

**STRATEGIES TO ENHANCE ELECTRONIC HEALTH
RECORD (EHR) IMPROVEMENT IN DATA QUALITY
HELP IN PATIENT QUALITY OF CARE AND
DECISION-MAKING: A CASE STUDY OF
SMARTCARE.**

By

Dale Nchimweta Chizoma

A Dissertation submitted in partial fulfilment of the
requirement for the Degree of Masters in Operations, Projects
and Supply Chain Management.

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SIGNATURE: DATE

Student

This Research Project has been submitted for examination with my approval as the university supervisor.

SIGNATURE:.....DATE:.....

Dr. Jason Mwanza

Supervisor,

GRADUATE SCHOOL OF BUSINESS

UNIVERSITY OF ZAMBIA

CERTIFICATE OF APPROVAL

We, the undersigned as examiners, recommend that this dissertation has fulfilled the requirements of the Degree of Master of Operations, Projects and Supply Chain Management of the University of Zambia.

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ABSTRACT

The Electronic Health Record (EHR) system has had the potential to revolutionize medical documentation and patient management. With a focus on improving the patient quality of care and decision-making, the Ministry of Health (MOH) is spearheading the use of Information Communication Technology (ICT) to transition from a paper based health system to a national integrated electronic health system. This EHR system is called SmartCare, and is for implementation and use in all Health Centres offering antiretroviral services as this will ease provision of continuity of care, patient safety, cooperation of clinicians, collection and aggregating of reports and securing patient data among other services. However, in its current use, the system has shown inconsistency in reports generated and erroneous data that include incomplete records, missing or inaccurate information which may cause unintended consequences to patients, providers and erode promises of the EHR system.

The objective of the study is to develop strategies using Diffusion of Innovations Theory (DOI) and the Technology Acceptance Model (TAM) in a cross sectional case study that determine the individual's characteristics, social and technical factors that may be used to reduce the likelihood of introducing errors in the EHR system. The significance of this study is having a framework based on the study findings that may aid in developing a positive influence with the end users to curb errors while using EHR systems hence improving data quality and bettering the quality of health care and decision making.

Key words: Diffusion of Innovation (DOI), Electronic Health Record (EHR), Errors, Information Communication Technology (ICT), Technology Acceptance Model (TAM).

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ABBREVIATIONS AND ACRYNORMS

ANT	Actor-Network Theory
ARV	Antiretroviral
CDC	Centre for Disease Control and Prevention
DOI	Diffusion of Innovations
DRGS	Directorate of Research and Graduate Studies
EHR	Electronic Health Records
HAHC	Hospital Affiliated Health Centres
HC	Health Centres
HIT	Health Information Technology
HMIS	Health Management Information System
HP	Health Post
ICT	Information and Communication Technology
MOH	Ministry of Health
PHC	Primary Health Care
TAM	Technology Acceptance Model
UTH-HAP	University Teaching Hospital –HIV AIDS Program

CHAPTER ONE - INTRODUCTION

1.1 Introduction

This chapter lays out the study by bringing out its background, statement of the problem, general purpose of the study through the research objectives and questions. Further it outlines the significance of the study including its scope and limitations. Lastly, it provides both the theoretical and conceptual frameworks governing this study.

1.2 Background

The healthcare system in Zambia predominantly has used a paper-based system for providing Primary Health Care (PHC). The patient medical records are maintained at the respective health institution a client visits in various source documentation tools such as physical paper clinical records, registers, activity sheets and tally sheets in the provisioning of PHC services at Health Centres (HC), Health Posts (HP), Hospital Affiliated Health Centres (HAHC) and 1st Level Hospitals (Ministry of Health, 2008). These health institutions may be public, private or non-governmental organizations, managed by the District Health Offices. The data from the various source documentation at health centre level is thereafter manually aggregated, collated, analysed, presented, interpreted and used for decision making to aid in improving patient continuity of care and service delivery. There is transmission of the same information to higher levels of the health sector at district, provincial and finally national level in the Health Management Information System (HMIS) for higher decision making such as in disease surveillance, planning and accountability. In efforts to improve delivery of health care services, like many other countries around the world, Zambia through the Ministry of Health (MOH) has embraced the adoption and use of Information and Communication Technology (ICT) in the health sector by utilising Electronic Health Records (EHR) system. An EHR system records and stores a longitudinal electronic record of patient health information such as patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports while automating and streamlining the clinician's workflow (Healthcare Information and Management Systems, 2018). The EHR record is simply a computerised medical document generated and stored on a computer. This provides the ability to have a

complete record of a clinical patient encounter - as well as supporting other care-related activities directly or indirectly via interface - including evidence-based decision support, quality management, and outcomes reporting (Healthcare Information and Management Systems, 2018). There is overwhelming literature on the benefits on the adoption, implementing and use of EHR. Some of these are continuity of care, reducing the incidence of medical error, reducing duplication of tests, reducing delays in treatment, patients well informed to take better decisions, making health information available to health providers for diagnosis and the support of evidence-based decision support in disease surveillance at various levels within the health sector. With the support and collaboration of the Centre for Disease Control and Prevention (CDC), MOH developed a national Electronic Health Records (EHR) system named SmartCare (Ministry of Health Zambia, 2013). SmartCare is a fully integrated EHR system to provide continuity of care and a clinical management information system at the facility and district level which is the core to having a national integrated health system, that will improve patient care and data quality for decision-making and, therefore, is key in the monitoring and evaluation of the national health systems performance (Ministry of Health Zambia, 2013). This system is now mandatory for use as a PHC system at all health institutions countrywide providing antiretroviral (ARV) therapy. MOH with the support of CDC and in collaboration with other implementing partners in the health sector, have the mandate to ensure that the system wide deployment and implementation of the system done in all health centres providing ARV services. The current implementation strategies of the system are:

- Electronic Last (e-Last): this is where the health centre is running both the paper based system and the EHR system. The documentation of a client interactions are on paper documents such as registers and patient charts before entry electronically in the system. After the completing paper, documentation is there electronic entry, and in most cases, the client would have left.
- Electronic Fast (e-Fast): the entry of data occurs concurrently in both the paper system and electronically and all updates are complete in both systems before the client leaves the health centre.

- Electronic First (e-First): the capture of health care service is electronic, directly into the EHR system.

There is however, emphasis that all health centres in the country transition to a fully functional e-First SmartCare to reap the full benefits of EHR system. This will strengthen plans to make healthcare safe, effective, patient-centred, timely, efficient and equitable through the collecting and storing of health information about patients such as medical history, medication orders, vital signs, laboratory results, radiology reports, and provide up-to-date medical knowledge, reminders or other actions that aid health professionals in decision-making (Paolo Campanella, 2015). This will aid in the continuous healing relationship, customisation of service according to patient needs and values that patient are the source of control of shared data and free flow of information in a transparent, safe system that anticipates needs, continuous decrease of waste and cooperation among clinicians.

1.3 Statement of the Problem

Training of health clinicians in the use and operation of SmartCare system which is the national electronic health record system in and for provision of health related services is conducted within health institutions. To achieve the aims and benefits stated of an EHR system, there is a connection to having accurate, timely and easily available information, that will translate into the improvement in data quality, patient quality of care and decision-making. The use of the system has shown to have inconsistencies in data or data errors or “bad data” which include incomplete records, missing or inaccurate information. The reasons for this is not exactly clear or known. If this problem is not explored and solutions are not found, patient service and quality of delivery will continue to be affected.

1.4 Research Aim and Objectives

The purpose of this study is to develop a framework for SmartCare to Enhance EHR system improvement in data quality that will foster patient quality of care and decision-making.

- 1) To describe the types of errors that are prevalent in the health institutions.
- 2) To test the error/discrepancy theory to account for erroneous data such as incomplete records, and missing or inaccurate information in EHR system.
- 3) To develop strategies that could be used to reduce the error rate to 3%.

1.5 Research Questions

- 1) What are the types of errors that are prevalent in SmartCare?
- 2) Why are there erroneous data such as incomplete records and missing or inaccurate information in EHR system?
- 3) Given the incomplete records, and missing or inaccurate information profiles, how would EHR system data quality be improved to help in patient quality of care and decision-making?

1.6 Significance of the study

With EHR systems viewed as key in the improvement of data quality, patient quality of care and decision making, it is imperative that the implementation of this system does not suffer from errors that would erode its benefits. To determine, understand EHR errors and the associated adverse events, near misses, and patient harm that may result from problems with such systems or from interactions between EHR, its users, and the work system will be helpful in devising strategies that will address the root causes as well as ascertaining where future vulnerabilities lie. If these problems are not proactively addressed, patient quality of care is going to be affected as the adoption, implementation and use continues while the cost of having such system would continue to rise.

1.7 Scope and limitations

The study is a cross-sectional study that will focus on Paediatric Centre of Excellence and Adult Centre of Excellence at University Teaching Hospital in Lusaka, which are under the direct supervision of University Teaching Hospital – HIV AIDS Program (UTH-HAP). Since it is a cross-sectional study, it will have limited to extend to other health centres. This is because within the health sector there are other implementing partners managing the implementation of the EHR using a different approach within MOH guidelines.

1.8 Theoretical Framework

Diffusion of Innovations (DOI) research, while not specific to information technology, examines the social processes surrounding changes that occur in the introduction of an innovation. An innovation under DOI is a new idea, practice, or entity introduced into an organization (Rogers, 2003). The healthcare society is a complex social system that comprise individuals with varying backgrounds,

experiences, and values. It is important to understand how these social factors influence unintended consequences of errors in Electronic Health Record (EHR) system. The Technology Acceptance Model (TAM) emphasis is solely on factors that determine users' behavioural intentions toward using a new computer system or technology, specifically through perceived usefulness and perceived ease of use (Davis, 1989). This theory suggests that external variables, such as human and social factors, indirectly determine an individual's attitude toward technology acceptance by influencing perceived usefulness and perceived ease of use (Viswanath Venkatesh, Hillol Bala, 2008).

These models have had an extensive use in prior research with both frameworks having influential contribution to peoples' perception toward information system use.

Few studies show empirical evidence of unintended consequences such as having errors or the introduction of new errors that would affect data quality during and after implementation of EHR systems.

1.9 Conceptual Framework

Study theme: Factors attributing to errors in EHR system

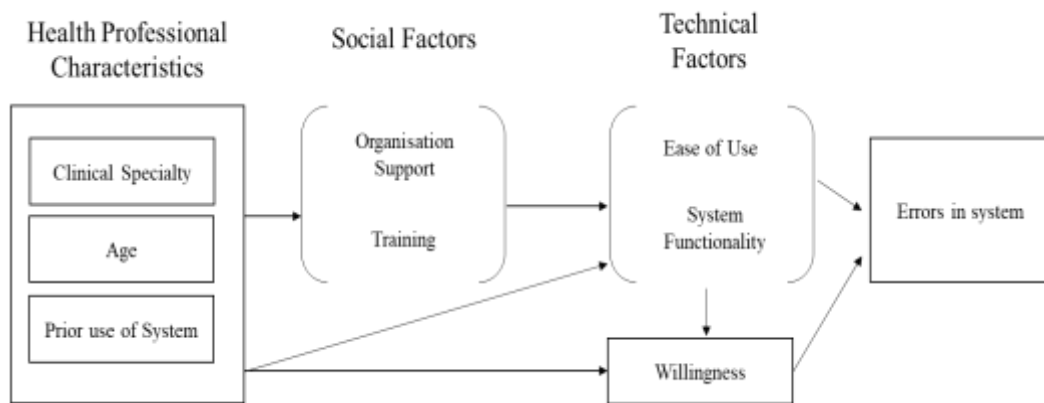


Figure 1: Conceptual framework showing attributing to errors in EHR system

The above framework aids the study in fully understanding the factors that attribute to errors in the EHR system (SmartCare). As health professionals are primary end users of the SmartCare system working in a complex working environment which is increasing its reliance on ICT technologies, factors that encompass social or human factors and technology will guide this study in determining likely influences leading

to the cause of errors in the large health care system. The background characteristics of users e.g. specialty, age, sex and employment status, social factors e.g. organisation support and trainings, technical factors e.g. ease of use and system functionality, and willingness are variables allied to the theories in DOI and TAM as independent variables and errors in the system is the dependant variable

As there is little know on the causes of errors in the EHR system, the above stated variables will be used in the study as they encompass both the technical and human social interactions in the work environment.

CHAPTER TWO - LITERATURE REVIEW

2.1 Introduction

This chapter presents information from various literatures that were reviewed concerning the subject at hand. A review of literature involves systematic identification, location and analysis of documents and materials containing information related to the research problem under investigation. In research studies, literature review is crucial as it shows a picture of the state of knowledge in the area of study. It enables the researcher to evaluate existing studies and identify limitations and gaps in knowledge, while further aiding the researcher in better defining the research problem.

2.2 The Need for Information and Communication Technology

Globally, all sectors are embracing Information and Communication Technologies (ICT) to enhance service delivery and increase competitiveness and efficiency. Health care is increasing its reliance on ICT or Health Information Technology (HIT) which encompasses Electronic Health Record (EHR) systems for better and efficient service delivery such as patient quality of care, decision making, information sharing and for improvement of training of health personnel and research in the health sector. Many countries, Zambia inclusive, are investing huge amounts in the development and implementation of EHR systems that will improve the general performance of public, private and faith based facilities in healthcare services to the society at increasing lower costs (Samuel Darko-Yawson and Gunnar Ellingsen , 2016). Electronic health records (EHRs) can formally be defined as a database or warehouse containing digital patient data which is stored in a secure manner, can be exchanged and is available to various authorised users (Hayrinen, 2008). Another definition of EHR is an individual's healthcare data of his entire lifetime, with the aim of continuity of care, supporting teaching and research and the sharing of this information with confidentiality and security ensured. These systems have the potential to make healthcare delivery safer by providing benefits such as timely access to accurate and complete patient information, advances in diagnosis and coordination of care, enhancements for monitoring patient vitals and patient empowerment (Fareed, 2013). There is consideration that EHR system are pivotal for the health sector advances in service delivery, research and eLearning. However,

there is growing evidence from the body of literature, which suggested that the introduction of EHRs, has led to the recording of a greater quantity of bad data, or inducing of errors instead of improving the quality of data being recorded (Ellingsen, 2016). Errors can arise for numerous reasons such as poorly designed systems, a poor fit of technology in practice and poor training. The concern is particularly significant in healthcare as bad data can lead to medical errors, medical malpractice, which can kill or cause long-term damage to the health of patients (P. Vimalachandran, 2016). Furthermore, even if the errors in data may have little potential for harm, cumulative consequences in the medicine are huge (David W. Bates, 2001).

2.3 Case Studies

While EHR benefits are emphasised, there are some case study researches that demonstrate or suggest the implementation and use of these systems introduce unintended consequences.

Singh et al (2013) conducted a study to determine the types of diagnostic errors in a primary health care setting. In 190 cases between October 1, 2006, and September 30, 2007, 68 unique diagnoses were missed with common conditions in primary care namely, pneumonia (6.7%), decompensated congestive heart failure (5.7%), acute renal failure (5.3%), cancer (primary) (5.3%), and urinary tract infection or pyelonephritis (4.8%) being most common. Patient- practitioner encounter breakdowns attributing from problems in history-taking (56.3%), examination (47.4%), and/or ordering diagnostic tests for further work-up (57.4%). Most errors were associated with potential for moderate-to-severe harm.

Further, there is a study by Watcher (2017) that cites a closed claims study by The Doctors Company, a medical liability insurer stating malpractice claims for errors caused, all or in part, by electronic health records have risen significantly. The claims closed by the company from January 2007 through June July 2014, 0.9% had EHR-related contributing factors while a further study from July 2014 through December 2016, 1.6% had EHR-related contributing factors. The contributing factors to the rise in the malpractice claims attribute to the system such as design (drop-down menus, templates), lack of integration of the system with the hospital, lack of alerts while on the user end are data entry errors, copy-and-paste errors and

alert fatigue. Although such claims represent the vast minority of malpractice claims, the damages generally associated with EHR-errors are significantly higher than many other malpractice claims (Haines, 2018).

2.4 Types of Errors in SmartCare

Patient harm attributing to failures in health care systems has only recently received great attention, largely attributed to the increasing costs of providing health services to the general population. For decades, human factors failures have been of great concern in other sectors such as aviation, engineering and nuclear power. The labelling of failures is errors and violations. A violation is an instance in which the actor consciously ignores rules or guidelines of correct behaviour for performing an action. There is no willing intention to cause harm by the actor but rather to achieve some competing priority or save time. Contrary to violations, an error is a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency (Reason, 1990). This definition gives rise to categorise errors into two main types, namely slips and mistakes. The increase in the adoption and use of EHR within the health sector is bringing change in the practice of medicine from the perspective of systems; hence, any shortcoming in the design, implementation and use of such a system has a huge consequences and risks of harm arising from errors on patient quality of care. Weiner et al. (2007) define the term “e-iatrogenesis” as “patient harm caused at least in part by the application of health information technology”. Sittig and Singh (2011) recognise the relationship of e-iatrogenic events in a comprehensive EHR enabled healthcare system that includes both “traditional” errors similar in nature to those that occurred during the paper-based medical record era as well as new kinds of errors with no exact analogue in the paper-based era. Consequently, there are various types of errors identified and related to EHR of heterogeneous in nature due to the integration of health care delivery and these can be categorised into four categories: diagnostic, treatment, preventive, and other. All the categories errors fall under medical error that is the preventing of adverse effect in care, which might result from erroneous or careless diagnosis or treatment of a disease, syndrome, injury, infection, behaviour, or other ailment. These unintended consequences also may increase fraud and abuse and can have serious legal implications.

2.5 Reasons for Erroneous

The broad grouping of data elements is structured and textual data. Structured data primarily consists of quantifiable numeric values and discrete elements made up of predefined categories such as in ICD-10. Textual data are narrative data and are the free text areas of the patient chart that may be difficult to analyse quantitatively due to the breadth of human expression, grammatical errors, the use of acronyms and abbreviations, and the potential for different interpretations of the same phrase depending on context.

2.5.1 Slips

Slips are errors that result from some failure in the execution and /or storage stage of an action sequence regardless of whether or not the plan, which guided them, was adequate to achieve its objective (Reason, 1990). The two main classes are:

- 1) Actioned-based is generally performing the wrong actions.
- 2) Memory-lapse is not performing the intended action or evaluating the results.

2.5.2 Mistakes

Mistakes are deficiencies or failures in the and/or inferential process involved in the selection of an objective or in the specification of the means to achieve it, irrespective of whether or not the action directed by this decision scheme run according to plan (Reason, 1990). The three main classes under here are:

- 1) Rule-based is deciding of following an erroneous course of action after previously correctly diagnosing the situation.
- 2) Knowledge-based is not correctly resolving the problem because of either erroneous or incomplete knowledge.
- 3) Memory-lapse is the forgetting of the steps or stages for procedures, processes, plans or evaluation.

There are many causes of errors. Though one can be lead to think that some of the most common ones in nature stem from the tasks and procedures that require people to behave in unnatural ways—staying alert for hours at a time, providing precise, accurate control specifications, all the while multitasking, doing several things at once, and subjected to multiple interfering activities (Norman, 2013). It is important

to note and one may argue that the attitude of people may be one of the most contributing factors towards errors.

2.6 Theories used in Smart care

This section covers theories used in SmartCare. They look at the adoption of technology, system or an innovation within an organisation and how individuals perceive this new system and other aspects that may influence the use of the system.

2.6.1 Actor-Network Theory (ANT)

Actor Network Theory, usually abbreviated as ANT, is a distinctive approach to social theory and research that originated in the field of science studies that seeks to conceptualise the relationship between technology and societies. The two leading science scholars of the theory are Michel Callon and Bruno Latour. The use of ICT in health care is on the assumption and projection that it will improve data quality, data quality management, patient safety, information flow and patient quality of care. Thus, the evaluation of complex IT systems in a health organisation like EHR in the delivery of healthcare services would benefit from ANT (Kathrin Cresswell, Allison Worth, Aziz Sheikh, 2010). This is because ANT is an extremely effective tool for analysing the processes by which inventions and technological systems such as EHRs come into being, or fail to materialize (Manya Ayub, Baa Jorn, Sahay Sundeep, 2015). In a health organisation, EHR is both an actor and a tool for establishing a network linking other actors. Therefore, the actors within a network consist of both human and non-human factors that are heterogeneous to the extent that the treatment is the same for both. It is heterogeneous, meaning that there is an open-ended array of things to align including work-routines, incentive structures, training, information systems modules and organizational roles (Monteiro, 2000). Hence, this theory is useful in helping to appreciate the complexity of reality (including the complexity of organizations) and the active role of technology in this context (Kathrin Cresswell, Allison Worth, Aziz Sheikh, 2010). The central idea of ANT is to investigate and theorise about how networks come into being, to trace what associations exist, how they move, how actors are enrolled into a network, how parts of a network form a whole network and how networks achieve temporary stability though, not how actors act independently (Kathrin Cresswell, Allison Worth, Aziz Sheikh, 2010). This is important when considering the fast-moving and

ever-changing area of healthcare itself, and particularly so in relation to government-led change initiatives and resulting changes in power relationships.

Key attributes of ANT

Actor: an actor in a network is depending or counting on one, and not ignorable in the network but relates to other actors because of the actor's role or influence (Law, 1987). Actors include both human beings and non-human actors (Walsham, 1997).

Inscription: refers to how technological artefacts or objects embody pattern of use (Monteiro, 2000). Inscription is the process of translating ones interest through embodying them into technical artefacts or the ability to translate, that is, re-interpret, represent or appropriate others' interests to one's own perspective from the other actors diverse set of interests. This provides the programming actions that defines the role or competencies of actors and the system. Monteiro (2000) argues that the interpretation of an artefact is always on the appropriate flexibility and strength of inscription in using it for anticipating or providing restrictions depending on the irreversibility of the actors in the network in the development and use of a technology.

Translation: this involves associating heterogeneous entities in an actor-world. It defines their identity, interests, a role to play, a course of action to follow, and projects to carry out (Callon, 1986). It involves reconciling the different meanings the actors hold of a given phenomenon through collaboration, compromise, and negotiation. The requirements, needs, interests, expectations and ways of perceiving a problem by the actors within a network may differ, thus there is need to build synergies between them as they interact with each other within the network to establish how the system will work, and ensuring the system is stable through its use. In the case of implementing an EHR, it is imperative to ascertain the interests of all the actors, and carefully manipulate the interests of others, in order to forestall any hindrances (Attah, 2017).

Callon (1986) States that there are four stages necessary in the translation process, which are problematization, interessement, enrolment and mobilization. Problematization, is when actors offer problem statements and seek to convince others that they have the correct solutions while interessement corresponds to the strengthening of the links between the interests of various actors (Arild Wæraas and

Jeppe Agger Nielsen, 2015). Enrolment refers to the participation of actors and their acceptance of their role in prioritizing a particular problematization while mobilization concerns with the maintenance of the network by ensuring that spokespersons act according to its interests (Arild Wæraas and Jeppe Agger Nielsen, 2015). This means that the occurrence of a successfully aligned network depends on how successful actors translate each other's interests.

2.6.2 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) theory is specific to model the behaviour of how users accept and use information systems or technology. It is an adaptation of Theory of Reasonable Action. The basis of the theory is on technology acceptance, centred on two behavioural premises, which are perceived usefulness (PU) and perceived ease of use (PEU) (Davis, 1989). Perceived usefulness is the factor that indicates the potential of the person belief that the information system will assist or improve actions in them performing their tasks or job. Perceived ease of use is the second factor, referring to potential degree persons believe using the target system will be effortless or will not be difficult to use. External variables are other factors that would influence the person use of a system. TAM theorises that a user's behaviour intention predicts actual system use therefore useful in predicting how acceptable a technology will be. TAM has evolved over time. TAM2 is an extension of the original model by Venkatesh and Davis (2000) seeking more detail explanation for reasons for users finding a particular system useful. Two-addition theoretical construct added to TAM perceived usefulness are cognitive instrumental processes and social influence processes. The perceived usefulness has four cognitive factors of influence that are job relevance, output quality, result demonstrability, and perceived ease of use. On the other hand, perceived usefulness has three social potencies; subjective norm, image, and voluntariness. These hypotheses are a link between the users' mental valuation of important goals of work and the consequences of performing job tasks using the system serving as a basis for forming perceptions regarding the usefulness of the system and its opportunity of adoptions or rejection. (Viswanath Venkatesh, Fred D. Davis, 2000). Venkatesh (2000) propose a theoretical framework that describes the determinants of system-specific perceived ease of use as persons evolve from the early stages of experience with the target system to stages of significant experience thus providing for

anchoring and adjustment in framing for human decision-making. The suggested anchors are computer self-efficacy, computer anxiety, computer playfulness, and perceptions of external control or facilitating conditions (Venkatesh, 2000). The first three anchors characterise differences in a person general belief in associating with computers and computer use such as personal ability to use a system and user motivation associated with using any new system. Perceptions of external control is in relation to persons' control of beliefs regarding the availability of organizational resources and support structure to facilitate the use of a system. While the is suggestion of anchors driving the initial judgements of perceived use of use, the persons' will continue to adjust these judgements as they have direct hands on use and experience with the new system. The two characteristics in relation to adjustment is perceived enjoyment and objective usability (Venkatesh, 2000). TAM 3 is the development through the combination of TAM2 and the model of the determinants of perceived ease of use as an integrated model (Viswanath Venkatesh, Hillol Bala, 2008). The authors of TAM3 where using four different types including the individual differences, system characteristics, social influence, and facilitating conditions which are determinants of perceived usefulness and perceived ease of use. TAM3 presents a complete nomological network of the determinants of individuals' IT adoption and use (Viswanath Venkatesh, Hillol Bala, 2008).

2.6.3 The Theory of Diffusion of Innovations (DOI)

One of the oldest social science theories is Diffusion of Innovation (DOI) Theory developed by Everett Rogers in 1962. While it may not be specific to information technology, DOI examines an innovation as communicated through certain channels over time among the members of a social system that seeks to explain how, why, and at what rate new ideas and technology spread through cultures. The definition of an innovation is "an idea, practice, or objective perceived as new by an individual, a group, an organization or other unit of adoption are spread (Rogers, 2003). He further goes on to state that newness of an innovation need not involve new knowledge, rather an innovation may have been known for some time by an entity but not yet developed a favourable or unfavourable attitude toward it, nor have adopted or rejected it. Rogers (2003) asserts that DOI occurs through a five-step (stage) process that are:

- i. Knowledge; the entity has their first exposure to the innovation but lacks the information pertaining to the innovation. There is generally no inspiration to acquire more information of the innovation.
- ii. Persuasion; there is interest on the part of the entity in the innovation and is actively seeking information.
- iii. Decision; the entity takes the concept of the innovation and weighs the advantages/disadvantages of using the innovation and decides whether to adopt or reject the innovation
- iv. Implementation; the entity employs the innovation to a varying degree depending on the situation while there is a continuation to determine the usefulness of the innovation through further search of information.
- v. Confirmation; the entity finalizes on the decision to continue using the innovation and may use the innovation to its fullest potential.

There is another set of five attributes important to the assessing of the diffusion potential of an innovation according to Rogers (2003) and these are:

- i. Relative advantage; is the innovation "better" than the idea it replaced.
- ii. Compatibility; is it consistent with existing values and needs of users.
- iii. Complexity; the level of difficult it has to understand and use.
- iv. Trialability; can you experiment with it.
- v. Observability; are results visible to others.

According to Ash et la (2007) adopting any innovation inescapably generates consequences; such consequences can be desirable or undesirable and anticipated or unanticipated. The unintended consequences are the least studied in an innovation diffusion process (Rogers, 2003). Rahimi et la (2009) asserts that undesirable, unintended, and unanticipated consequences consist of the adverse events or constraints previously seen may have consequences for the effectiveness and efficiency of the system. It is always hopeful to perceive consequences such as increasing effectiveness and efficiency will follow the introduction of an innovation.

2.7 Strategies Used to enhance system data quality

Generally, there are two strategies to reduce errors and enhance data quality of a system that are the Person-centred and the system-focused.

2.7.1 Person-Centred Approach

This has been the predominate approach adopted in many industries such as aviation and nuclear power. The underlying philosophy under the person-centred approach is that errors are caused by human weaknesses or uncharacteristic mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence, and recklessness. Hence, the perception or notion is that some humans are more prone to errors and procedural violations (Sara Garfield, Bryony Dean Franklin, 2016). The natural focus is associating countermeasures directed at reducing unwanted inconsistency in human behaviour (Reason, 2000). These approaches comprise poster campaigns that appeal to people's sense of fear, writing another procedure, disciplinary actions, holding them responsible, retraining, naming, blaming, and shaming before targeting them for any correction interventions.

2.7.2 System Approach

In contrast, the system-focused approach has the underlying philosophy that errors are caused by systems of which humans only form one part (Sara Garfield, Bryony Dean Franklin, 2016). It seeks to reduce errors by looking at a range of factors, including the organisation itself, its procedures, policies and environment. As such, systems models discourage the focus on individuals as the source or cause of errors. This provides a greater variety and opportunities of error prevention methods such as tasks that have a high risk of causing errors, the environmental condition in which the work being performed and the possibility of designing systems that are more error-tolerant. In clinical settings, this would include the use of incident reporting, or other methods, to identify errors and share lessons learnt, make changes to the system, and reduce the chances of errors occurring in the future (Sara Garfield, Bryony Dean Franklin, 2016).

2.8 Research designs used in Smart care

Clinical care today is complex, team based and reliant on technology that potentially give rise to increasingly complex and multifaceted errors in healthcare. New technologies continue to alter the nature of errors and asserts that these changes necessitate new models and methods for investigating technology-related errors. The frequency, potential harm and nature of errors relating to EHR involves great responsibility since the quality of care of each individual on the system and services offered. The model use in SmartCare are the following.

2.8.1 The James Reasons accidental model

The James Reasons accidental model or Swiss cheese model is a model adopted and adapted in healthcare to understand the nature of errors following its success use in other industries. It classifies factors contributing to the occurrence errors or cause of accidents into three domains namely organisation/system, local workplace and unsafe acts. This promotes a focus on the conditions or situation in which the person is trying to perform that may lead to the creation of an incident or error, hence moving the blame from human error to the environment or system and to randomness of actions rather than deliberate. This approach to error classification and analysis helps in the investigation by identifying the initial circumstances or starting point, the anticipated behaviour of the system and the abnormal events that led to system failures or human error (Malcolm Elliot, Karen Page and Linda Worrall-Cater, 2012). According to the model, the system has a sharp end that represents active failures and a blunt end representing latent failures (Sara Garfield, Bryony Dean Franklin, 2016). Active failures are unsafe acts classified into slips, lapses, mistakes and violations caused by front-line workers that not occur in isolation, but are a result of ‘error-producing conditions’ that arise at different levels within the system (Sara Garfield, Bryony Dean Franklin, 2016). Latent failures are decisions that set up an individual within the organisation for failure or fail to protect the individual from foreseeable errors or omissions (Malcolm Elliot, Karen Page and Linda Worrall-Cater, 2012). The attributing factors are decisions made by designers, builders, policy writers’ organisation culture, procedures and the environment that would influence the occurrence of active failures. The final part of the model is a system’s series of defences to prevent an adverse outcome. However, rather than being completely intact, each of these defences is seen as having holes in it giving rise to the name ‘the Swiss cheese model’ (Norman, 2013). These holes can arise because of active failures and latent conditions within the system. Even if one of these holes is penetrated, the next defence may block a potentially dangerous situation. However, a trajectory of ‘accident opportunity’ arises if the whole series of defences is penetrated (Sara Garfield, Bryony Dean Franklin, 2016).

The comprehensive interaction of technology, policies and procedures, internal and external environment, work system context and users within their workflow processes illustrates the complex relationships that may bring about active and latent

errors. Clinical professions work in a complex setting, with complex systems where standards and guidelines change quite frequently, hence the need to have a means to adapt to changes while reducing the occurrences ‘of situations likely to cause errors.

CHAPTER THREE - RESEARCH METHODOLOGY

3.1 Introduction

The chapter describes how the researcher went about selecting the sample size and frame, the research design and how data was collected in order to answer the research questions and thereby addressing the research problem. Research methodology is a systematic way to solve a problem by a researcher selecting procedures of how they are going to conduct their work of describing, explaining and predicting phenomena within the scope of a particular discipline (Rajasekar, Philominathan & Chinnathambi, 2013). A research design matrix is presented that outlines how each research question was approached, the logic and appropriate population, sampling data collection technique and the analysis of the data collected.

3.2 Study Design

This was a cross sectional case study that looked at developing a framework for SmartCare for enhancing Electronic Health Record (EHR) system in improving data quality that will foster patient quality of care and decision making through the curbing of unintended consequences through its use by health care professionals. Heale and Twycross (2018) describe a case study as an intensive, systematic investigation of a single individual, group, community or some other unit in which the researcher examines in-depth data relating to several variables. A case study is particularly appropriate since it provides an opportunity for one aspect of a problem to be investigated in-depth within a limited time scale. By implementing and training health care professionals in the use of EHR system, it is perceived not only that patient data will be stored in a central repository and contain all the patient history data, but that health providers will be able to capture complete patient data more safely, efficiently and effectively, thereby enhancing quality of data for decision making and improving patient quality of care. The research design matrix show that a mixed method approach was appropriate for this research. The research combined quantitative and qualitative methods to take advantage of the strengths’ each has and

overcome the weakness of each approach. The overall goal was to expand and strengthen the study's conclusions as it further contributes to building strategic frameworks that address problems and contribute to published literature.

3.3 Study Population

The study population were staff under direct supervision of University Teaching Hospital - HIV AIDS Program (UTH-HAP) in Lusaka, Zambia. UTH -HAP is selected as study site because it is of high-density and it serves as a referral hospital offering all antiretroviral services up to third line medication, hence SmartCare is in use in various departments. Health care professionals interact with the system as they offer medical service to the population, as clients might need to visit various service points or departments to receive a service as data entered directly and synchronized in the system and later on the patient card.

3.4 Inclusion Criteria

- Employees (health professionals) that are required to use SmartCare in service delivery and capture of data

3.5 Sampling

3.5.1 The Sampling Method

For this study, random sampling was used to enrol participants to take part in the study. The target population was approximate 60 employees selected from a list of workers required to use and operate with SmartCare within the organisation.

3.5.1 The Sample size determination

The following formula was used to calculate the sample size. Considering that the population size was small, for normal approximation, hypergeometric distribution was used.

$$n = Nz^2pq/(E^2(N-1) + z^2pq)$$

n = sample size.

N = the population size.

z = the level of confidence. In this case the confidence level was set at 95%, in which case z is set to 1.96.

pq = is the estimation of population proportions. In this study, 50% (0.5) was used as the actual proportion was not known.

E = accuracy of your sample proportions or a measure of precision, thus the margin of error. In this study, a precision of 5% (0.05) was tolerated.

Therefore, the estimated sample size was as follows:

$$n = 60(1.96)^2(0.5)(0.5) / (0.05)^2(60-1) + (1.96)^2(0.5)(0.5)$$

$$n = \underline{53}$$

3.7 Study Variables

Table 1: Study Variables

Variable	Operational Definition	Scale of Measurement
Dependant variable		
Errors	Errors in the system	Percent
Independent Variables		
Ease of use	The level of ease that a user perceives the system is to operate.	Nominal
Willingness	Willingness to accept and use the system	Nominal
Organisation Support	Organisation attributes such as work flow, user support, existing values and needs of users	Nominal
System functionality	The operations of the system meets work requirements and is available at all times	Nominal
Training	Trained in the use of the EHR system operations	Nominal

3.6 Data Collection Method and Techniques

The researcher used structured survey questionnaires to collect data from consenting participants. In order to guide the data collection, we took use of a TAM2 model and DOI model. Prior to the administering of the questionnaire, a pilot study was conducted using a sample of 7 health care professionals' who use SmartCare in order to check for the appropriateness and estimate the time duration it would take to administer. All questions not clear were revised. Further, a careful selection of

respondents' that participated in the questionnaire survey were selected to participate in a focus group discussion. Two focus group discussion's where conducted comprising of seven participants, a moderator and an observer / recorder to help in the deliberation of the discussion. Care was taken in the composition of each group to ensure members are able to participate freely and contribute in the discussion.

3.8 Pilot Study

A pilot study was conducted to test the measurement instrument (questionnaire) required to be completed by the voluntary participants in the study. This was to ensure that the questionnaire items accurately addressed the research questions and was comprehensive, appropriate, well defined while being presented in a consistent manner to be clearly understood. Further, the consent form was tested for comprehension. The survey questionnaire was divided into seven sections comprised that related to (a) user information; (b) knowledge of electronic health record (EHR) system and use (SmartCare); (c) EHR training; (d) ease of use; (e) perceived willing to use; (f) organisation support; and (g) system functionality with closed ended questions and rank questions using a 7 point Likert scale. Six participants were randomly selected and invited in the pilot study and all agreed. These subjects where from the population that is different from those to be recruited for the main study so as to avoid to influence the results of the main study in any way if the same subjects are to be included (Zailinawati Abu Hassan, Peter Schattner, Danielle Mazza, 2006).

3.9 Data Analysis

The data collected using these questionnaires was tabulated in keeping with the objective of the study. It was further analysed using univariate, bivariate, percentages, frequency, cross-tabulation techniques and nonparametric correlations. These were used to draw conclusions and establish relationships for the various variables. Nonparametric Correlations test was used to determine the association between categorical variables. Cross-tabulation to understand the association between different variables. The statistical significance in this study was set at 5% (0.05) and confidence interval at 95%. The study used SPSS version 23 for analysing quantitative data.

After collection and interpretation of the data, a focused group discussion was held to help get a deeper understanding of reasons that health care professionals are

facing in the use of the EHR system that may lead them to commit errors hence lead to unintended consequences to quality delivery of health care service and decision making. Thematic analysis approach used in analysing the data from the focused group discussion using Microsoft Excel 2016. A seven (7) step thematic process was followed by placing each successive analysis in a separate tab. The step was (1) transcribing the raw recorded data; (2) colour code data that is similar; (3) creating themes from the colour coded data; (4) compare moderator data; (5) final review one; 6) final review two; and 7) data overview and key points to obtain the main themes.

3.10 Ethical Consideration

Ethical approval for this research was obtained from Directorate of Research and Graduate Studies (DRGS). Permission was also sought from the University Teaching Hospital HIV-AIDS Program. Further approval was obtained through standard consent from participants and the participants were allowed to withdraw from the research study if the deem to be excluded. A detailed explanation about the objective (purpose) and benefit of the study was described to the study participants and their full cooperation, and written consent was taken. The study was of benefit to the participants in that it provided information that would be informative on what they know of SmartCare, and how its use has on the work in the local work area that may likely cause or lead to occurrence of errors in the system. This would help in formulating strategies and interventions that would mitigate these from occurring and improve the quality of data that would lead to better patient quality of care and decision making in health service. The study assured the respondents that no names will be attached to responses for confidentiality and that the information will be used strictly for academic purposes. Participants were interviewed separately and information submitted was treated with strict confidentiality except for the purpose of the study. Data presentation was made with no references to names of respondents.

Research Questions	Research Objectives	Population and Sampling	Data Collection Method	Data Analysis
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Table 2: Research Design Matrix

1) What are the types of errors that are prevalent in SmartCare? (Realist Ontology and inductive strategy)	1) To describe the types of errors that are prevalent in the health institutions.	Population of healthcare professionals in the health institution. (Random sampling)	Survey questionnaire	Univariate / analysis
2) Why are there erroneous data such as incomplete records, and missing or inaccurate information in EHR system? (Nominalist ontology and abductive strategy), (Realist ontology and abductive strategy)	2) To test the error/discrepancy theory to account for erroneous data such as incomplete records, and missing or inaccurate information in EHR system. 3) To understand from the point of view of health actors the occurrence of errors.	Population of healthcare professionals in the health institution.(Random sampling)	Survey questionnaire Key informant /FGDs	Univariate/ Bivariate analysis To develop analysis Qualitative content analysis
3) Given the incomplete records, and missing or inaccurate information profiles, how would EHR system data quality be improved to help in patient quality of care and decision making? (Pragmatist ontology and pragmatic logic)	4) To develop strategies that could be used to reduce the error rate to below 3%.	Population of healthcare professionals in the health institution. (Random sampling)	Interviews and focus group discussion	Qualitative thematic analysis

CHAPTER FOUR - RESULTS

4.1 Introduction

The purpose of this chapter is to present an analysis of the findings of the case study from consenting participants. The expected sample size of this study was 53 and all the 47 participants responded to the questionnaire yielding a response rate of 87 percent.

4.2 Quantitative Analysis

4.2.1 Description of the sample

The findings of the study are based on the analysis of responses from sampled patient data responses from consenting health professionals. At the time of the cross sectional study at the University Teaching Hospital - HIV AIDS Program (UTH_HAP) Paediatric Centre of Excellence in Lusaka, Zambia, there was an estimated 4,000 active patient files. From this estimate, 300 paper based files with their corresponding electronic health record version in the SmartCare where randomly sampled. There were 12 files (3%) that had incomplete data in a patient record, that is a file in the electronic system not found such as no information of patient history while 16 (5%) had missing data, that is a patient record has some data missing as entered file in the electronic version such as patient diagnosis notes. (See Figure 2).

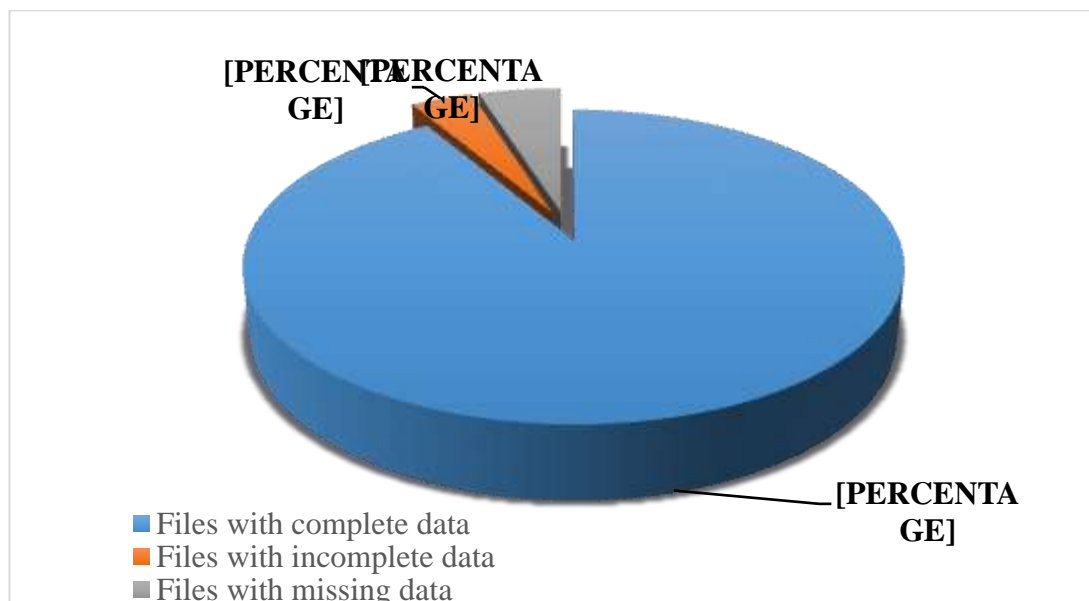


Figure 2: Description of Electronic Health Records

There were 54 questionnaires distributed with n = 46 (85%) participants who responded to the questionnaire, while n = 14 (23%) did not respond. This rate is acceptable according to (Fincham, 2008). The mean age was 40.78 and the youngest was 23 whereas the oldest was 67. It was observed that the majority of respondents' n = 19 (41%) were nurses and most of the respondents' n = 15 (33%) in the study fall in the age group 30 – 39. Regarding working experience with SmartCare in the work environment, n = 15 (33%) started using it within the last 6 months while the rest n = 31(67%) range for its use between within 12 months to less than 10 years at the time of the study. The number of times that respondents' were trained in the use and operation of SmartCare system showed n = 39 (85%) attended a training once while the remaining n = 7 (15%) had a training more than once. In respect to when each respondent had attended a training, n = 19 (41%) were trained at least 6 months ago, n = 17 (37%) were trained more than 3 years ago, with the rest n = 10 (22%) had a training between more than 6 months and 3 years (see Table 3).

Table 3: User Information (Demographic Information)

Demographic Factor	Frequency	
Job title	Doctor	4
	Nurse	19
	Counsellor	6
	Pharmacist	3
	Laboratory Technician	4
	Clerical Clerk	10
Working with SmartCare	Less than 6 months	15
	Less than 12 months	9
	Less than 3 years	8
	Less than 5 years	9
	Less than 10 years	5
Times trained in SmartCare	Once	39
	Twice	3
	Three	1
	Five	2
	Seven	1
When last trained	6 months ago	19
	12 months ago	3
	18 months ago	2
	24 months ago	5

4.2.2 Level of Training

An analysis of training in the use of SmartCare system was done. It is evident that from the table below, that the respondents' $n = 39$ (85%) who attended and where trained felt they were fully trained, while 10 felt they were not fully trained, 9 of whom responded that they were partially trained and 1 was poorly trained (See Table 4).

Table 4: Level of training in SmartCare

Level of Training	Trained fully	Partially trained	Poorly trained
Male	11	1	0
Female	27	6	1
Total	39	6	1

4.2.3 Ease of Use

An analysis of the state of ease of use of SmartCare system was done. It is evident that from the table 5 below, that only $n = 7$ (15%) of the respondents find the system ease to use while $n = 39$ (85%) do not find it easy to use of which 34 respondents say it is fairly easy to use and 5 find it challenging to use.

Table 5: Ease of Use

Ease of Use	Ease to use	Fairly easy to use	Challenging to use
Male	2	9	1
Female	5	25	4
Total	7	34	5

4.2.4 System Functionality

An analysis of the state of the functionality of SmartCare system was done. It is evident that from the table 6 below, the system does not function optimally. The system only meets $n = 20$ (43%) of the respondents' noted that the system functions highly functional as compared to $n = 26$ (57%) who fall outside the optimal range and said $n = 22$ the system is moderate in its functions and $n = 4$ the system does not function well nor is it reliable.

Table 6: System Functionality

System Functionality	Highly	Moderate	Low
Male	4	7	1
Female	16	15	3
Total	20	22	4

4.2.5 Perceived Willingness to Use

An analysis of to determine the respondents' perceived willingness to use Smartcae system was done. Table 7 below shows that of all the respondents, n = 36 (78%) are non-willing in the use of the system while n = 10 (32%) is through their willingness to use it. There is no significant difference in the mean between the males and females with the mean for males slightly lower at is 15.25 and females is 15.71(See Figure 3).

Table 7: Perceived Willingness to Use

Perceived Willingness to Use	Willingness	Non Willingness
Male	3	9
Female	7	27
Total	10	36

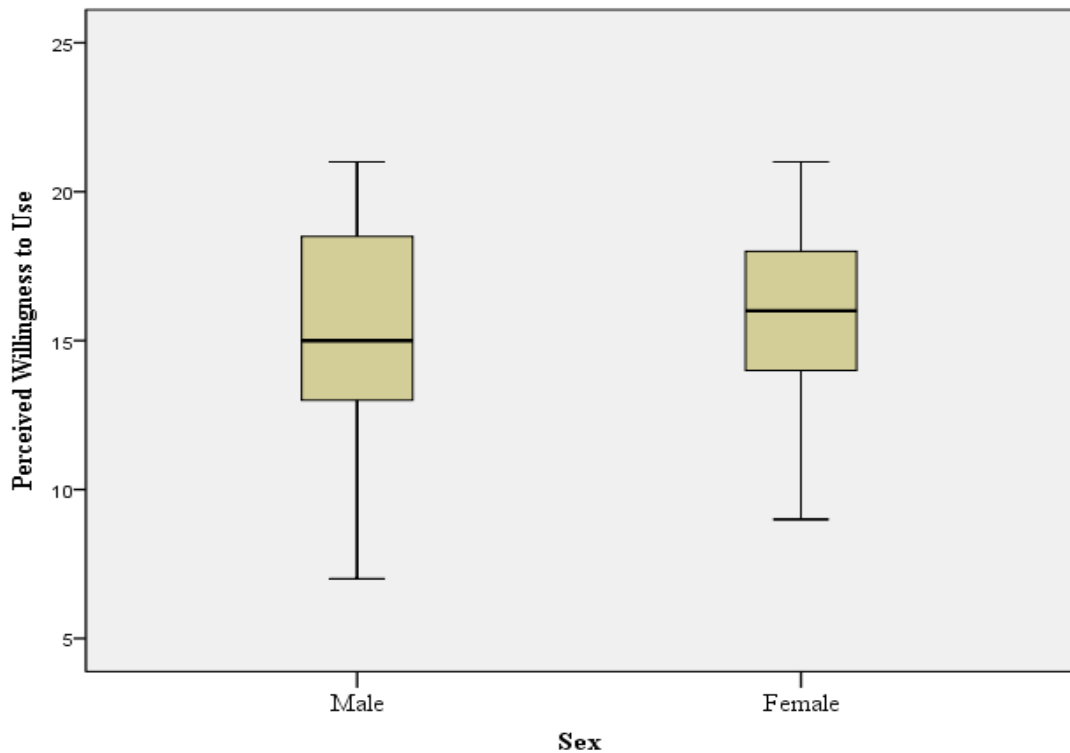


Figure 3: Perceived Willingness to Use

4.2.6 Organisations Support

There was a high response from the participants in the survey in regard of receiving organisation support with the use of SmartCare system. Table 8 shows n = 32 (70%) of getting high support while n = 14 (30%) of which 10 state receiving moderate support and 4 low support.

Table 8: Organisation Support

Organisation Support	High Support	Moderate Support	Low Support
Male	7	4	1
Female	25	6	3
Total	32	10	4

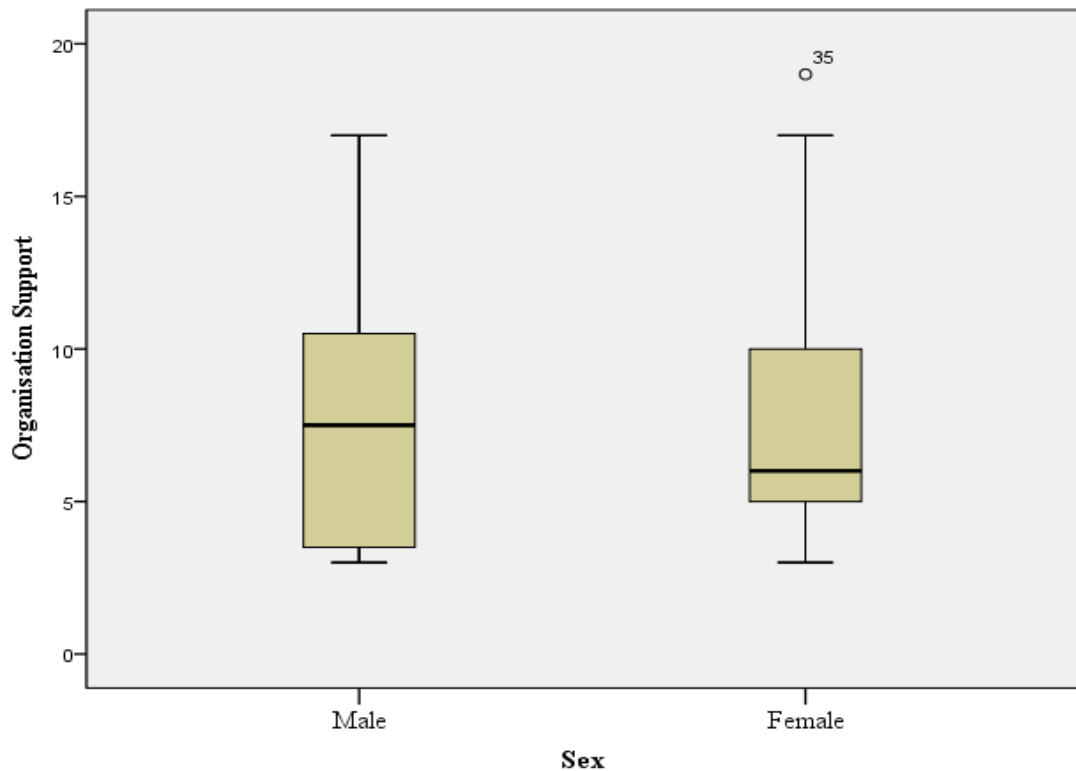


Figure 4: Organisation Support

4.2.7 Association of Perceived Willingness to Use and Organisation Support using Spearman’s correlation

The significant Spearman’s correlation coefficient calculation was done on two variables namely perceived willingness to use and organisation support with a value of -0.370 (See Table 9). At the level of significance value (α) 0.05, the computed p-value is 0.011 which is lower than the alpha value. From these output, we say there is some evidence to believe that perceived willingness to use and organisation support values are correlated with a weak negative monotonic association.

Table 9: Association of Perceived Willingness to Use and Organisation Support

Nonparametric Correlations				
			Perceived Willingness to Use	Organisation Support
Spearman's rho	Perceived Willingness to Use	Correlation Coefficient	1	-.370[*]
		Sig. (2-tailed)	.	0.011
		N	46	46

	Organisation Support	Correlation Coefficient	-.370[*]	1
		Sig. (2-tailed)	0.011	.
		N	46	46
*. Correlation is significant at the 0.05 level (2-tailed).				

4.3 Qualitative Analysis

They were two focus group discussion conducted by inviting respondents who participated in the initial questionnaire survey. Each discussion consisted of 7 respondents. The finding from the analysis of the data revealed two themes outlined below.

4.3.1 Theme: System Usability

Some of the concerns of the health professions is the slow response of the EHR system while they attend to a client to enter data on system at certain times and searching for a client. One of the experiences of a health professional was during counselling a client and to enrol them in the system so as to be able to access treatment services. The logged on provider would click on the option to enrol a new client, though the system would not bring up the requested page immediate, but take time as it processes the request, and this may vary from several seconds to minutes. Depending on the prevailing circumstances such as queue of clients waiting to be served or the client needing to go for other services, leads to the provider to capture details on paper that would be used to enter on the system at a much later convenient time. Another experience that the providers faced was at certain times the inability or failure to search for an existing client using the clients' unique patient ID on the system as they can access continued treatment care on their appointment date or any other day. This means searching for a client using the given names, which may present a challenge if their multiple clients sharing the same names appear. This means that more information required from the client such as date of birth, to help ascertain and select the right client on the system, and if no helpful information is able to be provided due to such circumstances' as a guardian who's not familiar with a child details, there is a risk of the provider selecting the wrong client, hence all treatment details may be recorded on a different patient than the one seeking the service on that particular day and time.

Key Points

- Slow response of the EHR system
- System failing to search by unique patient ID

4.3.2 Theme: Organisation Communication

The health professionals placed importance on having ready information regarding the functionality of the system such as common problems inherent in the current operation of the EHR system and the scheduled implementation of upgrades and maintenance with the necessary changes that these effect. One of the instance described was when a maintenance upgrade was done on of the system and some of the health professionals had not been informed of this. As the providers where trying to enrol new clients, assigning the clients the usual unique client ID which is partly composed of the health centre code, the system would not save the details and the record. This escalated to a lot of calls to the technical IT support to help resolve this issue. This cause much of delay in carrying out their work and affected health service delivery. It was later discovered and information given that the recent upgrade had change the health centre code and hence was the cause of the failure to enrol and save data for the clients. At a different time, the health professionals where aware of an upgrade on the EHR system. However, there was no information made available on what improvements or unintended consequences the EHR system maintenance would introduce for the users. The provider discovered as they used the latest version that data for most of the existing clients was not showing basic information such as residence, treatment start date, treatment support among other details. This was a great concern as it meant that there was a possibility to affect reporting on services that are offered at the health institution such as how many clients are receiving a particular type of treatment

Key Points

- Lack or late communication with regards of to EHR system upgrade or improvements
- No ready information of common problems with the system

The results from the analysis of the data collected from the willing participants shows that even though health professions felt they are well trained in SmartCare,

the system offers moderate to high functionality amid high organisation support do not find the system ease to use or have of their own desire to use them system. Further, suggestions are that they do not have reasons as to causes that lead to the system being slow in response while in use and failures of certain functionality such as patient search. This compounds the issue in that there is lack of proper communication with regard to the EHR system evolution and known list of problems.

CHAPTER FIVE - DISCUSSION OF RESULTS

5.1 Introduction

This chapter presents a discussion of the key findings of this study. It involves an interpretation of the study findings through explanation using the two theories used in the study which are the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI).

5.2 Discussion

The findings reveal that even in the situation where 85 % of health professionals were fully trained as shown in table 4, the users do not find it easy to use SmartCare nor highly functional that meets their ideal way of performing the tasks as show under tables 5 and 6 respectively. Through Further discussion with health professionals, they felt that the system in its current state of use presented challenges as ascribed under the theme system usability section 4.3.1 such as component failures like client search and slow system response together with poor communication surrounding scheduled upgrades and current shortcomings of the system. These factors contribute and able to provide an explanation for the low perceived willingness to use the EHR system of 10% as show in table 7. Perceived willingness to use is the reluctance to use new information technology or is the rate of adoption, or the relative speed with which members of a social system adopt an innovation, compared with other individuals within that social system (Rogers, 2003). Within this study, the variables influencing willingness to use are ease of use allied to perceived ease of use (TAM), system functionality to complexity (DOI) and system usability to relative advantage (DOI).

Organisation support is aligned to compatibility (DOI), of which 70% of users stated that they required and received high organisational support as shown under table 8. Compatibility is the level of an individual's perception of new innovation to be consistent with the socio-cultural values, practices, previous ideas or perceived needs within the social target group or environment. Since SmartCare is mandatory, the organisation is spending significant resources on health professionals to adopt and use the system, such as have higher management to champion use of the EHR system, operation support from supervisors and technical support and trainings while there is little consideration of the values among the users leading to the negative perception and behaviour rather than to maintain their jobs.

Shown in table 9, there is a significant inverse association between perceived willingness to use and organisational support within the organisation health setting, giving rise that these two dimension have a strong influence towards the entry of errors or its prevention.

The aim of the study is to develop a strategic framework that will enhance EHR system improvement in data quality that will foster patient quality of care and decision-making by reducing unintended consequences that are caused by the user of the system. Figure 5 below illustrates the proposed framework.

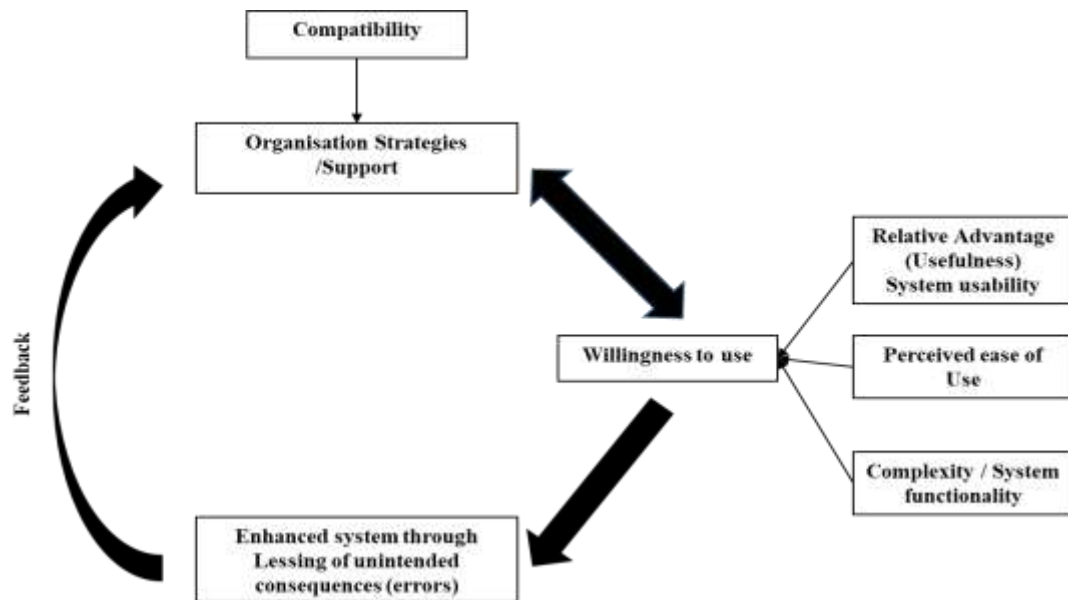


Figure 5: Framework for enhancing EHR system (adapted from TAM and DOI)

The framework is modelled based on two theories which are TAM and DOI. This is by getting perceived ease of use (TAM), relative advantage (DOI), and complexity(DOI) as to the key factors influencing individual willingness to use. Compatibility (DOI) is the strategy within the organisation that must be used to get buy in from the intended users. The organisation is made of people, principles, culture and systems constituting shared values, attributes, trust, transparency and leadership among members working towards the purposed vision and objectives. More importantly, SmartCare is the EHR system with a vital role in health. It is prudent to have conceived strategies promoting its continual use, fitness to the values, vision and objectives of the organisation, users and patient that creates confidence in better delivering health services by promotes easier, faster comprehensive and concise decision making. The strategies will discourse relative advantage, ease of use, complexity contributing to the willingness to use by the health professionals, system documentation and the system operating values which are used to curb unintended consequences such as errors there by improving data quality that will translate to better quality of care and decision making.

5.3 Limitations of the study

This study was based on a cross-sectional case study design and the findings are limited to the selected health institution that was involved, therefore, they cannot be generalised to other health institutions' that are implementing or have implemented the EHR system through the support of various Ministry of Health (MOH) partners linked to the various health centres which are providing the Technical Assistance (TA) support.

5.4 Conclusion

The main objective of the study was to develop a strategic framework that will enhance EHR system improvement in data quality that will foster patient quality of care and decision-making. The study shows that most health professions use the EHR system non willingly or because it is a required of them. The other factors that include ease of use, system usability and system functionality contribute to an individual's willingness to use a system, therefore, it is important that efforts are made to win over these users. Further, organisation support must be channelled in a positive manner as it is always present in the organisation to drive strategies that win over users to adopt the EHR system as the system evolves.

5.5 Recommendations

- i. It may be important to redesign the implementation of the EHR system. Since organisation support is high, it would be essential to devise strategies using this strength to build willingness to use among healthcare professionals.
- ii. A good channel of communication will ensure all parties are kept informed at the right time with the correct information to mitigate unintended consequences and erode the much benefits EHR systems promise.
- iii. Training should not simply just a matter of conveying information to or acquiring technical competency on an EHR system for its users but should leverage their understanding of how clinical practice and the system interact each other to better deliver health services thereby creating a positive influence.
- iv. Providing processes and procedures to facilitate data entry after a system has been down. These can be extended to how to integrate new users joining the work force.

5.6 Area for Further Research

With EHR systems here to stay, it is prudent to study behaviour change among health professions towards system changes in the work environment as the system evolves and the level to which health professions role changes. Further, EHR systems are treated as a separate entity and glorifying the benefits of its use without significant consideration of the impacts on criteria of measuring quality of data, rate of response to health care guideline changes, and general health profession ownership and responsibility. It would be imperative to study all these variables influence in the health institution and how it affect the provision of quality health care provision.

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APPENDCIES

Appendix I: Consent Form and Information sheet



THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

**HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS
COMMITTEE**

Telephone: +260-211-290258/293937

P. O. Box 32379

Fax: +260-211-290258/293937

Lusaka, Zambia

E-mail drgs@unza.zm

**HUMANITIES AND SOCIAL SCIENCES RESEARCH ETHICS
COMMITTEE**

CONSENT FORM

(Translated into vernacular if necessary)

TITLE OF RESEARCH: Strategies to Enhance Electronic Health Record (EHR) improvement in data quality help in patient quality of care and decision-making: A Case Study of SmartCare.

Informed Consent Form for Clinical Health Workers

You are invited to take part in a research study of strategies to enhance electronic

health record (EHR) improvement in data quality help in patient quality of care and decision-making: a case study of SmartCare. This consent form is tailored for clinical health workers working in a Health Centre that is providing antiretroviral services and required to use SmartCare. These are doctors, nurses, counselors, laboratory technicians, pharmacists and registry clerks.

[Name of Principle Investigator] Dale Nchimweta Chizoma

**[Name of Organization] University Teaching Hospital – HIV AIDS Program
(UTH-HAP) Paediatric Center of Excellence**

[Name of Sponsor] Dale Nchimweta Chizoma

[Name of Project and Version]

This Informed Consent Form has two parts:

- **Information Sheet (to share information about the study with you)**
- **Certificate of Consent (for signatures if you choose to participate)**

You will be given a copy of the full Informed Consent Form

Part I: Information Sheet

I am Dale Nchimweta Chizoma, a student at the University of Zambia under the Graduate School of Business. I am kindly inviting you to participate in a study on strategies to enhance Electronic Health Record (EHR) improvement in data quality help in patient quality of care and decision-making: A Case Study of SmartCare. The information being collected may be used to help develop strategies for to Enhance EHR system improvement such as SmartCare in data quality help in patient quality of care and decision-making. Before you decide whether or not you will take part in this study, detailed explanation of the purpose and benefits will be explained to you.

Purpose of the research

With the introduction of computers and electronic record systems (SmartCare) in the health industry, particularly where HIV/AIDS services are offered, we would like to find out likely causes that may lead to occurrence of errors in the system. We believe that you will help us in telling us what you know about SmartCare and how its use

has on the work practices in the local work area. This will help in developing strategies and interventions that will mitigate these from occurring and improve the quality of data that would lead to better patient quality of care and decision making in health service.

Type of Research Intervention

The research will involve your participation in answering a questionnaire that will take 20 – 30 minutes. You may be selected later to participate in a focus group discussion that will take about one hour.

Participant Selection

You are invited to participate in the research study as you may be required to work with SmartCare for performing all your work tasks. We feel you will be able to provide a valuable contribution on your experience and understanding in working with this system.

Voluntary Participation

Your participation in this study is voluntary. If you agree to take part in this study, you may withdraw at any time without consequences of any kind.

Procedures

If you agree to be in this study, you will be asked to take a self-administered survey questionnaire that you may read on your own or the principal investigator would read it aloud and you provide the responses. Further, an invitation may be extended to some participants in the research study for focus group discussion.

Survey Questionnaire

The survey questionnaire is going to be distributed and collected by Dale Nchimweta Chizoma. You may answer the questionnaire yourself, or it can be read to you and you can say out loud the answer you want me to write down. If you do not wish to answer any of the questions included in the survey questionnaire, you may skip them and move on to the next question. Your response to the survey questionnaire will be treated with the highest confidentiality and only an identification number on the form will be used to identify you in the research.

Focused Group Discussions

The focused group discussions will be limited to 5 – 6 persons and will be guided by the principle investigator, Dale Nchimweta Chizoma. The investigator will guide the group to ensure that all are comfortable and freely able to contribute in the discussion. The discussion will be conducted in a secure premise, and all participants will be required to commit to maintain the highest level of privacy and confidentiality.

Duration

Include a statement about the time commitments of the research for the participant including both the duration of the research and follow-up, if relevant.

The research will take place over a period of 60 days / two months in total. During that time, will have three focused group discussions, with two of the discussions occurring in the first month, while the third discussion will be in the last month of the research. The focused group discussion will take one hour to one and a half hours.

Risks

There is no direct risk to the participant in this research. However, there is a risk that you may share some personal information by chance, or that you may feel uncomfortable talking about your experience with the use of SmartCare, though we do not wish for this to happen. You do not need to answer any question or take part in the discussion/interview/survey if you feel the question(s) make you uncomfortable.

Benefits

There will be no direct benefit to you, but your participation is likely to help in developing strategies that would lead to stakeholders in considering and making decisions that would be of benefit in enhancing the use of electronic health records such as SmartCare.

Reimbursements

You will not receive any payment for your participation in this research.

Confidentiality

All the information you provide will be strictly confidential. The information will not be shared with anyone outside the group of the research team. Any information about you will have a number on it instead of name that will be known only by the interviewer. The Directorate of Research and Graduate Studies, Humanities and Social Sciences Research Ethics Committee may review your records under this study under strict confidentiality.

We will ask you and others in the group not to talk to people outside the group about the discussion in the group. Each individual or participant in the focus group will be asked to keep all matters discussed in the group confidential. You should know, however, that we cannot stop or prevent participants who were in the group from sharing things that should be confidential.

Sharing the Results

All the information you provide will be strictly confidential, nothing that you tell us today will be shared with anybody outside the research team, and nothing will be attributed to you by name and your name.

Right to Refuse or Withdraw

You do not have to take part in this research if you do not wish to do so, and choosing to participate will not affect your job or job-related evaluations in any way. You may stop participating in the [discussion/interview/questionnaire] at any time that you wish without your job being affected.

Who to Contact

1. Mr. Dale Nchimweta Chizoma
Postal Box CA20
Castle Post Office
LUSAKA
Mobile line 0977 966096. Email: g4dale@gmail.com

2. Dr. Jason Mwanza
The Chairperson, Humanities and Social Sciences Research Ethics
Committee
University of Zambia
P. O. Box 32379
LUSAKA
Mobile Number: 0977-945790. Email: Jason.mwanza@unza.zm

3. Dr. Henry M. Sichingabula
Director, Directorate of Research and Graduate Studies
University of Zambia
P. O. Box 32379
LUSAKA
Mobile Number: 0977-945790. Email: drgs@unza.zm

This proposal has been reviewed and approved by HSSREC, which is a committee whose task it is to make sure that research participants are protected from harm. If you wish to find about more about the IRB, contact

Dr. Jason Mwanza
The Chairperson, Humanities and Social Sciences Research Ethics
Committee
University of Zambia
P. O. Box 32379
LUSAKA
Mobile Number: 0977-945790. Email: Jason.mwanza@unza.zm

Do you know that you do not have to take part in this study if you do not wish to? You can say No if you wish to? Do you know that you can ask me questions later, if you wish to? Do you know that I have given the contact details of the person who can give you more information about the study? Etc.

Part II: Certificate of Consent

I have been invited to participate in the research about strategies to enhance electronic health record (EHR) improvement in data quality help in patient quality of care and decision-making: A Case Study of SmartCare.

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study

Print Name of Participant_____

Signature of Participant _____

Date _____

Day/month/year

*If illiterate*¹

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____

Thumb print of participant

Signature of witness _____



Date _____

Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands

¹ A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team). Participants who are illiterate should include their thumb print as well.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this ICF has been provided to the participant.

Print Name of Researcher/person taking the consent (Dale Nchimweta Chizoma)

Signature of Researcher /person taking the consent_____

Date _____

Day/month/year

Appendix II: Questionnaire One

QUESTIONNAIRE ONE

USER INFORMATION (DEMOGRAPHIC INFORMATION)

1. What is your current job title? (Please, check one)

1) Doctor

2) Nurse

3) Counsellor

4) Pharmacist

5) Lab Technician

6) Clerk

2. What is your sex? (Please, check one)

1) Male

2) Female

3. Age at last birthday

4. In this section, indicate your employment status in this place where I have found you. (Please, check one)

1) Full-time

2) Part-time

5. How many years of work experience do you have in using SmartCare? (Please, check one)

- 1) < 6 months 2) <12 months 3) < 3 years 4) < 5years 5) < 10 years

KNOWLEDGE OF ELECTRONIC HEALTH

SYSTEM AND USE (SMARTCARE)

5. How many times have you attended SmartCare

training?

6. The last training you attended was.

- 1) 6 months ago 2) 12 months ago 3) 18 months ago 4) 24 months ago 5) over 36 months ago

EHR TRAINING

7. For each of the questions below, circle the response that best characterises how you feel about the statement, where 1 = Strongly agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree nor disagree, 5 = Somewhat disagree, 6 = Disagree, and 7 = Strongly disagree.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The training in the use and operating the SmartCare system was adequate	1	2	3	4	5	6	7
The training methods used made it easy to learn in using the system	1	2	3	4	5	6	7
Adequate resources were available when learning to use the system (e.g. participant manual, computer, tablet)	1	2	3	4	5	6	7
There is need for a repetition of training in SmartCare	1	2	3	4	5	6	7

EASE OF USE

8. For each of the questions below, circle the response that best characterises how you feel about the statement, where 1 = Strongly agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree nor disagree, 5 = Somewhat disagree, 6 = Disagree, and 7 = Strongly disagree.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
My interaction with SmartCare system is clear and understandable and as such, I do not make errors	1	2	3	4	5	6	7
SmartCare design and features makes it easy to navigate and use and as such, I do not make errors	1	2	3	4	5	6	7
It is easy for me to remember how to perform tasks using SmartCare and as such, I do not make errors	1	2	3	4	5	6	7
The sequence to follow in SmartCare to do my work is too long and can lead to errors	1	2	3	4	5	6	7
Interacting with SmartCare system does not require a lot of my mental effort and as such, I do not make errors	1	2	3	4	5	6	7

The arrangement of fields (text boxes, combo boxes, dropdown list) in the system are not in a logical sequence to do my work and can lead to errors

1 2 3 4 5 6 7

There are too many steps to remember and follow in executing a task in the system and can lead to errors

1 2 3 4 5 6 7

My workstation is very busy and this may lead me to not complete entries in the system and can lead to errors

1 2 3 4 5 6 7

PERCIEVED WILLINGNESS TO USE

9. For each of the questions below, circle the response that best characterises how you feel about the statement, where 1 = Strongly agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree nor disagree, 5 = Somewhat disagree, 6 = Disagree, and 7 = Strongly disagree.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The use of SmartCare system is expected of me from my superiors or supervisors, and as such, I am likely to make errors.	1	2	3	4	5	6	7
My use of SmartCare system is of my own liking and as such, I am likely to make errors.	1	2	3	4	5	6	7
My supervisor or superior and wants at all times that I use the SmartCare system, and as such I am likely to make errors	1	2	3	4	5	6	7

ORGANISATION SUPPORT

10. For each of the questions below, circle the response that best characterises how you feel about the statement, where 1 = Strongly agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree nor disagree, 5 = Somewhat disagree, 6 = Disagree, and 7 = Strongly disagree.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
Managers/supervisors support me in the use of the SmartCare system and as such, I do not make errors easily	1	2	3	4	5	6	7
I get support from other important people to me within the organisation that support the use of SmartCare system and as such, I do not make errors easily	1	2	3	4	5	6	7
If I have a problem with the system I easily get help and as such, I do not make errors easily	1	2	3	4	5	6	7

SYSTEM FUNCTIONALITY

11. For each of the questions below, circle the response that best characterises how you feel about the statement, where 1 = Strongly agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree nor disagree, 5 = Somewhat disagree, 6 = Disagree, and 7 = Strongly disagree.

	Strongly agree	Agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Disagree	Strongly disagree
The SmartCare system has all the necessary data fields (text boxes, dropdown list, combo boxes) for entry and this prevents me from making errors easily	1	2	3	4	5	6	7
The SmartCare system has an easy to follow process for performing work and this prevents me from making errors easily.	1	2	3	4	5	6	7
The SmartCare system provides an easy procedure to edit and/or make corrections to data entries and this prevents me from making errors easily	1	2	3	4	5	6	7
The SmartCare system presents entry options for a service in a clear and ease manner and this prevents me from making errors easily.	1	2	3	4	5	6	7

The SmartCare system is rarely down due to network outage during operating hours and this prevents me from making errors easily

1 2 3 4 5 6 7

The SmartCare system is rarely down due to system crashing during operating hours (for example, a system crash is the abruptly closing while you operating with it) and this prevents me from making errors easily.

1 2 3 4 5 6 7

The SmartCare system is rarely down due to system freezing during operating hours (A system freeze is when the system is open and running but you failing to use it) and this prevents me from making errors easily.

1 2 3 4 5 6 7

Appendix III: Questionnaire Two

QUESTIONNAIRE TWO

1. What are key issues with the current deployment of the electronic health record (SmartCare) in the practice setting that are likely to lead you to cause errors while using the system?
2. What hindrance if any has the EHR system have on your work that is likely to make you cause errors while using the system.