcare facilities are using paper-based medical records with some form of IT to record basic patient information. Further, results of the study showed that some of the Health Information Systems (HIS) utilized at these healthcare facilities in the FS include Meditech, PADS, PharmAssist, Tier.net, HPRS, Rx Solutions, RDM, ETR and DHIS. According to this study, investments into IT infrastructure need to be considered by these health facilities as the current internet facilities will not be able to accommodate the use of cloud computing and only some facilities have internet facilities in place. Despite these challenges, these healthcare facilities are willing to adopt a cloud-based EMR system. Lastly, results of the study revealed that the factors associated with the intent to adopt cloud computing included relative advantage, security concern, organization readiness and top management support.

Keywords: Adoption, Adoption Theory, Cloud Computing, eHealth, Electronic Medical Record, Health, Innovation, Paper-based Medical Records, Public Healthcare Facilities, Technology-Organization-Environment (TOE) Framework

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RESEARCH OUTPUTS

Publications

[1] *Article*: Masana N., Muriithi G.M. (2018) Investigating TOE Factors Affecting the Adoption of a Cloud-Based EMR System in the Free-State, South Africa. In: Belqasmi F., Harroud H., Agueh M., Dssouli R., Kamoun F. (eds) Emerging Technologies for Developing Countries. AFRICATEK 2017. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 206. Springer, Cham

[2] *Book Chapter*: Masana, N., Muriithi G.M. (2016). "Investigating the adoption of a cloud-based Electronic Medical Record (EMR) system in the Free-State province, South Africa", INTERIM: Interdisciplinary Journal, vol 15, No. 1, 2016, p. 18 – 34.

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[2] *Poster Paper*: Masana, N., Muriithi, G.M. "Investigating TOE Factors Affecting the Adoption of a Cloud-Based EMR System in the Free-State, South Africa", AFRICATEK 2017, Marrakech, Morocco, March 27-28, 2017 Proceedings

Accepted Conference Papers

[1] *Conference Paper*: N. Masana and G. Muriithi. "Adoption of an integrated Cloud-based Electronic Record System at Public Healthcare Facilities in Free State, South Africa". ICTAS2019 conference

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LIST OF ABBREVIATIONS

CC	Cloud Computing
CEO	Chief Executive Officer
CHC	Community Health Center
DDos	Distributed Denial of Service
DoH	Department of Health
DOI	Diffusion of Innovation
EMR	Electronic Medical Record
FS	Free State
HIS	Health Information System
HSREC	Health Sciences Research Ethics Committee
IaaS	infrastructure as a Service
ICBEMR	Integrated Cloud-Based Electronic Medical Record
IT	Information Technology
KMO	Kaiser-Meyer-Olkin
NHRD	National Health Research Database
NIST	National Institute of Standards and Technology
PaaS	Platform as a Service
PCA	Principal Component Analysis
PHC	Primary Healthcare
Q	Question
RQ	Research Question

SA	South Africa
SaaS	Software as a Service
SHC	Secondary Healthcare
SPSS	Software Package for Social Sciences
Std.	Standard
TAM	Technology Acceptance Model
TMS	Top Management Support
TOE	Technology-Organization-Environment
UFS	University of the Free State

CHAPTER 1: INTRODUCTION

1.1 Background

According to Katurura and Cilliers, more than half of South African public healthcare centers still utilize paper-based records for filling purposes [1]. Paper records are prone to challenges such as lack of real-time access to patient data and inability to share and exchange medical data among different health institutions. Further, information on paper records is inaccurate and incomplete, which can lead to gaps in patient healthcare and may affect results of medical research [2].

A solution to address most of the challenges associated with paper-based medical records is to have an information system (such as an Electronic Medical Record (EMR) system) that will track patients' treatment, record laboratory test results and medication, and provide on-going reports about treatment status [3].

An EMR, one of the services made possible by eHealth, is a digital medical record that can be shared and transferred among different health institutions [4]. The EMR system forms an essential element of the infrastructure that needs to be in place for effective healthcare services [5].Compared to paper-based approaches, EMRs are more complete and provide faster access to patient data as opposed to paper records [6]. They offer benefits such as reduced typographical errors and the need for computerized decision support [7]. EMRs can improve healthcare by ensuring guidelines and protocols are being adhered to.

Although EMRs may help resolve some of the problems with paper-based medical records, if the EMR systems are not linked or integrated, the problem of real-time accessibility and exchange of patient data remains unresolved. In addition, traditional approaches in which health institutions individually operate their own infrastructure for the management and sharing of medical records are too complex and expensive for most healthcare facilities. This poses a challenge in the transition from paper-based systems to electronic systems.

The emerging cloud-computing model, which leverages the Internet to allow the sharing of IT resources as services, may offer a possible solution of integrating the EMR systems. Cloud computing is a model that offers ubiquitous access to the network in a convenient way with minimal management effort [8]. It provides large data storage centres used by corporations for low-cost information technology services [9].

Furthermore, most managers and experts believe that cloud computing may improve healthcare services and benefit medical research and reduce costs associated with setting up a shared EMR infrastructure [10]. Integrating EMR systems with the cloud enables the sharing and exchange of selected medical data among the different healthcare facilities [11]. Despite the benefits offered by cloud computing, progress towards development of e-government services (including e-health and e-education) in South Africa is found to be quite slow due to the limited use of cloud computing in the public sector [12].

Similar to introducing an innovation, adopting cloud computing involves many factors which require evaluation prior to introducing the new computing model to an organization [10]. Although researchers in past years placed their focus on security issues of the Cloud [13], recent studies show that there are many factors that can affect the adoption of cloud computing [14]. Discovering these factors can help accelerate the implementation and use of an innovation or it can hinder the innovation being supported.

1.2 Problem Statement

Most public healthcare facilities in South Africa are still utilizing paper-based medical records [1]. Paper-based medical records face many challenges, including the inability to get real-time access to patient data when needed, exchange and share medical data among health institutions, and inaccurate medical reports. In addition, paper-based medical records are often difficult to use for medical research and problematic when used for clinical studies [15]. This negatively affects the ability to improve a patient's health. Although some public healthcare facilities are utilizing electronic medical record (EMR) systems to store basic patient details, which may help resolve some of the problems with paper-based medical records, the lack of integration among these systems remains a challenge [1]. Issues associated with the exchange of data and real-time access of patient data remain unresolved. This leads to challenges in monitoring a patient's health progress and providing continuity of care.

The emerging cloud-computing model may offer a cost-effective solution of integrating diverse EMR systems [16]. This model offers the ability to access the network in a convenient way with less management effort. It can provide an exchange platform which can be used by all hospitals and clinics [11]. Furthermore, it can serve as an electronic medical record storage centre which simplifies the complexities with EMR exchange methods between different

systems and saves the equipment setup expenses for smaller healthcare facilities. In addition, cloud computing may improve healthcare services and benefit medical research [10].

However, the adoption of cloud computing in the healthcare industry is the slowest compared to other industries [17]. Very few empirical studies have focused on exploring factors influencing the adoption of cloud computing, especially in the public health sector [18]. Therefore, the challenge remains to determine factors leading public healthcare facilities to adopt and deploy cloud computing. The extent to which Free State (FS) public healthcare facilities are willing to adopt cloud EMR remains unclear. Furthermore, Technology-Organization-Environment (TOE) factors affecting the intent to adopt cloud computing at public healthcare facilities in the Free State have not been widely explored.

1.3 Purpose of the Study

The study aims to investigate the viability of an integrated cloud-based EMR (ICBEMR) for public health facilities in the Free State (FS) province by exploring factors which influence the intent to adopt cloud computing. This study draws on the Technology-Organisation-Environment (TOE) framework [19] [20], a firm-level innovation adoption framework, through which the impacts of technological, organizational and environmental factors on the intent to adopt an ICBEMR system are identified and explored.

Objectives of the study are as follows:

- Assess the current systems used in capturing, storing and analyzing patient data at public healthcare facilities in the Free State.
- Investigate, using questionnaires, the viability of adopting an integrated cloud-based EMR system that is accessible to key stakeholders in the FS public health sector.
- Using the Technology-Organization-Environment (TOE) framework, derive a set of key predictors of adoption for a cloud-based EMR system for the FS health sector.

1.4 Research Questions

Having identified the aim and objectives of the study, the study's research questions are as follows:

RQ1: *What is the current state of health information systems (HIS) at public healthcare facilities in the Free State?*

RQ2: *What is the state of internet facilities at healthcare facilities?*

RQ3: *Are public healthcare facilities in the Free State province willing to adopt a cloud-based Integrated EMR system that permits the sharing of patient data among different health institutions?*

RQ4: *What are the technological, organizational and environmental factors influencing the intent of public healthcare facilities to adopt an integrated cloud-based EMR system in the Free State?*

1.5 Statement of Hypothesis

This study is anchored on the TOE framework. The study derived a set of factors adapted from existing studies and modified to suit the study's context. Factors affecting the intent to adopt and the hypotheses to be tested for the study are as follows:

1. **Technological Factors**
    a. Relative Advantage

    H_0: *The relative advantage of an ICBEMR has no impact on the intent to adopt.*

    H_1: *The relative advantage of an ICBEMR has an impact on the intent to adopt.*

    b. Compatibility

    H_0: *Compatibility of an ICBEMR system has no impact on the intent to adopt.*

    H_2: *Compatibility of an ICBEMR system has an impact on the intent to adopt.*

    c. Security Concern

    H_0: *Security concern over an ICBEMR system has no impact on the intent to adopt.*

    H_3: *Security concern over an ICBEMR system has an impact on the intent to adopt.*

    d. Availability of Resources/IT Infrastructure

H_0: Availability of resources for an ICBEMR system has no impact on the intent to adopt.

H_4: Availability of resources for an ICBEMR system has an impact on the intent to adopt.

2. Organizational Factors

a. Top Management Support

H_0: Top management support for an ICBEMR system has no impact on the intent to adopt.

H_5: Top management support for an ICBEMR system has an impact on the intent to adopt.

b. Organization Readiness

H_0: Organization readiness towards an ICBEMR system has no impact on the intent to adopt.

H_6: Organization readiness towards an ICBEMR system has an impact on the intent to adopt.

c. Organization Size

H_0: The size of the health facility has no impact on the intent to adopt an ICBEMR system.

H_7: The size of the health facility has an impact on the intent to adopt an ICBEMR system.

3. Environmental Factors

a. Competitive pressure

H_0: Competitive pressure for an ICBEMR has no impact on the intent to adopt.

H_8: Competitive pressure for an ICBEMR has an impact on the intent to adopt.

b. Vendor Support

H_0: Vendor support for an ICBEMR has no impact on the intent to adopt.

H_9: Vendor support for an ICBEMR has an impact on the intent to adopt

1.6 Significance of the study

1.6.1 Theoretical Impact

A limited number of empirical studies on the adoption of cloud computing in health, especially in SA, are limited. In addressing this gap, the study identifies and explores factors which contribute towards the adoption of cloud computing in health. The study anchors its theory on the TOE framework, a theoretical model covering the technological, organizational and environmental aspects of an organization. The inclusion of the environment context within the TOE framework makes it more appropriate in explaining the adoption of an innovation in an organization [13]. The study provides the significance of the cloud-computing adoption theory based on the TOE framework which measures the intention towards the adoption of cloud computing. Further, adding to the knowledge body, the study provides a South African perspective on the adoption of cloud computing in health, especially in the public health sector.

1.6.2 Practical Impact

The study provides new knowledge on the adoption of cloud computing and an opportunity for transitioning to a cloud-based EMR system to improve healthcare. It informs of the ubiquitous model of cloud computing which offers cost-effective and flexible solutions. The public health sector is informed of the benefits provided by cloud computing and how it can be incorporated into the operations of the organization for improved productivity and quality healthcare services. Having an integrated medical system can help address challenges faced by rural communities of South Africa. According to literature, having a national cloud framework for healthcare will be able to allow users in the rural areas to access doctors, medical diagnosis and treatment over the internet [21].

Furthermore, the study provides information on the current state of HIS within healthcare facilities in the FS. This will help the decision makers to make an informed decision on the next step required to be taken by the Department of Health (DoH) to have all healthcare facilities running and operating at maturity stage 5 (which means a fully integrated, centralized national EMR system). In addition, the DoH is also informed on improvements required in

terms of internet facilities, to re-evaluate the current ISP and invest in IT services. Without a stable and reliable internet connection, the adoption of cloud computing cannot be achieved. Lastly, factors which are drivers for the adoption of cloud computing are addressed by the study. This informs the DoH of the main factors to consider should they desire to adopt the innovation.

1.7 Research Method

In this study, a quantitative approach was followed by conducting a cross-sectional survey research using questionnaires for data collection. According to Creswell [22], a quantitative approach is best as the problem in this study calls for the identification of TOE factors influencing the adoption of an innovation by the FS Health Department. Additionally, in survey research design, the researcher administers the survey to a sample of the population to examine the behaviour, opinions, attitudes and characteristics of the study population [23] [24].

Thirty-one public healthcare facilities in FS and five district principal network controllers, one from each district (Motheo, Fezile Dabi, Lejweleputswa, Thabo-Mofutsanyana, Xhariep) in FS, were involved in the study. Of the 31 facilities, 15 were Clinics, 6 were Community Health Centres (CHC) and 10 were District Hospitals. Participants in the study from public healthcare facilities included senior management personnel and doctors/nurses.

The data was collected using a questionnaire, which was checked for internal consistency, reliability and validity. A reliability test was conducted to ensure the Cronbach's Alpha value of the scale items have internal consistency and fall within the acceptable values (.6+). The questionnaire was checked for validity by conducting a Principal Component Factor Analysis (PCA). Prior to carrying out factor analysis, analysis of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity values were evaluated, as well as communalities and factor-loading values to verify that the sample size is adequate to perform factor analysis. Spearman's Coefficient Correlation was conducted to test the study's hypotheses. Data was analyzed using a Statistical Package for Social Sciences (SPSS v.19).

1.8 Assumptions and Limitations

The assumption of the study is that the results of the study can be generalized to the entire population as public healthcare facilities are under the same management (DoH FS) and working towards a similar goal.

A limitation of the study is that the data may be subject to respondent bias, as is the case with most surveys: that respondents may not always answer truthfully.

1.9 Structure of the study

The remainder of the chapters are set up as follows:

Chapter 2 provides a review of related literature on Paper-based Medical Records, Electronic Medical Records, the South African e-Health Strategy and Standards (Normative Standards) maturity levels, Cloud Computing, an Integrated Cloud-Based EMR system, Adoption Theories and the Technology-Organization-Environment (TOE) Framework on which this study is anchored. **Chapter 3** explains how the study was conducted by providing the research design followed and the methods applied to solve the research problem. **Chapter 4** presents the statistical analysis and results of the study. **Chapter 5** presents a discussion of the results and provides answers to the research questions. **Chapter 6** concludes the study by providing a summary of the study, implications of the study, recommendation for future research, and concluding remarks.

Summary

This chapter introduced the study's topic by giving an overview of the study, drawing attention to the study's *what* (the problem, purpose, objectives), *why* (the significance of the study) and *how* (the research method) questions. In addition, the study's assumptions and limitations were identified, as well as the layout of the study is provided. The next chapter provides a review of literature related to the study's topic and theoretical model.

CHAPTER 2: LITERATURE REVIEW

This chapter presents a review of literature on Paper-based Medical Records, Electronic Medical Records, the South African e-Health Strategy and Standards (Normative Standards) maturity levels, Cloud Computing, and an Integrated Cloud-Based EMR system. Literature review on Adoption Theories, the Technology-Organization-Environment (TOE) Framework on which this study is anchored; and the factors which will be explored in this study are also presented.

2.1 Paper-based Medical Records

A medical record can be a hard or soft copy which contains confidential information about a patient; it also provides information to healthcare providers about a patient's medical history [25]. Good quality medical records are an essential component of safe and effective healthcare. Their main function is to facilitate continuity of care.

In South Africa, most healthcare centers still utilize a paper-based filling system [1]. Typically, institutions "open" a file folder for each patient who visits the health facility. The folder contains manual records pertaining to a patient's personal and contact details, treatment history, test results, prescriptions, etc. If a patient visits a different institution, a similar file folder is opened. Over time, a patient's treatment history is scattered over multiple institutions, each holding a partial 'snapshot' of the patient's medical history.

This leads to many challenges, including the inability to get real-time access to patient data when needed, inability to exchange and share medical data among health institutions, and difficulties in compiling accurate medical reports and in monitoring patient health progress. In addition, paper-based medical records are often difficult to use for medical research and problematic when used for clinical studies [15]. Literature shows that some physicians conducting research rely solely on the information recorded on medical records, and if the information is inaccurate or incomplete, this may affect the results of the research or produce incorrect results [2]. The use of paper-based medical records leads to gaps in patient healthcare.

In an archival survey that was attempted in a rural community in South Africa, Wegner and Rhoda [26] discovered the following results after their data collection:

(1) Incorrect documentation. Five out of 64 folders (8%) presented folder numbers that did not match the patient requested;
(2) Different folder numbers, whereby some patients' out-patient folder number did not match the patients' hospital folder number;
(3) Patient folders with incomplete information.
(4) Method of filing. Three of the four hospitals studied had no storage space left while the fourth hospital had records in unfiled stacks on the floor. In two of the hospitals, filing shelves were overloaded, making it difficult to remove or replace a folder as they were squeezed tightly together.

In more than 80% of the cases in an observational study by Tang *et al.* [27], patient information needed to work on the patient during their visit could not be found in the medical record. If physicians cannot get access to medical records when needed, they may require to re-examine and re-do the tests, which results in money and time being wasted for the health facility, the patient and the physician [2].

Other factors to be considered which can negatively affect the use of paper-based medical records are natural disasters such as fire and floods from which data cannot be recovered once lost. For example, the hurricane Katrina in the United States left patients at risk of being incorrectly diagnosed or treated as doctors had to treat patients without the knowledge of their condition and medication due to lost medical records [28].

Additionally, with Makkah and Madinah (cities of Saudi Arabia) being overcrowded throughout the year, visitors are exposed to health problems due to overcrowding and climate change, but because of lack of real-time access to a complete medical history, patients do not receive appropriate healthcare provision on time [29].

Another challenge with paper records is human error. Errors made while capturing/documenting a patients' medical information during consultation and the results of the diagnosis are a serious issue in healthcare. Since the medical information is captured by hand, it can be illegible/unreadable, unorganized and incomplete, resulting in incorrect diagnosis being made and the patient being on the wrong treatment, which in turn makes it difficult to ensure continuity of quality healthcare [6].

Furthermore, Faramarz *et al.* [2] discovered that poor handwritten notes, missing notes/records/information are some of the major problems with paper-based medical record.

He further stated that in all the records they used from the hospital he used in his study, not all information was correctly documented and compatible with the official format for medical records which is provided by the Iran Ministry of Health and Medical Education.

A study carried out by Wegner and Rhoda [26] discovered that inadequate record-keeping is a major obstacle in doing archival research in a rural community in South Africa. Furthermore, the authors state that “Inadequate record keeping can compromise the health of the patient as well as the career of the health-care practitioner”, and poor medical research will negatively affect the quality of medical teaching and of healthcare services.

A solution to address most of the challenges associated with paper-based medical records is to have an information system that will track patients’ treatment, record laboratory test results and medication, and provide on-going reports about treatment status [3]. A system such as an EMR can be a solution and may help resolve challenges associated with paper-based medical records. The following section explains more on EMR systems and the literature associated with the use of this system and how it can be used to improve healthcare.

2.2 Electronic Medical Records

Medical information is broad and new medical knowledge is being added every day, but it is impossible for a physician to know it all, so physicians need to take advantage of the offers made available by technology for them to monitor their patients’ health and carry out research [30].

The term e-Health, according to the World Health Organization (WHO), is “the use of information and communication technologies (ICTs) for health to, for example, treat patients, pursue research, educate students, track diseases and monitor public health” [31]. Another definition given by Eysenbach [32] refers to e-Health to include not only technical development, but also as an emerging field in medical informatics, the health services offered, and data delivered through the internet.

E-Health marries healthcare and Information Technology to make possible a variety of services such as Electronic Health/Medical Record (EMR/EHR), m-Health, Telemedicine, HealthCare Information Systems, etc. [33]. One of the services made possible by e-Health is a digital medical record that can be shared and transferred among different health institutions, known as an Electronic Medical Record (hereafter referred to as EMR) [4]. An EMR system

forms an essential element of the infrastructure that needs to be in place for effective healthcare services [5].

The state of EMR implementation varies greatly across different public healthcare facilities within each province in South Africa. For a clearer understanding of where FS facilities are positioned, the following sub-section looks at the eHealth Strategy South Africa in terms of the maturity stage South Africa is at with regards to the implementation of eHealth as well as the status of FS.

2.2.1 The South African e-Health Strategy and Standards (Normative Standards) maturity levels/stages

The eHealth Strategy South Africa (SA) sets out the National Department of Health's (NDoH) strategies in improving the state of health in South Africa and providing a way forward on future implementations. It defines eHealth as a broad domain which includes mHealth, telemedicine and all information communication technologies (ICTs) used to promote, support and strengthen healthcare [31]. The strategy [31] aims to support the strategic objectives of the Department of Health (DoH) in a way that is comprehensive, pragmatic and innovative, providing a single, harmonized and comprehensive eHealth strategy. Figure 1 depicts the strategy's vision, mission and aims.

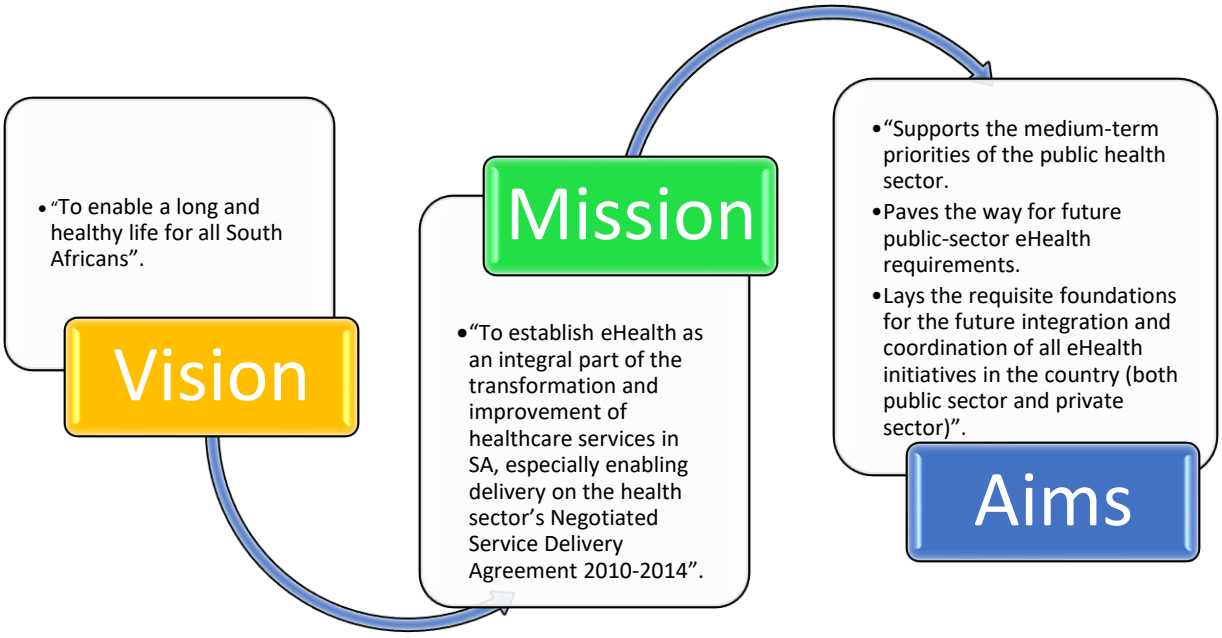

Figure 1. eHealth strategy's vision, mission and aims

Table 1 describes the different e-Health maturity levels/stages as classified by the e-Health Strategy South Africa [31] and the National Health Normative Standards [34]

Table 1. eHealth Maturity Stages/Levels

South Africa e-Health Strategy Maturity Levels	National Health Normative Standards Maturity levels	Description
Stage 1 & 2	**Level1**	Fully paper-based system with no form of IT support at all.
Stage 3	**Level 2**	Paper-based system with some form of IT support to record patient basic details
Stage 4	**Level 3**	A centralized EMR per hospital/clinic, with less integration between the different EMRs
Stage 5	**Level 4**	A fully integrated, centralized national EMR system

According to the strategy, some provinces in South Africa are still operating at Stage 2 while others are at Stage 4 due to the availability of resources, trained workforce and the cost of ICT [34] [31].

Table 2 shows the different electronic systems in place in each province in South Africa. Some provinces such as the Free State, Gauteng, KwaZulu-Natal and the Western Cape have more than one EMR system in place [31]. This places South Africa at maturity Stage 3 [31].

Table 2: Hospital Information Systems in use per province in South Africa

Province	**Patient Management/Hospital Information Systems in use.**
Eastern Cape	Delta 9
Free State	Meditech; PADS
Gauteng	Medicom; Soarian MedSuite, PharmAssist, PAAB
KwaZulu-Natal	Medicom; Meditech; PALS; Pro-Clin; ReMed
Limpopo	Medicom
Mpumalanga	PAAB
North West	PAAB
Northren Cape	Nootroclin
Western Cape	Clinicom; Delta 9; PHCIS; JAC Pharmacy

In continuation, EMRs are proven to be more complete and quicker to access as opposed to paper records [6]. They offer benefits such as reduced typographical errors and the need for computerized decision support [7]. EMRs can improve healthcare by ensuring guidelines and protocols are being adhered to and decreased medical errors. They help keep track of patients and report on patients who missed their appointments in a timely manner, thereby enabling a search or follow-up on those patients to be carried out [35].

However, a brief review of existing literature reveals that managing the transformation from a paper-based system to an electronic system is complex in nature, as it entails a fundamental change in the healthcare culture [5]. Although there may be security and privacy risks associated with the implementation of an EMR system, it is argued that with proper safeguards and technology, an EMR may have better security than paper-based records [36].

Despite the challenges or negative aspects (lack of financial assistance, security and privacy, complexity of the system) hampering the widespread use of EMR systems, the benefits of this system (such as high-quality care, efficient patient care, reduced medical errors, cost-effectiveness, reduced duplication of information and promotion of standard care) greatly outweigh these negative aspects [37]. Moreover, the use of electronic record systems would improve quality of care, increase security, reduce waiting time for consultations and the

number of errors for prescribed medication, reduce time spent on administrative tasks, and provide accurate and complete medical records [38] [39].

The adoption of an EMR system has been proven to have a positive financial return on investment in primary care [40]. For example, EMR systems in health centres have greatly saved the Canadian healthcare systems close to $1.3 billion throughout the entire country of Canada in the past three years [38].

An EMR system is not only limited to the above-mentioned benefits, but it also offers advantages to carrying out clinical research. Since all the medical data is contained and stored in one system, researchers are able to retrieve and access the necessary medical data required to carry out the research in virtually no time directly from the system with less effort, compared to searching for medical data at different health institutions using traditional paper records. It also provides the researcher with the relevant patients for the study while still ensuring adherence to protocols that need to be followed [41].

A brief review of literature from a study in Canada by Zelmer and Hagens, revealed that the adoption of EMR has more than doubled since 2006 with improved efficiency and patient care benefits (for example, reduced time managing laboratory test results and fewer adverse drug events); these benefits are expected to rise more as EMR is more generally adopted [42]. Compared with paper medical records, there were 5% more consultations per hour with the EMR in place [43].

Although EMRs may help resolve some of the problems with paper-based medical records, if the EMR systems are not linked or integrated, the problem of real-time accessibility and exchange of patient data remains unresolved. Traditional approaches of integrating diverse systems for inter-operability are often complex, expensive and time-consuming. Healthcare providers in smaller healthcare facilities are often left with the option to use only insecure paper records due to lack of funds and resources to transition to electronic health records (EHRs) [44].

The emerging cloud-computing model, which leverages the Internet to allow the sharing of IT resources as services, may offer a possible solution of integrating the EMR systems. The following sections look at cloud computing and how it can be integrated with EMR systems to provide accessibility and exchange of medical information anytime and anywhere there is internet.

2.3 Cloud Computing

The National Institute of Standards and Technology (NIST) defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” [8]. The cloud model comprises five essential characteristics, three service models and four deployment models. Figure 2 depicts the cloud model.

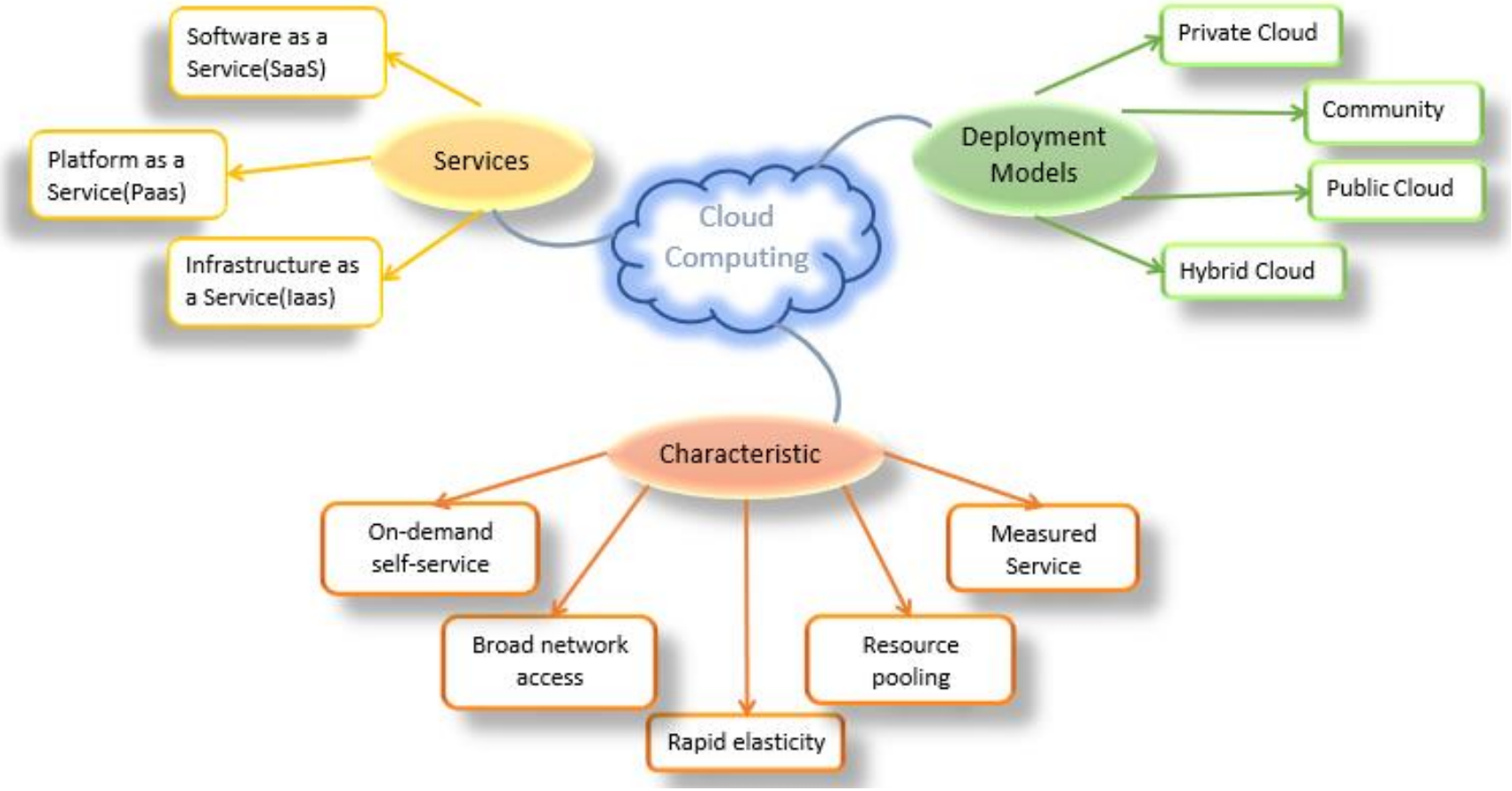

Figure 2. Cloud-computing Model

Table 3 gives a description of the characteristics, services and deployment models as defined by the NIST [8].

Table 3: Cloud Model

Characteristics
• *On-demand self-service.* A user can make use of cloud computing services (emails, applications and network storage) without the service provider's interaction.
• *Broad network access.* Cloud capabilities available over the network for different platforms such as mobile phones, laptops and accessed via certain mechanisms
• *Resource pooling.* All the provider's computing resources are made available to numerous customers using "multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand".
• *Rapid elasticity.* The cloud capabilities are provided to the subscriber rapidly and elastically, giving the subscriber an unlimited access to these capabilities and the ability to increase or decrease the services as desired.
• *Measured service.* Cloud systems control and optimize resources used automatically by measuring the service capability that is appropriate for the type of service provided.
Services
• *Software as a Service (SaaS).* The subscriber/consumer uses the provider's applications run on the cloud infrastructure. These applications are accessible from different client devices either through a client interface such as a web browser (e.g. web-based email) or a program interface. The consumer does not manage or control the underlying cloud infrastructure.
• *Platform as a Service (PaaS).* This service allows the subscriber/consumer to deploy onto the cloud infrastructure applications created by him/her or obtained using programming languages and tools supported by the provider. The consumer

does not manage or control the underlying cloud infrastructure but has control over the deployed applications and configuration settings.
• *Infrastructure as a Service (IaaS).* The service allows the consumer/subscriber to make use of the processing, storage, networks and other computing resources where he/she is able to deploy and run other software, operating systems and applications.
Deployment Models
• *Private cloud.* The cloud infrastructure is provisioned solely for a single organization.
• *Community cloud.* The cloud infrastructure is shared by a specific community of consumers with a shared concern (mission, policy, and security requirements)
• *Public cloud.* The cloud infrastructure is made available for use by the public.
• *Hybrid cloud.* A cloud infrastructure comprising two or more cloud infrastructures that remain unique entities but are bound together by standardized technology enabling data and application portability.

Benefits and challenges associated with the adoption of cloud computing should be taken into consideration by organizations before taking the decision to adopt. The following table presents some of the benefits and challenges of cloud computing [45] .

Table 4: Benefits and Challenges of CC

Benefits	Challenges
Ease of Access: Cloud-based medical record systems are much better, faster and easier to access than traditional server-based storage systems.	*Distributed Denial of Service (DDos) Attacks*: The hacker can exploit weaknesses of the cloud defence system by using less expensive and easily accessible tools to launch DDos attacks.
Cost-Effectiveness: The use of cloud computing technology can decrease the costs of information technology industry by	*Confidential Data Leakage*: Confidentiality of data cannot be maintained because of lack of visibility, the exchange of

20% yearly by reducing hardware, software and on-site IT costs.	information on the cloud and malicious insiders.
Increased Productivity and Efficiency: Physicians do not have to spend more time when accessing medical information from the cloud because the information is available in one connected data storage.	*Security issues:* Security becomes a major concern to the organization when a cloud computing technology must be implemented
Scalability: Cloud computing offers the user the choice to pay for the services as they use them (pay-as-you-go), where they pay only for storage they have utilized.	*Zero Tolerance*: Due to encryption or watermarking, spots will appear in medical images retrieved from the cloud leading to incorrect interpretations of the medical images (e.g. presence of a tumour or growth), and doctors may give faulty diagnosis.

Cloud computing is becoming a popular computing model that provides large data storage centres used by corporations for low-cost information technology services [9]. With cloud computing, applications are not on a stand-alone computer, but are stored on a shared server accessed on the internet [46]. Users are able to access information from the cloud anywhere, whenever they want, using any device as long as they are connected to the internet [47]. For example, one can (1) upload a file to a cloud account and retrieve/download it from any device when needed; (2) share the file or anything else securely with friends, colleagues or family by giving them access to the file so that they retrieve it when they log in to their cloud account anywhere, anytime [48].

The cost associated with setting up one's own infrastructure (hardware and software), installing, configuring, testing, running, securing and updating it as a firm is very high and time-consuming, but with cloud computing this is not necessary as one does not need to manage anything: everything is handled by the vendor and upgrades are automatic [49].

Organizations have taken advantage of this technology to grow their enterprises without the need for setting up the infrastructure for it, and the cloud being dynamic, it offers organizations

the choice to use the services and resources as needed, increase them if required and pay for what they have used because of the technology's pay-as-you-go cost structure [50].

The cloud has brought about the use and application of information technology in almost every area of our lives, one of these areas being the health sector [21].Cloud computing enables EMRs to be integrated to facilitate the sharing and exchange of selected medical data among health institutions. This approach offers affordable storage to smaller health facilities with limited human and financial resources [51].

The next section reviews literature on integrated EMR systems through cloud computing, outlining the necessity of having an integrated system and the benefits of having such a system.

2.4 Integrated cloud-based Electronic Medical Records (ICBEMR)

Getting the right information at the right time when it is needed saves lives [52]. Due to its improved accessibility, storing medical data in the cloud enables physicians and medical staff to collaborate with each other for medical research in order to achieve better quality healthcare services to all people [53] [54]. By moving to a centralized cloud EMR, healthcare professionals can easily collaborate with each other, access reports and patients' medical records including scans, treatment/prescriptions and lab results, as well as reducing the chances of misdiagnosis and prescription of wrong medication [55].

If integrated with the Internet, an EMR platform provides flexibility in terms of *"transferability of information, greater communication among doctors, and improvement in quality of care"* [5]. A preliminary investigation carried out by a team of researchers in Kenya implemented a cloud-based EMR for maternal and child health in rural Kenya and compared it with the existing paper-based record. They concluded that a cloud-based EMR model offered the ability to share data across multiple sites in real time, providing enhanced data access for different levels of care [11].

Furthermore, studies have shown that a national cloud framework for healthcare will be able to allow users in the rural areas to access doctors and medical diagnosis and treatment over the internet [21]. In addition, rural health centres can benefit greatly in terms of resources and cost reduction from the cloud model [56]. The cloud can help break the barriers to the adoption of EMR in resource-poor areas, removing the need for building a local infrastructure (including

a server, network, security, maintenance and power supply) for each health facility, but have only one server used to cater for all health facilities [57].

However, implementing a cloud-based EMR platform comes with several risks compared to dedicated agency data centres [9], some of which were highlighted in Table 4 in the previous section, most importantly security and confidentiality.

Despite these challenges, Vogel *et al.* [58] postulate that "*distributed networks effectively manage the tensions between privacy, security, and public health by allowing institutions to retain complete control of their health data, while simultaneously enabling authorized users to submit queries for authorized purposes".* In addition, Shortliffe [41] states that there are technical and policy measures which can be put in place to ensure the records are accessible always and are secured.

The EMR system offers many other benefits, such as medical advice, clinical guidance, and interaction between health professionals and integrated biomedical data [41]. It can also be used to check for available physicians, specialists, products or services offered, and refer patients to the correct physician [52]. If the EMR system can be adopted widely, it can lead to savings in healthcare as it was found by Hillestad *et al.* [59] in their study in the US, that having all resources in one network can save about $81 billion per year.

The cloud offers the ability to maintain an electronic record containing all the medical information of a patient from all health institutions that patient has visited, creating a "virtual medical record" which contains all the patient's health data from all settings [41]. In a study carried out by Wu and Chiu [60], the EMR system was used effectively in Taiwan whereby organizations shared EMRs using the "*Exchange Centre of EMR under a Virtual Private Network (VPN)*" which improved the management of medical records and reduced the amount of paper used. Figure 3 shows an example of an ICBEMR system.

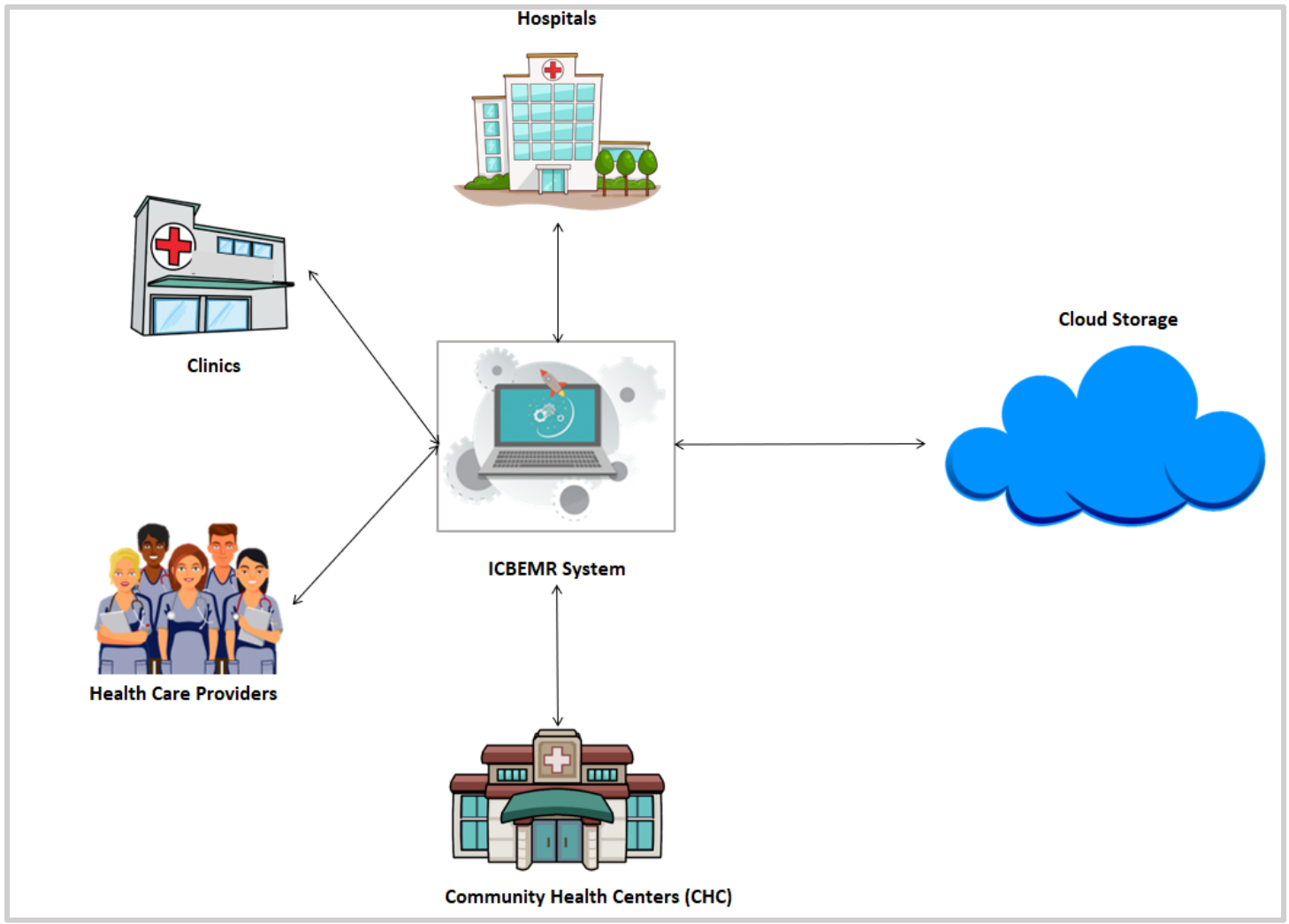

Figure 3. Integrated cloud-based EMR

Having medical information shared between patients and health facilities can help improve diagnoses and add to patients' knowledge of how to take care of themselves [61]. Exchanging and sharing medical data among different clinics will also help reduce medical expenses [62]. Preliminary research revealed that with an EMR, information is made available everywhere without jeopardizing the patient's safety, quality of treatment and confidentiality [63].

Additionally, institutions such as insurance companies can benefit from a cloud-based EMR, which gives them the privilege of accessing a client's medical data to review it as part of their policy to know a client's medical state before insuring them [64]. However, access to patient data may differ from country to country due to the laws and regulations in place to protect people's privacy.

Due to financial and geographical barriers, masses of people who cannot afford or obtain better quality services can benefit greatly from a nationalized framework, whereby their diagnosis can be studied by specialist physicians around the world [54]. Furthermore, a growing number of managers and experts believe a cloud-based EMR system can improve healthcare services and promote better medical research [10].

The adoption of an innovation such as this can be positively or negatively influenced by external or internal factors in an organization. Discovering these factors can help accelerate the implementation and use of an innovation or it can hinder the innovation being supported at all. In the next section, adoption theories – specifically the adoption theory on which this study is anchored – will be reviewed and factors that might influence the adoption of an ICBEMR will be identified.

2.5 Information Systems Adoption Theories

The process of adopting cloud computing involves many factors which require rigorous evaluation prior to introducing the new computing model to an organization [10] .

Adoption theories deal with identifying factors influencing the adoption of a technology [65]. Literature on factors influencing cloud-computing adoption found the Technology Acceptance Model (TAM) and Technology-Organization-Environment (TOE) theories to be used most frequently, followed by the Diffusion of Innovation (DOI) and the Unified Theory of Acceptance and Use of Technology (UTAUT) theories [65].

The TAM, DOI and TOE theories will be reviewed further in the following sections.

2.5.1 TAM

The TAM model has been used and accepted widely for understanding the adoption of IT innovation [66]. Proposed by Davis, the model focuses on two constructs – Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Perceived Usefulness refers to the extent a user believes an innovation will enhance his/her performance at work, while Perceived Ease of Use refers to the extent a user believes that the innovation will be easy to use [67]. Discovering these factors about the user/employee's intention on the use of the innovation helps employers and organizations to manipulate these factors to promote the use of IT innovations as they predict the users' acceptance and use of the innovation [66], [67].

The models' constructs lack the flexibility of exploring adoption factors of innovative technologies such as cloud computing (CC) and are relevant to adoption studies at the individual level as they provide only a user's perspective on the use of an innovation [65].

2.5.2 DOI

As with the TAM model, the Diffusion of Innovation (DOI) Theory has been used widely in exploring predictors of adopting IT innovation in organizations [68]. The DOI theory, developed by Rogers, is used to explain why, how and at what rate new innovations occur at both individual and organizational levels [18], [69]. The main contribution of this model is its set of attributes which include relative advantage, compatibility, complexity, trialability, and observability [69], [67]. These attributes are considered to be drivers which influence the decision to adopt an innovation. Similar attributes such as relative advantage, compatibility and complexity form part of the TOE framework's technological context [67].

However, Dunne [65] found that the model's attributes focus on the primary objective features of the technology itself rather than the subjective features operating on the perceptions of the adoption decision maker.

2.5.3 TOE Framework

The Technology-Organization-Environment (TOE) framework is an organizational theory explaining the elements which influence a firm's decision on the adoption of an innovation [19] [20] . It was found to be consistent with the DOI theory which identified the internal and external factors of an organization as predictors for organizational innovation [13]. The framework was produced in 1990 by Tornatzky and Fleischer and suggests that the adoption

of a technology is influenced by three contexts: technological context, organizational context and environmental context [70].

The **technological context** of an organization considers both the existing technologies and technologies that can be purchased or added to the existing ones for improvement of the firm; **organizational context** refers to the organization's resources, which include how the employees are structured, communication methods, the size/scope of the firm and managerial structures; **environmental context** refers to the structure of the industry, consisting of government, community, competitors and the availability of service provider or suppliers [19] [71] [72]. Figure 4 depicts the TOE framework developed by Tornatzky and Fleischer.

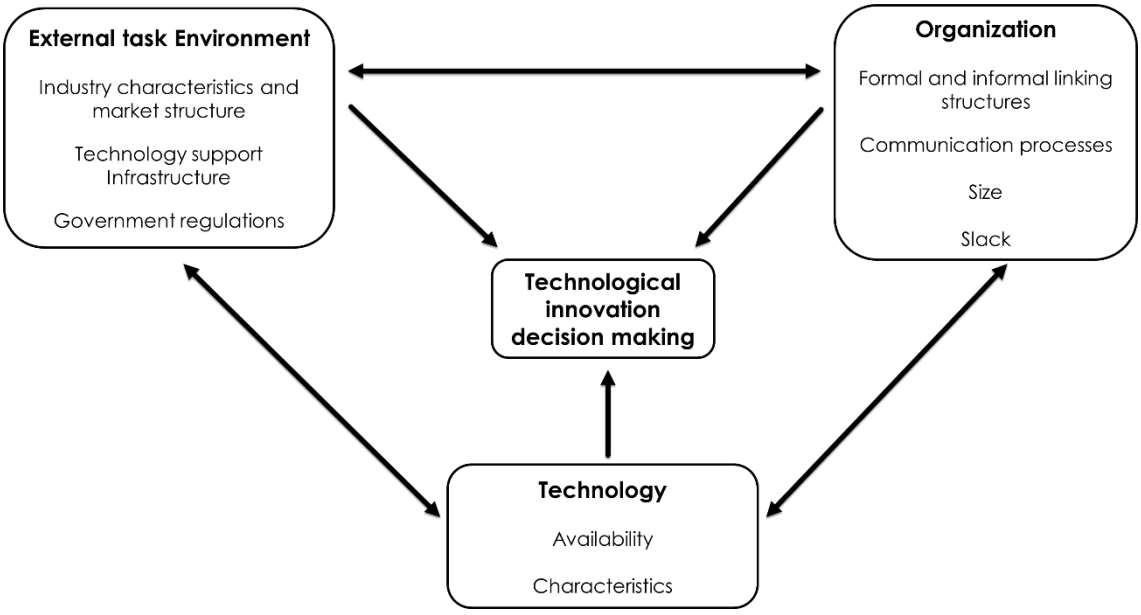

Figure 4. Technology-Organization-Environment (TOE) Framework

The TOE framework has been used and supported widely in many technology adoption studies as a theoretical foundation and has proven to be effective from past research with studies on innovation technologies such as information systems, e-commerce, web service, e-CRM and cloud computing being anchored on the TOE framework [73], [74]. It is more favoured by researchers and has gained momentum widely as a theoretical perspective on IT adoption [66], [65].

Contrary to the DOI theory, the TOE frameworks' inclusion of the environmental context provides a holistic view of factors that influence the adoption of a technology. The inclusion

of the environment context within the TOE framework makes it more appropriate in explaining adoption of an innovation in an organization [13] .

Moreover, the inclusion of technological, organizational and environmental variables has made TOE advantageous over other adoption models in studying technology adoption, technology use and value creation from technology innovation [66].

Table 5 presents some of the studies that have used the TOE framework as a basis to study the adoption of specific technologies by firms.

Table 5: Related studies on TOE framework

Source/Study	Technological Factors	Organizational Factors	Environmental Factors
Assessing A New IT Service Model, Cloud Computing [75]	• Perceived benefits • Perceived barriers	• Organizational learning capacity • Organizational IT capability	• Competitive pressure • Expectation of network dominance
Factors that affect cloud computing adoption by small and medium enterprises in Kenya [76]	• Relative advantage • Complexity • Compatibility	• Top management • Firm size • Technological readiness	• Competitive pressure • Trading partner pressures
Factors Influencing the Adoption of Cloud Computing by Small and Medium Enterprises in Developing Economies [77]	• Trial ability of cloud services • Existence of required it infrastructure and resources • Compatibility with existing systems • Strength of In-built security systems • Learning capability of employees • Limited technical knowledge about similar technologies	• Top management support and involvement • Resistance towards new technologies • Conformity with work culture and style • Impact of organizational structure and size • First adopters in our industry	• Adequate user and technical support from provider • Choice of skilled and expert cloud vendors • Influence of market scope • The nature of industry • Relationship with providers, government and competitors

Source/Study	Technological Factors	Organizational Factors	Environmental Factors
	• Non-performance of cloud services to support operations		
Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors [78]	• Technology readiness	• Top management support • Firm size	• Competitive pressure • Regulatory support
Cloud computing adoption in Greece [79]	• Relative advantage • Uncertainty • Privacy risk • Privacy risk due to geo-restriction • Compatibility • Observability • Complexity • Trial ability	• Size • Top management support • Innovativeness • Prior experience	• Competitive pressure • Industry • Market Scope • External support • Financial crisis
Understanding SaaS adoption from the perspective of	• Relative advantage • Simplicity • Compatibility • Experience ability	• IT infrastructure • Top management support	• Competitor pressure • Partner pressure

Source/Study	Technological Factors	Organizational Factors	Environmental Factors
organizational users: A tripod readiness model [80]			
Cloud Computing in South African SMMEs: Risks and Rewards for Playing at Altitude [81]	• IS resources • IS competency	• Size • Top management support • Industry	• Competitive pressure • External support • Industry influences
Estimating influence of TOE factors on e-government usage: Evidence of Jordanian Companies [82]	• IT infrastructure • Relative advantage • Compatibility • Security	• Top management support • Financial resources • Human resources • Culture	• Government support • Competition pressure
TOE drivers for cloud transformation: direct or trust-mediated? [83]	• Reliability • Information Security	• Size • International scope • IT competence • Entrepreneurship	• Institutional pressure • Structure assurance • Vendor scarcity
Evaluating the critical determinants for adopting e-market in Australian small and medium-sized enterprises [84]	• Perceived direct benefit • Perceived indirect benefit	• Size • Organization readiness • Top management support	• External pressure

Source/Study	Technological Factors	Organizational Factors	Environmental Factors
Factors affecting the adoption of B2B e-commerce technologies [85]	• Costs • Network reliability • Data security • Scalability • Complexity	• Top management support • Trust	• Pressure from trading partner • Pressure from competition
Exploring the factors influencing the adoption of Open Source Software in Western Cape schools [86]	• Relative advantage • Compatibility • Skills of existing ICT workers • Fit to task • Product performance	• IT innovativeness • Boundary spanners • Slack	• Technology support and services • Legitimacy • Product awareness
Cloud computing adoption by SMEs in the north east of England [87]	• Relative advantage • Uncertainty • Compatibility • Complexity • Trial ability	• Size • Top management support • Innovativeness • Prior IT experience	• Competitive pressure • Industry • Market scope • Supplier efforts and external computing support
Cloud Computing Adoption by firms [88]	• Technology Readiness	• Global scope • Top management support • Firm size	• Competitive pressure • Regulatory support

Source/Study	Technological Factors	Organizational Factors	Environmental Factors
The adoption of software-as-a-service (SaaS): ranking the determinants [72]	• Relative advantage • Compatibility • Complexity • Trial ability • Observability • Security and privacy	• Sharing and collaboration culture • IT resource	• Competitive pressure • Social influence

2.6 Technology-Organization-Environment Factors

After reviewing the three adoption theories (TAM model, DOI theory, TOE framework), the study finds the TOE framework to be suitable for studying factors influencing the adoption cloud computing and to evaluate and explore the significance of these factors on the intent to adopt cloud computing. The following are the different factors which will be studied.

Technological context. Technological factors that will be explored include relative advantage, compatibility, security concern and availability of resources.

***Relative advantage*.** This factor explores whether the innovation is better than that which is already in place. Espadanal and Oliveira [88] defined relative advantage as "the degree to which an innovation is perceived as being better than the idea it supersedes." They further added that innovations with a clear advantage in effectiveness or cost-effectiveness are easily adopted and implemented.

Compatibility. According to Alshamaila *et al*. [79], compatibility is the degree to which an innovation is consistent with the existing technologies in a firm. Several studies revealed that compatibility with existing technologies and practices is a key predictor on the adoption of an innovation [80]. "The decision to adopt technology is influenced by the available technology's fit for the organization (its compatibility), how easily it can be integrated into the existing technology landscape and the extent to which the technology is used within the organization" [89].

***Security concern*.** One of the first or major questions concerning technology, computers and data sharing over the cloud is about safety, whether the innovation or technology is secure enough for data storage and transference. "Due to the open nature of the Internet, privacy risk has been recognized as a key factor hindering the use of some ICT technologies, for example. e-service evaluation and adoption" [87].

Availability of resource/IT infrastructure. In their study, Yeboah-Boateng and Essandoh discovered this factor's level of importance to be high, in second place after Trial ability of Cloud Services [77]. With proper IT infrastructure in place and the necessary resources available, the adoption of a cloud EMR system and implementation thereof are made easy.

Organizational context. Organizational factors that will be explored include top management support, organizational readiness, and size of the organization.

Top management support. The support of top management plays an important role when it comes to the adoption of an innovation, whereby the top management of an organization has the final say on organizational IT strategy and investment. When top managers understand the importance cloud computing can have for their business, they will influence other organizational members to accept it; however, if they do not understand the advantages, they will be considered as a barrier to cloud computing adoption [88]. The support of top management is considered one of the three top forecasters for IT innovation adoption, as suggested by the latest review on IT adoption [90]. Thus, they can influence the adoption decision either positively or negatively.

Organizational readiness. This refers to the availability of an organization's financial and technological resources [74]. The organization must be financially ready to cover the cost that comes with adopting an innovation and have the technological resources required. Mamatela [89] states that as healthcare facilities invest in information technologies to improve the quality care, provide continuity of care and reduce costs, understanding the technological factors influencing the organization's readiness to change presents an important avenue for research. Furthermore, financial constraints place limitations on an organization's ability to attain the necessary resources for the successful implementation of an innovation [89].

Size of the organization. Larger firms often need robust information systems to facilitate the sharing of information, and a high usage level of a system requires large volumes of transactions and information storage to help with the management of data and facilitate the sharing of information across all departments with ease [89]. The size of a firm is deemed to be a crucial determinant of cloud computing adoption [90]; hence, a large user number impacts on the need for technology innovations.

Environmental context. Environmental factors that will be explored include competitive pressure and vendor support.

Competitive Pressure. The competitive environment impacts the organization's strategic decisions. For example, if the organization's competitors adopt an innovation and are gaining strategic advantage from it, it may put pressure on an organization to integrate a specific technology to retain competitive advantage [91] [80].

Vendor support. This refers to the ability of a vendor to supply or offer training on their system and provide the organization with technical assistance on how to use the cloud EMR system. In a study carried out on the factors influencing the adoption of Open Source Software (OSS) [86], all respondents shared the opinion that structured vendor support must be in place and be available at all times in order to give support with regards to the new technology that is introduced.

Summary

This chapter presented a review of literature from prior studies covering important elements of the study. The review covered paper-based medical records, electronic medical records (EMR), building up towards the main focal point of the study which is cloud computing and the integration of EMRs. Additionally, three most commonly used adoption theories, namely the Technology Acceptance Model (TAM), Diffusion of Innovation (DOI) and Technology-Organization-Environment (TOE) framework were reviewed. Based on the literature reviewed and supporting arguments from prior studies, the TOE framework among the other two adoption theories was found to be the most suitable theory to base the study on. TOE factors which were adapted in this study included relative advantage, compatibility, security concern, availability of resources, top management support, organizational readiness, size of the organization, competitive pressure and vendor support. The next chapter presents methods and procedures followed in carrying out the study.

CHAPTER 3: METHODOLOGY

The main aim of the study is to investigate the viability of an integrated cloud-based EMR (ICBEMR) for public health facilities in the Free State (FS) province by exploring TOE factors influencing the intent to adopt an ICBEMR. To achieve the study's aims and objectives, several methods and procedures had to be applied. This chapter outlines those methods and procedures.

This study followed a quantitative research approach, which, according to Creswell [22], is the best to use in this study as the problem calls for the identification of TOE factors influencing the adoption of an innovation by the FS Health Department. The study will conduct a cross-sectional survey research using questionnaires for data collection. The research design outlines the population and sample used for the study, the instrument, ethical considerations associated with the study, data collection and analysis methods used.

3.1 Survey Research Design

Survey research design is a procedure in quantitative research whereby a researcher administers a survey to a sample of the population to examine the behaviour, opinions, attitudes and characteristics of the study population [23] [24]. The researcher collects numeric data using questionnaires or interviews, and statistically analyzes the collected data to describe trends about the respondents, to answer research questions and to test the research hypotheses [92].

Glasow further adds that "first, survey research is used to quantitatively describe specific aspects of a given population. These aspects often involve examining the relationships among variables. Second, the data required for survey research are collected from people and are, therefore, subjective. Finally, survey research uses a selected portion of the population from which the findings can later be generalized back to the population" [23].

Therefore, before conducting the survey as indicated by Glasow [23], "the researcher must predicate a model that identifies the expected relationships among these variables. The survey is then constructed to test this model against observations of the phenomena*."*

A cross-sectional survey will be conducted using questionnaires for data collection. In a cross-sectional survey design, the researcher collects data at one point in time [92]. Figure 5 presents the research design steps followed to carry out the study.

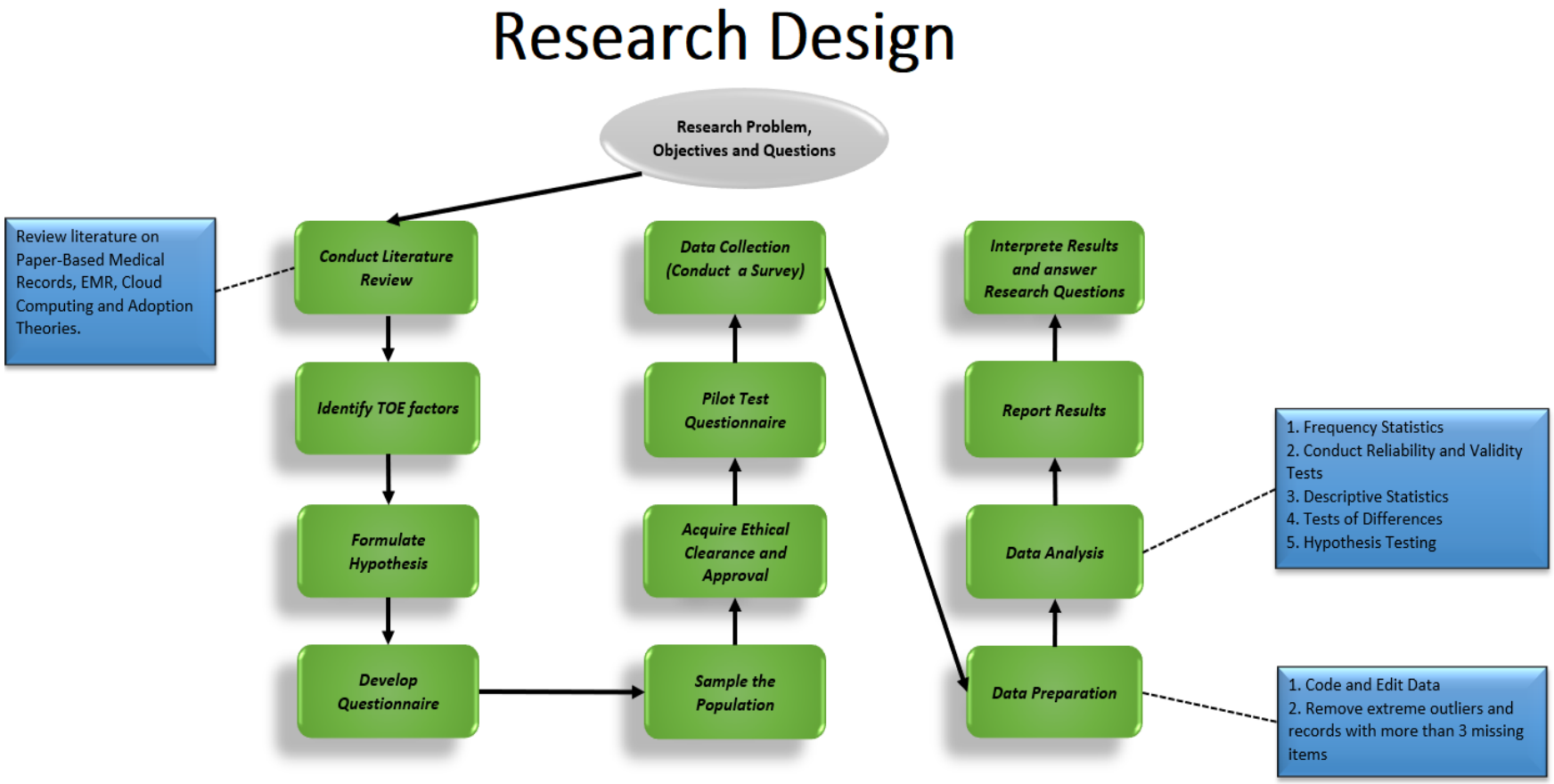

Figure 5: Research Design

3.3 Population and Sample

Figure 6. Free State Map *[93]*

Above is a map of the Free State province, South Africa, which is the study's target location. The population of the study involves public healthcare facilities from each of the five districts in the FS province, as depicted in Figure 6. These districts are: Motheo district, Lejweleputswa district, Thabo Mofutsanyana district, Fezile Dabi district and Xhariep district.

According to the National Health Research Database (NHRD), there were 252 public health facilities to choose from for the study. Convenience sampling was used to select health facilities to be involved in the study. "Convenience sampling is a selection process in which respondents are chosen based on their convenience and availability*"* [92]. Using this sampling technique, thirty-one public healthcare facilities (consisting of 15 clinics, six community health centres and 10 district hospitals) were selected to participate in the study and five principal network controllers. Two participants per health facility were asked to participate in the survey

which included senior management personnel (CEO/Manager/Heads of Dept.) and a medical staff(nurses/doctors).

Of the 31 health facilities, 30 health facilities responded, one of the chosen health facilities could not participate due to the unavailability of participants, two of the facilities had only one participant responding, which left only 58 participants. In addition, there were five principal network controllers who participated in the study, one from each of the five districts of the FS province. A total of 63 participants were involved in the study.

3.5 Instrument Design and Layout

"An instrument is a tool for measuring, observing, or documenting quantitative data. It contains specific questions and response possibilities that you establish or develop in advance of the study" [92]. Three different survey questionnaires were designed as instruments for data collection. The instruments were designed to suit the different groups of participants (senior management personnel, medical staff and IT personnel) involved in the study. The questionnaires were structured as follows:

- **Senior Management Personnel:**
  - *Section A*: Questions related to demographics, the current HIS and cloud computing awareness
  - *Section B*: Contains questions about the TOE factors and the intent to adopt.
- **Medical Staff:**
  - *Section A*: Questions related to demographics, the current HIS and cloud computing awareness, the current system used for capturing and storing patient data manually (paper-based)
  - *Section B*: Contains questions about the TOE factors and the intent to adopt.
- **IT personnel:**
  - *Section A*: Questions related to demographics, the current IT infrastructure at health facilities in the district, current HIS in the district, and cloud computing awareness
  - *Section B*: Contains questions about the TOE factors and the intent to adopt.

The three questionnaires are attached, see Appendix B. The questionnaires consist of multiple choice, Yes/No and Likert scale questions.

A 5-point Likert-type scale (1=Strongly Disagree to 5=Strongly Agree) was used to measure each of the model's independent variables. The dependent variable was also measured using a five-point Likert-type scale.

3.5.1 Variables

"A variable refers to a characteristic or attribute of an individual or an organization that can be measured or observed and that varies among the people or organization being studied. Independent variables are those that (probably) cause, influence, or affect outcomes. They are also called treatment, manipulated, antecedent, or predictor variables. Dependent variables are those that depend on the independent variables; they are the outcomes or results of the influence of the independent variables. Other names for dependent variables are criterion, outcome, effect, and response variables." [22]. Below are the criterion and predictor variables of the study.

Criterion Variable:

Organization Intent (intent to adopt cloud computing). This scale item was measured using five item scales on a five-point Likert scale adapted from studies by Son and Lee [75] and Kinuthia [74]. The respondents were asked to determine their level of agreement with regards to the intentions to adopt cloud computing: (1) I think that using cloud computing services is advantageous. (2) I am in favour of using the cloud computing services. (3) Our health department is likely to adopt and use a Cloud EMR system in the near future. (4) Our health department is more likely to adopt Cloud EMR if a private cloud is used. (5) Our health department is likely to consider cloud EMR if a Community Cloud linking similar institutions is put in place.

Predictor variables:

Relative Advantage. Five items where used to measure Relative Advantage on a five-point Likert scale. The items were adapted from prior studies on Cloud Computing ([88]; [78]; [75]). The items included: (1) Cloud EMR will enable me to accomplish my job tasks quickly and effectively. (2) Using Cloud EMR will improve the quality of my work. (3) Using Cloud EMR will increase the organization's productivity. (4) Using Cloud EMR will improve help access patient data easily. (5) Adopting a Cloud EMR system is more cost-effective than purchasing traditional EMR systems (systems that are not on the cloud)

Compatibility. Compatibility was measured using four items on a five-point Likert scale adapted from a study by Espadanal and Oliveira [88], Oliveira *et al*. [78] and Kinuthia [74]. The respondents were asked to indicate their level of agreement with these statements: (1) A Cloud EMR system will be compatible with our existing IT infrastructure (system's format, interface and other structural data) in the organization. (2) The transition to a Cloud EMR system will not require a new infrastructure (hardware and software). (3) Adopting a Cloud EMR is part of our strategy for the coming years. (4) The adoption of a Cloud EMR system has been implemented in some of the health facilities.

Security Concern. Items to measure Security Concern where adapted from Espadanal and Oliveira [88], Oliveira *et al.* [78], Sila [85], and modified to fit the study. The adapted five items measured on a five-point Likert scale were: (1) Internet security is a major concern to our firm when deciding to adopt Internet/Cloud based technology. (2) I am comfortable with exchanging and sharing medical data online within my organization/colleagues, (3) I am comfortable exchanging and sharing medical data online with other health facilities in my area, (4) I am comfortable exchanging and sharing medical data online with other health facilities provincially, (5) I believe Cloud EMR system is more secure than manual medical records.

Availability of Resources. A five-point Likert scale was used to measure Availability of Resources. The respondents were asked to determine their level of agreement on the two item measurements adapted from a study by Yeboah-Boateng and Essandoh [77] and Mamatela [89]: (1) We have sufficient technological resources to adopt a Cloud EMR system, (2) We have high bandwidth connectivity to the internet to support a Cloud EMR system

Top Management Support. Three item measurements on a five-point Likert scale were used to measure Top Management Support. The measurements were adapted from studies by Oliveira *et al.* [78], Kinuthia [74], Sila [85] and modified to fit the study. The three measurements included: (1) Top management is likely to consider the adoption of cloud computing as strategically important, (2) Top management is willing to take the risks involved in the adoption of Cloud EMR, (3) The adoption and use of Cloud EMR in our organization will receive strong support from top management.

Organization Readiness. Three item measurements were used to measure Organization Readiness. Respondents were asked to indicate their level of agreement with the following item measurements on a five-point Likert scale:(1) Our organization has enough technological resources required to adopt a Cloud EMR system, (2) Our organization has the necessary

financial aid to implement a Cloud EMR, (3) Our organization is willing to fund the implementation of a Cloud EMR system. The item measurements were adapted from prior studies ([85], [75]).

Organization Size: The scale was measured by asking respondents to specify the number of employees in the organization and the number of patients per day. The respondents were given five options for number of employees to choose from: 1-10, 11 -50, 51 – 100, 101- 500, >500; and six options for number of patients to choose from: <10, 10-50, 51 – 100, 101 – 150, 151 – 200, >200. The items were adapted from prior studies on Cloud-Computing adoption ([88]; [78]; [75]; [89]).

Competitive Pressure. In this study, competitive pressure was measured using four item measurements adapted from prior studies ([88], [85]; [75]; [74]). The respondents were asked to determine their level of agreement with the following item measurements on a five-point Likert scale: (1) Our industry is pressuring our organization or company to adopt Cloud EMR system, (2) There is government pressure on our organization or company to adopt Cloud EMR system, (3) There is pressure from other organizations in our industry to use Cloud EMR system, (4) We understand the competitive advantages offered by cloud computing in our Industry.

Vendor Support. Four item measurements were used to measure Vendor Support on a five-point Likert scale. The item measurements were adapted from prior studies ([75]; [74]) and included the following statements: (1) We ensure that cloud vendors implement strong access and identity management to ensure unauthorized access to cloud computing, (2) Our suppliers expect us to adopt cloud computing technology, (3) Our suppliers are willing to give us technical assistance in adopting Cloud EMR system, (4) Our suppliers are willing to support our staff by training them in how to use a Cloud EMR system.

A summary of the measurement items along with the studies they were adapted from is shown in Table 6.

Table 6: Scale Variables

Scale	Scale Item Alias	Scale Items	Source
Relative Advantage	TRA1	A Cloud EMR will enable me to accomplish my job tasks quickly and effectively.	([88]; [78]; [75])
	TRA2	Using Cloud EMR will improve the quality of my work.	
	TRA3	Using a Cloud EMR will increase the organization's productivity.	
	TRA4	Using a Cloud EMR will improve help access patient data easily	
	TRA5	Adopting Cloud EMR system is more cost-effective than purchasing traditional EMR systems (systems that are not on the cloud)	
Security Concern	TS1	Internet security is a major concern to our firm when deciding to adopt Internet/Cloud-based technology	([88]; [78]; [85])
	TS2	I am comfortable with exchanging and sharing medical data online within my organization/colleagues	
	TS3	I am comfortable exchanging and sharing medical data online with other health facilities in my area	

Scale	Scale Item Alias	Scale Items	Source
	TS4	I am comfortable exchanging and sharing medical data online with other health facilities provincially	
	TS5	I believe a Cloud EMR system is more secure than manual medical records	
Compatibility	TC1	A Cloud EMR system will be compatible with our existing IT infrastructure (system's format, interface and other structural data) in the organization.	([88]; [78]; [74])
	TC2	The transition to a Cloud EMR system will not require a new infrastructure (hardware and software)	
	TC3	Adopting a Cloud EMR is part of our strategy for the coming years	
	TC4	The adoption of a Cloud EMR system has been implemented in some of the health facilities.	
Availability of Resources/IT Infrastructure	TAR1	We have sufficient technological resources to adopt a Cloud EMR system	([77]; [89])
	TAR2	We have high bandwidth connectivity to the internet to support a Cloud EMR system	
Top Management Support	OTM1	Top management is likely to consider the adoption of cloud computing as strategically important	([78]; [74]; [85])

Scale	Scale Item Alias	Scale Items	Source
	OTM2	Top management is willing to take the risks involved in the adoption of Cloud EMR	
	OTM3	The adoption and use of Cloud EMR in our organization will receive strong support from top management.	
Organization Readiness	OOR1	Our organization has enough technological resources required to adopt a Cloud EMR system	([85], [75]).
	OOR2	Our organization has the necessary financial aid to implement a Cloud EMR	
	OOR3	Our organization is willing to fund the implementation of a Cloud EMR system	
Organization Size	OS1	Please indicate the approximate number of Employees in your Institution/Facility	([88]; [78]; [75]; [89]).
	OS2	On average, how many patients does your facility handle per day?	
Competitive Pressure	ECP1	Our industry is pressuring our organization or company to adopt a Cloud EMR system.	([88], [85]; [75]; [74]).
	ECP2	There is government pressure on our organization or company to adopt a Cloud EMR system	
	ECP3	There is pressure from other organizations in our industry to use a Cloud EMR system	

Scale	Scale Item Alias	Scale Items	Source
	ECP4	We understand the competitive advantages offered by cloud computing in our Industry	
Vendor Support	EVS1	We ensure that cloud vendors implement strong access and identity management to ensure unauthorized access to cloud computing	([75]; [74])
	EVS2	Our suppliers expect us to adopt cloud computing technology	
	EVS3	Our suppliers are willing to give us technical assistance in adopting a Cloud EMR system	
	EVS4	Our suppliers are willing to support our staff by training them in how to use a Cloud EMR system	

3.6 Data Collection Procedure

The data collection process was facilitated using questionnaires, which were hand- distributed by the researcher to the selected healthcare facilities for participants to fill in. The researcher arranged with the CEOs/Managers/Heads of the healthcare facilities, informing them about the survey for the study to be conducted at their respective facilities and asking for their help to arrange participants who would be involved in the study. With their permission, the researcher visited the different health facilities at the arranged time and date to conduct the survey. The purpose for arranging the time and date for the survey was so that the researcher could wait for the participants to fill in the questionnaire and return with the questionnaires. In addition, the willingness to participate was good as the health facilities were notified in time about the survey and it also gave time for the participants to prepare themselves for the survey without interruptions to their daily duties/service delivery. The researcher was responsible for the distribution and collection of the questionnaires. The data was collected in all five districts (Fezile Dabi, Lejweleputswa, Thabo Mofutsanyane, Motheo and Xhariep) of the Free State province. Once all the data had been collected, the responses were compiled into an excel spreadsheet and loaded into the Statistical Package for Social Sciences (SPSS) software version 19.0 for analysis. Figure 7 below presents the stages involved in the data collection to the analysis of the data.

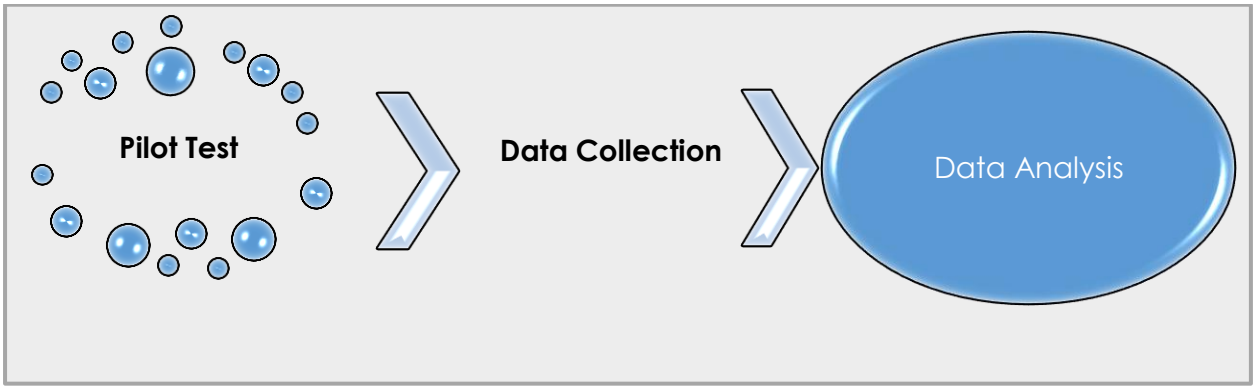

Figure 7*:* Data Collection and Analysis Stages

3.6.1 Pilot Test

To test the effectiveness of the questionnaire and improve it, the questionnaire was piloted to three healthcare facilities in Bloemfontein, resulting in six participants for the pilot. The aim of the pilot was to: a) determine the level of easiness of questions; b) the easiness to comprehend the questions; and c) the relevance of the questions asked. The questionnaire consisted of closed-ended multiple choice questions, five-point Likert scale questions (strongly disagree to strongly agree) and short questions (Yes/No). Participants were given two weeks to complete

the questionnaire, after which the researcher would collect the completed questionnaire. The challenge encountered during the process of delivering and leaving the questionnaire with the participants to fill in during their own time was that they forgot to fill in the questionnaire. However, after the two weeks, the researcher gave the participants another day or two to fill in the questionnaire and collected them after the set time. Minor changes were made to the final questionnaire based on the results of the pilot study.

3.6.2 Final Questionnaire

For the distribution of the final questionnaire and to avoid delays which took place during the Pilot Test stage, the researcher contacted the health facilities to set up appointments (date and time) telephonically for conducting the survey, informing them of the nature of the study, the number of participants required, and how long the questionnaire would take to complete. Contact details of the health facilities were searched for online at www.yellowpages.co.za. Having set the appointments and receiving approval to conduct the survey at the healthcare facilities by the CEO/Manager/Heads, the researcher visited the health facilities and hand-distributed the questionnaires to the participants to fill in while waiting for them. This procedure was effective as opposed to the data collection method that was used for the pilot test.

However, due to time constraints and the amount of work the participants had to cover per day (considering that the study must not hinder the participants from performing their daily duties/render services to patients), the researcher resorted to asking for not more than two participants per health facility to participate.

3.7 Ethical Consideration (Safety, Confidentiality and Anonymity for Human Subjects)

To ensure the confidentiality and anonymity of participants, consent was given by participants to the researcher to use the information collected for this study (see cover page of questionnaire in Appendix B1, B2, B3). Furthermore, to ensure that proper procedures were followed to protect human subjects and to conduct the study, on April 2017, ethical clearance was applied for by the researcher to the UFS Health Sciences Research Ethics Committee (HSREC) via the rims website. At the end of April 2017, a response from the Ethics Committee was received with minor changes required to be made by the researcher on the e-Form and supporting documents. With the required changes made, the application was re-submitted by the researcher in May 2017 and conditional approval from the HSREC was obtained by the end of May 2017. With the conditional approval granted, the researcher applied for approval to conduct research at selected health facilities in the Free State from the FS DoH on the National Health Research Database (NHRD) website at beginning of June 2017. Approval

from the FS DoH was obtained on 25 June 2017. The approval letter from the FS DoH was then submitted to the HSREC for final approval. Approval of ethics was obtained from the HSREC by 25 July 2017. The approval letters from the FS DoH and HSREC are attached: see Appendix A.

3.8 Data Analysis Strategy

Data was analyzed using a statistical software package SPSS version 19. According to Creswell [92], there are several steps to be taken when analyzing quantitative data: the first step is to prepare the data by means of screening it and assigning numeric codes; the second step is to begin the data analysis.

For scale items, a scale reliability test was performed to determine the scale's internal consistencies by checking the Cronbach's Alpha value of each scale. A reliability test was performed on the scales used in the study: Relative Advantage, Compatibility, Security Concern, Availability of Resources, Top Management Support, Organization Readiness, Competitive Pressure and Vendor Support. Secondly, to test for validity of constructs, factor analysis was performed. Lastly, to test the study's hypotheses, the researcher conducted a Spearman's Correlation Coefficient test.

Summary

This chapter outlined the methods and procedures which were followed in conducting the study. The study will follow a quantitative research approach, by conducting a cross-sectional survey using questionnaires for data collection. The study's target population included public healthcare facilities based in the Free-State (FS) province of South Africa. A sample of 31 public healthcare facilities, which included clinics, community health centers and hospitals were surveyed. Participants involved senior management personnel (CEO/Manager/Heads of Dept.), medical staff(nurses/doctors) and five district principal network controllers, one from each of the five districts of the FS. Three different questionnaires were designed to suit the different participants in the study. Ethical clearance was obtained from the FS Department of Health and the UFS Health Sciences Research Ethics Committee (HSREC). The data collected in this study will be analyzed using a statistical software package for social sciences (SPSS). The following chapter presents the how the data was analyzed and provides results obtained from the analysis.

CHAPTER 4: DATA ANALYSIS

The study aimed to investigate the viability of an integrated cloud-based EMR (ICBEMR) for public health facilities in the Free State. This was achieved by assessing the state of HIS in FS and exploring TOE factors influencing the intent to adopt an ICBEMR by the FS public health sector. This chapter presents the data preparation procedure and the findings of the study on the state of HIS in FS, the state of IT infrastructure in terms of internet facilities and accessibility, the willingness to adopt the innovation, and TOE factors influencing the intent to adopt an ICBEMR by the FS public health sector.

The data was analyzed using the Statistical Package for Social Sciences (SPSS) version 19 by obtaining frequency tables and graphs to display the distribution of the responses. The responses obtained from the data collected informed the study about the necessity of adopting an ICBEMR system and areas requiring improvement. Further, the researcher was able to make recommendations regarding the cloud computing adoption and important factors to consider when adopting the innovation.

4.1 Data Preparation

The data preparation procedure proceeded with scoring data by assigning each response category for each question a numeric score. The data was compiled into a spreadsheet to be loaded to SPSS. Prior to loading the data to SPSS, the data was screened for missing values.

Of the 30 participants who were in senior management positions, only 29 questionnaires were received back. Twenty-four cases were deemed valid and complete, three cases had one missing item, one case had two missing items and one other case was discarded as it was incomplete. Furthermore, 29 questionnaires from the medical staff were received back. Seventeen cases were deemed valid and complete, six cases had one missing item, three cases had two missing items and three other cases were discarded due to incompleteness. In total, of the 58 responses received from the healthcare facilities (senior management personnel and medical staff), only 54 cases were deemed valid and usable for analysis. The data was missing at random as there was no pattern among the missing items. Further, all five questionnaires received from the principal network controllers were found valid. The table below summarizes the missing data.

Table 7: Missing Items per case

Number of Items Missing	Number of Cases per Missing Item
1	9
2	4
6	1
10	1
17	1
31	1

A total of four cases were deleted from the dataset due to a high number of incomplete items, leaving a total of fifty-nine valid cases for data analysis.

Once the data had been loaded into SPSS, all the variables were defined and assigned scores. To check for errors, the researcher ran frequencies to ensure that the scores entered are within the range of values assigned for each question. All errors found were fixed and replaced with the correct value from the questionnaire for the particular case. There were no extreme values found.

4.2 Demographic Characteristics of the Sample.

The respondents in this study involved healthcare personnel and district principal network controllers at health facilities in FS. Healthcare personnel involved in the study were senior management personnel and medical staff (nurses and doctors). A graphical presentation of the respondents' demographic information: the district they were located at, the type of health facility they worked at, the number of employees at the healthcare facility, the number of patients per day, job title, gender, age group and highest qualification are presented in Figures 8 – 14.

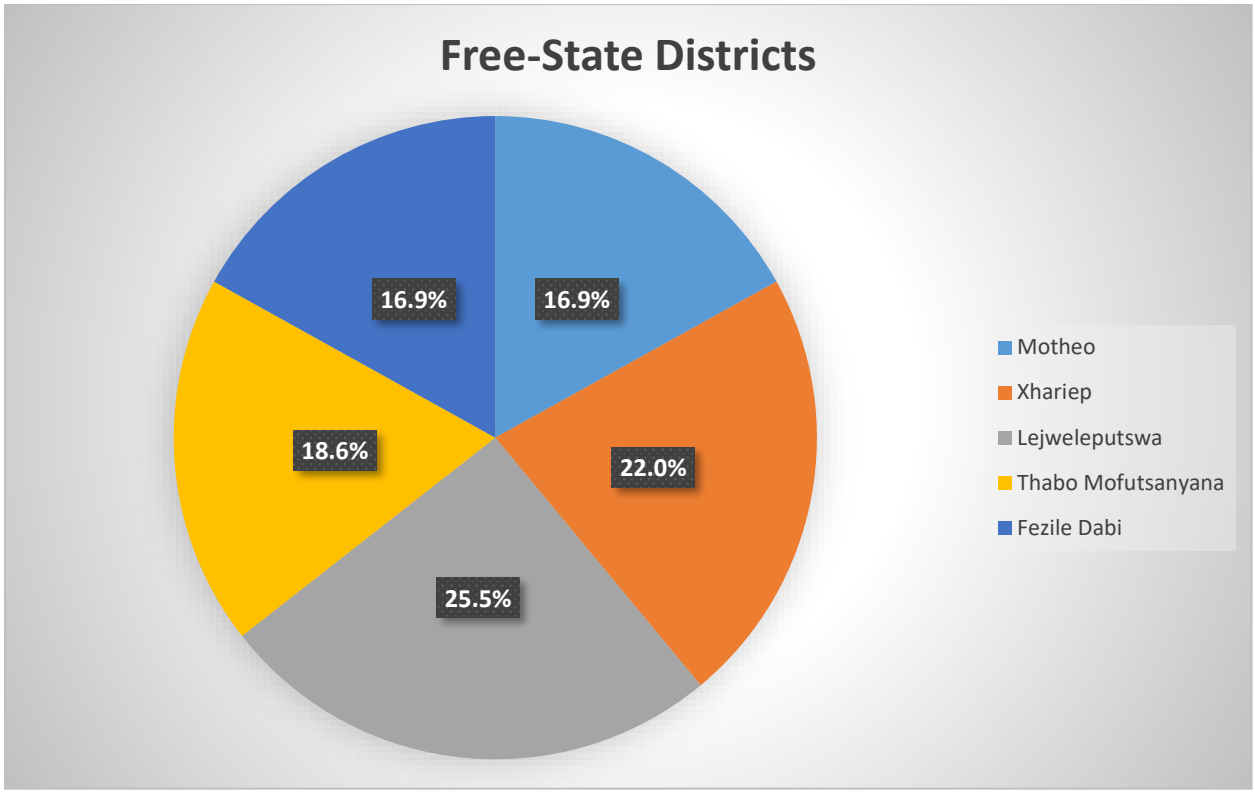

Figure 8: Demographic-FS District

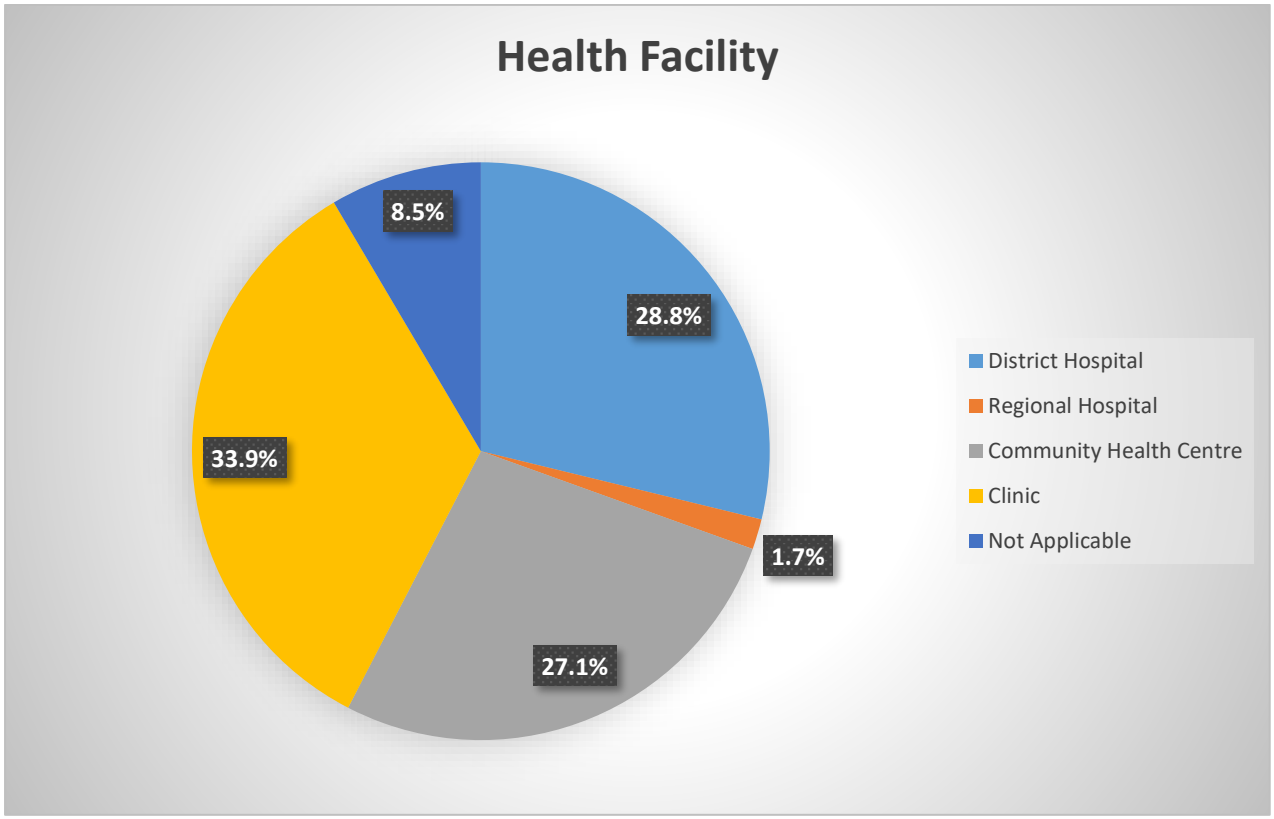

Figure 9: Demographic – Type of Health Facility

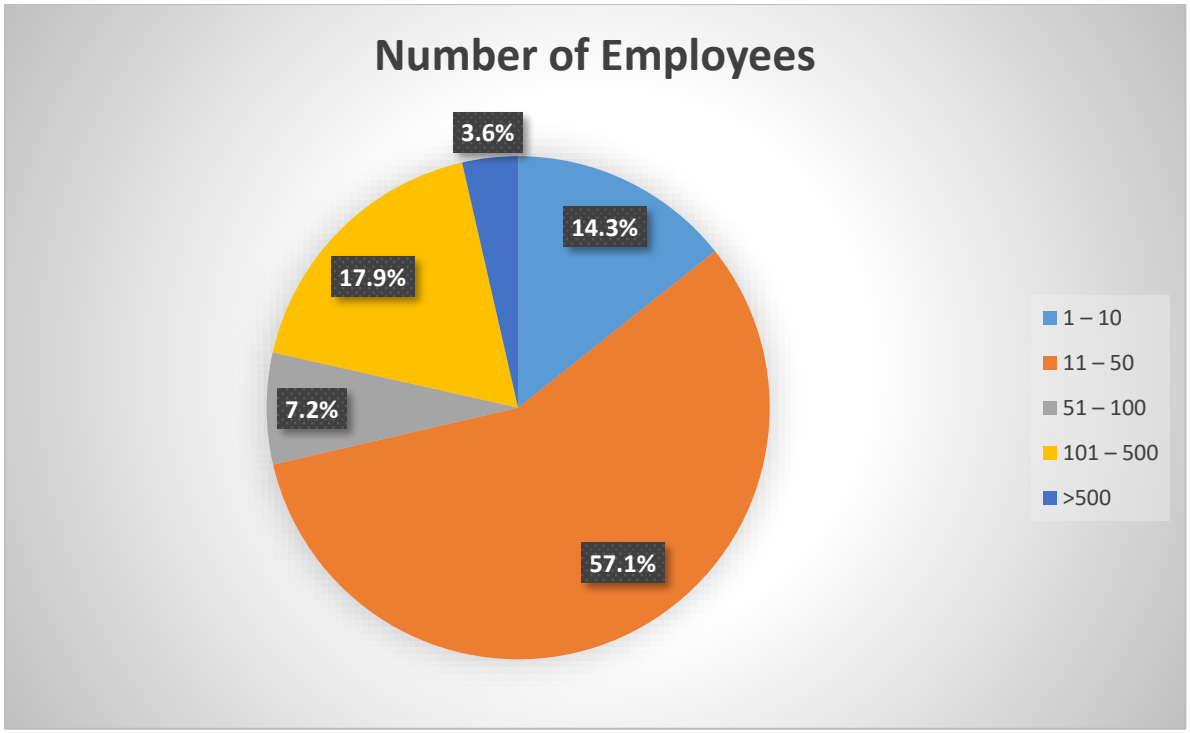

Figure 10: Demographic – No. of Employees

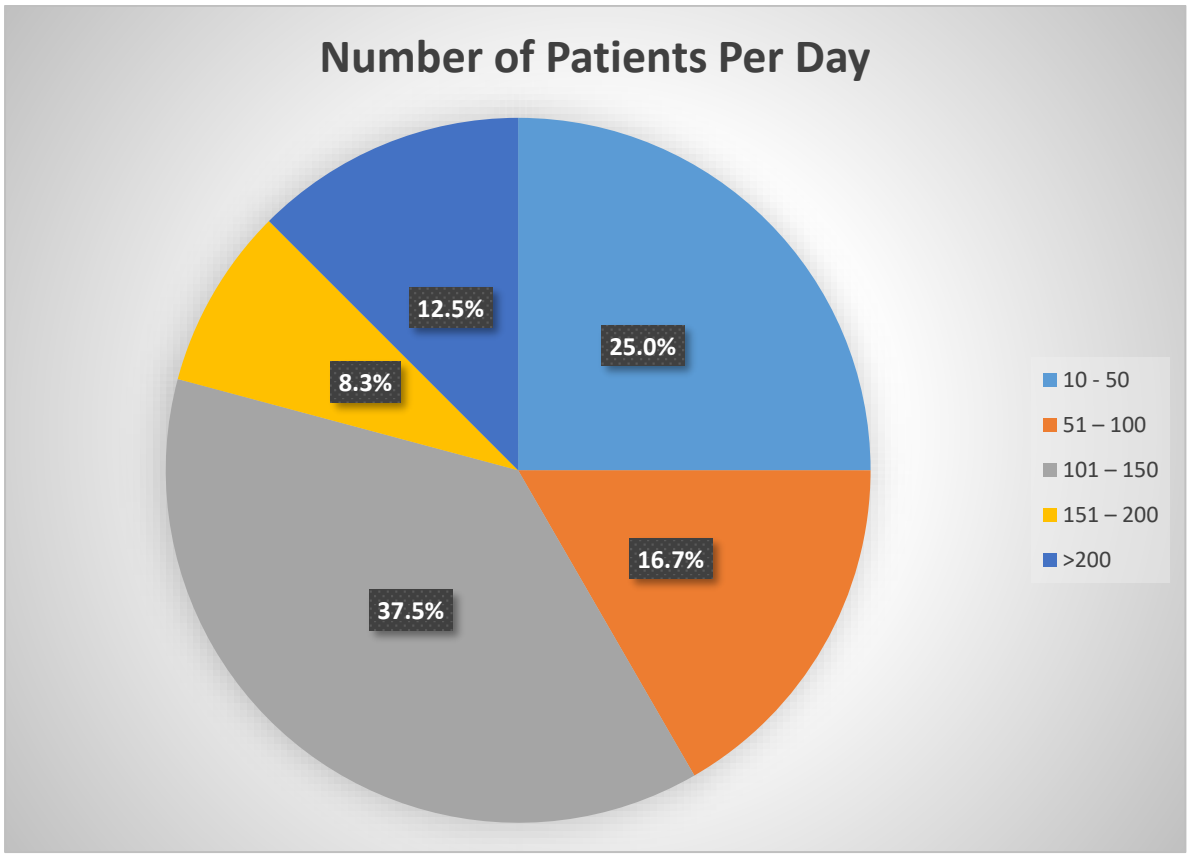

Figure 11: Demographic – No. of Patients Per Day

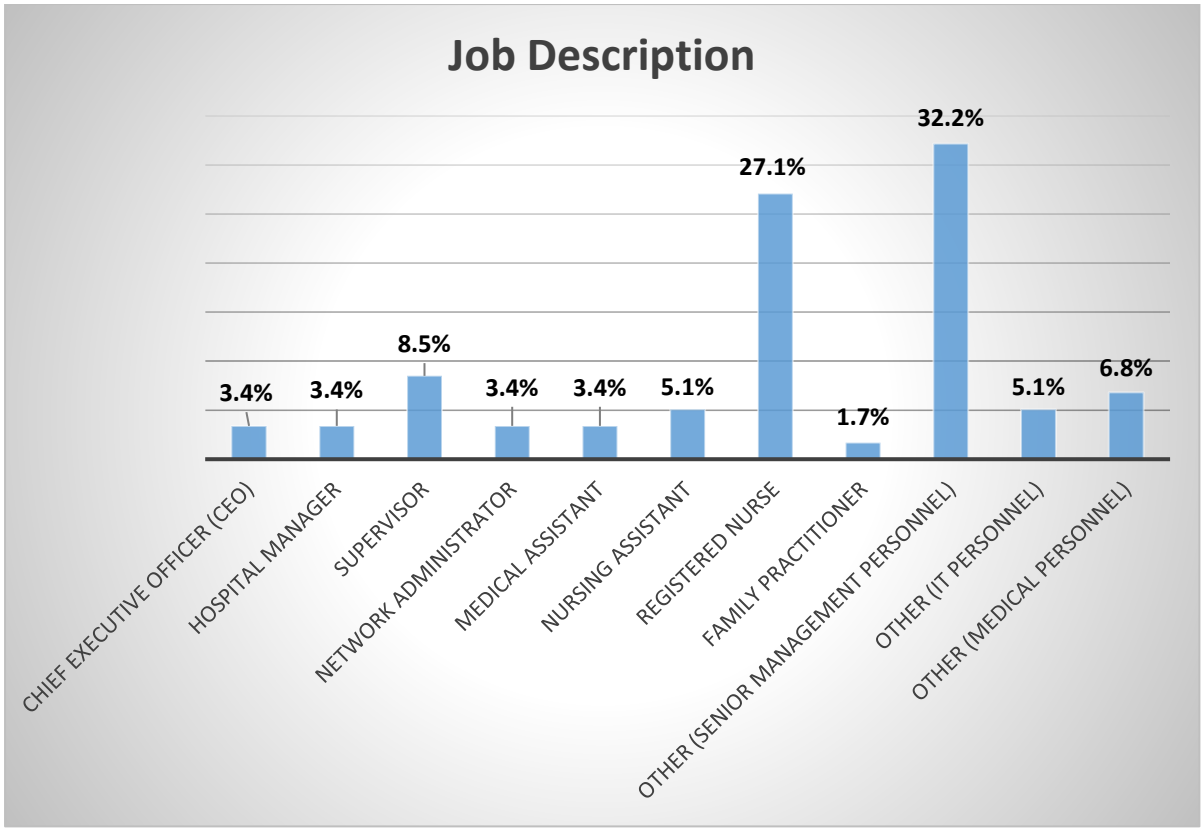

Figure 12: Demographic – Job Description

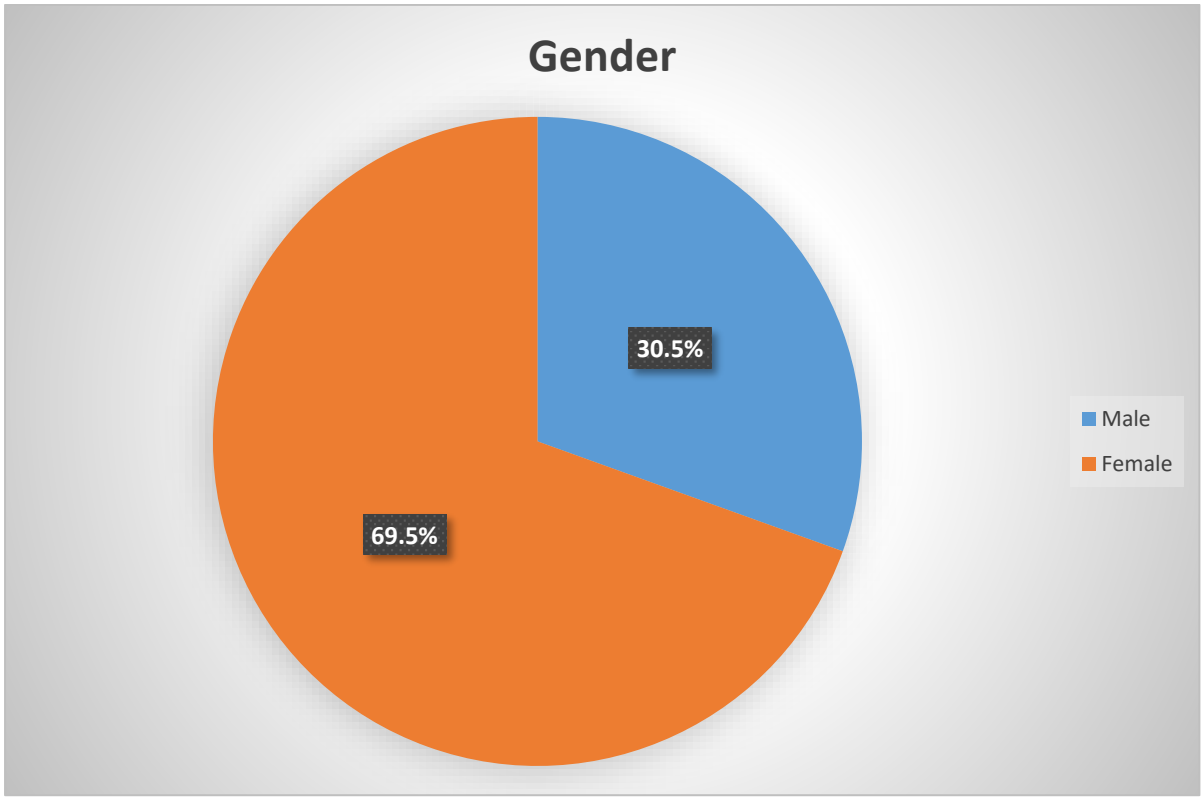

Figure 13: Demographic – Gender

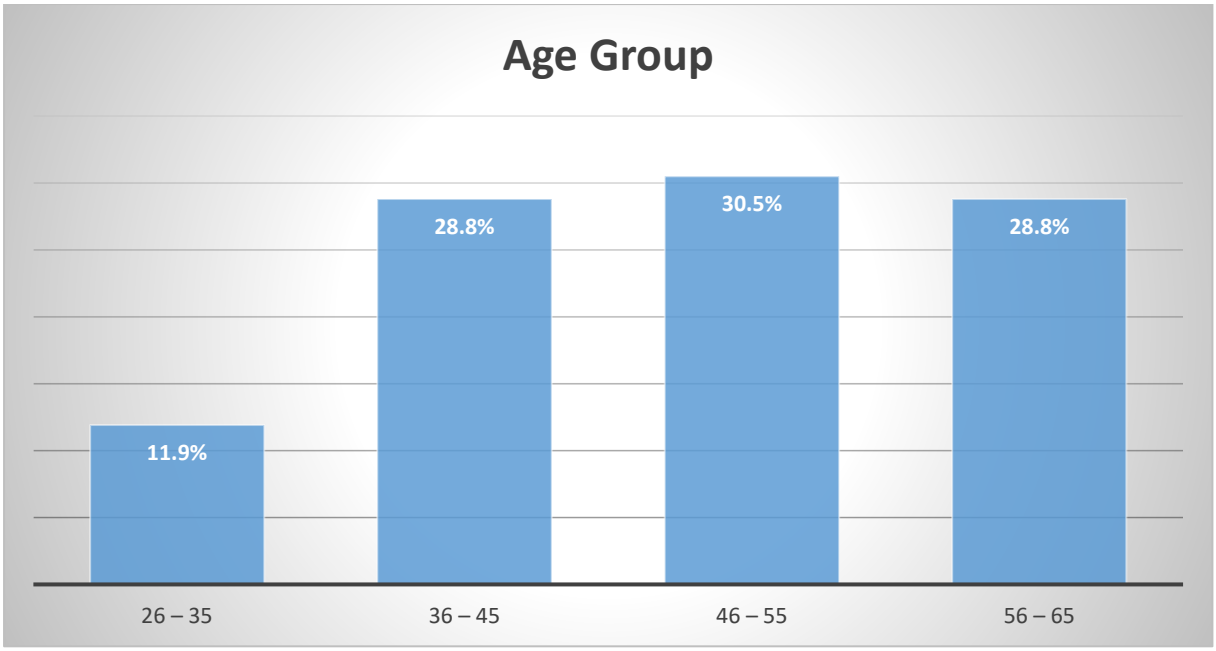

Figure 14: Demographic – Age Group

4.3 Current HIS state

To better understand the current systems used for storing and capturing patient data within healthcare facilities in the FS, the study conducted a survey asking multiple choice, Yes/No and Likert scale questions related to the current patient management system used for capturing, processing and storing patient data; ease and convenience of the paper-based system; electronic medical systems used and their features. Furthermore, questions relating to Internet facilities at healthcare facilities within the five districts of FS and whether health facilities are willing to adopt a cloud-based EMR system were posed to the Principal Network Controllers. In addition, senior management personnel were asked which information they perceived suitable to be deployed on a cloud-based EMR system.

Table 8 and Figure 15 present the results obtained on the current patient management system used within the health facilities. The respondents were given four options to choose from: Fully paper-based system; Paper-based system with some form of IT support; Centralized stand-alone EMR, and An EMR system that serves our facility BUT is also linked to other external EMRs.

Table 8: Patient Management System Results

Options	Frequency	Percentage
Fully Paper Based	8	13.6%
Paper Based with IT	46	77.9%
Standalone EMR System	1	1.7%
Linked EMR system	4	6.8%
Total	**59**	**100.0%**

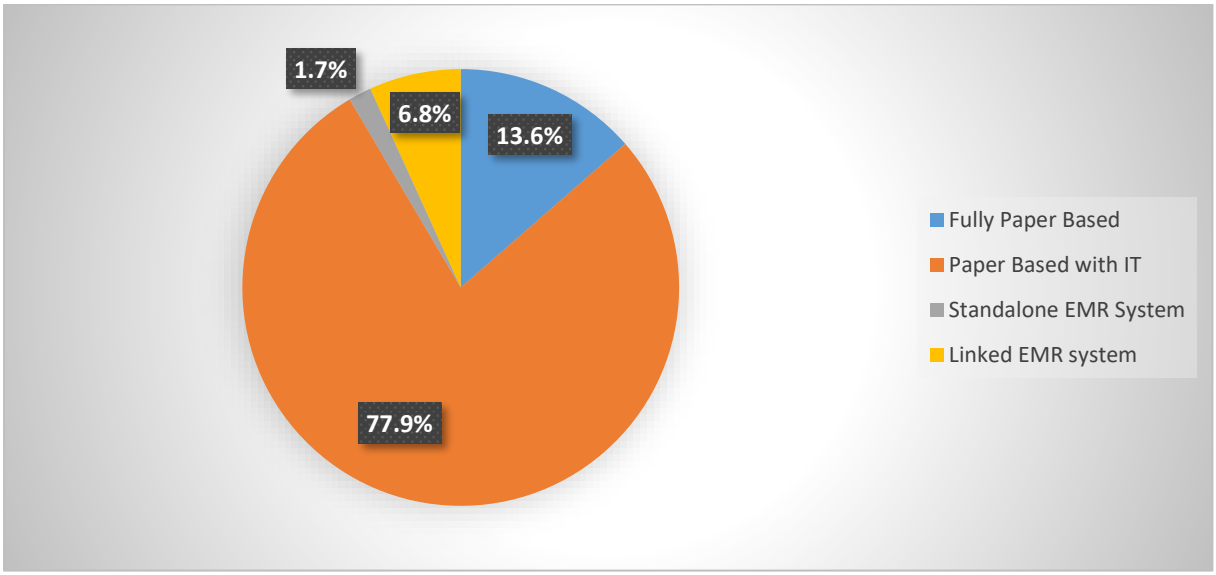

Figure 15:Patient Management Systems Results

Of the 59 responses received, about 14% of the health facilities were still utilizing paper-based records, almost 78% of the health facilities were utilizing paper-based records with some form of IT, close to 2% were utilizing stand-alone EMR systems and about 7% were utilizing linked EMR systems.

Further questions pertaining to the ease and convenience of paper-based medical systems (**Appendix B2: Question 28 – 37**) were posed to the medical staff. Results obtained from the data collected for these questions are presented below.

Q28: Are you able to access a patient's information anywhere, anytime to monitor his/her progress?

Results obtained for this question revealed that of the 26 responses received, 25 were valid and 1 was missing. Seven respondents answered "Yes" to the question, and 18 answered "No" to the question. This accumulated to 28% of the respondents having real-time access to

patient data and 72% not having real-time access to patient data. Table 9 and Figure 16 present the results of the question.

Table 9:Q28 Results

Options	Frequency	Percentage
Yes	7	28.0%
No	18	72.0%
Total Valid Options	**25**	**100.0%**
Missing	1	
Total	**26**	

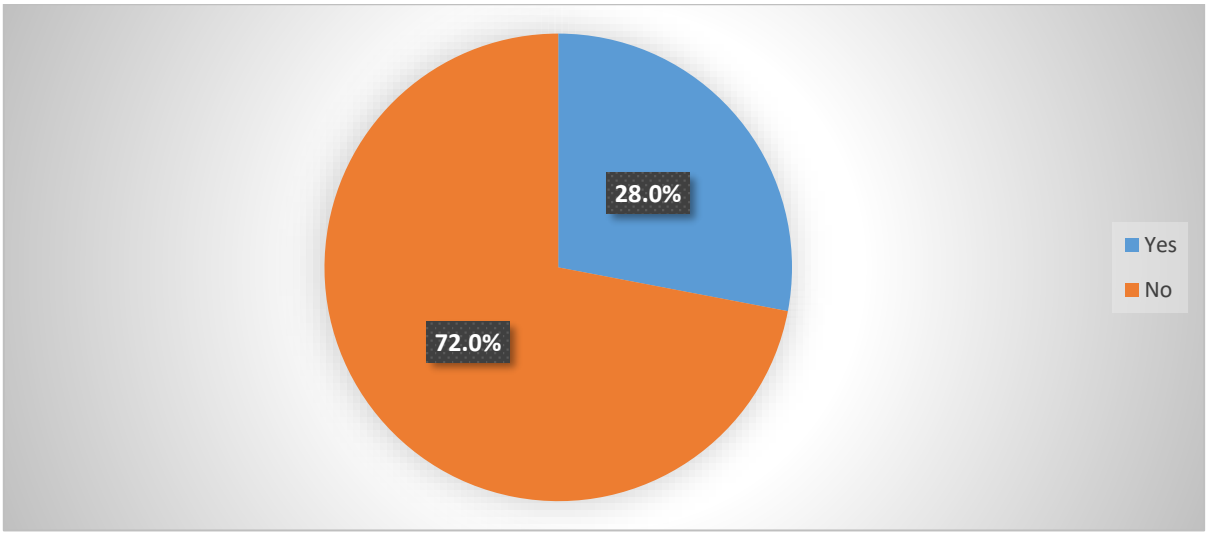

Figure 16:Q28 Results

Q29: The current medical systems for recording patient data (manually on paper) is time-consuming

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether manual recording of patient data on paper is time-consuming were as follows: 3.8% strongly disagreed, 7.7% disagreed, 7.7% were neutral (uncertain), while 30.8% agreed and 50.0% strongly agreed that manual recording is time-consuming. Table 10 and Figure 17 presents the results of the question.

Table 10: Q29 Results

Options	Frequency	Percentage
Strongly Disagree	1	3.8%
Disagree	2	7.7%
Neutral	2	7.7%
Agree	8	30.8%
Strongly Agree	13	50.0%
Total	**26**	**100.0%**

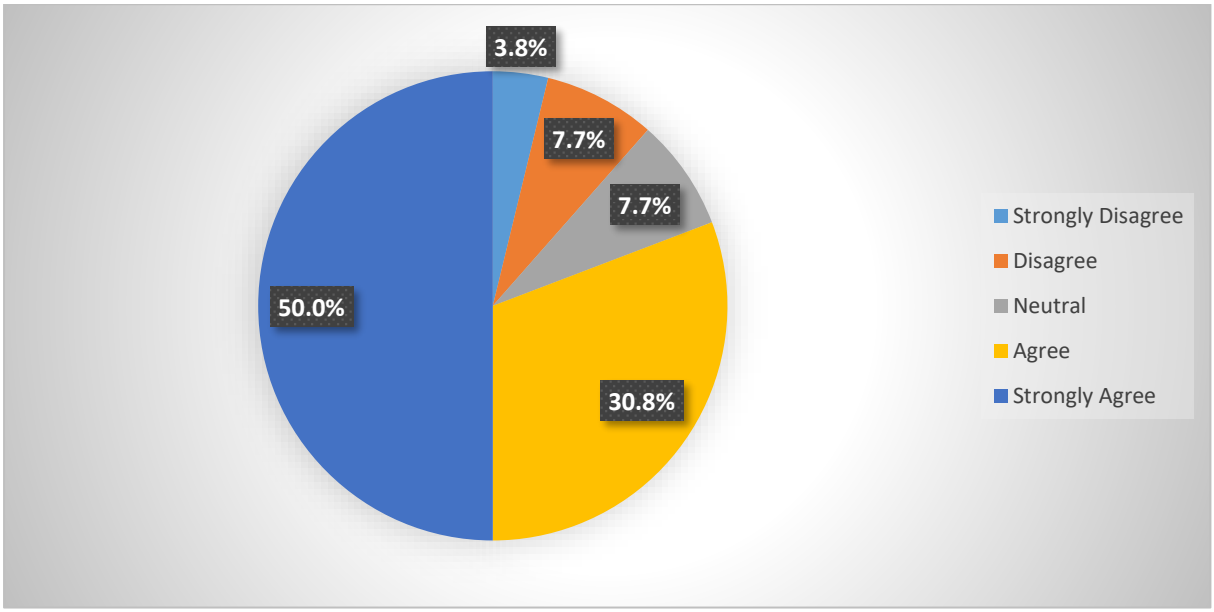

Figure 17:Q29 Results

Q30: The current medical systems for recording patient data (manually on paper) is easy to use

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether manual recording of patient data on paper is easy to use were as follows: 7.7% strongly disagreed, 23.1% disagreed, 11.5% were neutral (uncertain), whereas 34.6% agreed and 23.1% strongly agreed that manual recording is easy to use. Table 11 and Figure 18 present the results of the question.

Table 11: Q30 Results

Options	Frequency	Percentage
Strongly Disagree	2	7.7%
Disagree	6	23.1%
Neutral	3	11.5%
Agree	9	34.6%
Strongly Agree	6	23.1%
Total	**26**	**100.0%**

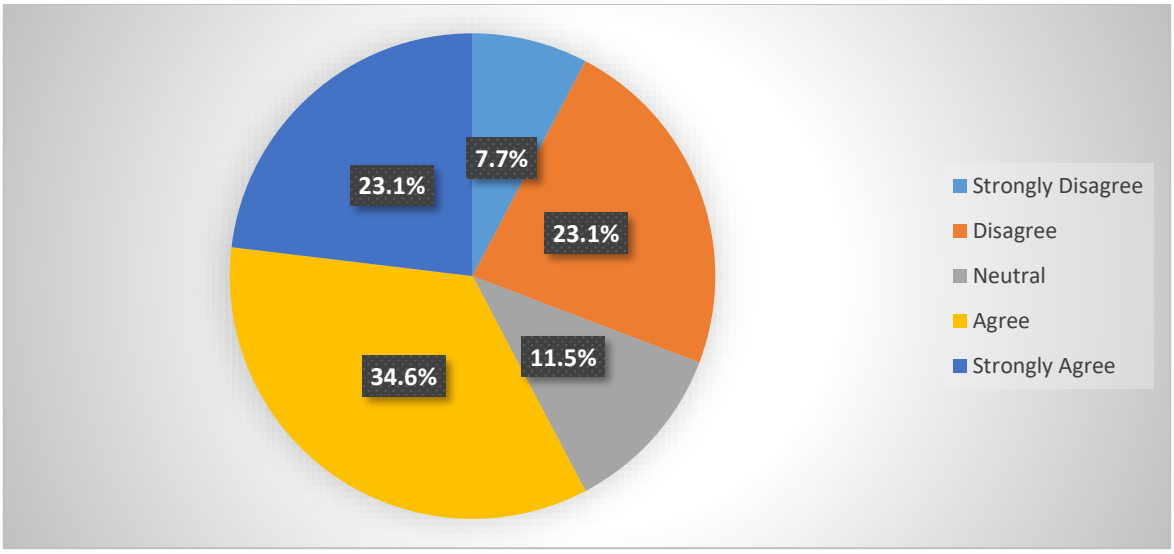

Figure 18:Q30 Results

Q31: The current medical systems for recording patient data (manually on paper) is safe and reliable

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether manual recording of patient data on paper was safe and reliable were as follows: 23.1% strongly disagreed, 19.2% disagreed, 15.4% were neutral (uncertain), whereas 30.8% agreed and 11.5% strongly agreed that manual recording is safe and reliable. Table 12 and Figure 19 present the results of the question.

Table 12: Q31 Results

Options	Frequency	Percentage
Strongly Disagree	6	23.1%
Disagree	5	19.2%
Neutral	4	15.4%
Agree	8	30.8%
Strongly Agree	3	11.5%
Total	**26**	**100.0%**

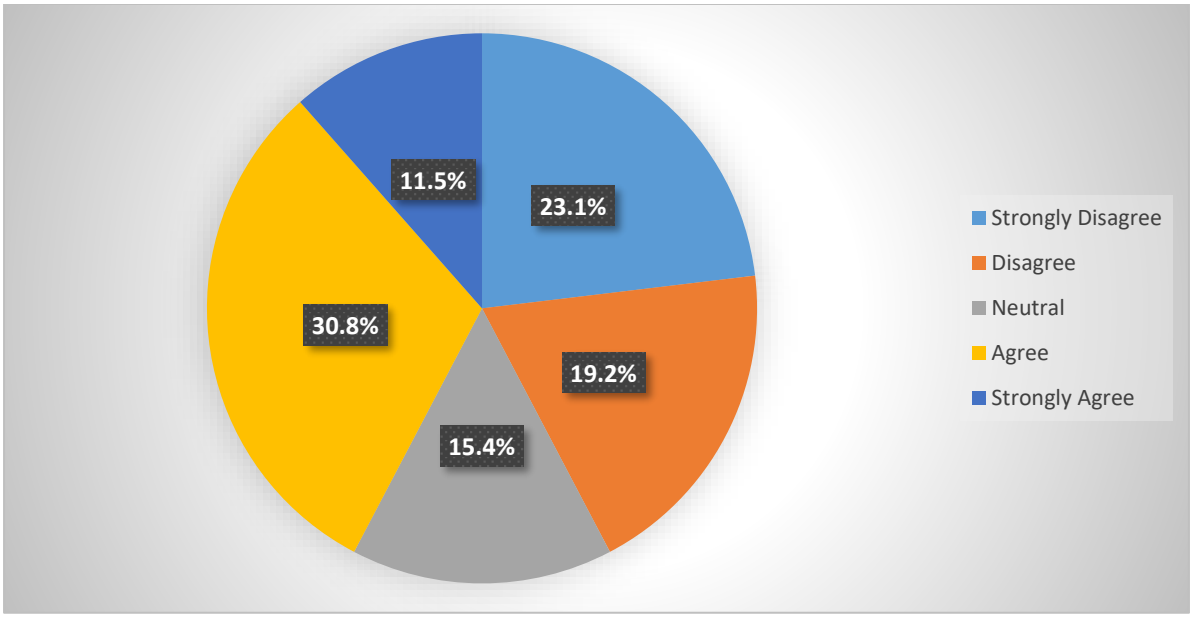

Figure 19:Q31 Results

Q32: The current data collection and submission methods of health reports is time-consuming

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether creating paper health reports are time-consuming were as follows: 3.8% strongly disagreed, 11.5% disagreed, 11.5% were neutral (uncertain), whereas 50.0% agreed and 23.1% strongly agreed. Table 13 and Figure 20 present the results of the question.

Table 13: Q32 Results

Options	Frequency	Percentage
Strongly Disagree	1	3.8%
Disagree	3	11.5%
Neutral	3	11.5%
Agree	13	50.0%
Strongly Agree	6	23.1%
Total	**26**	**100.0%**

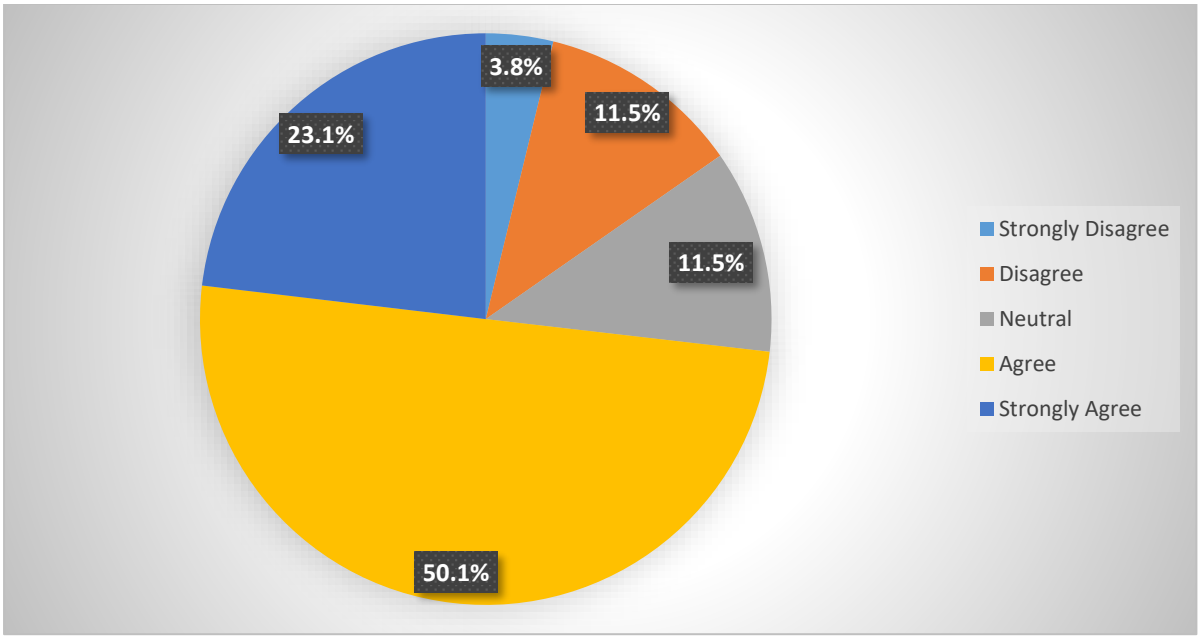

Figure 20:Q32 Results

Q33: The current data collection and submission methods of health reports are not easy to use

Results obtained for this question revealed that of the 26 responses received, 25 responses were deemed valid and 1 was missing. 8.0% strongly disagreed that creating paper health reports was easy to use, 28.0% disagreed, 8.0% were uncertain, 40.0% agreed and 16.0% strongly agreed. Table 14 and Figure 21 present the results of the question.

Table 14: Q33 Results

Options	Frequency	Percentage
Strongly Disagree	2	8.0%
Disagree	7	28.0%
Neutral	2	8.0%
Agree	10	40.0%
Strongly Agree	4	16.0%
Total Valid Options	**25**	**100.0%**
Missing	1	
Total	**26**	

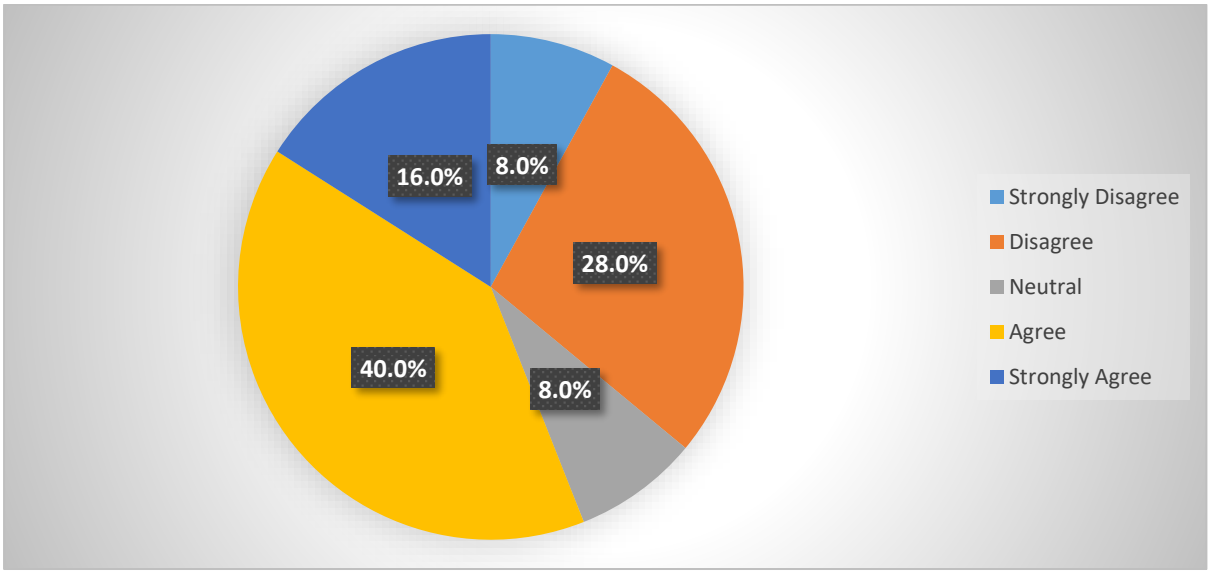

Figure 21: Q33 Results

Q34: It is very easy to have real-time Information of a patient

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether access to real-time information of patients was very easy were as follows: 7.7% strongly disagreed, 38.5% disagreed, 15.4% were neutral (uncertain), while 23.1% agreed and 15.4% strongly agreed. Table 15 and Figure 22 present the results of the question.

Table 15: Q34 Results

Options	Frequency	Percentage
Strongly Disagree	2	7.7%
Disagree	10	38.5%
Neutral	4	15.4%
Agree	6	23.1%
Strongly Agree	4	15.4%
Total	**26**	**100.0%**

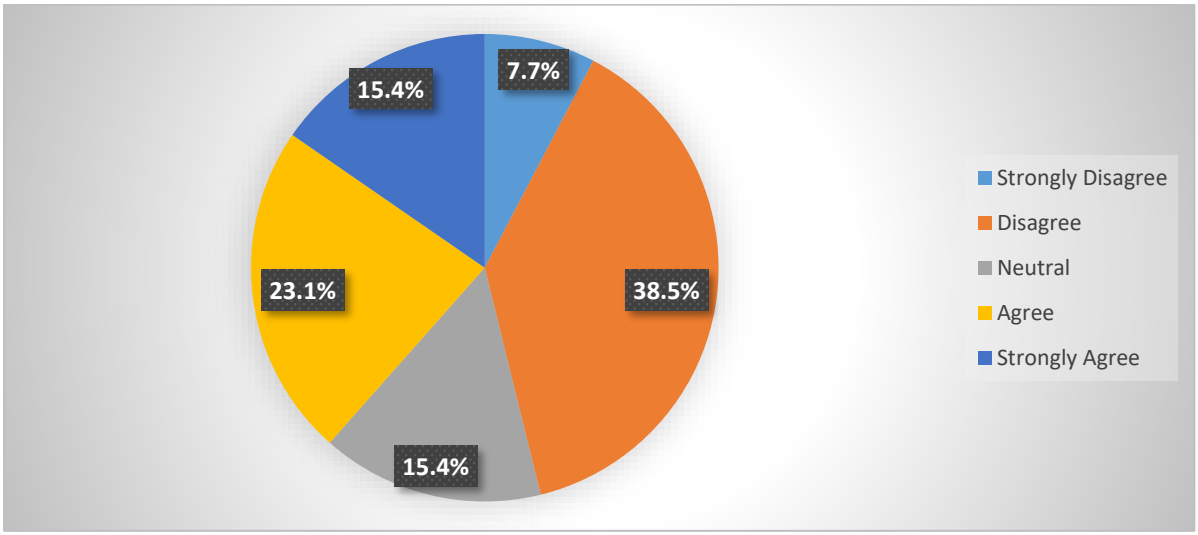

Figure 22:Q34 Results

Q35: Having one centralized data storage (like a server) that contains all the information for patients is a good idea and will help improve healthcare

Results obtained for this question revealed that of the 26 responses received, all responses were deemed valid for this question. Results for whether having a centralized data storage for medical data was a good idea were as follows: 3.8% strongly disagreed, 7.7% disagreed, 3.8% were neutral (uncertain), while 30.8% agreed and 53.8% strongly agreed that a centralized data storage for medical data was a good idea. Table 16 and Figure 23 present the results of the question.

Table 16: Q35 Results

Options	Frequency	Percentage
Strongly Disagree	1	3.8%
Disagree	2	7.7%
Neutral	1	3.8%
Agree	8	30.8%
Strongly Agree	14	53.8%
Total	**26**	**100.0%**

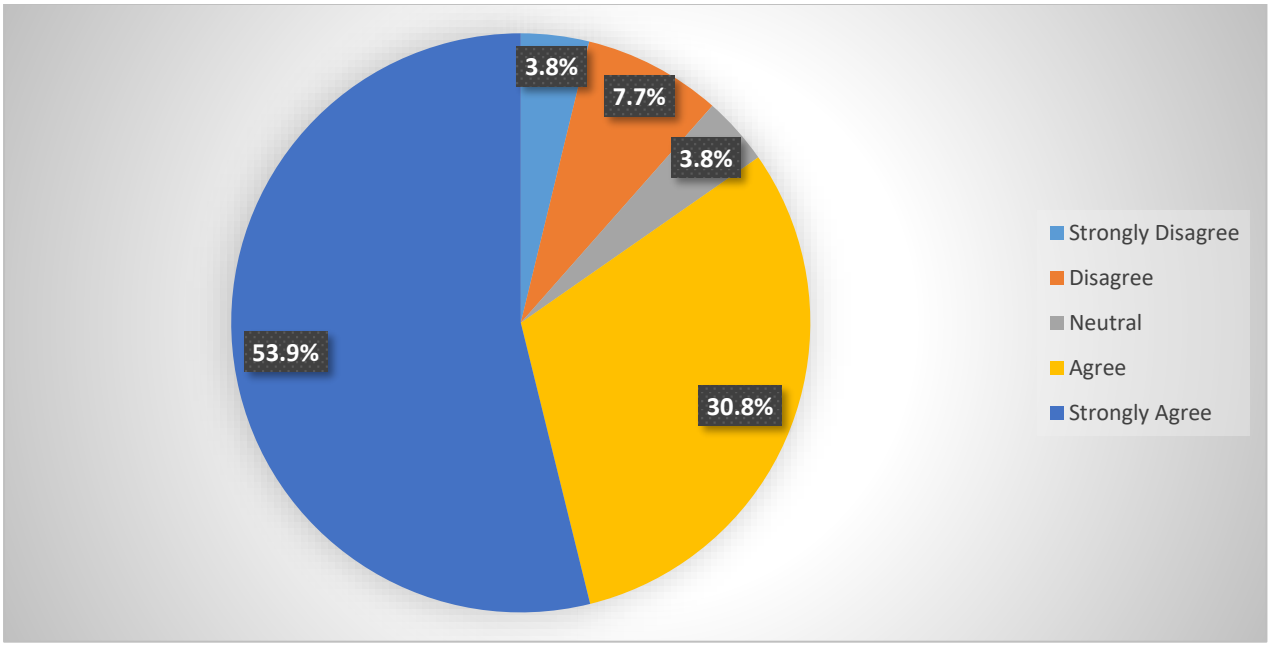

Figure 23:Q35 Results

Q36: How do you manage paper in the office?

Results obtained for this question revealed that of the 26 responses received, 25 responses were deemed valid while 1 was missing. Results on how medical paper records were handled in these health facilities were as follows: 92.0% made use of paper charts, 4.0% scanned the old files to a computer, and 4.0% stored them on an EMR system. Table 17 and Figure 24 present the results of the question.

Table 17: Q36 Results

Options	Frequency	Percentage
Filed in paper charts	23	92.0%
Scanned old files to computer	1	4.0%
Reviewed results scanned to EMR	1	4.0%
Total Valid Options	**25**	**100.0%**
Missing	1	
Total	**26**	

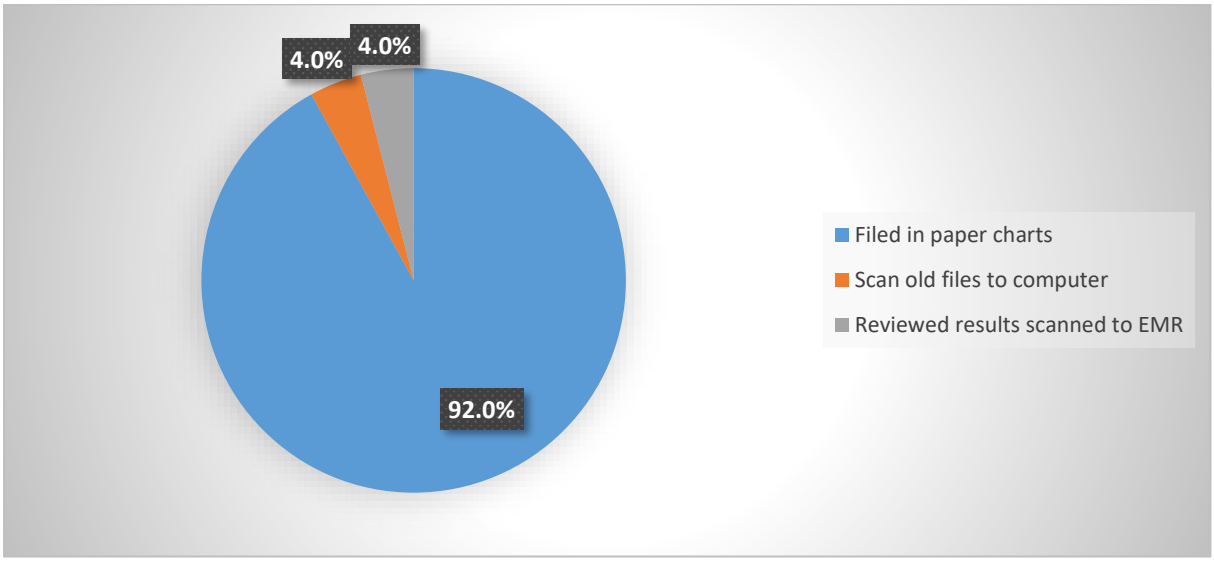

Figure 24: Q36 Results

Q37: How do you share medical information with other doctors or health institutions OUTSIDE office (e.g. specialists, hospital), not including formal referrals?

Results obtained for this question revealed that of the 26 responses received, 25 responses were deemed valid while 1 was missing. A 100% of responses indicated that they made use of a phone or fax to share information with other health facilities. Table 18 and Figure 25 present the results of the question.

Table 18: Q37 Results

Options	Frequency	Percentage
By phone/fax	25	100.0%
Missing	1	
Total	**26**	

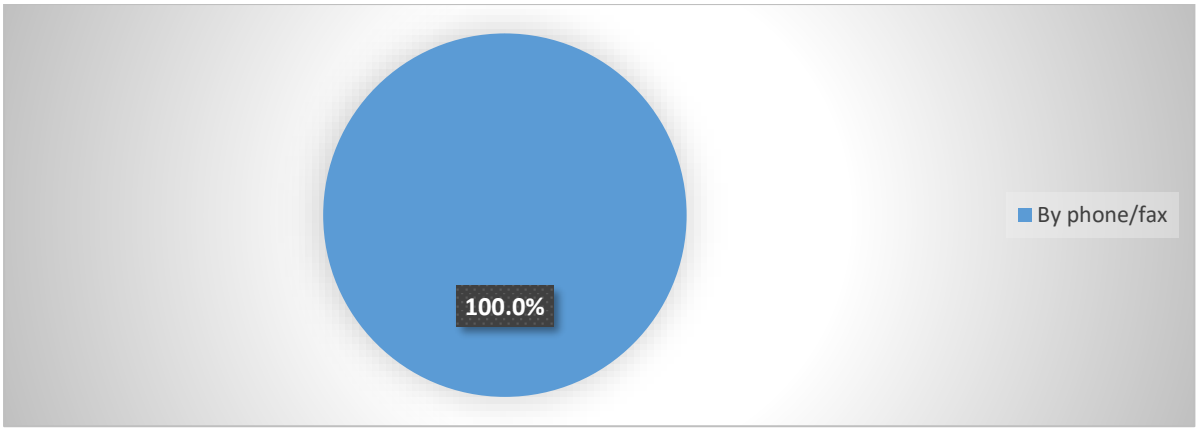

Figure 25:Q37 Results

Table 19 presents a summary of the group statistics for the above questions.

Table 19: Group Statistics

Statistics					
	N		Mode	Minimum	Maximum
	Valid	Missing			
Are you able to access a patient's information anywhere, anytime to monitor his/her progress?	25	1	2	1	2
The current medical systems for recording patient data (manually on paper) is time consuming	26	0	5	1	5
The current medical systems for recording patient data (manually on paper) is easy to use	25	1	4	1	5
The current medical systems for recording patient data (manually on paper) is safe and reliable	26	0	4	1	5
The current data collection and submission methods of health reports is time consuming	26	0	4	1	5
The current data collection and submission methods of health reports is not easy to use	25	1	4	1	5
It is very easy to have real time Information of a patient	26	0	2	1	5
Having one centralized data storage (like a server) that contains all the information for patient's is a good idea and will help improve health care	26	0	5	1	5
How do you manage paper in the office?	25	1	1	1	4
How do you share medical information with other doctors or health institutions OUTSIDE office	25	1	1	1	1

Next, an analysis of the electronic medical systems utilized within at these public healthcare facilities was conducted. Questions were asked (**Appendix B1: Question 8 -10, Appendix**

B2: Question 23 – 25, Appendix B3: Question 12 - 14) regarding the systems used and their features.

Q: Is there any computerized system to store medical data at the health facility?

Table 20: Results on the availability of a computerized system

Options	Frequency	Percentage
Yes	45	77.6%
No	12	20.7%
Some	1	1.7%
Total	**58**	**100%**

Of the 58 responses received, 77.6% answered Yes to the question, 20.7% answered No and 1.7% answered Some as presented in Table 20. If the respondents answered Yes/Some they were further requested to provide the systems that were used and their features. Table 21 presents the results of the following questions:

- **Q: If Yes, which of the following system(s) do you use? Select all that apply.**
- **Q: What are the features of the system(s) in the previous question? Choose all those that apply.**

Table 21: Results on the systems used and their features

	Systems			
Features	Meditech	PADS	PharmAssist	Other Electronic Systems
Health Information	✓	✓	✓	✓
Laboratory Management	✓	✓	✓	✓
Diagnostics Management	✓	✓	✓	✓
Medication Management	✓	✓	✓	✓
Referrals	✓	✓	✓	✓
Decision Support	✓	✓	✓	✓
Electronic Communication	✓	✓		✓
Patient Support	✓	✓	✓	✓
Administrative Processes	✓	✓		✓
Practice Reporting	✓	✓		✓

4.4 Internet Facilities and Accessibility

Internet connection is the drive for most of the EMR systems and for cloud-based systems. Information regarding internet facilities at public healthcare facilities was obtained from the principal network controllers and analyzed. Table 22 presents the results regarding the state of internet at public healthcare facilities in the FS.

Table 22: Results on internet facilities

Internet Facilities		
	Frequency	**Percentage**
Q7. Do all health facilities in the district have Internet facilities?		
Yes	2	40%
Some	3	60%
Total	**5**	**100%**
Q8. If Yes/Some, characterize the speed of the Internet connection		
Fair	5	100%
Total	**5**	**100%**
Q9. Would you consider the Internet connectivity reliable (i.e. how often is it usually accessible and available for use)?		
Reliable	2	40%
Fair	2	40%
Poor	1	20%
Total	**5**	**100%**
Q10. Who pays for the Internet services?		
Government	4	80%
Don't Know	1	20%
Total	**5**	**100%**
Q11. On a scale of 1 to 5 (1 being Very Affordable, 5 Being Very Expensive) how would you rate the affordability of the Internet connectivity?		
Affordable	1	25%
Fair	1	25%
Expensive	2	50%
Missing	*1*	
Total	**5**	**100%**

In addition to the questions asked regarding internet facilities, senior management personnel and principal network controllers were asked if any part of the systems used was cloud-based (accessible online) and if so, which parts were cloud-based. Of the responses received, 68% claimed that part of the systems used at their health facility was cloud-based, while 31% said that no part of the systems used was cloud-based. With regards to the features of the system which were cloud-based, almost 58% of the respondents said that the Patient Management feature was cloud-based, followed by the Appointment/Scheduling feature with 27.3%, Pharmacy/Dispensing Drugs feature with 18.2%, Accounting/Billing with 12.1% and lastly, Prescriptions with 6.1%. Tables 23 and 24 present results obtained from the analysis of these two questions.

Table 23: Results on cloud-based HIS services

Options	Frequency	Percent
Yes	22	68%
No	10	31%
Total	**32**	**100%**

Table 24: Results on the online services provided

Options	N	Cloud Based	Not Cloud-Based	Total
Patient Management	33	57.6%	42.4%	100%
Accounting/Billing	33	12.1%	87.9%	100%
Prescriptions	33	6.1%	93.9%	100%
Appointments/Scheduling	33	27.3%	72.7%	100%
Pharmacy/Dispensing Drugs	33	18.2%	81.8%	100%

4.5 Willingness to Adopt

Furthermore, the Principal Network Controllers were asked if health facilities within their districts were willing to adopt a cloud-based EMR system or not. Of the responses received, 1 was missing, of the 4 valid responses, 100% said Yes; health facilities were willing to adopt cloud-based EMR. Table 25 presents the results for this question.

Table 25: Results on the willingness to adopt

Health facilities willing to adopt cloud based EMR		
Options	**Frequency**	**Percent**
Yes	4	100%
Total	**4**	**100%**

Lastly, Table 26 presents the results regarding the information that is deemed suitable to be deployed on a cloud-based EMR system by the senior management personnel respondents. The options that were given were Patient Details; Appointments; Treatment Details; Billing Data and Lab Results. Of the responses received, Lab results scored high with 89.3% of respondents deeming it suitable for deployment on a cloud-based EMR system. This was followed by Treatment Details at 85.7%, Appointment at 82.1%, Patient Details at 78.6% and lastly, Billing Data at 60.7%.

Table 26: Results on data suitable for deployment on a cloud-based EMR

Data Suitable for Deployment on a Shared Cloud-Based EMR system				
Options	**N**	**Include**	**Do Not Include**	**Total**
Patient Details	28	78.6%	21.4%	100%
Appointments	28	82.1%	17.9%	100%
Treatment Details	28	85.7%	14.3%	100%
Billing Data	28	60.7%	39.3%	100%
Lab Results	28	89.3%	10.7%	100%

4.6 Scale Reliability, Validity and Hypotheses Testing

4.6.1 Reliability

According to Creswell [92], “when one modifies an instrument or combines instruments in a study, the original validity and reliability may not hold for the new instrument and it becomes important to reestablish validity and reliability during data analysis*”.* The study’s scale items were tested for reliability and validated using principal component analysis (PCA) to ensure the instrument’s internal consistency. Knowledge of the validity scores in a survey helps to identify whether an instrument would be a good one to utilize for the survey.

The researcher followed several steps which included an analysis of Cronbach’s Alpha to ensure that the scale items had internal consistency and that they fell within the acceptable values. “Cronbach’s Alpha is a measure of reliability and, more specifically, internal consistency. A coefficient of .93 is a high coefficient; .6 is an acceptable level for determining

whether the scale has internal consistency" [92]. The measurement scales of the study were five items for Relative Advantage, four items for Compatibility, five items for Security Concern, two items for Availability of Resources, three items for Top Management Support, three items for Organization Readiness, four items for Competitive Pressure and five items for Vendor Support.

All scale items in the study had a Cronbach's Alpha value of .7 and above, except for two scale items in Availability of Resource with a Cronbach's Alpha value of .571 and scale items in Compatibility. Availability of Resources scale was dropped at this stage of the analysis.

However, for the Compatibility scale, the results of the reliability test such as mean statistics and Cronbach's Alpha value if item is deleted were considered. Removal of items with a lower or higher mean statistic could increase the Cronbach's Alpha value. Table 27 showed that the mean statistic of TC1(4.00) was higher and for TC4(1.40) it was lower than that of other scale items.

Table 27:Compatibility Item Statistics Results - No.1

Scale Items	Mean	Std. Deviation	N
TC1	4.00	1.000	5
TC2	2.80	1.643	5
TC3	3.40	1.817	5
TC4	1.40	.548	5

The reliability test was performed again by removing these two items one after the other to see the impact of each variable when not included in the analysis, starting with the removal of TC4. TC1 loaded a higher mean statistic (4.00), and the Item-Total Statistic table showed the Cronbach's Alpha if this item were deleted would be .824. The results are presented in Tables 28 and 29.

Table 28:Compatibility Item Statistics Results - No.2

Scale Items	Mean	Std. Deviation	N
TC1	4.00	1.000	5
TC2	2.80	1.643	5
TC3	3.40	1.817	5

Table 29: Compatibility Item-Total Statistics

Scale Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TC1	6.20	10.200	.000	.000	.824
TC2	7.40	4.300	.616	.495	.000[a]
TC3	6.80	3.700	.601	.495	.000[a]

a. The value is negative due to a negative average covariance among items. This violates reliability model assumptions. You may want to check item codings.

Based on these results, TC1 was dropped from the analysis. Only two items (TC2 and TC3) of the Compatibility scale were carried for further analysis. The test was run again with only two items (TC2 and TC3) and returned a Cronbach's Alpha value of .824 for the Compatibility scale – see Table 30.

Table 30:Compatibility Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.824	.826	2

Security Concern, Top Management Support, Competitive Pressure and Vendor Support scales had acceptable Cronbach's Alpha values. However, to make the instrument more reliable, results of the above-mentioned scales from the Inter-Item Correlation Matrix, Item-Total statistics and Item Statistics tables were considered. These tables assist in determining which scale items to remove from the analysis to produce higher Cronbach's Alpha values.

For the Security Concern scale, the Inter-Item Correlation Matrix table indicated that TS1 has r <.3 values and the Cronbach's Alpha value would be .801 if the item was deleted as shown in the Item-Total Statistics table. Thus, TS1 was dropped at this stage of the analysis. The Inter-Item Correlation Matrix table (Table 31) and Item-Total Statistics table (Table 32) are presented below.

Table 31:Security Concern Inter-Item Correlation Matrix

Scale Items	TS1	TS2	TS3	TS4	TS5
TS1	1.000	.167	.009	.166	.099
TS2	.167	1.000	.667	.439	.402
TS3	.009	.667	1.000	.704	.386
TS4	.166	.439	.704	1.000	.384
TS5	.099	.402	.386	.384	1.000

Table 32:Security Concern Item-Total Statistics

Scale Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
TS1	15.19	16.409	.136	.104	.801
TS2	15.05	12.444	.620	.502	.635
TS3	15.33	11.083	.662	.678	.608
TS4	15.28	11.634	.633	.542	.624
TS5	15.07	13.638	.443	.216	.701

For the Top Management Support scale, the Item-Total Statistics table shows that OTM1 would produce a higher Cronbach's Alpha value when deleted. The Cronbach's Alpha value would increase from .852 to .961. OTM1 was dropped at this stage of the analysis. Table 33 presents results of the Item-Total Statistics for this scale.

Table 33: TMS Item-Total Statistics

Scale Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
OTM1	5.80	7.700	.559	.316	.961
OTM2	6.40	6.800	.809	.876	.706
OTM3	5.80	7.700	.843	.879	.701

For Competitive Pressure scale, the mean statistic value of ECP4 was higher at 3.54 and the Cronbach's Alpha value would be .843 if the item was deleted as shown in Table 34 and 35 respectively. ECP4 was dropped at this stage of the analysis.

Table 34:Competitive Pressure Item Statistics

Scale Items	Mean	Std. Deviation	N
ECP1	2.68	1.249	28
ECP2	2.50	.962	28
ECP3	2.11	.956	28
ECP4	3.54	1.071	28

Table 35:Competitive Pressure Item-Total Statistics

Scale Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
ECP1	8.14	5.312	.776	.619	.657
ECP2	8.32	6.745	.734	.580	.695
ECP3	8.71	7.397	.582	.463	.763
ECP4	7.29	7.767	.406	.242	.843

For the Vendor Support scale, Table 35 shows that EVS1 had a mean value of 3.50 and Table 36 showed that the Cronbach's Alpha value would be .893 if deleted. Therefore, EVS1 was dropped at this stage of the analysis. See Table 36 and 37.

Table 36: Vendor Support Item Statistics – No.1

Scale Items	Mean	Std. Deviation	N
EVS1	3.50	.984	32
EVS2	2.88	1.040	32
EVS3	3.06	1.162	32
EVS4	3.09	1.201	32

Table 37: Vendor Support Item – Total Statistics – No.1

Scale Items	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EVS1	9.03	9.580	.514	.269	.893
EVS2	9.66	8.684	.638	.414	.850
EVS3	9.47	7.096	.845	.891	.762
EVS4	9.44	6.835	.860	.895	.754

The test was performed again with only three items (EVS2, EVS3 and EVS) of the Vendor Support scale. EVS2 had a low mean statistic of 2.88 and the Cronbach's Alpha value would be .970 if the item was deleted. Thus, EVS2 was dropped at this stage of the analysis. See Table 38 and 39 respectively.

Table 38:Vendor Support Item Statistics – No.2

Scale Items	Mean	Std. Deviation	N
EVS2	2.88	1.040	32
EVS3	3.06	1.162	32
EVS4	3.09	1.201	32

Table 39:Vendor Support Item Total Statistics – No.2

Scale Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
EVS2	6.16	5.426	.634	.403	.970
EVS3	5.97	4.096	.879	.891	.768
EVS4	5.94	3.931	.883	.893	.763

After deletion of these items from the analysis, reliability tests were performed again on Security Concern, Compatibility, Top Management Support, Competitive Pressure and Vendor Support scale items.

Table 40 presents a summary of the results of the scales which exceeded the acceptable Cronbach's Alpha value of 0.7.

Table 40: Cronbach's Alpha table per scale

Scale	No. of items	Valid Cases	Excluded Cases	Total Cases	Cronbach's Alpha
Relative Advantage	5	52	7	59	.872
Compatibility	2	5	54	59	.824
Security Concern	4	57	2	59	.801
Top Management Support	2	5	54	59	.961
Organization Readiness	3	54	5	59	.867
Competitive Pressure	3	28	31	59	.843
Vendor Support	2	32	27	59	.970

4.6.2 Factor Analysis (Validity)

Principal component factor analysis was performed on the scale items to validate the study's constructs using SPSS (version 19). The principal component analysis (PCA) extraction method was used to extract the components of the study. Prior to carrying out factor analysis, analysis of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity values were evaluated, as well as communalities and factor- loading values to verify that the sample size was adequate to perform factor analysis. Factor analysis was performed twice, first with scale items related to two or all groups of participants, second with scale items related to one group only (the Principal Network Controllers).

KMO and Bartlett's significance tests were conducted for all scale items of Relative Advantage, Security Concern, Organization Readiness, Competitive Pressure and Vendor Support. The KMO sampling value was 0.678 and the Bartlett's test of sphericity significance value had a value of $p<0.001$. The KMO value was at the acceptable level of 0.6 and the Bartlett's test of Sphericity was significant at the 0.001 level. See Table 41.

Table 41: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.687
Bartlett's Test of Sphericity	Approx. Chi-Square	257.349
	df	153
	Sig.	.000

According to Dr. Field (2005), Kaiser recommends accepting values greater than 0.5 as acceptable. In addition to the KMO and Bartlett's significance values, the Communalities of the scale items had values of 0.6 and above, except for two scale items (TRA4:0.576 & TRA5:0.516) in Relative Advantage and one scale item (TS5:0.566) in Security Concern. See Table 42 below.

Table 42: Communalities

Communalities		
Scale Items	Initial	Extraction
TRA1	1.000	.765
TRA2	1.000	.860
TRA3	1.000	.753
TRA4	1.000	.576
TRA5	1.000	.516
TS2	1.000	.692
TS3	1.000	.840
TS4	1.000	.699
TS5	1.000	.566
OOR1	1.000	.882
OOR2	1.000	.879
OOR3	1.000	.674
ECP1	1.000	.808
ECP2	1.000	.806
ECP3	1.000	.780
EVS3	1.000	.941
EVS4	1.000	.965
Extraction Method: Principal Component Analysis.		

According to Kinuthia [74], performing factor analysis can be justified if the communalities value of the items is more than 0.6 or the average communalities of the scale items is 0.7. The average communalities of Relative Advantage and Security Concern were 0.7 and communalities of all other scale items were 0.6 and above. Therefore, it was justifiable and deemed adequate to conduct factor analysis for this study.

Varimax with the Kaiser Normalization rotation method was used to obtain factor loadings for the scale items. Items are considered practically significant if they load higher than 0.5. Most items had loadings higher than 0.5 and above. TS5 had the lowest factor loading of 0.566. The items were extracted and loaded into five components as expected. Table 43 presents the factor loadings of the items and the rotated components.

Table 43:Rotated Component Matrix

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
TRA2	.875				
TRA1	.849				
TRA3	.845				
TRA5	.712				
TRA4	.669				
TS3		.910			
TS2		.803			
TS4		.795			
TS5	.355	.566			
OOR1			.926		
OOR2			.911		
OOR3	.316		.696		
ECP3				.872	
ECP1				.857	
ECP2				.855	
EVS4					.951
EVS3					.947

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Another analysis of these measures (KMO and Bartlett's significance) was conducted separately for scale items of Compatibility and Top Management Support as these scale items were related to only one group (Principal Network Controllers) of participants with a sample size of five and had to be treated separately. The scale items of these two constructs were overlapping as these items loaded into the same component. See Table 44 for Component Matrix results of these two item scales.

Table 44:Component Matrix – TMS and Compatibility

Component Matrix[a]	
	Component
	1
OTM3	.984
TC2	.968
OTM2	.963
TC3	.845
Extraction Method: Principal Component Analysis. a. 1 component extracted.	

The factor loading for OTM3 was higher at 0.984, followed by TC2 at 0.968 and OTM2 with 0.963, TC3 had the lowest loading among the three scale items with a value of 0.845. Thus, TC3 was dropped from the analysis. The top three items (OTM3, TC2 and OTM2) were constructed into one construct: Top Management Support. The KMO value of these scale items was 0.769 and the Bartlett's test of sphericity was at a significance level of $p<0.05$. Table 45 presents these results.

Table 45: KMO and Bartlett's Test – TMS and Compatibility

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.769
Bartlett's Test of Sphericity	Approx. Chi-Square	11.114
	Df	3
	Sig.	.011

The KMO measure of sampling statistic was acceptable and the Bartlett's test of sphericity statistic was significant to conduct factor analysis. In addition, the communalities measure of the scale items exceeded the acceptable value of 0.6. It was therefore justifiable and adequate

to perform factor analysis in this study. The solution was not rotated because only one component was extracted.

Table 46 provides a summary of the factor analysis results for six constructs (Relative Advantage, Security Concern, Top Management Support, Organization Readiness, Competitive Pressure and Vendor Support).

Table 46: Factor Analysis

Scale Items	Components						Communalities
	Rotated Component Matrix					Component Matrix	
	Relative Advantage	Security Concern	Organization Readiness	Competitive Pressure	Vendor Support	Top Management Support	
TRA2	.875						.765
TRA1	.849						.860
TRA3	.845						.753
TRA5	.712						.576
TRA4	.669						.516
TS3		.910					.692
TS2		.803					.840
TS4		.795					.699
TS5		.566					.566
OOR1			.926				.882
OOR2			.911				.879
OOR3			.696				.674
ECP3				.872			.808
ECP1				.857			.806
ECP2				.855			.780
EVS4					.951		.941
EVS3					.947		.965
TC2						.989	.979
OTM2						.982	.965
OTM3						.980	.960
Eigenvalue	4.463	3.136	2.235	1.825	1.342	2.904	
% of Variance	26.253	18.448	13.146	10.737	7.895	96.791	
Cumulative %	26.253	44.701	57.847	68.584	76.478	96.791	
TRA= Relative Advantage; TS= Security Concern; OOR=Organization Readiness; OTM=Top Management Support; ECP=Competitive Pressure; EVS=Vendor Support							

4.6.3 Descriptive Statistics

Descriptive statistics of the computed Relative Advantage, Security Concern, Top Management Support, Organization Readiness, Competitive Pressure and Vendor Support were obtained to see the distribution of data. The descriptive statistics obtained are presented in Table 47.

Table 47: Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Relative Advantage	59	2	5	4.45	.090	.693
Security Concern	59	1	5	3.82	.130	1.002
Top Management	5	2	5	2.90	.620	1.387
Organization Readiness	54	1	5	3.20	.176	1.292
Competitive Pressure	28	1	4	2.43	.176	.929
Vendor Support	33	1	5	3.08	.200	1.146

The score for organization size was computed separately by calculating the average of the number of employees and the number of patients per day per healthcare facility. These two variables were answered by the senior management personnel (number of employees) and medical staff (number of patients). To calculate the average, the two responses were added together per health facility according to the codes given to identify these health facilities. For example, for facility A, the response from the senior management personnel at facility A and the response of the medical staff at facility A were added together, and the average would be the organization size. Table 48 presents the descriptive scores of this variable.

Table 48: Descriptive Stats - Organization Size

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Organization Size	25	1	5	2.52	.170	.848

4.6.3.1 Group Statistics

The number of cases (N), Mean, Standard Deviation, and Standard Error of the Mean for each predictor variable scale are as follows:

Relative Advantage. Relative Advantage scored a Mean value of 4.45, a Standard Deviation of .693, a Standard Error of the Mean value of .090 and an N value of 59.

Security Concern. Security Concern scored a Mean value of 3.82, a Standard Deviation of 1.002, a Standard Error of the Mean value of .130 and an N value of 59.

Top Management Support. Top Management Support scored a Mean value of 2.90, a Standard Deviation of 1.387, a Standard Error of the Mean value of .620 and an N value of 5

Organization Readiness. Organization Readiness scored a Mean value of 3.20, a Standard Deviation of 1.292, a Standard Error of the Mean value of .176 and an N value of 54

Competitive Pressure. Competitive Pressure scored a Mean value of 2.43, a Standard Deviation of .929, a Standard Error of the Mean value of .176 and an N value of 28.

Vendor Support. Vendor Support scored a Mean value of 3.08, a Standard Deviation of 1.146, a Standard Error of the Mean value of .200 and an N value of 33.

Organization Size. Organization Size scored a Mean value of 2.52, a Standard Deviation of .848, a Standard Error of the Mean value of .170 and an N value of 25.

An independent samples t-test was conducted to compare the response on the intent to adopt for respondents who have no knowledge of cloud computing and those who have knowledge of cloud computing. There was no significant difference in the scores for respondents with no knowledge (M=3.97, SD=0.773) and respondents with knowledge (M=3.91, SD=0.767) of CC; t (57) =0.288, p=0.774. These results suggest that knowledge of CC has no impact on how respondents respond on the intent to adopt. Therefore, the assumption of equality of variance between the two groups was not violated. Table 49 and 50 present these results.

Table 49: Independent Samples Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Intent to Adopt	Equal variances assumed	.042	.838	.288	57	.774	.059	.204	-.350	.468
	Equal variances not assumed			.289	49.834	.774	.059	.204	-.351	.469

Table 50: T-test Group Statistics

	Cloud Computing Knowledge	N	Mean	Std. Deviation	Std. Error Mean
Intent to Adopt	No Knowledge of Cloud Computing	35	3.97	0.773	0.131
	Have Knowledge of Cloud Computing	24	3.91	0.767	0.157

Next, the study presents results of the a one-way between subjects' ANOVA.

A One-way between subjects' ANOVA was conducted to compare the response on the intent to adopt between the senior management, medical staff and principal network controllers' roles. There was no significant difference at $p<0.05$ level for the three roles [F (2, 56) =1.13, p=.330]. These results suggest that the response on the intent to adopt is not influenced by the role of the participant. Table 51 presents these results.

Table 51: One-way between subjects' ANOVA

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.318	2	.659	1.132	.330
Within Groups	32.609	56	.582		
Total	33.927	58			

The final step of the analysis presents the hypotheses testing of the study using the Spearman's Correlation Coefficient.

4.6.4 Hypothesis Testing

The relationship between the independent variables (Relative Advantage, Security Concern, Organization Readiness, Top Management Support, Organization Readiness, Competitive Pressure and Vendor Support) and the Intent to Adopt was investigated using Spearman's Correlation Coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. The correlation coefficient *rho* (r_s) measures the strength and direction of a linear relationship between two variables on a scatterplot. A p-value less than 0.05 indicated that there was a statistical significance between the predictor variable and the criterion variable. The results of the Spearman rho are presented in Table 52.

Table 52: Spearman's Correlation

Correlations Spearman's rho								
	TRA	TSC	OOR	OTM	OS	ECP	EVS	OI
TRA	1							
TSC	.244	1						
OOR	.358**	.187	1					
OTM	.335	-.300	.	1				
OS	-.005	.156	-.057	.	1			
ECP	.154	.308	.604**	.	-.140	1		
EVS	.009	.237	.391*	.359	-.296	.122	1	
OI	.515**	.312*	.549**	.900*	-.232	.340	.201	1
N	59	59	54	5	54	28	33	59
TSC=Security Concern; TRA=Relative Advantage; OOR=Organization Readiness; ECP=Competitive Pressure; EVS= Vendor Support; OS=Organization Size; OTM=Top Management Support; OI= Intent to Adopt **. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).								

Results obtained from the correlation are as follows:

Hypothesis 1: The relationship between Relative Advantage (M=4.45; SD=.693) and Intent to Adopt (M=3.95; SD=.765) had a positive large correlation which was statistically significant at a 0.01 significance level (r_s =.515; p<0.01). Therefore, we reject the null hypothesis and accept the alternative hypothesis.

Hypothesis 2: The relationship between Security Concern (M=3.82; SD=1.002) and Intent to Adopt (M=3.95; SD=.765) had a positive medium correlation which was statistically significant at a 0.05 significance level (r_s =.295; p<0.05). Therefore, we reject the null hypothesis and accept the alternative hypothesis.

Hypothesis 3: The relationship between Top Management Support (M=2.90; SD=1.387) and Intent to Adopt (M=3.95; SD=.765) had a positive large correlation which was statistically significant at a 0.05 significance level (r_s =.900; p<0.05). Therefore, we reject the null hypothesis and accept the alternative hypothesis.

Hypothesis 4: The relationship between Organization Readiness (M=3.20; SD=1.292) and Intent to Adopt (M=3.95; SD=.765) had a positive large correlation which was statistically

significant at a 0.01 significance level (r_s =.549; p<0.01). Therefore, we reject the null hypothesis and accept the alternative hypothesis.

Hypothesis 5: The relationship between Organization Size (M=2.52; SD=.848) and Intent to Adopt (M=3.95; SD=.765) had no significant correlation at a 0.05 significance level (r_s=-.232; p>0.05). This indicates that the healthcare facility's size cannot be associated with its intent to adopt. Therefore, we fail to reject the null hypothesis.

Hypothesis 6: The relationship between Competitive Pressure (M=2.43; SD=.929) and Intent to Adopt (M=3.95; SD=.765) had no significant correlation at a 0.05 significance level (r_s =.340; p>0.05). This indicates that competitive pressure is not associated with the intent to adopt. Therefore, we fail to reject the null hypothesis.

Hypothesis 7: The relationship between Vendor Support (M=3.08; SD=1.146) and Intent to Adopt (M=3.95; SD=.765) had no significant correlation at a 0.05 significance level (r_s =.201; p>0.05). This indicates that vendor support had no association with the intent to adopt. Therefore, we fail to reject the null hypothesis.

Summary

This chapter presented the findings of the study. The data was analyzed using descriptive statistics and inferential statistics. In addition, frequency tables were analyzed to answer questions related to the current state of HIS within the Free State health facilities, which also fulfils one of the study's research aims. After testing the data for reliability and validity, two of the initial nine hypotheses, namely H_2 and H_4 as presented in Section 1.5 of Chapter 1 of this document, were dropped at this stage of analysis because the Cronbach's Alpha value of H_4 was not at the acceptable level of .6, and the scale items of H_2 loaded into the component of H_5. Furthermore, t-tests were conducted to test for differences on the responses for the intent to adopt between those who had and those who did not have knowledge of cloud computing. A One-way between subjects' ANOVA was conducted to determine if there were differences between the three groups of respondents with regards to their response on the intent to adopt. Lastly, a Spearman's Correlation was conducted to test the study's seven hypotheses on relative advantage, security concern, top management support, organization readiness, competitive pressure and vendor support. The following chapter discusses the findings of the study and answers the research questions and aims.

CHAPTER 5: DISCUSSION

In this chapter, we discuss the results of the analysis that was carried out in the previous chapter and answers to the research questions. The study aimed to investigate the viability of an integrated cloud-based EMR (ICBEMR) for public health facilities in the Free State (FS) province by exploring factors which influence the intent to adopt cloud computing. In addition, the study's objectives included assessing the current state of HIS in public health facilities in the FS by evaluating the ease and convenience of the paper-based system, determining systems that are utilized for capturing and storing patient data, and the availability of internet facilities.

Sections in this chapter present a summary of major results, discussion of the research questions in the order they appear in Chapter 1 of this document, and TOE predictors on the intent to adopt.

5.1 Summary of Major Results

Data was analyzed to gain more insight on the current HIS system used, the current IT infrastructure and factors that influence the intent to adopt by health facilities in the FS. Results revealed that most public healthcare facilities (78%) in the FS are utilizing a paper-based system with some form of IT to record basic patient details. This places the FS health department at stage 3 according to the SA e-Health Strategy Maturity Stages [31]. In addition, results revealed that 77.6% of these public healthcare facilities are in possession of a computerized system used for medical data. These systems comprise Meditech, PADS, PharmAssist and other electronic systems such as Tier.net, HPRS, Rx Solution, RDM, ETR and DHIS.

However, with internet access being one of the major attributes required for the adoption of a cloud-based EMR system, a major concern was that some health facilities had access to internet, and some did not. Nevertheless, results revealed that more than 60% of these computerized systems had a cloud platform, with the top feature being patient management, followed by the Appointment/Scheduling feature.

Furthermore, according to the results obtained from the analysis, all these public healthcare facilities were willing to adopt a cloud-based EMR system. In addition, specific data was deemed appropriate to be deployed on a cloud-based EMR system, with laboratory results being deemed most important over others, followed by treatment details, appointments, patient details and billing data. This was quite interesting as the researcher expected patient details to be deemed more important than others.

It was further expected by the researcher that there should be no significant difference in response to the intent to adopt between participants who had knowledge about cloud computing and those who did not, the results of the t-test met this expectation. Again, it was also expected that there would be no significant difference in response on the intent to adopt between the different groups of participants who were involved in the study; the results of the one-way between subjects' ANOVA satisfied this expectation. Since the study had targeted the public health sector, the results obtained from the participants were expected to be in support of one another and of the innovation.

The following technological, organizational and environmental factors were tested to see their impact on the intent to adopt: Relative Advantage, Security Concern, Top Management Support, Organization Readiness, Organization Size, Competitive Pressure and Vendor Support. Table 53 presents the hypotheses that were proposed for the study and whether the hypotheses were supported or rejected.

Table 53: Hypotheses results

Hypothesis Number	Hypothesis	Supported/Not Supported
H_1	The relative advantage of an ICBEMR has an impact on the intent to adopt.	Supported
H_2	Security concern over an ICBEMR system has an impact on the intent to adopt.	Supported
H_3	Top management support for an ICBEMR system has an impact on the intent to adopt.	Supported
H_4	Organization readiness towards an ICBEMR system has an impact on the intent to adopt.	Supported
H_5	The size of the health facility has an impact on the intent to adopt an ICBEMR system.	Not Supported
H_5	Competitive Pressure for an ICBEMR has an impact on the intent to adopt.	Not Supported
H_7	Vendor support for an ICBEMR has an impact on the intent to adopt.	Not Supported

The following section discusses in depth the research question and the answers obtained from the data analysis and related literature.

5.2 The current state of HIS at public healthcare facilities in the FS

The first question (RQ1) of the study was: What is the current state of health information systems (HIS) at public healthcare facilities in the Free State? This question was addressed by asking several questions on the current patient management system used for capturing, processing and storing patient data, the ease and convenience of the paper-based system, electronic medical systems used and their features.

According to the eHealth Strategy South Africa 2012 [31], South Africa is at maturity Stage 3, which is a paper-based system with some form of IT support to record basic patient details. This is due to the availability of resources, trained/skilled human resource and the cost of ICT, leaving some provinces in SA operating at Stage 2(Fully paper-based system with no form of IT support at all) while others are at Stage 4(A centralized EMR per hospital/clinic with less integration between the different EMRs) [31] [34] .

In this study, participants were asked to indicate from the following which state is their patient management system: Fully paper-based; Paper-based system with some form of IT support; Centralized stand-alone EMR; an EMR system that serves our facility BUT is also linked to other external EMRs.

Results revealed that 13.6% of health facilities are still paper-based, meaning they are using paper for capturing, processing and storing patient data. Most of these healthcare facilities (about 78%) are utilizing paper with some form of IT support to store basic patient details, while 1.7% of them have a stand-alone EMR system and 6.8% are utilizing an EMR system linked with other external EMR systems. In addition, 88.5% of participants mentioned that all patient data is processed and filed in paper charts, while only 3.8% had the files scanned into a computer and 3.8% have most or nearly all paper scanned into the EMR.

Next, the study evaluated the ease and convenience of the paper-based system. Firstly, participants were asked to state the ease of having real-time access to patient data, results were in support of prior research stating that lack of real-time access to patient data is associated with the use of paper-based records [29], as most of the participants did not have real-time access to patient data when needed. Additionally, concerning time, results proved that the use of paper records and the compilation of health reports were time-consuming. However, paper records proved to be more user-friendly. The safety and reliability of these paper records proved to have equal cases, where some participants believed paper records to be safe and reliable and other participants were not of the same opinion. Furthermore, the exchange and sharing of medical information with other health facilities was done over the phone or by fax.

Lastly, the different types of electronic systems used and their features were evaluated. As discussed under Summary of Major results, the majority of these health facilities had an electronic system used for medical data. According to the South African e-Health Strategy [31], hospital information systems used in the FS are Meditech and PADS. The study has proved that these two systems are among the electronic systems utilized within the healthcare facilities in FS. The other systems include PharmAssist, Tier.net, HPRS, etc. as mentioned under the Summary of Results section.

Therefore, the study concludes that these healthcare facilities in the FS are still relying mostly on paper for capturing, processing and storing patient data; however, there are electronic systems in place to help with the burden of information stored on paper records.

The next section evaluates the Internet facilities in place at these health facilities.

5.3 Internet facilities in place at public healthcare facilities in FS

The second research question (RQ2) was: What is the current IT infrastructure in place in terms of Internet facilities at health facilities? This question was addressed to the IT personnel of each district in the FS. Results revealed that some (but not all) health facilities have internet facilities. The speed of the internet connection was said to be quite fair. The reliability of the internet connection was proven to be good at some districts, but fair or rather poor at other districts of the FS. The provision to internet facilities was paid for by the South African government. These internet services were quite expensive in other districts but slightly more affordable in some districts.

5.4 Willingness of public healthcare facilities in FS to adopt an ICBEMR system

The third research question (RQ3) of the study was: Are public healthcare facilities in the Free State province willing to adopt a cloud-based Integrated EMR system that permits the sharing of patient data among different health institutions? This question was addressed by asking participants about their willingness to adopt a cloud-based EMR system.

Results revealed that the health facilities were willing to adopt a cloud-based EMR system for the sharing, storing and capturing of patient data and medical data. In addition to this, participants believed laboratory results, patient details, treatment details, appointments and billing data were suitable to be deployed on a shared cloud-based EMR system.

5.5 Effects of the Technology-Organization-Environment (TOE) factors on the Intent to Adopt an ICBEMR system

The study aimed to determine the technological, organizational and environmental factors influencing the intent of public healthcare facilities to adopt an ICBEMR system in the Free State. The study's hypotheses were tested using the Spearman's Correlation Coefficient to answer the main research question (RQ4): What are the technological, organizational and environmental (TOE) factors influencing the intent of public healthcare facilities to adopt an integrated cloud-based EMR system in the Free State? Four of the seven hypotheses were supported by the data as shown in Table 53 previously. The following sections discuss the impact of each factor of each context of the TOE framework.

5.5.1 Effects of Technological Factors on the Intent to Adopt.

Technological factors that were included in the study were Relative Advantage of an integrated cloud-based EMR and Security Concerns around cloud-based EMR systems. In this study, relative advantage was found to have a positive impact on the intent to adopt a technological innovation such as an ICBEMR system. This finding is consistent with prior studies [78] stating that relative advantage is a predictor of cloud computing adoption. The study's results also revealed that healthcare facilities are aware of the advantages provided by cloud computing. Advantages identified by the study included accomplishment of tasks quickly and effectively, improved quality of work, increased productivity, improved access to patient data and cost-effectiveness. In their study, Oliveira *et al.* [78] found cost to be an important driver of relative advantage.

The second key finding was the significant influence of security concern on the intent to adopt. Security concern was found to be a predictor of cloud computing adoption in this study. This is consistent with a study done by Li *et al.* [83] showing reliability and information security of cloud services to have significant positive effects. The study discovered that the more comfortable and at ease people are with the exchange, sharing and storing of medical data on the cloud, there was an aspect of trust that the cloud is more secure and reliable enough to retain such confidential information without any data leakages. This finding was further supported by Li *et al.* [83], stating that the influence of information security on cloud service trust indicates that organizations would trust cloud service more if they thought it was secure enough. Therefore, the fewer risks posed by having such sensitive information on the cloud increases the chances of having the system adopted.

5.5.2 Effects of Organizational Factors on the Intent to Adopt.

The organizational context included the following three factors: Top Management Support to adopt an ICBEMR, Organization Readiness for an ICBEMR system and Organization Size. Of the three hypotheses, the hypotheses for Top Management Support and Organization Readiness were supported by the data. The hypothesis for Organization Size was not supported.

As hypothesized by the study, results support the notion that the more support obtained from the top management, the greater the intent to adopt would be. This is no surprise as the main decision makers are at the top management level of the organization as they dictate which technology solutions should be implemented. Furthermore, Oliveira *et al*. [78] state that top management can influence the adoption of cloud-computing by supporting the innovation financially, providing necessary resources and being involved in the process. This finding is consistent with prior studies on the adoption of cloud computing [78], [74].

Furthermore, the organization's readiness to embrace new technology has an impact on the adoption of an innovation. In this study, it was found that the readier the organization is for the new technology the greater the intent to adopt would be. Prior studies have shown that organization readiness has a positive significant impact on the adoption of technology [74]. The organization's readiness is determined by its financial and technological readiness to adopt an innovation. These two factors can drastically affect the organization's intent to adopt positively or negatively. The better prepared the organization is financially and technologically, the easier it will be for the organization to transition to a new technology. In this study, these two aspects were considered to be predictors of organization readiness. The results proved the organization to be both financially and technologically ready to adopt the innovation.

The study also hypothesized organization size to be a predictor of cloud computing adoption. However, the study's results did not support this hypothesis. The results revealed that the size of the organization was insignificant to the organization's intention to adopt an ICBEMR system. This result differed from the findings discovered in prior studies [76] where size had a significant impact. These studies predicted that the bigger the organization's size, the more likely it was that the innovation would be adopted. In another study [74], size was found to be a predictor of adoption in that larger organizations were more likely to adopt an innovation to accommodate expansion whereas smaller ones could still manage to carry out day-to-day business without new technology. This was not the case in this study. As far as the literature reviewed in this study is concerned, there is no prior research consistent with the results obtained in this study. The results in this study were therefore acceptable and to be expected, due to both public primary healthcare (PHC) and secondary healthcare (SHC) being under

one umbrella, and whatever decision or innovation would be adopted, it would be to the benefit of all public healthcare facilities as they all report to one entity. Despite the size of the healthcare facility, they should all be in one accord working towards the same goals.

5.5.3 Effects of Environmental Factors on the Intent to Adopt.

The environmental context included the following two factors: competitive pressure and vendor support for a cloud-based EMR system. These factors were found to have no significant impact on the intent to adopt.

The study proposed that competitive pressure would have a significant impact on the intent to adopt. Results revealed otherwise. It was found that competitive pressure could not be associated with the intent to adopt and could therefore not predict adoption. This finding is not surprising to the study due to the divide between the private and public health sectors, with each sector focusing only on its own growth and improvements which are not propelled by competition. The other reason as mentioned in the above section, was that all healthcare facilities under the public health sector are governed by the same management and they all carry out what has been instructed by the DoH. In addition, prior research supports the findings that competitor pressure may not be of as much importance as other cloud-computing adoption issues such as cost reduction [94]. In this case, the healthcare facilities seem to be more interested in the benefits and advantages offered by cloud computing, rather than competing with the private sector. Findings contrary to this were carried out at different enterprises and in the private health sector. In his study, Mamatela [89] found that competitive pressure among different health enterprises predicted adoption.

Similar to this is vendor support. The study hypothesized that vendor support would have a significant impact on the intent to adopt. In this study, this was not the case. The study's results revealed that vendor support had no significant impact on the intent to adopt. This finding was not consistent with prior research on the adoption of cloud computing. The reason leading to such results might be that the Department of Health in the FS had assigned its own in-house IT personnel to handle technology-related issues. Contrary to this are the findings made by Dunne [65] and Kinuthia [74]. In their study, they found vendor support to have a significant impact on the adoption as it would encourage organizations to adopt cloud services. In addition, Kinuthia [74] believes that vendors can take the opportunity to showcase their capabilities when they offer free training sessions and technical support for the adopted technology. Although this may be the case, the analysis does not support the hypothesis for this factor.

Summary

This chapter presented a summary of the major results of the study and elaborated further on the results by discussing each research question. The study consisted of four research questions. The chapter then discussed the current state of HIS within healthcare facilities in the FS, showing that most healthcare facilities still relied on paper records but had an electronic system in place to record specific details of patient data. In addition, the current paper-based system proved to be easy to use but time-consuming at the same time. Furthermore, not all healthcare facilities had access to internet services, which could present a challenge when deciding to move to a cloud-based system. The study also showed that there were several TOE factors which predicted the intent to adopt an ICBEMR system. Among these factors, relative advantage and top management proved to be the most important factors for adoption. Similarly, security concern and organization readiness also predicted adoption. The next chapter gives a summary of the study, the implications of the results, recommendations and future research, and concluding remarks.

CHAPTER 6: CONCLUSION

This chapter concludes the study by presenting an overall overview and summary of the study, implications of the study, and recommendations and future research.

6.1 Summary of the Study

This section presents a summary of the entire study by outlining the important aspects presented in each chapter of the study.

Chapter 1 introduces the study by presenting the study's problem statement, purpose of the study, research questions, hypotheses, significance of the study, methods, assumptions and limitations. The study had identified that most public healthcare facilities were still relying on paper to record patient data. Although there are electronic systems in place, these systems were not integrated. Cloud computing might offer a cost-effective solution of integrating diverse EMR systems. According to literature, cloud computing can solve the many challenges faced with paper records and help improve healthcare. However, the adoption of cloud computing is slowest in healthcare and factors influencing the adoption of cloud computing have not been widely explored. The study's main objective was to investigate the viability of adopting an integrated cloud-based EMR system by identifying TOE factors influencing the intent to adopt. The study's' objectives included assessing the current systems used in capturing, storing and analyzing patient data at public healthcare facilities in the FS, investigating the viability of adopting an integrated cloud-based EMR system that is accessible to key stakeholders in the FS public health sector, and identifying TOE factors influencing the adoption of a cloud-based EMR system.

Chapter 2 presented a review of literature to give the reader an insight into the topic. First, a review of literature on the paper-based medical records was carried out. This first section of this chapter presented related literature on paper records and its challenges. Some of these challenges included lack of real-time access to patient data, inability to exchange and share data, inadequate data, and inability to monitor patient health progress. The second section of this chapter provided a review of literature on Electronic Medical Record systems, inclusively touching on the South African e-Health Strategy and extended on challenges faced with standalone EMR systems. The third section provided a review of literature on cloud computing (characteristics, service models and deployment model; benefits and challenges) and an integrated cloud-based EMR system. Lastly, a review of literature on adoption theories and on the theoretical framework used in the study was conducted. The TOE factors identified were as follows: **Technological factors** included: Relative Advantage, Compatibility, Availability of Resources and Security Concern; **Organizational factors** included: Top

Management Support, Organization Readiness and Organization Size; **Environmental factors** included: Competitive Pressure and Vendor Support.

Chapter 3 described the methods and research design used to carry out the study. The study conducted a cross-sectional survey research. The target population for the study involved public healthcare facilities in the FS. Participants included senior management personnel, medical staff (nurses and doctors) and IT personnel from each FS district. The study surveyed 31 healthcare facilities including five IT personnel. Questionnaires were hand- distributed to healthcare facilities involved in the study with arrangements made with CEOs/Managers of these healthcare facilities. A pilot test was carried out to test the effectiveness of the questionnaire and to improve it. The final questionnaire was then developed and distributed to health facilities.

In Chapter 4, data was analyzed by performing different statistical procedures for different types of data. The first section of the chapter presented frequency tables on the categorical data. The questionnaire was tested for internal consistency and validity using SPSS. All constructs except Availability of Resources proved to be reliable with scale items having Cronbach's Alpha values of .7 and above. Principal component factor analysis (PCA) was performed to validate the study's constructs. Six constructs were extracted from the analysis: Relative Advantage, Security Concern, Organization Readiness, Top Management Support, Competitive Pressure and Vendor Support, including Organization Size. Descriptive statistics of the continuous variables: Relative Advantage, Security Concern, Organization Readiness, Top Management Support, Organization Size, Competitive Pressure and Vendor support were also presented. Additionally, an independent samples t-test was done on cloud-computing knowledge. A one-way between subjects' ANOVA was conducted on the Role variable to test for response difference on the intent to adopt. Finally, a Spearman's Correlation Coefficient was used to test the study's hypotheses and to identify which factors predicted the adoption of cloud computing. The results obtained from this chapter were discussed in Chapter 5 of the study.

In Chapter 5, a summary of major results was discussed as well as answers to the research questions. The study aimed to assess the current systems used in capturing, storing and analyzing patient data, and assess the current state of HIS, which is tied to RQ1. Results revealed that most healthcare facilities are paper-based with some form of IT to record basic patient and medical information, which according to the eHealth Strategy South Africa is maturity stage 3. The IT part referred to the electronic medical systems utilized at these healthcare facilities. These systems included Meditech, PADS, PharmAssist, Tier.net, HPRS, Rx Solutions, RDM, ETR and DHIS. However, not all healthcare facilities have these electronic

systems: minority of them are still fully paper-based. Secondly, the study evaluated the availability of internet facilities at healthcare facilities. Results revealed that there are internet facilities at some of these healthcare facilities. The speed of the internet connection is said to be fair, and its reliability good at some districts. The study also evaluated the willingness of healthcare facilities to adopt cloud computing, and it was tied with RQ3. The study found that healthcare facilities were willing to adopt an integrated cloud-based EMR system. Lastly, the study's main aim was to identify TOE factors that affected the intent to adopt. Data supported four hypotheses of the study and three were not supported. Results revealed that all factors except Organization Size, Competitive Pressure and Vendor Support are predictors of cloud-computing adoption.

The remainder of this chapter addresses the implications of results on practice and theory, recommendation and future research, and concluding remarks.

6.2 Implications on Practice

Results from the study will benefit both the patients and public healthcare facilities. This study informs healthcare facilities of the benefits that can be accrued by adopting cloud computing. One of these benefits is ease of access to medical data or patient information. Having patient data stored electronically on the cloud makes is easier for healthcare providers to have real-time access to patient data when needed. It also helps in monitoring a patient's health progress to offer continuity of care. Access to information when needed leads to an increase in productivity and efficiency. Collecting medical data through manual methods can be time-consuming and may hinder productivity, but having the data accessible on the cloud makes it easier for physicians to get hold of the medical data needed for them to perform their duties. It also helps in terms of research, as they can have access to the medical data they require to carry out their research and to bring more solutions to the medical field.

The study further informs the public health sector of improvements they may need to consider in terms of their internet facilities. Adopting cloud computing requires reliable and steady internet connections to administer the flow of data within the health sector. Without proper internet facilities in place, transitioning to the cloud may become a challenge as all administrative tasks will be done on the internet. This may hinder production and patient care may be compromised. However, this opens an opportunity for Internet Service Providers (ISPs) to present their services to the DoH and the offers they have in place. Financial implications of outsourcing an ISP should be considered; however, the cost-effective solutions offered by cloud computing bring about a balance within the IT infrastructure and the health facilities. Investments in IT infrastructure and a well-established network will be a great improvement for healthcare.

Based on the results, the DoH FS may need to review the health information systems in place. Results show that primary healthcare (PHC) utilize a different HIS to capture patient data and specific medical data than that utilized by secondary healthcare (SHC). It would be good to consider having one system used by every healthcare facility rather than having multiple systems whereas all these healthcare facilities are under the same management and are committed to a similar agenda. A study done by Mamatela [89] on eHealth technologies used by SA medical enterprises found that the non-standardization of eHealth explains why the inter-organizational eHealth benefits (access to other clinician's patient data, reduced clinical error, reduced cost of services rendered to patients, reduced clinician time per patient, etc.) were not realized. Having an inter-connected system used by all public healthcare facilities would be more beneficial and cost-effective.

Furthermore, the study informs us that healthcare facilities are ready to move from paper to cloud. Results revealed that most healthcare facilities are willing to adopt cloud computing, which is an indication of a move in the right direction. The willingness of healthcare facilities to embrace this technology will make it easier for its implementation with support from healthcare providers.

Top managers play a vital role in the organization. They are the ones who make the final decision, authorize the use of resources needed and release financial resources. Without their support, the adoption of cloud computing cannot be carried out. Therefore, the top management's decision is of great importance to the organization and should be taken into consideration.

6.3 Implications on Theory

The study was grounded on the TOE framework, which is a theoretical model that was developed by Tornatzky and Fleischer, explaining elements which influence a firms' decision on the adoption of an innovation [19] [20]. This model considered the technological, organizational and environmental aspects influencing the intent to adopt. According to Kinuthia [74], this framework was proved to be consistent with the diffusion of innovation theory (DOI). Nevertheless, the TOE framework was deemed appropriate to be used in this study.

The study investigated seven variables within the proposed research framework. The most important context with the highest effect size in this study was the organizational context, followed by the technological context. The environmental context had no significant importance on the intent to adopt. Results revealed that the most critical factors on the intent to adopt were: top management support, organization readiness, relative advantage and

security concern. This study adds to the knowledge body in the field of cloud computing. Researchers can depend on the results obtained from this study for future research on cloud computing adoption in health.

The study can, however, be improved by applying other theoretical models to explore factors influencing the intent to adopt.

6.4 Recommendations and Future research

The study recommends the use of one centralized system to which all public healthcare facilities can have access and on which they can store patient and medical data. This will help reduce the cost associated with the maintenance of different systems at different facilities. Having a patient's details and information about the patient's health history available at all healthcare facilities will help reduce the time it takes before the patient is treated. In addition, to make the use of cloud computing in health a success, the study recommends having a steady internet connection at all public healthcare facilities. Policies and regulations regarding access to patient details will need to be formulated as well, to protect both the patient and the healthcare providers.

An opportunity exists for similar research on cloud computing to be carried out in other South African provinces or nationally. In this study, only a limited number of TOE factors were investigated. The study can still be expanded by including more factors such as complexity, cost, network reliability, regulatory support and external support. The study can also be improved by applying other theoretical models or integrating the current model with other theoretical models such as the Diffusion of Innovation (DOI). The study can be extended by including the private health sector and investigating how an integration of medical systems can improve healthcare and reduce costs, and how technology can be used to bridge the gap between services rendered at private and public health sectors.

The theoretical model adapted in this study can be tested using different statistical software packages such as SEM. This may yield different results from those obtained in this study or give an insight into new knowledge. In addition, more research can be done on the existing HIS at public healthcare facilities to establish if these systems are dynamic to accommodate their integration. Future projects include developing and pilot testing a prototype of an integrated cloud-based EMR system at selected public healthcare facilities in FS.

6.5 Concluding Remarks

Integrating information technology with healthcare can bring a significant change within the medical field. The main role of healthcare facilities is to provide quality services and care to

patients and improve their health. As literature suggested, cloud computing can help achieve these goals. Not only will it help improve patient care, but it will also assist healthcare providers with their day-to-day tasks and provide the necessary data to conduct research. This study has contributed to existing cloud computing adoption and theoretical model literature. The model used to conduct the study will inform the public health sector of the important factors they should consider when they intend to adopt cloud computing. The study also provides information about the current state of HIS in the FS and the improvements required. The study indicated the benefits of adopting an integrated cloud-based EMR system and how it can improve healthcare.

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APPENDIX A: ETHICAL CLEARANCE

Appendix A1: Free-State Department of Health Approval Letter

health
Department of Health
FREE STATE PROVINCE

19 June 2017

Ms. N Masana
Dept. of Computer Science and Informatics
CUT

Dear Ms. N Masana

Subject: Investigation of the viability of an integrated cloud-based electronic medical records for health Clinics in Free State, South Africa.

- Please ensure that you read the whole document. Permission is hereby granted for the above – mentioned research on the following conditions:
- Participation in the study must be voluntary.
- A written consent by each participant must be obtained.
- Serious Adverse events to be reported to the Free State department of health and/ or termination of the study
- Ascertain that your data collection exercise neither interferes with the day to day running of the Selected facilities nor the performance of duties by the respondents or health care workers.
- Confidentiality of information will be ensured and please do not obtain information regarding the identity of the participants.
- **Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).**
- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of Free State and to Free State Department of Health.
- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the University of Free State and to Free State Department of Health.
- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to** sebeelats@fshealth.gov.za **before you commence with the study**
- No financial liability will be placed on the Free State Department of Health
- Please discuss your study with the institution manager/CEOs on commencement for logistical arrangements
- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study
- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)
- You are encouraged to present your study findings/results at the Free State Provincial health research day
- Future research will only be granted permission if correct procedures are followed see http://nhrd.hst.org.za

Trust you find the above in order.
Kind Regards

Dr D Motau
HEAD: HEALTH
Date: 27/06/17

Head : Health
PO Box 227, Bloemfotein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfotein
Tel: (051) 408 1646 Fax: (051) 408 1556 e-mail:khusemj@fshealth.gov.za@fshealth.gov.za/chikobvup@fshealth.gov.za
www.fs.gov.za

Appendix A2: UFS Health Sciences Research Ethics Committee (HSREC) Approval Letter

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

26 July 2017

MS NOMABHONGO MASANA
DEPT OF COMPUTER SCIENCE AND INFORMATICS
CUT

Dear Ms Nomabhongo Masana

HSREC 54/2017 (UFS-HSD2017/0481)
PRINCIPAL INVESTIGATOR: MS NOMABHONGO MASANA
SUPERVISOR: MR GM MURIITHI
PROJECT TITLE: INVESTIGATION OF THE VIABILITY OF AN INTEGRATED CLOUD-BASED ELECTRONIC MEDICAL RECORD FOR HEALTH CLINICS IN FREE STATE, SOUTH AFRICA

APPROVED

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this protocol after all conditions were met at the meeting held on 25 July 2017.
2. The Committee must be informed of any serious adverse event and/or termination of the study.
3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.
4. A progress report should be submitted within one year of approval and annually for long term studies.
5. A final report should be submitted at the completion of the study.
6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.
7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Health Sciences Research Ethics Committee
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APPENDIX B: FINAL QUESTIONNAIRES

Appendix B1: Questionnaire for Senior Management Personnel

Questionnaire(CEO/Manager/Head)

Project Title: Investigation of the Viability of an Integrated Cloud-Based Electronic Medical Record for Health Clinics in Free State, South Africa

Investigator: Nomabhongo Masana, Central University of Technology.

Terms:

> ***Electronic Medical Record (EMR)***: a digital/electronic medical record that can be shared and transferred among different health institutions
>
> ***Cloud Computing***: a new emerging technology (also phrased as the "cloud" or "Internet") where you can store and access data and programs over the Internet instead of your computer's hard drive.

Introduction/Purpose of the study: This study is part of Master's dissertation research project. The purpose of the study is to explore your perception about the adoption of an integrated cloud-based EMR system in the health sector with regards to the technological, organizational and environmental (TOE) factors and how they affect the adoption of an integrated cloud-based EMR system.

Outline: The questionnaire is divided into two sections. The first section (**Section A**) will contain questions about your demographic details, your organization, how medical information is handled in your organization and challenges you are facing with the current medical systems you are using at your work places. The second section (**Section B**) contains questions about the TOE factors that may influence the decision to adopt an integrated cloud-based EMR system. The questionnaire takes 10-15 minutes to complete.

Confidentiality: Please note that the data collected here will be used for research purposes only and will not be divulged to third parties in its raw form, all responses will be kept anonymous. Information such as your name will not be collected as part of this survey. Your responses will not be tied to you as they will be anonymous.

Voluntary Participation: You have been asked to participate in a research study. Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire. The results of the study may be published.

Contact: For any questions or more information regarding the questionnaire, you may contact:

Nomabhongo Masana
Central University of Technology
Department of Information Technology, Private Bag X20539, Bloemfontein, 9300
Email: nnomabhongo@cut.ac.za / nnomabhongo@gmail.com

Section A

Demographic Questions

1. **In which Free State District is the facility located?**

   Motheo ☐ Xhariep ☐ Lejweleputswa ☐ Thabo Mofutsanyana ☐ Fezile Dabi ☐

2. **Type of Health Facility**

   District Hospital: ☐ Community Health Centre: ☐

   Regional Hospital: ☐ Tertiary Hospital: ☐

   Central Hospital: ☐ Other (Please Specify) ☐: _____

3. **Please indicate the approximate number of Employees in your Institution / Facility**

   1-10 ☐ 11 -50 ☐ 51 – 100 ☐ 101- 500 ☐ >500 ☐

4. **Which of the following positions best describes your current role/profession at the Institution?**

   Chief Executive Officer ☐ Supervisor ☐

   Hospital Manager ☐ Other (Please specify) ☐:_____

5. **Gender**

   Male ☐ Female ☐

6. **Age Group**

   18 - 25 ☐ 26 - 35 ☐ 36 - 45 ☐ 46 - 55 ☐ 56 - 65 ☐ 66+ ☐

7. **Please indicate your Highest Qualification**

   Master's Degree ☐

   Bachelor's Degree ☐

   Diploma ☐

   National Senior Certificate ☐

   Higher National Diploma ☐

   PhD ☐

   Higher Certificate ☐

   Other (Please Specify) ☐ :_____

Current Patient Management System / EMR System

8. **Is there any computerized system to store medical data at the health facility?**

   Yes ☐ No ☐

9. **If Yes, which of the following system(s) do you use? Select all that applies**

Delta 9	☐	Pro-Clin	☐
Meditech	☐	PALS	☐
PADS	☐	ReMed	☐
Soarian MedSuite	☐	Medicom	☐
PharmAssist	☐	Nootroclin	☐
PHCIS	☐	PAAB	☐
Clinicom	☐	JAC Pharmacy	☐

Other (Please Specify) ☐ :_____

10. **What are the features of the system(s) in the previous question? Choose all those that apply.**

Health Information	☐	Decision Support	☐
Laboratory Management	☐	Electronic Communication	☐
Diagnostics Management	☐	Patient Support	☐
Medication Management	☐	Administrative Processes	☐
Referrals	☐	Practice Reporting	☐

11. **Which of the following statements best describes your current patient management system (Capturing, Processing and Storing patient data?)**

Fully Paper Based System with no form of IT support at all. ☐

Paper-based system with some form of IT support to record basic patient details. ☐

Computerized – A centralized standalone EMR that serves only our facility. It is not linked to other external systems. ☐

An EMR system that serves our facility BUT is also linked to other external EMRs. ☐

Cloud Awareness

12. **How familiar are you with the term Cloud Computing?**

I have no Idea what this means ☐

I have sufficient knowledge on what the term means ☐

I have expert knowledge on what the term means ☐

13. **Is any of your Health Information System (HIS) services Cloud Based i.e. accessible Online?**

No ☐ Yes ☐

14. **If yes, which of the following services are cloud based or online? Select all that applies**

Patient Management ☐

Accounting / Billing ☐

Prescriptions ☐

Appointments/Scheduling ☐

Pharmacy / Dispensing Drugs ☐

Section B

This section gauges your perception regarding the use of Cloud Based EMR systems. In our context, ***Cloud EMR*** denotes an integrated cloud-based platform that enables different institutional EMRs to share and exchange selected medical data among health institutions online, making it possible to access such data anywhere, anytime, from any internet ready device. By sharing this data, healthcare providers can quickly access important patient data such as a patient's medical history, chronic conditions, latest X-Ray scans etc. even if the patient has not visited the facility before. Such an online system has both benefits and challenges. We would like to hear your view regarding this.

15. **Which of the following data do you perceive as being suitable for deployment on a shared Cloud EMR platform? Select all that applies**

Patient Details (Names, Addresses, etc.) ☐

Appointments (e.g. When to See Which Doctor) ☐

Treatment Details (e.g. ailments, diagnosis, etc.) ☐

Billing Data ☐

Lab Results (X-Rays, Blood Tests, etc.) ☐

Please make one choice per statement, unless stated otherwise

Based on the current health system(paper/computerized) in your institution, rate the extent to which you agree with the following statements in as far as adopting / transitioning to a Cloud based EMR is concerned (1 - strongly disagree, 5 strongly agree)	**1**	**2**	**3**	**4**	**5**
Cloud EMR will enable me to accomplish my job tasks quickly and effectively.	☐	☐	☐	☐	☐
Using Cloud EMR will improve the quality of my work.	☐	☐	☐	☐	☐
Using Cloud EMR will increase the organization's productivity.	☐	☐	☐	☐	☐
Using Cloud EMR will improve help access patient data easily	☐	☐	☐	☐	☐
Adopting Cloud EMR system is more cost effective than purchasing traditional EMR systems (systems that are not on the cloud)	☐	☐	☐	☐	☐
For Security, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Internet security is a major concern to our firm when deciding to adopt Internet/Cloud based technology	☐	☐	☐	☐	☐
I am comfortable with exchanging and sharing medical data online within my organization/colleagues	☐	☐	☐	☐	☐
I am comfortable exchanging and sharing medical data online with other health facilities in my area	☐	☐	☐	☐	☐
I am comfortable exchanging and sharing medical data online with other health facilities provincially	☐	☐	☐	☐	☐
I believe Cloud EMR system is more secure than manual medical records	☐	☐	☐	☐	☐
For Organizational Readiness, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Our organization has enough technological resources required to adopt a Cloud EMR system	☐	☐	☐	☐	☐
Our organization has the necessary financial aid to implement a Cloud EMR	☐	☐	☐	☐	☐
Our organization is willing to fund the implementation of a Cloud EMR system	☐	☐	☐	☐	☐
For Competitive Pressure, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Our industry is pressuring our organization or company to adopt Cloud EMR system.	☐	☐	☐	☐	☐
There is government pressure on our organization or company to adopt Cloud EMR system	☐	☐	☐	☐	☐
There is pressure from other organizations in our industry to use Cloud EMR system	☐	☐	☐	☐	☐
We understand the competitive advantages offered by cloud computing in our Industry	☐	☐	☐	☐	☐
For Vendor support, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
We ensure that cloud vendors implement strong access and identity management to ensure unauthorized access to cloud computing	☐	☐	☐	☐	☐

Our suppliers expect us to adopt cloud computing technology	☐	☐	☐	☐	☐
Our suppliers are willing to give us technical assistance in adopting Cloud EMR system	☐	☐	☐	☐	☐
Our suppliers are willing to support our staff by training them how to use a Cloud EMR system	☐	☐	☐	☐	☐
For Organizational Intent to Adopt an integrated cloud-based EMR, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
I think that using cloud computing services is advantageous	☐	☐	☐	☐	☐
I am in favor of using the cloud computing services	☐	☐	☐	☐	☐
Our organization is likely to adopt and use a Cloud EMR system in the near future.	☐	☐	☐	☐	☐

Would you mind if we contact you for a follow-up interview?

Yes ☐ No ☐

Any comments about the adoption of an integrated cloud-based EMR system:

Thank you for completing this questionnaire. We highly appreciate it.

Appendix B2: Questionnaire for medical personnel

Questionnaire (Doctor/Nurse)

Project Title: Investigation of the viability of an integrated cloud-based EMR system in the Free-State, South Africa.

Investigator: Nomabhongo Masana, Central University of Technology.

Terms:

> ***Electronic Medical Record (EMR)***: a digital/electronic medical record that can be shared and transferred among different health institutions
>
> ***Cloud Computing***: a new emerging technology (also phrased as the "cloud" or "Internet") where you can store and access data and programs over the Internet instead of your computer's hard drive.

Introduction/Purpose of the study: This study is part of master's dissertation research project. The purpose of the study is to explore your perception about the adoption of an integrated cloud-based EMR system in the health sector with regards to the technological, organizational and environmental (TOE) factors and how they affect the adoption of an integrated cloud-based EMR system.

Outline: The questionnaire is divided into two sections. The first section (**Section A**) will contain questions about your demographic details, your organization, how medical information is handled in your organization and challenges you are facing with the current medical systems you are using at your work places. The second section (**Section B**) contains questions about the TOE factors that may influence the decision to adopt an integrated cloud-based EMR system. The questionnaire takes 10-15 minutes to complete.

Confidentiality: Please note that the data collected here will be used for research purposes only and will not be divulged to third parties in its raw form, all responses will be kept anonymous. Information such as your name will not be collected as part of this survey. Your responses will not be tied to you as they will be anonymous.

Voluntary Participation: You have been asked to participate in a research study. Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire. The results of the study may be published.

Contact: For any questions or more information regarding the questionnaire, you may contact:

Nomabhongo Masana
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Department of Information Technology, Private Bag X20539, Bloemfontein, 9300
Email: nnomabhongo@cut.ac.za / nnomabhongo@gmail.com

Section A

Demographic Questions

16. Which Free State District is the facility located?

Motheo ☐ Xhariep ☐ Lejweleputswa ☐ Thabo Mofutsanyana ☐ Fezile Dabi ☐

17. Type of Health Facility

District Hospital: ☐ Community Health Centre: ☐

Regional Hospital: ☐ Tertiary Hospital: ☐

Central Hospital: ☐ Other (Please Specify) ☐: _____

18. On average, how many patients does your facility handle per day?

Less than 10 ☐ 10 – 50 ☐ 51-100 ☐ 101 – 150 ☐ 151 – 200 ☐ 200+ ☐

19. Which of the following positions best describes your current role/profession at the Institution?

Medical Assistant ☐ Clinical Laboratory Technologist ☐

Nursing Assistant ☐ Family Practitioner ☐

Physician ☐ Dentist ☐

Therapist ☐ Nurse Practitioner ☐

Registered Nurse ☐ Surgical Technologist ☐

Clinical Laboratory Technician ☐ Physician Assistant ☐

Dental Assistant ☐ Surgeon ☐

Other (Please specify) ☐:_____

20. Gender

Male ☐ Female ☐

21. Age Group

18 - 25 ☐ 26 - 35 ☐ 36 - 45 ☐ 46 - 55 ☐ 56 - 65 ☐ 66+ ☐

22. Please indicate your Highest Qualification

Master's Degree ☐

Bachelor's Degree ☐

Diploma ☐

National Senior Certificate ☐

Higher National Diploma ☐

PhD ☐

Higher Certificate ☐

Other (Please Specify) ☐ :_____

Current Patient Management System / EMR System

23. Is there any computerized system to store medical data at the health facility?

Yes ☐ No ☐

24. If Yes, which of the following system(s) do you use:

Delta 9	☐	Pro-Clin	☐
Meditech	☐	PALS	☐
PADS	☐	ReMed	☐
Soarian MedSuite	☐	Medicom	☐
PharmAssist	☐	Nootroclin	☐
PHCIS	☐	PAAB	☐
Clinicom	☐	JAC Pharmacy	☐

Other (Please Specify) ☐ :_____

25. What are the features of the system(s) in the previous question? Choose all those that apply.

Health Information	☐	Decision Support	☐
Laboratory Management	☐	Electronic Communication	☐
Diagnostics Management	☐	Patient Support	☐
Medication Management	☐	Administrative Processes	☐
Referrals	☐	Practice Reporting	☐

26. Which of the following statements best describes your current patient management system (Capturing, Processing and Storing patient data?)

Fully Paper-based System with no form of IT support at all. ☐

Paper-based system with some form of IT support to record basic patient details. ☐

Computerized – A centralized standalone EMR that serves only our facility. It is not linked to other external systems. ☐

An EMR system that serves our facility BUT is also linked to other external EMRs. ☐

Cloud Awareness

27. How familiar are you with the term Cloud Computing?

I have no Idea what this means ☐

I have sufficient knowledge on what the term means ☐

I have expert knowledge on what the term means ☐

Questions on the current system being utilized for medical records

Please select one response per question unless stated otherwise

28.Are you able to access a patient's information anywhere, anytime to monitor his/her progress? Yes ☐ No ☐
To what extent do you agree or disagree with the following statements: **(This applies to Paper-Based medical records)**
29.The current medical systems for recording patient data (manually on paper) is time-consuming Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐
30.The current medical systems for recording patient data (manually on paper) is easy to use Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐
31.The current medical systems for recording patient data (manually on paper) is safe and reliable Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐
32.The current data collection and submission methods of health reports is time consuming Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐

33.The current data collection and submission methods of health reports is not easy to use Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐	
34. It is very easy to have real time Information of a patient Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐	
35.Having one centralized data storage (like a server) that contains all the information for patient's is a good idea and will help improve healthcare Strongly Agree ☐ Agree ☐ Neither Agree/Disagree ☐ Disagree ☐ Strongly Disagree ☐	
36.How do you manage paper in the office? Please select one of the following answers.	
All patient information is processed and filed in the paper charts.	☐
We scan old records into files on a computer (e.g. as PDF files) that are not connected to any electronic information system.	☐
We are scanning in some paper to an EMR – either for select patients or select pieces of information.	☐
After any incoming results / reports are reviewed they are scanned into the EMR.	☐
Most/nearly all paper is scanned into the EMR and tagged (e.g. as an X-ray or consult) once it is received and then it is reviewed electronically in the EMR.	☐
We have almost no paper coming into the office anymore, all or nearly all patient information is received electronically into the EMR	☐
37.How do you share medical information with other doctors or health institutions OUTSIDE office (e.g. specialists, hospital), not including formal referrals? Please select one of the answers below	
For the majority of communication, it is by phone / fax. It is kept / documented in the paper chart	☐
Stand-alone, secure electronic communication (e.g. secure email) is used in my community for most of my external communication.	☐
Any external communication is generated outside my EMR but copied / scanned into the EMR for all patients.	☐
I use my EMR to generate outgoing notes, which are printed and faxed. All notes are stored in my EMR.	☐
We have an electronic communication network for much of the communication that is connected to my EMR. Messages arrive in my inbox from others electronically (i.e. are not scanned).	☐

Section B

This section gauges your perception regarding the use of Cloud Based EMR systems. In our context, ***Cloud EMR*** denotes an integrated cloud-based platform that enables different institutional EMRs to share and exchange selected medical data among health institutions online, making it possible to access such data anywhere, anytime, from any internet ready device. By sharing this data, healthcare providers can quickly access important patient data such as a patient's medical history, chronic conditions, latest X-Ray scans etc. even if the patient has not visited the facility before. Such an online system has both benefits and challenges. We would like to hear your view regarding this.

Please make one choice per statement, unless stated otherwise

Based on the current health system(paper/computerized) in your institution, rate the extent to which you agree with the following statements in as far as adopting / transitioning to a Cloud based EMR is concerned (1 - strongly disagree, 5 strongly agree)	**1**	**2**	**3**	**4**	**5**
Cloud EMR will enable me to accomplish my job tasks quickly and effectively.	☐	☐	☐	☐	☐
Using Cloud EMR will improve the quality of my work.	☐	☐	☐	☐	☐
Using Cloud EMR will increase the organization's productivity.	☐	☐	☐	☐	☐
Using Cloud EMR will improve help access patient data easily	☐	☐	☐	☐	☐
Adopting Cloud EMR system is more cost effective than purchasing traditional EMR systems (systems that are not on the cloud)	☐	☐	☐	☐	☐
For Security, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Internet security is a major concern to our firm when deciding to adopt Internet/Cloud based technology	☐	☐	☐	☐	☐
I am comfortable with exchanging and sharing medical data online within my organization/colleagues	☐	☐	☐	☐	☐
I am comfortable exchanging and sharing medical data online with other organizations locally	☐	☐	☐	☐	☐
I am comfortable exchanging and sharing medical data online with other organizations provincially	☐	☐	☐	☐	☐
Cloud EMR system is more secure than manual medical records	☐	☐	☐	☐	☐
For Organizational Intent to Adopt an integrated cloud-based EMR, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
I think that using cloud computing services is advantageous	☐	☐	☐	☐	☐
I am in favor of using the cloud computing services	☐	☐	☐	☐	☐
Our organization is likely to adopt and use a Cloud EMR system in the near future.	☐	☐	☐	☐	☐

Any comments about the adoption of an integrated cloud-based EMR system:

Thank you for completing this questionnaire. We highly appreciate it.

Appendix B3: Questionnaire for IT personnel

Questionnaire (IT Personnel)

Project Title: Investigation of the viability of an integrated cloud-based EMR system in the Free-State, South Africa.

Investigator: Nomabhongo Masana, Central University of Technology.

Terms:

> ***Electronic Medical Record (EMR)***: a digital/electronic medical record that can be shared and transferred among different health institutions
>
> ***Cloud Computing***: a new emerging technology (also phrased as the "cloud" or "Internet") where you can store and access data and programs over the Internet instead of your computer's hard drive.

Introduction/Purpose of the study: This study is part of master's dissertation research project. The purpose of the study is to explore your perception about the adoption of an integrated cloud-based EMR system in the health sector with regards to the technological, organizational and environmental (TOE) factors and how they affect the adoption of an integrated cloud-based EMR system.

Outline: The questionnaire is divided into two sections. The first section (**Section A**) will contain questions about your demographic details, your organization, how medical information is handled in your organization and challenges you are facing with the current medical systems you are using at your work places. The second section (**Section B**) contains questions about the TOE factors that may influence the decision to adopt an integrated cloud-based EMR system. The questionnaire takes 10-15 minutes to complete.

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Voluntary Participation: You have been asked to participate in a research study. Please note that by completing this questionnaire you are voluntarily agreeing to participate in this research study. You will remain anonymous and your data will be treated confidentially at all times. You may withdraw from this study at any given moment during the completion of the questionnaire. The results of the study may be published.

Contact: For any questions or more information regarding the questionnaire, you may contact:

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Section A

Demographic Questions

1. **Which Free State District is the facility located?**

   Motheo ☐ Xhariep ☐ Lejweleputswa ☐ Thabo Mofutsanyana ☐ Fezile Dabi ☐

2. **Types of Health Facilities you assist**

   District Hospital: ☐ Community health Centre: ☐

   Clinic: ☐ Regional Hospital: ☐

   Tertiary Hospital: ☐ Central Hospital: ☐

   Other (Please Specify) ☐: _____

3. **Which of the following positions best describes your current role/profession at the Institution?**

   Health Information Technician ☐ Network Administrator ☐

   Other (Please specify) ☐:_____

4. **Gender**

   Male ☐ Female ☐

5. **Age Group**

   18 - 25 ☐ 26 - 35 ☐ 36 - 45 ☐ 46 - 55 ☐ 56 - 65 ☐ 66+ ☐

6. **Please indicate your Highest Qualification**

   Master's Degree ☐

   Bachelor's Degree ☐

   Diploma ☐

   National Senior Certificate ☐

   Higher National Diploma ☐

   PhD ☐

   Higher Certificate ☐

   Other (Please Specify) ☐ :_____

Current IT Infrastructure at Health Facilities in the District

Internet Facilities

7. **Do all health facilities in the district have Internet facilities?**

   Yes ☐ Some ☐ No ☐

8. **If Yes/Some, how would you characterize the speed of the Internet Connection**

   Very Good ☐ Good ☐ Fair ☐ Poor ☐ Very Poor ☐

9. **Would you consider the Internet connectivity reliable (i.e. how often is it usually accessible and available for use)?**

   Very Reliable ☐ Reliable ☐ Fair ☐ Poor ☐ Not Reliable at all ☐

10. **Who Pays for the Internet Services?**

We don't pay for it. It is provided by the government.	☐
Donor Funded (Please specify the Donor, e.g. Telkom).	☐
Privately funded (e.g. Owner or Health Centre or the Health Centre).	☐
I don't Know.	☐

11. **On a scale of 1 to 5 (1 being Very Affordable, 5 Being Very Expensive) how would you rate the Affordability of the Internet connectivity:**

    1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Current Patient Management / EMR Systems

12. **Do Health Facilities in the district have any computerized systems to store medical data?**

    Yes ☐ Some ☐ No ☐

13. **If Yes/Some, which of the following system(s) do they use:**

Delta 9	☐	Pro-Clin	☐
Meditech	☐	PALS	☐
PADS	☐	ReMed	☐
Soarian MedSuite	☐	Medicom	☐
PharmAssist	☐	Nootroclin	☐
PHCIS	☐	PAAB	☐

Clinicom ☐ JAC Pharmacy ☐

Other (Please Specify) ☐ :_____

14. What are the features of the systems in question 13? Choose all those that apply.

Health Information	☐	Decision Support	☐
Laboratory Management	☐	Electronic Communication	☐
Diagnostics Management	☐	Patient Support	☐
Medication Management	☐	Administrative Processes	☐
Referrals	☐	Practice Reporting	☐

15. Which of the following statements best describes the current patient management systems (Capturing, Processing and Storing patient data?)

Fully Paper Based System with no form of IT support at all. ☐

Paper-based system with some form of IT support to record basic patient details. ☐

Computerized – A centralized standalone EMR that serves only our facility. It is not linked to other external systems. ☐

An EMR system that serves our facility BUT is also linked to other external EMRs. ☐

Cloud Awareness

16. How familiar are you with the term Cloud Computing?

I have no Idea what this means ☐

I have sufficient knowledge on what the term means ☐

I have expert knowledge on what the term means ☐

17. Is any of the Health Information System (HIS) services at health facilities Cloud Based i.e. accessible Online?

No ☐ Yes ☐

18. If Yes, which of the following services are cloud based or online

Patient Management ☐

Accounting/Billing ☐

Prescriptions ☐

Appointments/Scheduling ☐

Pharmacy/Dispensing Drugs ☐

19. **Which of the following best describes the type of cloud used for your online services (or intend to use)?**

Public (Externally hosted by a Public Cloud Service Provider) ☐

Private (Cloud only available for our health institution and associated clinics) ☐

Community Cloud (We are part of a consortium of health facilities tied together by a cloud platform that we all share) ☐

Hybrid (Some of our systems run on our private cloud, others use external clouds) ☐

Section B

This section gauges your perception regarding the use of Cloud Based EMR systems. In our context, ***Cloud EMR*** **denotes an integrated cloud-based platform that** enables different institutional EMRs to share and exchange selected medical data among health institutions online, making it possible to access such data anywhere, anytime, from any internet ready device. By sharing this data, healthcare providers can quickly access important patient data such as a patient's medical history, chronic conditions, latest X-Ray scans etc. even if the patient has not visited the facility before. Such an online system has both benefits and challenges. We want your view regarding this.

20. **Health Facilities in the district are willing to Adopt a Cloud based EMR**

Yes ☐ No ☐

Please make one choice per statement, unless stated otherwise

Based on the current EMR system at health facilities, rate the extent to which you agree with the following statements in as far as adopting / transitioning to a Cloud based EMR is concerned (1 - strongly disagree, 5 strongly agree)	**1**	**2**	**3**	**4**	**5**
Using Cloud EMR will increase the organization's productivity.	☐	☐	☐	☐	☐
Using Cloud EMR will improve help access patient data easily	☐	☐	☐	☐	☐
Adopting Cloud EMR system is more cost effective than purchasing traditional EMR systems (systems that are not on the cloud)	☐	☐	☐	☐	☐
For Compatibility, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
A Cloud EMR system will be compatible with our existing IT infrastructure (system's format, interface and other structural data) in the organization.	☐	☐	☐	☐	☐
The transition to a Cloud EMR system will not require a new infrastructure (hardware and software)	☐	☐	☐	☐	☐
Adopting a Cloud EMR is part of our strategy for the coming years	☐	☐	☐	☐	☐
The adoption of a Cloud EMR system has been implemented in some of the health facilities.	☐	☐	☐	☐	☐

For Security, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Internet security is a major concern in the district when deciding to adopt Internet/Cloud based technology	☐	☐	☐	☐	☐
I am comfortable with the exchange and sharing of medical data online between health employees within the same health facility.	☐	☐	☐	☐	☐
I am comfortable with the exchange and sharing of medical data online between health employees at different health facilities	☐	☐	☐	☐	☐
I am comfortable with the exchange and sharing of medical data online between health employees provincially	☐	☐	☐	☐	☐
Cloud EMR system is more secure than manual medical records	☐	☐	☐	☐	☐
For Availability of Resources, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
We have sufficient technological resources to adopt a Cloud EMR system	☐	☐	☐	☐	☐
We have high bandwidth connectivity to the internet to support a Cloud EMR system	☐	☐	☐	☐	☐
For the Top Management Support factor, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
Top management is likely to consider the adoption of cloud computing as strategically important	☐	☐	☐	☐	☐
Top management is willing to take the risks involved in the adoption of Cloud EMR	☐	☐	☐	☐	☐
The adoption and use of Cloud EMR in our organization will receive strong support from top management.	☐	☐	☐	☐	☐
For Vendor support, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
We will ensure that cloud vendors implement strong access and identity management to ensure unauthorized access to cloud computing	☐	☐	☐	☐	☐
Our suppliers expect us to adopt cloud computing technology	☐	☐	☐	☐	☐
Our suppliers are willing to give us technical assistance in adopting Cloud EMR system	☐	☐	☐	☐	☐
Our suppliers are willing to support our staff by training them how to use a Cloud EMR system	☐	☐	☐	☐	☐
For Organizational Intent to Adopt an integrated cloud-based EMR, on a scale of 1-5(*1-strongly disagree, 5-strongly agree*) please rate the extent to which you agree or disagree with the following statements	**1**	**2**	**3**	**4**	**5**
I think that using cloud computing services is advantageous	☐	☐	☐	☐	☐
I am in favor of using the cloud computing services	☐	☐	☐	☐	☐
Our health department is likely to adopt and use a Cloud EMR system in the near future.	☐	☐	☐	☐	☐
Our health department is more Likely to Adopt Cloud EMR if a Private Cloud is used	☐	☐	☐	☐	☐
Our health department is likely to consider cloud EMR if a Community Cloud linking similar institutions is put in place	☐	☐	☐	☐	☐

Any Comments about the adoption of an integrated cloud-based EMR system:

_____

_____

_____

_____

Thank you for completing this questionnaire. We highly appreciate it.

APPENDIX C: LANGUAGE EDIT CERTIFICATE

ELIZABETH LE SUEUR
Language practitioner
for expert wordwork

editburo@gmail.com 073-254-4995

CERTIFICATE

This is to certify that I, the undersigned, have completed the language editing of the dissertation submitted in fulfilment of the requirements of the degree of Master of Information Technology in the Faculty of Engineering and Information Technology at the Central University of Technology, Free State by

NOMABHONGO MASANA
(Student number 210001534)

titled: INVESTIGATION OF THE VIABILITY OF AN INTEGRATED CLOUD-BASED ELECTRONIC MEDICAL RECORD FOR HEALTH CLINICS IN FREE STATE, SOUTH AFRICA

I am satisfied that the academic style and language usage are of a very high standard.

ELIZABETH LE SUEUR (BA Hons)
EDITBURO (est. 1975)

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06 October 2018