INVESTIGATING THE IMPLEMENTATION OF SMARTCARE ELECTRONIC HEALTH RECORD SYSTEM PROJECT IN ZAMBIA USING TENETS OF PROJECT MANAGEMENT.

By

Katayi Francis Pande

A dissertation submitted to the University of Zambia in partial fulfilment of the requirements for the Degree of Master of Engineering in Project Management

THE UNIVERSITY OF ZAMBIA

LUSAKA

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DECLARATION

I, **Katayi Francis Pande**, hereby declare that works presented in this study for the Master of Engineering in Project Management has not been presented whether wholly or in part for any other study programme and is not being submitted for any other Master's programme. The result is entirely the results of my own independent investigation. The various resources to which I am indebted have been acknowledged.

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ABSTRACT

Health Information Systems (HIS) are an integral part of a functioning health system. The SmartCare Electronic Health Record system is one such HIS implemented in Zambia. However, studies done on SmartCare HIS are limited when it comes to the success of the project from the developer's view using project management principles. There is inadequate evidence establishing the success of elements and characteristics of the SmartCare project. This study was conducted to determine how effective the system has been run from the system development perspective using project management principles in Zambia.

A mixed method approach was used for data collection. Data collection included in-depth interviews for the qualitative arm, questionnaires for the quantitative arm, and a review of the literature available on the subject matter. Sample size comprised of 102 SmartCare system users from Lusaka province, which consisted of all Assistant Monitoring and Evaluation Officers from Lusaka district, and purposive sampling was used to select Data Associates, Data Coordinators and Technical Officers within the province. Data was analyzed using thematic analysis approach and Stata software.

According to the study, while the implementation was successful, it was evident by half the users that the performance of SmartCare system was sufficient and met minimum requirements. Furthermore, 44 percent indicated that the functionality of the system was below the required standard. Additionally, 64 percent of users revealed that the system challenges and constraints limited the system efficiency and sustainability. However, it was evident by 80 percent of users that the system Critical Success Factors are critical to its success. It was further established that only eight SmartCare components were compliant with the global standards of HIS.

The results of this study show that the system performance, functionality, and components are barely meeting software design expectations according to tenets of project management. Thus, depriving productivity standards. Future interventions to develop or improve the system should focus on technical design, continuous monitoring and improving qualities, stakeholder engagement, and adoption of key HIS standard components.

Keywords: *Health Information Systems, SmartCare, Project Management, Performance, Functionality, Challenges*.

DEDICATION

This dissertation is dedicated to my dear and loving mother, the late Doris C. Chibale who did not only raise and nature me but installed values and morals, and always a source of motivation and strength over the years of my education and intellectual development. Above all am grateful to God for His grace.

To all intellectuals and health care workers past, present and future who will find this work useful.

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LIST OF ABBREVIATIONS AND ACRONYM

AIPM – Australian Institute of Project Management

ANC – Antenatal Care

APM – Application Performance Management

ART – Antiretroviral Therapy

CIDRZ – The Centre for Infectious Disease Research in Zambia

CDC – Center for Disease Control and Prevention

COVID-19 – Coronavirus

CPU – Central Processing Unit

DA – Data Associate

DHIO – District Health Information Officer

EHR – Electronic Health Record

EHRO – Electronic Health Record Officers

EMR – Electronic Management Record

FREQ – Frequency

HIS – Health Information System

HMIS – Health Management Information System

HTC – HIV Testing and Counselling

IDI – In-depth interviews

IP – Implementing Partner

IPD – Inpatient Department

IPMA – International Project Management Association

IS – Information Systems

ISO – International Standards Organization

KA – Knowledge Area

KPI – Key Performance Indicators

LAN – Local Area Network

LPHO – Lusaka Provincial Health Office

M&E – Monitoring and Evaluation

MOH – Ministry of Health

NASREC – Natural and Applied Sciences Research Ethics Committee

NHRA – National Health Research Authority

NGO – Non-Governmental Organization

OPD – Out-Patient Department

PC – Personal Computer

PMAJ – Project Management Association of Japan

PMBOK – Project Management Body of Knowledge

PMI – Project Management Institute

PRINCE2 – Projects in Controlled Environments

RBAC – Role-based Access Control

RAM – Random Access Memory

SDG – Sustainable Development Goals

SI – Strategic Information

SOP – Standard operating procedures

SQL – Structured Query Language

TS – Technical Support

UEMO – European Union of General Practitioners

USAID – United States Agency for International Development

WBS – Work Breakdown Structure

WHO – World Health Organization

CHAPTER 1: INTRODUCTION

1.1 Introduction

Health Information Technology is an application of information technology to healthcare. The application helps improve the quality and effectiveness of healthcare (SelectHub, 2018). The use of Information Technology to improve patient care globally continues to be one of the biggest goals in the health sector. Its impact has revolutionized patient care on a global scale. Health Information System (HIS) can help from paper-based to computer-based processing and storage as well as increase of data in health care settings (Yazdi-Feyzabadi et al., 2015). The Electronic Health Record (EHR) system replaced paper records by digitizing medical charting, making digital versions of charts and patient histories. HISs are designed to manage healthcare data. The aim is to improve the processes of data handling and extract useful information. The system has been utilized for collecting, processing, storing, and transferring the required patient's EHR for planning and decision-making at various levels of health sector to provide quality services (Brook, 2018; Yazdi-Feyzabadi et al., 2015). In addition, EHRs help physicians treat patients by looking at their history, diagnoses, treatments, medications, test results and more against past entries (Heier, 2018). The challenge for physicians, however, is the learning curve which can be too much for them as they have mostly worked their whole careers on paper-based documentation (Newman, 2018).

The World Health Organization in 2008 observed that the HIS serves broader ends, by providing an alert and early warning capability, supporting patient and health facility management, enabling planning, supporting global reporting, and underpinning communication of health challenges to diverse users. Dissemination and communication are as well essential attributes of a HIS. Availability of accurate and timely information and understanding of how to use them effectively in the health system are critical components for evidence-informed decision making which are provided by the HIS (Clarke et al., 2013). SelectHub website (2018) states that Health Information Technology increases the accuracy of diagnoses and promotes individual and public health. The software reduces costs and medical errors, while improving the efficiency of both administrative and clinical processes. However, issues such as privacy and security must be handled well.

1.2 Background

Lau et al., (2010) observes that experts consider Health Information Technology key to improving efficiency and quality of health care. HISs are an essential element in the health industry. There are however potential liability issues associated with HIS implementation. Implementation comes with a cost which includes setting up, maintenance, and training users. The implementation of these systems in hospitals and practices have monumental effects.

If properly implemented, the HIS could allow the use of HIS data not only for patient care and administrative purposes but also for health care planning and research. Health information is thus an integral part of a functioning health system (WHO, 2008). As stated by the Measure Evaluation website (2019), HIS supports a country's ability to report progress with the aim of meeting the ambitious goals of global initiatives, such as the Sustainable Development Goals (SDGs), controlling the Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome (HIV/AIDS) epidemic, preventing child and maternal deaths, and combatting infectious disease threats. The advantages of HIS make it much easier to access critical data, but there must be protections in place to keep that data out of unauthorized hands (Ayres, 2019).

To this end, many attempts have been accomplished by the health sector and donors concerning the design, development, and implementation of computerized HIS in developing countries (Kimaro and Nhampossa, 2007). According to the African Health Observatory (2019), significant progress has been made in Zambia in establishing comprehensive routine and periodical HIS for collection, analysis, management, reporting and disseminating vital health data at all the levels of the health sector. A comprehensive set of appropriate HIS has been developed and implemented. Among which the most important one is undoubtedly the SmartCare Electronic Health Record System.

1.3 Problem Formulation

Globally there have been a lot of studies on HISs. Despite the impressive number of these studies available, there has been limited reviews focusing on post-evaluation of elements and characteristics of project success and its process groups of these projects from the system developer's view. PMBOK (2017) defines process groups as phases that each project goes through. There are many indicators of project success. Westland (2015) indicates that a formal project evaluation is of use during and after a project to give a clear indication of how the project is or has performed against the original estimates. Many known projects have either delayed, have had cost overruns, or did not meet the initial objectives. The World Health Organization (2010) reports that one of the core components of strengthening health systems globally is the need to improve its development. Ammenwerth et al., (2016) recommends a rigorous evaluation of HIS technology which is of high importance for decision makers and users. According to Ammenwerth et al., (2016) evaluation is the act of measuring or exploring properties of a HIS in planning, development, implementation or operation, the result of which informs a decision to be made concerning that system in a specific context. Hence, rigorous evaluation studies on different HIS implementation projects in those settings are necessary to understand the critical success and failure factors (Verbeke et al., 2013). In Zambia, many studies on SmartCare HIS have looked at the impact of traditional clinical or public health services, but SmartCare HIS has also unique characteristics such as technical complexity that affect program sustainability, especially in resource-poor settings (Moucheraud et al., 2017). This study was conducted to determine how effective the system has been run from the system development perspective using project management principles in Zambia.

1.4 Problem Statement

In Zambia, the studies done on SmartCare HIS are limited when it comes to the success of the project from the developer's view using project management principles. If not properly developed, the HIS could lack accepted standards or possess performance and functionality issues. In order to help fill this gap, this study was conducted to determine whether the SmartCare HIS development standards were met during the process groups and determine how effective the system was run from the system development perspective using project management principles in Zambia.

1.5 Aim

To investigate the implementation of SmartCare Electronic Health Record System project in Zambia using tenets of project management.

1.6 Objectives

1. To determine the critical success factors and challenges of Health Information System.
2. To measure the performance and functionality of SmartCare HIS in Zambia.
3. To compare the international Health Information System standard components to the components of SmartCare HIS in Zambia.

1.7 Research Questions

1. What are the critical success factors and challenges of Health Information System?
2. How effective is SmartCare Health Information System performance and functionality in Zambia?
3. What are the international standard components of Health Information Systems and key components of SmartCare HIS in Zambia?

1.8 Research Methodology

Research methodology consists of study design, study settings, study population, study sample with a review of research methods sampling technique and characteristics of the sample. It also outlines the data collection procedure and timeline followed. In this research study, we looked at the HIS implementation in other countries through literature and how it has been implemented in Zambia. Literature review also made us understand the system scope, quality, required key components and system's critical success factors and challenges. Analysis involved reading the existing literature such as journals, relevant books, reports, and papers. Questionnaires were issued to system users to understand the system performance and functionality. To understand SmartCare HIS's key components, In-depth interviews with SmartCare HIS users were conducted, respectively. The study produced recommendations based on information acquired.

1.9 Significance of the Study

A post-evaluation of a project is of use during and after a project to give a clear indication of how a project has performed against the set project management standards. The study may assist in improving current and future development of SmartCare System in Zambia.

A well implemented SmartCare HIS may focus upon improving the availability and utilisation of sound health information for policymaking and planning, programme monitoring and evaluation, and measuring equity in health.

1.10 Ethical Consideration

Approval for the study was sought from the Natural and Applied Sciences Research Ethics Committee (NASREC) and the National Health Research Authority (NHRA), who's responsibility is to promote and regulate research in Zambia. Permission was also sought from the Ministry of Health through the Lusaka Provincial Health Office (LPHO), who are responsible for the data and the HIS in the province. The aim of the study was explained to the authorities including the participating hospitals and officials. The participating hospitals and institutions had access to their information on the study. Highest confidentiality was maintained throughout the study. Findings were shared with respective relevant authorities.

1.11 Organisation of Study

Chapter One is comprised of an overview of the research study followed by the problem definition, the research aim, research objectives, the research questions, significance of the study, ethical considerations, and organization of study.

Chapter Two presents an overview of the Health Information System (HIS) globally and within Zambia. It describes earlier studies done on the topic to date. It reviews the HIS SmartCare Electronic Health Information System and further outlines its benefits, outputs, success factors and challenges. The chapter presents an overview of Project Management Body of Knowledge (PMBOK) process groups and the PMBOK Knowledge Areas used for this study. The chapter gives an overview of what is known about the problem.

Chapter Three discusses the methodology. The study design, study settings, study population and study sample are subsequently described with a review of the instruments used and their properties. The chapter outlines the data collection procedure and timeline followed.

Chapter Four presents the research findings and discussions. The chapter addresses a comprehensive description, interprets the research findings, and presents the discussion and a detailed analysis of the data obtained from the research. The chapter presents research results, and the results are discussed in further detail.

Chapter Five presents the conclusion, research contributions, and addresses the limitation of the study. The chapter concludes with recommendations of areas of further research.

1.12 Chapter Summary

The chapter introduces the research area and outlines the background and rationale for the study. It briefly entails the HIS and outlines its benefits, usage, basic components, and shortcomings. The chapter subsequently describes the problem statement and aims of the study and provides the layout of the thesis. It further includes the research objectives and research questions to be answered, significance of the study and ethical consideration of the study. The following chapter presents literature from other authors of related research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The previous chapter introduced the research area and outlined the background and rationale for the study. This chapter discusses the literature review pertaining the research questions and topics to be answered. The chapter describes earlier studies done on the topic to date. The chapter presents an overview of the Project Management Body of Knowledge (PMBOK) process groups and some of the 10 PMBOK Knowledge Areas. It also gives an overview of Health Information Systems (HIS) globally and within Zambia. It further gives an overview of SmartCare Electronic Health Information System used in Zambia and other African countries. It outlines challenges and emphasises a well implemented HIS.

2.2 Definition of Project

PMBOK (2017) defines a project as a temporary endeavour undertaken to create a unique product, service, or result. Projects are undertaken to fulfil objectives (requirements) by producing deliverables. An objective is defined as an outcome toward which work is to be directed, a strategic position to be attained, a purpose to be achieved, a result to be obtained, a product to be produced, or a service to be performed. Software development can be considered as a project. A software development project is a complex undertaking by two or more persons within the boundaries of time, budget, and staff resources that produces new or enhanced computer code that adds significant business value to a new existing business process (Wysocki, 2010).

2.2.1 Project Success

There are various perspectives of describing project success. Radujković et al., (2017) describes project success as the results of the overall evaluation of project goals achievement. Atkinson (1999) describes project success with his widely spoken traditional Iron Triangle of cost, time, and quality which has been one of the measuring tools for assessing project performance and success. These basic criteria of cost, time and quality are easy and timely to measure yet evolving and developing by learning from the past mistakes and by adopting the best-believed practices appropriate for continuous improvement.

A Project manager is not responsible only for time, cost, and quality management, but also integration, scope, communication, risk, human resource, and procurement management (PMI, 2013). These are part of the areas defined as Knowledge Areas in the PMBOK by the Project Management Institute. The International Project Management Association (2006) goes on to state that Project management involves planning, organization, monitoring, and control of all aspects of project, with motivation of all included to achieve project goals on safe manner, within agreed schedule, budget, and performance criteria. According to Baker (2018), Quality, Scope, and Human Resources Knowledge Area (KA) principles were found to be relatively important in software organizations. Baker (2018) further states the most significant project management KAs at inception of a project including Project Scope Management KA, Project Quality Management KA and three other major project documents. It is for this reason that this study looked closely at Scope Management and Quality Management of SmartCare Electronic Health Record System in Zambia.

The outcome measure whether the project was successful or not is determined by overall results that the project accomplishes. In addition, measuring success of an information system is difficult because success does not have a common explicit definition (Van Der Meijden et al., 2003), and is dependent on expectations. The agreed hypothesis to say an information system is successful is when the implemented system is accepted to be used by the end user and the users are satisfied with the system (DeLone et al., 2003).

2.3 Process Groups

The foundation for project management theory is called process groups. Process groups are phases that each project goes through (Roseke, 2016). In the Project Management Body of Knowledge (PMBOK), the process groups form the master framework within which the other knowledge areas rest. PMBOK explains the process groups such as Project Initiation, Project Planning, Project Execution, Monitoring and Controlling and lastly Project Closing.

2.3.1 Project Initiating Process:

This is defined as the process(es) performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.

2.3.2 Project Planning Process:

The process(es) required to establish the scope of the project, refine the objectives and requirements, and define the course of action required to attain the objectives and requirements that the project be undertaken to achieve is called Project Planning. The goal of the planning phase of a project is to prepare the structure for project execution and control. Planning is a crucial factor for project success (Fortune and

White, 2006; Zwikael et al., 2005) and as such is recognized as one of the critical success factors of project management.

The major benefits from quality planning are: (1) to eliminate or reduce uncertainty, (2) to improve efficiency of the operation, (3) to obtain a better understanding of project objectives, and (4) to provide a basis for monitoring and controlling work (Kerzner, 2006).

2.3.3 Project Execution Process:

These are process(es) performed to complete the work defined in the project management plan to satisfy the project requirements.

2.3.4 Project Monitoring and Controlling Process

The process(es) required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes falls under Project Monitoring and Controlling.

2.3.5 Project Closing Process:

This involves process(es) performed to formally complete or close a project, phase, or contract.

Figure 2.1 illustrates the processes in the Process Groups interacting within each phase of a project divided into phases.

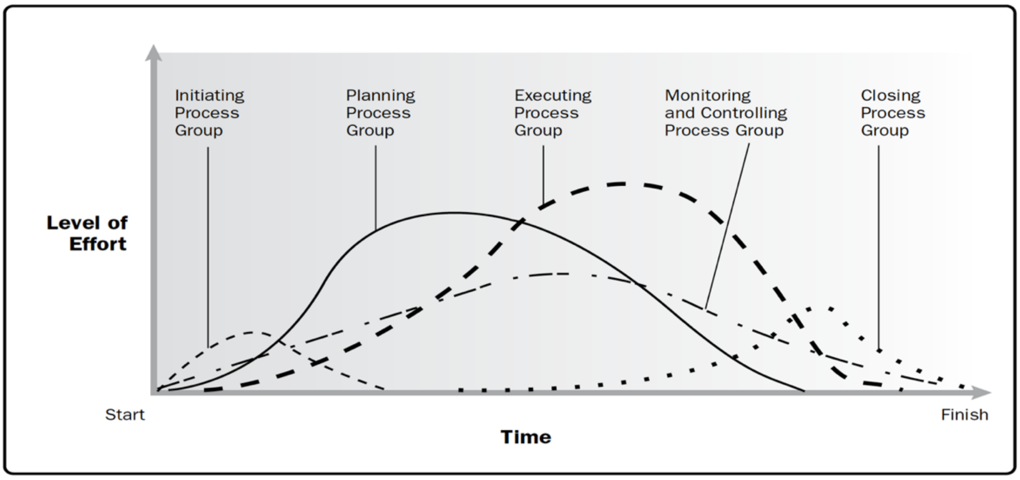

Figure 2. 1: Process Group Interactions within a Project or Phase (PMBOK, 2017)

2.4 PMBOK Knowledge Areas

A Knowledge Area (KA) is an identified area of project management defined by its knowledge requirements and described in terms of its component processes, practices, inputs, outputs, tools, and techniques (PMBOK 2017). Hartney (2016) notes that KAs occur throughout any time during the process groups of a project. Figure 2.2 illustrates the 10 Knowledge Areas as described by PMI (2013) in the PMBOK (2017).

Figure 2. 2: PMBOK Knowledge Areas (University College London, 2020)

A KA is important to project success when the higher extent of use of its related processes significantly improves project success. Zwikael (2009) revealed the differences in the relative importance of KAs in various industries. Hence, managing projects in different industry types requires unique focus and attention. In software organizations, Quality, Scope, and Human Resources KAs were found to be relatively important. Baker (2018) goes further to state the most significant project management KAs at inception of a project including Project Scope Management KA, Project Quality Management KA and three other major project documents. It is for this reason that this study looked closely at Scope Management and Quality Management of SmartCare Electronic Health Record System in Zambia.

2.4.1 Project Scope Management:

Knowledge Area of Scope Management involves the project scope. According to the PMBOK Guide–Sixth Edition (PMI, 2017), Project Scope Management includes all the processes and work required, and only the work required, to complete the project successfully. Managing the project scope is primarily concerned with defining and controlling what is and is not included in the project. In this context, the objective of the scope management is to control product and project boundaries, which can be a complex activity because the boundaries are not always clear and well defined and may involve political, social, technological, organizational, and economic forces (Alexander et al., 2009). It is important to adopt techniques that can help in the accomplishment of a process, contributing to the scope management (Lampa, 2017). In addition, scope management ensures the successful management of other key project management areas, including quality, time, and cost. According to Smith (2002) one of the main problems in information technology projects is related to the system requirements. Errors in the requirements are costly and can lead to loss of time, revenue, and reputation of the responsible organization. Therefore, the requirements must reflect the necessities and the demand imposed by the stakeholders (Sommerville, 2011). Thus, properly specified requirements describe clearly and accurately the real need of the stakeholders (Pandey et al., 2010). Hartney (2016), emphasizes that the boundaries of the project should be well defined from the outset and monitored rigorously.

In recent years, successful project managers are aware that a careful scope control is vital to time and cost delivery of projects (Charvat, 2003). Consequently, they now pay adequate attention to project scope management (Dexter, 2010; Frame, 2003). This is because, it has been established in prior work that the failure to appropriately define or productively manage the scope of a project would lead to total project breakdown, late delivery or over budget (Keivanpour et al., 2015; Khan, 2006; Nath and Momin, 2014). Furthermore, project managers are now faced with the task of successfully executing assigned projects based on a well-defined project scope that can help accomplish the overall projects goals and objectives (Khan, 2006). This implies that the success or failure of projects, is dependent on how productive the scope management is. In addition, scope management ensures that a project's scope is accurately defined and mapped and enables project managers to allocate the proper labour and costs necessary to complete the project.

The area of scope management has a group of six processes that, together, aim to register, monitor, and control which belongs or do not belong to the project boundaries, besides managing the product requirements and ensure that the project include all necessary work and just the necessary to the project conclusion (PMBOK, 2013).

These processes according to PMI (2017) are:

- Plan Scope Management – The process of creating a scope management plan that documents how the project and product scope will be defined, validated, and controlled.

- Collect Requirements – detailed requirements of the final product or service are assembled and itemized. It is a process of determining, documenting, and managing stakeholder needs and requirements to meet project objectives.
- Define Scope – The process of developing a detailed description of the project and product. The scope statement should be comprehensive enough that it reduces some of the major risks to the project.
- Create Work Breakdown Structure (WBS) – The process of subdividing project deliverables and project work into smaller, more manageable components.
- Validate Scope – The process of formalizing acceptance of the completed project deliverables.
- Control Scope – The process of monitoring the status of the project and product scope and managing changes to the scope baseline.

2.4.2 Project Quality Management:

Quality as a delivered performance or result is the degree to which a set of inherent characteristics fulfil requirements (PMI, 2017). Definitions for quality and quality management are almost the same in international project management standards. The standards describe the best practices in project quality management, prescribe methodologies to perform quality management in projects, or provide a basis to assess project quality management competence of an organisation or an individual. There seems to be an agreement about the elements of quality management of quality planning, quality control and management, and quality assurance in these standards. Differences seem to result from various targets, focuses, and structures of standards (Zafarani, 2011). Table 2.1 shows a summary of the approach of project management standards to project quality management.

Table 2. 1 - Approaches of project management standards to project quality management (Zafarani, 2011).

Book Title	Approach to project quality management
PMI's PMBOK	Project quality management is one of nine knowledge areas with three processes of Plan Quality (Planning process group), Perform Quality Assurance (Executing process group) and Perform Quality Control (Controlling and monitoring process group)
Construction Extension to the PMBOK	Similar to PMI's PMBOK
APM's PMBoK (Project Management Body of Knowledge)	A topic under section Planning the Strategy
ISO 10006:2003	The whole document provides guidelines for quality in management of projects; does not have a separate section on the project quality management
AIPM's Publication	Project quality management is a unit of competence with its respective elements, performance criteria, needed background knowledge, and evidence of demonstrated competence
PMAJ's Publication	Quality management is a section under project objectives (or goals) management which is itself under heading segment management in project management "tower"
PRINCE2	One of seven PRINCE2 principles is product-orientation that necessitates definition of quality requirements of project's products. Quality is also one of PRINCE2's seven themes which must be addressed continually throughout the project. It consists of quality planning, control, and assurance
IPMA Competence Baseline	Quality is a competence element among technical competence elements

The KA of Project Quality Management addresses the management of the project and the deliverables of the project (PMI, 2017). The quality level of a project should be established during project planning and specified within the Project Management Plan (Hartney, 2016). Failure to meet the quality requirements can have serious negative consequences for any or all the project's stakeholders (PMI, 2017). The processes that ensure the quality of the deliverables, and the deliverables themselves, must be inspected regularly to ensure they conform to the quality standards (Hartney, 2016).

The Project Quality Management processes according to the PMI (2017) are:

- Plan Quality Management – The process of identifying quality requirements and/or standards for the project and its deliverables and documenting how the project will demonstrate compliance with quality requirements and/or standards.
- Manage Quality – The process of translating the quality management plan into executable quality activities that incorporate the organization's quality policies into the project.
- Control Quality – The process of monitoring and recording the results of executing the quality management activities to assess performance and ensure the project outputs are complete, correct, and meet customer expectations.

2.5 Overview of Health Information System

HIS combines different elements of data, or inputs, which is analysed and processed to produce data outputs (WHO, 2008). However, many HIS which are technically sound for developers and healthcare managers, face resistance from users and ends up in failure (Dianna et al., 2013). Several studies have raised concerns about the performance and functionality of HIS(s) (Hahn et al., 2013). Research by Ahanhanzo et al., (2014) identified several factors associated with the poor quality of the data produced in the HIS in Benin. They indicated complexity of the technical factors associated with the HIS. The complexity of the HIS documents and procedures was a source of the problem. Out of the data assessed, they found most of the produced data to be poor and 88.8 percent of it was rejected. 8.6 percent and 9.5 percent of the batches were rejected due to reliability and accuracy. To improve the quality, they suggested re-designing part of the format of the system and engaging health workers (stakeholders) in the design process of the system. Chao et al., (2013) identified that 78 percent of the 32 physicians interviewed in Macao China pointed to privacy and confidentiality concerns both from the health institutes and patients. They went on to talk about the inefficiency of the HIS that only allowed retrieval of limited medical information of the patients which hindered physicians' acceptability of HIS. They also suggested that institutes responsible for developing the HIS should take into consideration interests of different stakeholders when designing and implementing HIS. The research by Tsai et al., (2013) highlights the concerns concerning poor interoperability and integration between different systems and the hindrance of implementation.

Other issues that surround the performance of HIS(s) are system quality (Topaz et al., 2016; O'Donnell et al., 2018), system compatibility (Hamamura et al., 2017), system inefficiency (slow response) (Nguyen et al., 2014), system failures, server crashes (Goldberg et al., 2012), and difficulties in finding HIS that meet user requirement needs (Raglan et al., 2014) which is key in Project Scope Management. Tsai et al., (2020) emphasises the functionality issues concerning HIS(s). These include both too many complex functions and too few needed functions. Too few functions were reported as barriers to their use. Studies by McAlearney et al., (2010), Hamamura et al., (2017) and Nguyen et al., (2014) agreed that usability such as the design of user interface and navigation were critical features of an HIS. One study showed that the survey respondents (clinicians) were dissatisfied with the usability of HIS at both months 11 and 17 post-HIS implementation (mean score 2.1 and 2.4

out of 5) (Sockolow et al., (2012). A careful scope control therefore is vital to time and cost delivery of projects (Charvat, 2003). It is important to pay adequate attention to project scope management (Dexter, 2010; Frame, 2003). This is because, it has been established that the failure to appropriately define or productively manage the scope of a project would lead to total project breakdown, late delivery or over budget (Keivanpour et al., 2015; Khan, 2006; Nath and Momin, 2014).

Recognition of the importance of HIS capable of generating reliable data is growing. In addition, measuring success of an information system is difficult because success does not have a common explicit definition (Van Der Meijden et al., 2003), and is dependent on expectations. The agreed hypothesis to say an information system is successful is when the implemented system is accepted to be used by the end user and the users are satisfied with the system (DeLone et al., 2003).

One of the core components of strengthening health systems globally is the need to improve its development (WHO, 2010). While the benefits of electronic HIS in Southern Africa has been documented in the literature, the implementation of these systems in public health care remains limited (Wright et al., 2017). HIS are however increasingly being incorporated into the healthcare organizations of developing countries that do not have well-developed infrastructure and well-trained technical personnel to use and manage the systems (Eysenbach, 2015). As outlined by Sood et al., (2008), the determinant factors that affected the information system success in those settings might be different from factors in developed countries. Hence, rigorous evaluation studies on different HIS implementation projects in those settings are necessary to understand the critical success and failure factors (Verbeke et al., 2013). A systematic review of literature about health information systems in resource-constrained settings recommended that it is urgent to evaluate barriers to implementation (Oluoch et al., 2012). Earlier independent research on extracting surveillance data from the Zambian HIS Electronic Management Record (EMR) system, SmartCare, highlighted some deficiencies including substantial amounts of missing data, and variable performance across the country (Singh et al., 2016; Gumede-Moyo et al., 2019).

2.5.1 Standard Key Components of a Health Information System

The functionality of HIS(s) varies across multiple settings, from the perspective of what is available from vendors to what can be developed and implemented locally. Some HIS have been developed locally and others by commercial vendors. Guidance to HIS on a set of key components that a HIS should possess promotes patient healthcare data. The development of a common set of requirements for the functional capabilities of various HIS software components allow providers to compare the systems that are available and enable vendors to build systems more in line with providers' expectations (Aspdenet al., 2004).

American Public University (n.d.) explains the key components of HIS as, health information system resources, indicators, data sources, data management, information products and lastly, dissemination and use of the information. These six components are broadly divided into three broad categories namely, inputs, outputs, and processes. The authors further describe the categories in detail as:

(a) Inputs:

These comprise of all the physical and structural pre-requisites and resources needed to put up a strong HIS. This involves a legislative, regulatory, and planning framework (rules and policies) as well as personnel (skills and capabilities), financing, logistic support, IT, and communication systems.

(b) Processes:

These include indicators, data sources and data management. Indicators refer to measurable sets of data that help to monitor the system's effectiveness by quantifying change that has taken place in a country's health profile over time. These determinants should be valid, reliable, sensitive, specific, and feasible. Data sources refer to both periodic and continual sources that provide quality information for the information system. Data management is aimed at enabling data to be collected to be stored, compiled, analyzed, and processed easily. Data management also allows easy access to relevant information for those who need it while maintaining privacy and confidentiality of the stored information. There are two types of data management: minimum dataset and integrated data repository. A minimum dataset simplifies data collection and improves the quality of data collected. An integrated data repository on the other hand combines data from various sources and helps in the collection, management, and distribution of the data.

(c) Outputs:

The author elaborates output as compromising of information products, dissemination, and use of the information. Output transfers the processed information to the people who will use it or to the activities for which it will be used (ibid).

Meanwhiles, Valdez (2007) described key components of Philippine Health Information System in Philippine. The key components described are:

(a) Selected Indicators: these consist of data collection, timeliness, periodicity, completeness, context, resources, and process. Other indicators are legal framework, human resources, and infrastructure.

(b) Data synthesis, analysis, and use: which includes dissemination and policy advocacy, implementation, resource allocation and planning.

(c) Data platforms: consisting of vital registration, survey, disease surveillance and health information systems.

The European Union of General Practitioners (2004) calls on the European governments and health authorities to define a functional model of key capabilities of HIS (Electronic Health Record System included). The HIS(s) must include the following mandatory capabilities that can be categorized into:

(a) Health information and data:

Must comprise of demographic and individual data, patient's problem list, medication list, risk factors, allergies, procedures and test results, referrals and hospitalisations, preventive programs (with risk assessment modalities), lifestyle interventions and recommendations, follow up schedule and control check- ups, issued prescriptions, and issued expertises, certificates, etc.

(b) Results management:

Must consist of laboratory, microbiology, pathology, radiology, and consulted specialists.

(c) Order entry – order management

Consisting of electronic prescribing, diagnostic procedures (laboratory, microbiology, X-ray etc.), referrals to specialists, referrals to hospital, nursing, and supplies.

(d) Decision-making expert systems:

This must have access to knowledge sources, drug alerts, reminders (For instance, preventive services, clinical guidelines, and pathway), chronic disease managementclinician work list, diagnostic decision support, and use of epidemiological data.

(e) Electronic communication:

Comprising of provider-provider, team coordination, patient-provider (e-mail, secure web messages), medical devices, trading partners (outside pharmacy, laboratory, radiology), integrated medical record, within setting, cross-setting, Iinpatient-outpatient, and other cross-setting.

(f) Patient support (Patient education/information):

Patient support comprising patient education (custom patient education and tracking), data entered by patient, family and or informal caregivers (home monitoring and questionnaires).

(g) Administration processes:

This must have scheduling management and eligibility determination (Clinical trial recruitment, drug recall, chronic disease management).

(h) Reporting & population health statistics:

Must comprise of patient safety and quality reporting (clinical dashboards, aad hoc reporting, public health reporting, reportable diseases), didentifying data, and disease registries.

By using standard software and standard communication networks, data interchange between the four levels of health care delivery (that is, the region, the institution, the clinical department, or outpatient clinic) is more efficient (ibid). Table 2.2 shows a summary of key components of HIS according to the American Public University (n.d.) and the European Union of General Practitioners (2004).

Table 2. 2 – Summary of key components of HIS (American Public University, n.d.; European Union of General Practitioners, 2004)

Framework	Key Components of HIS
Input	1. Health information system resources i.e., physical, and structural pre-requisites and resources which includes: ▪ legislative, regulatory, and planning framework (rules and policies), personnel skills and capabilities, financing, logistic support, and Information Communication and Technology.
Processes	1. Indicators. 2. Data sources. 3. Data management. 4. Order management. 5. Decision making expert system.
Output	1. Information products. 2. Information dissemination. 3. Use of the information e.g., of laboratory results, quality reports. 4. Electronic communication.

2.5.2 Benefits of Health Information Systems

Integrated HISs are becoming an essential part of the fabric of modern healthcare. HIS have evolved from pure record-keeping to an integrated, enterprise-wide system that holds the promise of accurate, real-time access to patient healthcare data (Mackinnon, 2009). HISs are considered prerequisites for the efficient delivery of high-quality health care in hospitals. The introduction of HISs is a general tendency in countries globally. The way of implementation and the time experience of using HISs vary among countries though. The acceptance of these systems by health professionals is crucial for the success of its implementation (Sanchez, 2005). HIS can provide healthcare administrators and clinicians with the information necessary to improve patient care and lower costs (Mackinnon, 2009).

Markus et al., (2000) defined HIS success factors from several angles, including:

(a) Success viewed in technical terms,

(b) Success viewed in economic, financial, or strategic terms,

(c) Success viewed in terms of the smooth running of proceedings of the operations,

(d) Success as viewed by the HIS-adopting organization's managers and employees; and

(e) Success as viewed by the HIS-adopting organization's customers.

Lab interfaces is an example of success in technical terms or success viewed in terms of the smooth running of proceedings of the operations and should be a high priority. With it, one will have a much easier time finding the specific lab result there looking for than they would if they we are using paper. Electronic interfaces speed up access to information in an HIS (Adler, 2007). Adler (2007) observes that progress note documentation with a HIS is typically slower than using dictation or even a paper check-box form. However, by documenting directly in a HIS, one immediately gains easily readable notes at the end of the hospital visit. Notes can then be shared with patients or consultants, or the notes can be used for immediate review of those patient-care questions that arise before a dictation would normally return. Direct HIS note entry also commonly allows you to record diagnoses and populate problem lists simultaneously.

Rai et al. (2002) focus on information system success is focused on five constructs. These are system quality, information quality, perceived usefulness, user satisfaction, and system use. Rai et al. represented system quality and system use in terms of ease use and system dependence. Figure 2.3 presents the broad theoretical model (Sabherwal et al., 2006), which includes three broad concepts.

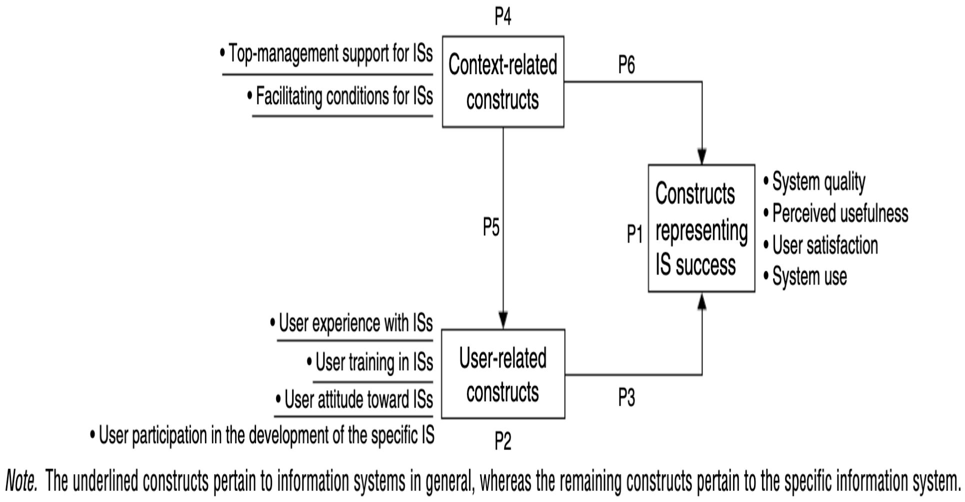

Figure 2. 3: The Broad Theoretical Model (Sabherwal et al., 2006)

Figure 2.3 shows the concepts of Information Systems (ISs) success. Proposition 1 (P1) represents the interrelationships among four constructs. These are system quality, perceived usefulness, user satisfaction, and system use. Four constructs - user experience with ISs, user attitude towards ISs, user training in ISs, and user participation in the development of the specific IS. Proposition 2 (P2) focuses on the interrelationships among these constructs, and Proposition 3 (P3) reflects their effects on IS success. The third concept, the context is represented by two constructs: top-management support for ISs and facilitating conditions for ISs. Proposition 4 (P4) deals with the relationship between these two constructs, and Propositions 5 (P5) and 6 (P6) focus on their effects on user-related constructs and IS success, respectively (Sabherwal et al., 2006).

2.5.3 Implementation of Health Information Systems

Implementing a HIS can be a challenging task to take on and planning the process is of utmost importance to minimize errors. Evaluating the selection criteria and implementation plan of an HIS system, intending interoperability, confidentiality, availability, and integrity of the patient health information data, while ensuring timely, accurate, and regulatory compliant generation of reports is a critical task. Using a proper implementation strategy for a new HIS, systems can facilitate success, minimize delays, and increase health care worker's satisfaction and decrease the chances of usability being compromised (Aguirre, et al., 2019). The implementation process first consists of performing an evaluation of the current workflows, define the needs and preferences to have in the HIS, including hardware needs, deployment of selection and training of users, and then plan the implementation and staff education (Hodgkins, 2015).

2.5.4 Testing Health Information Systems

Testing the implemented HIS ensures that every system in place is put through its paces to ensure data tables and files are loading properly, data collected are processed and stored correctly. In addition, it ensures that the system interfaces work as intended, that alerts are properly triggered and responding correctly, that the reports are generated accurately and completely, and that the security system is also checked to ensure it is correct (Wright, et al., 2017). Results of tested components, tables, procedures, processes etc., are rated as either outstanding, excellent, very good, good, average, poor or below minimum standard expected.

The global scoring guide as observed by the University of Pretoria (2015) is as follows:

- Outstanding 90 percent - 100 percent
- Excellent 80 percent - 89 percent
- Very good 70 percent - 79 percent
- Good 60 percent - 69 percent
- Average 50 percent - 59 percent
- Poor 40 percent - 49 percent

- Below minimum standard expected 0 percent - 39 percent.

Aguirre et al., (2019) offers a list of objectives to test a HIS. These are setting a scope of the test, establishing a testing strategy, establishing the environment requirements, establishing a control procedure, identify functions that will be tested, creating a list of deliverables, and identifying risks.

A. *Testing Scope*

Testing the scope of the system includes software configuration readiness, infrastructural readiness, and training readiness. These testing include the evaluation of workstations, servers, printers and network devices and related security measures. This plan further includes testing all workflows, procedures, and areas of the clinical record design. To evaluates staff readiness in the use of the system before it goes live, training staff is done.

The testing will be performed using a testing environment. Wright et al., (2017) recommends testing the system in such an environment to imitate how it will behave when the system is live.

B. *System functionality*

This test ensures that the HIS's major functions perform as required and the customizations work as requested. For example, the system screens appear as intended and functions as expected, verify that system does not have any spelling or grammatical errors, and that the content is appropriate. This testing ensures that workflows send and receive data properly between the systems, that the interfaces between applications move data correctly and completely, that users gain access as per assigned privileges, and that the data is processed accurately and populates correct data. This should also ensure that the system works with all integrated devices and system capabilities such as voice recognition and speech commands, as designed (Aguirre et al., 2019).

C. *System Performance*

This testing ensures the response times and process interactions are within the system timely and within acceptable limits as stated in the project deliverables. The testing evaluates the system usage during peak loads for accessibility and timely process of requested data, and timely generation of reports and evaluation of time for data dumps on system performance (Aguirre et al., 2019).

D. *Testing strategy*

During system testing it is important to ensure the testing plans cover different scenarios and situations. Scenarios such as system stress or load testing, contingency planning by developing a disaster recovery plan. Testing the ability to restore system from backups, ensuring that the system backup plan is in place and running and arrange for regularly scheduled pick up and off-site storage of backups (Lumetra, 2006).

E. *Identified risks*

The risks associated with the testing and implementation of an HIS are risks associated with achieving the objectives set for the HIS implementation. Risks such as having data that is incomplete, missing, or misleading, risk of confusing one patient with another. Risk of inaccurate or incomplete patient data, risk of open or incomplete patient orders, risk of automatic discontinuation of a prescription, data aggregation leading to erroneous data reporting etc. (Aguirre et al., 2019).

2.5.5 Challenges of Health Information Systems

After decades of development, experiences, and successes, the majority of HISs at most institutions are far from the stated goals of supporting healthcare through advanced clinical computing and an electronic health record (Kuhn and Giuse, 2001). While many reports have focussed on successes, there is evidence of surprisingly frequent failures. Interestingly, many authors have reported technical problems such as insufficient level of software development despite extensive pre-negotiation evaluation, and insufficient performance despite the vendor's contractual commitment to response time. Sanchez et al., (2005) observes that due to the lack of professional expertise and experience on developing HIS in-house, many health care organizations prefer to buy "off-the-shelf" systems to shorten the HIS implementation cycle. The available software on the market does not always meet all owners' requirements, so project owners can decide to stick for customized software applications that may have different limitations. Sanchez et al., (2005) further observes the factors categorized to this group of issues as; software market offer, capacity of vendor provider to develop the proper software according to the needs of the stakeholder, updating of software and software following international communication standards. Factors that could also influence the professional's opinion that is one of the main aspects of a successful implementation are:

(a) System easy to access and use
(b) System able to evolve
(c) Hardware performance
(d) Upgrading of hardware
(e) Security assurance

Acceptability of an HIS by health care professionals is very often influenced by technical characteristics of the system. The way how the new system is perceived by physicians is mainly linked with system's speed and reliability, stability, and security issues (Adler, 2007).

Poorly written software that requires numerous clicks to accomplish a process, compared to an alternate product that does the same thing with one click, makes it harder for HIS users to succeed. Inadequate server memory or processing power or poor network design can slow down common HIS tasks to the point of crippling them. For example, Adler (2007) experience in implementation of HIS came perilously close to failing when he ran into problems with network. All there HIS sites, and two, had problems with speed. Screen changes often took several seconds. This caused enough consternation among there physicians that some wanted to get their money back and return to paper. After much investigation, they learned that the primary issue was a lack of bandwidth. They found an affordable solution using network compression hardware. The national academic press IT support and maintenance can be expensive. The more complex the server and network environment, the more support and maintenance required. Furthermore, the technical capabilities required by HIS of the Internet are even more demanding because of several factors converge. High internet availability and consistence is required regardless of geographical area to ensure that patient records are accessed when needed and that systems remain operational.

Integration is central for HIS. Lack of system integration is one of the core problems. Healthcare institutions need timely patient information from various sources at the point-of-care. The sources of electronic patient information that do exist reside on many isolated systems in various locations (Kuhn and Giuse, 2001). The data processed differs in representation and semantics. Thus, application integration covers distinct aspects, such as ubiquitous data access, consistency, and a single system image (Lenz and Kuhn, 2001). Management of large-scale integrated systems is difficult to manage though (Kuhn and Giuse, 2001).

The benefits of Information Technology (IT) in healthcare are extremely difficult to quantify. It is difficult to demonstrate return on investment. Health IT suffers from lack of funding. Answers to the Health Information Management System survey show that it is difficult to provide quantifiable benefits and return on investment, and that consequently, IT is suffering from a lack of adequate financial support (Lenz and Kuhn, 2001).

2.6 Overview of SmartCare Electronic Health Record System

SmartCare Electronic Health Record System is an integrated health record system, clinical management information system and key component in 'one national monitoring and evaluation system,' that is currently presumably the largest HIS in use in Africa (Mengesha, 2011; Mwiinga, 2019). The increased demand for health information and the potential opportunity to supply it called for an investment in building a sustainable national Health Information System (MoH, 2007). The HIS was first developed and introduced in Zambia by a collaboration between the Centers for Disease Control and Prevention (CDC), Ministry of Health (MoH) Zambia and a consortium led by BroadReach HealthCare Corporation. This led to the development and deployment of an integrated patient management systems, delivering better treatment services (Jhpiego, 2013; BroadReach, 2020). Some of the key partners such as the Centre for Infectious Disease Research in Zambia (CIDRZ) assisted to facilitate much of the system roll-out since its inception. According to the

Zambia Development Agency (2013), Health systems in Zambia are classified into three major categories namely:

1) First Level - comprising of Health Posts, Rural Health Centre, and District Hospitals, where primary health care and preventive health services are provided.
2) Second Level - comprising the Provincial and General Hospitals, which provide curative care.
3) Tertiary level - comprising Central hospitals and the National University Teaching Hospitals which provide specialized care.

As of the year 2012, Lusaka district had a total number of 45 government health facilities and of these, 23 had SmartCare Health Information System running (MoH, 2012). In total, SmartCare is used in the following countries: Zambia, Ethiopia, and South Africa. SmartCare software development in Ethiopia happened in collaboration with the SmartCare developers' team in Zambia and the United States of America (Mengesha, 2011). In South Africa, the program has been deployed in the country with much presence in Eastern Cape province (Johns, 2003). According to the Zambian Ministry of Health (2013), SmartCare was approved in 2006 to be the sole electronic HIS to be standardized across all health facilities nationwide. Since 2005, it had been deployed to over 800 clinics and hospitals, in all 10 provinces of Zambia and in every district, therein (Jhpiego, 2013).

2.6.1 Scope and Quality of SmartCare HIS in Zambia

According to the project management Knowledge Areas, scope and quality is defined as what needs to be done and the standards to be attained (PMBOK, 2017). Juran (2010), emphasizes two components of quality that are critical to managing it. These are: features that meet customer needs and freedom from failures. Scope and quality specifications are detailed requirements that define the project and quality of a product, service, or process. Software quality specifications for the performance of a software service includes elements such as availability rate, etc. (Spacey, 2017). In this study, the scope and quality attributes of SmartCare HIS was recognized in various categories. These are System Security, System Stability, System Usability, System Scalability and Network requirements.

The vision of SmartCare HIS is to have an improved availability of access to, and utilization of both patient and management information. SmartCare aims to enable electronic data entry of patient health information so that health facility staff do not have to manually collect and aggregate data (Sanja, 2013). The four main objectives of SmartCare system are: to provide greater continuity of clinic-based care and provide timely data for patient management; increase the privacy of sensitive medical information; reduce the burden of paperwork on health staff and improve the quality of information and decision support for patients, while providing automated information flow into the government's existing Health Management Information System (HMIS) trend reporting and analysis for health officials (MoH, 2013).

A health record (medical information) in the HIS is the principal repository (storage place) for data and information about the healthcare services provided to an individual patient. It documents the who, what, when, where why and how of patient care (Lulembo and Silumbe, 2016). SmartCare supports quick access to patient records, which saves physicians time; sharing of patient records is made easier through updated patient SmartCare cards (Clarke et al., 2019). The system has made it easy to analyse processed data as the health professionals can quickly filter and select relevant reports to make quick decisions; and the presence of national, provincial and district databases has made monitoring and evaluation of HIV programs easier (Hornbrook, 2010; Neame, 2013). Cost savings from less paperwork, and the elimination of repeated investigations has proved to be a good benefit (Mweebo, 2014). Though the goal of the program is to support the integration of data from multiple healthcare systems around a country (BroadReach, 2020), there has been no evidence (at the time of this study) that the country systems are integrated.

A. SmartCare Infrastructure

Mengesha (2011) and Anju et al., (2012) observed that SmartCare HIS was developed using the most cutting age and accepted technology from Microsoft, which included Microsoft SQL Server, .NET framework and Language C#. The HIS is considered as being made up of three subsystems which are: the trained and certified users, the software system and computer and other physical infrastructure that supports use of the system. Figure 2.3 shows computer requirements of SmartCare HIS

Figure 2. 4: Computer requirements of SmartCare HIS (MoH, 2020)

The computer and other physical infrastructure requirements of the system as shown in Figure 2.4 are: SmartCare software system; Personal Computer (PC), Tablet or Laptop; Card Reader and Care Card. The computer can be a server and/or a PC client machine. The SmartCare Card is used to store patient data via the Card Reader from SmartCare software system installed on the computer. The SmartCare software system includes different modules that are used by the various units of healthcare facilities. These are Out-Patient (OPD), Inpatient Department (IPD), Antenatal Care (ANC), Delivery, Record of Birth, Postnatal, Under Five, Family Planning, HIV (Antiretroviral Therapy) Testing and Counselling, Adult ART, Pediatric ART, Laboratory, Pharmacy, Inventory, Report of Death, and Survey Modules (MoH, 2020).

To minimize the learning curve, SmartCare system offers a touch screen interface. Figure 2.5 shows the touch screen interface of the component/module of SmartCare HIS. The screen shows menus that help to navigate through the different modules.

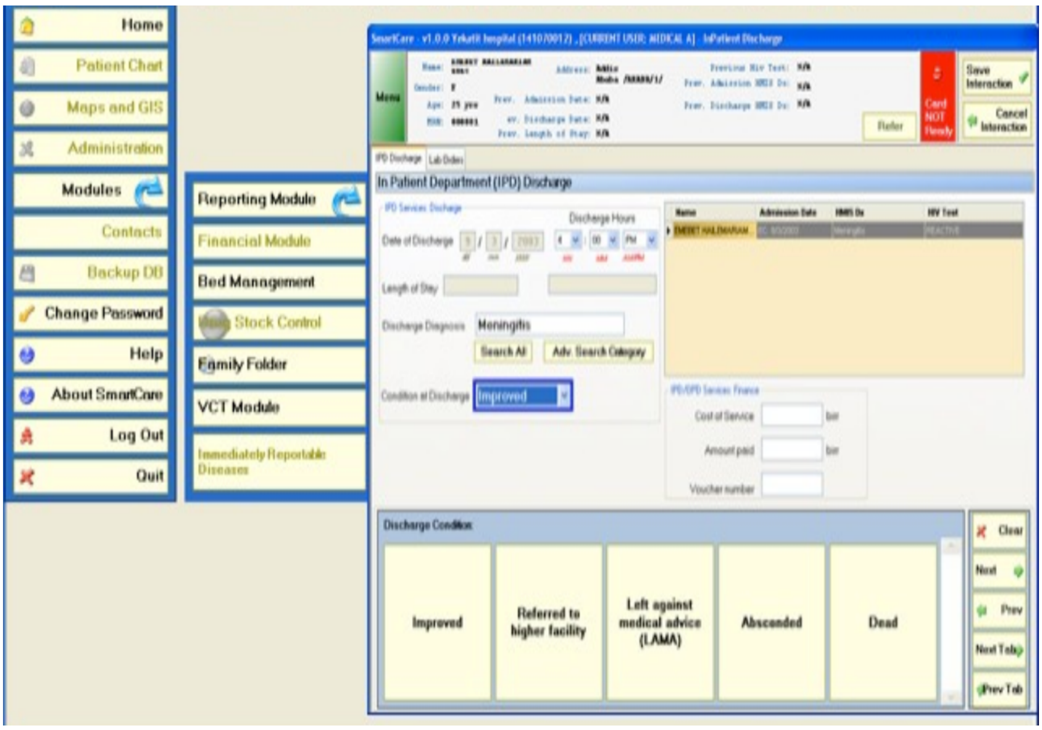

Figure 2. 5: Screenshot of SmartCare Component/Module (Mvula, 2017)

The system contains electronic forms that clinicians or data entry personnel use to record patient information that include counselling and testing, initial history and physical examination, investigations, medication, and long term follow up (WHO, 2013). The MoH and implementing partners (IP) are responsible for data entry from paper-based forms which have information collected by clinicians, pharmacists, and laboratory technicians, which is then entered into the system. The presence of these structured forms helps clinicians to collect all the necessary information as opposed to paper-based systems where some relevant information may be omitted (WHO, 2013). After entry of all the information, generation of reports in auxiliary services such as ART, pharmacy, labs, or antenatal care can be done. Patient data can also be copied to a SmartCare-card that can be accessed from any SmartCare facility.

B. Network Requirements

SmartCare system has evolved over time. A paper-based patient file was part of the initial implementation of SmartCare HIS, with data clerks entering all information from the paper-based file into the system at the end of the clinic day: this was called Electronic-Last. In 2015, the Zambian MoH together with key implementing partners introduced a direct entry system for SmartCare, with healthcare workers entering the data in real-time over a local area network: this was called Electronic-First (Moomba et al., 2020).

SmartCare system has now the ability to function either as a distributed (standalone) or as a centralized (client/server) mode. The distributed mode is used in the absence of online communication infrastructure were SmartCare-cards are used to transport patient data between different points of services or facilities. Computers running SmartCare system work independently without any network connection to each other. Each computer has its own database. Further in this mode, SmartCare system provides database merges by using any electronic data storage and exchange methods, for example flash disks and CDs. In the centralized mode, SmartCare system hosts the database on a central server and using online communications infrastructures such as LAN (Local Area Network) and Wireless LAN between networked computers running SmartCare system. This enables all points of services to obtain real time access to Patient's information from one database.

C. Security Measures

Health institutions work towards improving access to patient records. They have an obligation to ensure that ethical, privacy and confidentiality standards are met (Neame, 2013). Because patient information is confidential, there should be a balance between privacy and having the data readily available to those authorized to access it (Lee et al., 2013). The process of safeguarding the confidentiality and integrity of patient information is now a legal requirement that healthcare institutions should fulfil (Neame, 2013).

The SmartCare electronic patient record system (HIS) is safeguarded using staff login username and password credentials which are not exposed. Systems such as SmartCare should however incorporate more security features that protect against misuse by authorized users, hackers and those who steal the identity of patients (Lee et al., 2013). There are concerns about misuse of patient information accessed by different authorized health personnel. To address this need, Neame (2013) advocates for role-based access control (RBAC). RBAC is a method of restricting access to information based on the persons' role (Shen, 2020), for example only demographic data can be seen by a registry clerk.

Information on a lost SmartCare-card can be accessed by anyone if inserted into a computer, through a card-reader, with SmartCare software. In view of this security concern, Lee et al., (2013) suggested that in addition to using a SmartCare-card, there should be a secret key that should be entered before access to data on the SmartCare-card is granted. SmartCare-card will give the patient control of access to their records because the SmartCare-card will act as an index and access key to the SmartCare system database (Neame, 2013).

2.6.2 SmartCare System Functionality – Usability

'Usability' refers to the ease of access and/or use of a product. SmartCare system allows more than one user to access it. The system usable interface has three main outcomes; it should be easy for the user to become familiar with and competent in using the user interface on the first contact with the system, it should be easy for users to achieve their objective through using the system, and it should be easy to recall the user interface and how to use it on subsequent visits (Soegaard, 2018).

The goal of the program is to support the integration of data from multiple healthcare systems around a country (BroadReach, 2020), however there has been no evidence (at the time of this study) that the country systems are integrated. Technical factors, such as user-interface design and offline functionality, are likely to affect the user's experience with a HIS as well as the system's feasibility and acceptability (Shifo Foundation, 2016). For example, in Zambia, clinic staff's experience with failed attempts using SmartCare system and concerns regarding data loss impaired system uptake (Shelley et al., 2016). The SmartCare system is viewed as dependable and user-friendly. Though the database contained incomplete and incongruous data, staff perceived data as accurate but incomplete. Easy access to data was a strength (Clarke et al., 2019). Clarke et al., (2019) further argues that potential benefits of some SmartCare modules such as vaccination module were frequently unrealized due to infrastructure, workflow, and data flow challenges that resulted in low module use and poor information quality. A study by Mutale (2017) reviewed that health workers perceptions and experiences on SmartCare system was good. They pointed out that it was a good system, easier, efficient, and more convenient way to store and retrieve patient records than paper records. However, the study also showed that, SmartCare system was not being used for decision making in all the health facilities visited due to inadequate number of health staff to manage and enter data, work overload, duplication of work, lack of electric power to run computers, lack of support and regular maintenance of the equipment. To enhance utilization of SmartCare system for planning and decision making, it is important to strengthen health system related factors such as training and deploying specialized staff to help manage SmartCare system. It is also important to develop supportive infrastructure and other support systems in health facilities.

2.6.3 SmartCare System Performance – Stability

Software is a set of instructions, or a recipe, for a piece of hardware to follow. Much of the engineering done on a software project should be done to fit the project to those areas to remain stable. This yields a stable core design and, thus, a stable software product (Fayad and Altman, 2001).

SmartCare HIS is developed using an industrial standard modular architecture. The term modular product architecture is defined as a methodology or system that fulfils overall functions of a product through the combination of distinct modules which are designed independently (Shamsuzzoha, 2011). The modular product architecture provides the added advantage for simultaneous and phased development of various components of the application, without affecting the stability and integrity of the application (Mengesha, 2011). But despite the architecture, there have been reports of slow SmartCare system response and software system crashes. The system experiences software failure. Software failure occurs when the user perceives that the software has ceased to deliver the expected result. Gumede-Moyo et al., (2019) notes that data entry is often interrupted as the system also hangs up every now and then. The bulkiness of these databases affects the overall system performance. The program database system gets overwhelmed. The most significant causes of software failure are system overload, resource exhaustion and complex fault recovery routines. The Bisongrid (2018) goes on to say that computational performance of a computer server is measured by the hardware specifications that the server has. The main hardware components that affect a server's stability and ability to perform computational functions is the CPU or processor and RAM or memory (Bisongrid, 2018).

2.6.4 SmartCare System Scalability

Bondi (2000) describes scalability as “ability of a system, network, or process to handle a growing amount of work in a capable manner or its ability to be enlarged to accommodate that growth”. Scalability refers to the ability of a HIS to grow. These are the ability to add new users, add new program areas, add new levels of the health system, and/or new geographic areas of the country without degrading its performance. For example, in Zambia, can a HIS which began as a pilot project in a few districts accommodate the needs in data collection, reporting, analysis and dissemination, for the entire country? Can it do so for all health programs? (Boone and Cloutier, 2015). In computerized systems, a system whose performance improves after adding hardware, proportionally to the capacity added, is said to be a scalable system.

SmartCare system is designed to exchange data automatically and securely between different services in a facility. This is in the centralized mode, where SmartCare system hosts the database on a central server and using online communications infrastructures (LAN/Wireless LAN) between networked computers running SmartCare system in different services of the facility. This allows communication among different clinical services, that is, the lab, pharmacy, and other networked units and offices. Whether installed in a small clinic or a hospital, SmartCare system offers different options for data access and synchronizes data, eliminating redundancy of data entry. This integration includes patient demographics, provider notes, investigations, prescriptions, and scheduling (Mengesha, 2011). The CDC (2010) also states that the system supports integration of district, provincial and national system databases which makes monitoring and evaluation of HIV programs easier, however there has been no evidence (at the time of this study) that the country systems are integrated.

2.6.5 Risks and Challenges of SmartCare Electronic HIS in Zambia

Despite efforts to adopt and use HIS in most developing nations, various challenges have been faced leading to low rates of adoption compared to developed countries (Ouma and Herselman, 2008). A study by Berhanie (2014), whose focus was on the challenges and solutions of SmartCare HIS Implementation at Hiwot Fana Specialized University Hospital Laboratory in Ethiopia, found that the SmartCare electronic medical record was not serving the laboratory department and the professionals were not using it for the accomplishment of the Laboratory activities. He further went on to state that the participants of the project only used SmartCare system during the first 3 months implementation. The level of utilization of the system was gradually decreasing (Berhanie, 2014). E-Health infrastructure relevant or applicable also affects adoption and use of eHealth and ICTs for decision making in Africa (Qureshi et al., 2013).

One of the main risks and challenges of SmartCare system in Zambia is the high initial cost that comes with it. Some of these costs are computer costs and backup electricity power costs which has proved to be expensive. In rural health centres without electricity or other sources of power, there is often a backlog of paper-based health records that are not yet entered into the software system database. This backlog is a cause of concern about the completeness of the national database used for analysis (Miller and Sim, 2004; Richards et al., 2012; Tassie et al., 2010). However, using laptops with SmartCare HIS to capture the information at facilities without electricity has helped reduce the backlog of patient information that has not been entered into the national database. Furthermore, the use of SmartCare-cards ensures that even patients from these rural and remote locations have their medical history available once transferred to higher levels of care where electricity is available. However, some scholars advocate for inclusion of encryption on SmartCare-cards as a key security feature to prevent hackers (Ash et al., 2004). Neame (2013) observes that maintaining privacy and confidentiality by ensuring that access to health information is restricted and only allowed to those authorised by the patient is a major challenge. A study conducted by Mweebo (2014), focussed on security of SmartCare system in a resource limited setting in Zambia, highlighted that maintaining privacy and confidentiality by ensuring that access to health information is restricted and only allowed to users with access is still a major challenge. Furthermore, the study found that most doctors operating in the private sector are hesitant to share health information about their patients with other hospitals they perceive as competitors. In Zambia, another issue with the HIS is the existence of disjointed systems that do not communicate with each other (MoH, 2013), inaccurate data produced in reports generated by the system, data aggregation leading to erroneous data reporting (Kihuba et al., 2014), and software system bugs which causes hanging (MoH, 2009).

2.7 Chapter Summary

The chapter discussed the literature pertaining the research questions and topics to be answered. The chapter presented an overview of the project success and project management Knowledge Areas of scope and quality emphasized for this study. It also gave an overview of Health Information System globally and within Zambia. In Zambia, the focus was on SmartCare Electronic Health Record System, and further outlined its benefits, outputs, success factors and challenges. The following chapter outlines the methodology used for the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter gave an overview of what is known about the HIS. It described earlier studies done on the topic. This chapter presents a detailed explanation supporting the choice of research methodology used for the study. The chapter includes the research methodology, study design, study settings, study population, study sample with a review of research methods sampling technique and characteristics of the sample. The chapter also outlines the data collection procedure and timeline followed.

3.2 Research methodology

The research methodology is the specific procedures or techniques used to investigate a research problem and the rationale for the application of specific procedures or techniques to identify, select, process, and analyse information applied to understanding the problem, thereby, allowing the reader to critically evaluate a study's overall validity and reliability (Kallet, 2004). To establish this study findings, the project management tenets used were Project Scope Management and Quality Management Knowledge Areas. The methodologies adopted were qualitative approach and quantitative approach. These were used to assist in understanding the problem and find workable solutions to answer the research questions.

3.2.1 Mixed Method Approach

Mixed method types of research are defined as studies that are products of the pragmatist paradigm that combine the qualitative and quantitative approaches within the distinct phases of the research process (Tashakkori and Teddlie, 2008). Mixed methods allow the researcher to develop research protocols in stages and it further offers more than one way of looking at a situation, facilitates varied perspectives and allows for triangulation (O'Leary, 2010). Welman and Kruger (2001) assert that mixed methods allow for the use of both methods and helps to overcome either of their shortcomings. It is for this reason that a mixed method approach was adopted to balance out and overcome either limitation and offer more validity and reliability to the findings of the research. Mixed method was adopted to provide better focus by developing better and more specific instruments according to the research.

Quantitative methods provided quantified numerical data to measure critical success factors and challenges of HIS, as well as measure the performance and functionality of SmartCare HIS in Zambia. Qualitative methods were used to compare the international standard components of HISs to the key components of SmartCare HIS in Zambia.

A comprehensive research framework through which the research was carried out included the following activities:

1) Identification of the research topic.
2) Definition of the research problem and research questions.
3) Review of the literature available on the research matter.
4) Creation of the data collection tools.
5) Collect data.
6) Research data analysis
7) Research results and discussions
8) Summary of conclusion and recommendations

3.3 Research design

A research design shows a description of a plan to be used in collecting the relevant evidence to achieve the study objectives. For instance, case study, correlation, exploration, description, diagnosis, experimentation, and survey research designs. Welman and Kruger (2001) observes that the research design attempts to examine research situations to establish what the norm is, and what can be predicted to happen again. For this study, descriptive study design was adopted. This design relied on survey questionnaires, structured interviews, and literature review as a means of collecting data. These gave a picture of what is happening in a population. The quantitative approach relied on the survey questionnaires whilst the qualitative approach relied on structured interviews. The qualitative design method was suitable for this research because it enabled the author to interview and investigate the target group of participants, SmartCare users, to get the information that was required for the research and needed to create the survey questionnaire.

3.4 Study Setting

The study was conducted in Lusaka district of Lusaka province. The City of Lusaka is situated in the central part of Zambia. The district has a surface area of 360 square kilometres. The co-ordinates for Lusaka are 280-10' east of the Greenwich meridian and 150-30' south of the Equator. It shares district boundaries with Chongwe in the east, Mumbwa in the west, Chisamba in the north and Chilanga district in the south (LCC, 2018). The central position of the city has made it to be one of the most important economic hubs of Zambia as it provides the market for the absorption of the agriculture produce from all provinces. It projects a population of 1, 747 000 (CSO, 2010). As of the year 2012, Lusaka district had a total number of 45 government health facilities and of these, 23 had SmartCare Health Information System running (MoH, 2012).

3.5 Study Population

Population in research methodology is understood to be objects, phenomena, cases, events, or activities specified for sampling (Brynard and Hanekom, 2005). The study population comprised of SmartCare HIS users: Data Associates, Assistant Monitoring and Evaluation (M&E) Officers, SmartCare HIS Data Coordinators and Technical Support officers in Lusaka Zambia. These are system users and coordinators who had been trained and had experience in the utilisation and coordination of SmartCare system in Zambia.

3.6 Sample size

Sampling is defined as the process of obtaining information about an entire population by examining only a part of it (Kothari, 2004). Sapirie (2000) elaborates an approach of health information system assessment which has been developed by WHO and used in several countries. It encourages the selection of subsystems and domains for assessment because normally it is not possible to assess all health information subsystems in one study. The assessment does not have to be nationwide but could, for example, focus on one province or region. It is for this reason that the research sample size was focused in one region, Lusaka district of Lusaka province, and one health system category which is First (1^{st}) Level Hospital. Lusaka province was purposively selected because Lusaka is the provincial capital of the country and was the first province to have had rolled out and implemented the system.

To answer research question 1 and 2 via closed-ended questionnaire, which sought to determine the critical success factors and challenges of HISs and to measure the performance and functionality of SmartCare HIS in Zambia, an entire population of SmartCare HIS users which comprised of eighty-two (82) Assistant M&E Officers drawn from 1st Level Health Systems of the sub-districts of Lusaka district of Lusaka province Zambia were subjected to questionnaire survey. To have proficient and experienced SmartCare Assistant M&E officers, the inclusion criteria included respondents who had been trained or oriented to use SmartCare system. Exclusion criteria: Assistant M&E officers at the facility trained in SmartCare but with limited user rights for instance officers with only data entry rights. The eighty-two (82) Assistant M&E Officers selected as respondents for the structured questionnaire, were drawn from six (6) 1st Level Health Systems as shown in table 3.1.

Table 3. 1 – Number of Assistant M&E Officers respondents per Health System Category

S/N	Facility	No. of Assistant M&E Officers
1	Chelstone 1st Level	23
2	Chawama 1st Level	10
3	Chilenje 1st Level	13
4	Chipata 1st Level	6
5	Kanyama 1st Level	17
6	Matero 1st Level	13
	Total	**82**

To answer research question 3 and 4, which sought to compare the HIS standard components to the components of SmartCare HIS in Zambia, the sample size of ten (10) trained Data Associates (DA) and nine (9) SmartCare Data coordinators and Technical Support Officers were subjected to In-depth interviews (IDI). The inclusion criteria included DAs with at least 3 year’s work experience of using the system, and coordinators and technical support officers with at least 5 years' experience of coordinating and managing SmartCare HIS project in Zambia. The exclusion criteria were coordinators and officers not involved in the coordination and/or managing of SmartCare HIS for more than 3 years.

3.7 Sampling Techniques

Purposive Sampling is a non-probability sampling techniques that a researcher uses to choose a sample of subjects from a population (Etikan et al., 2016). This sampling method requires the researcher to have prior knowledge about the purpose of their studies so that they can carefully choose and approach eligible participants. Researchers use purposive sampling when they want to access a particular subset of people, as all participants of a study are selected because they fit a particular profile (Dawson, 2017). Purposive sampling was used in the study because it is convenient, and beneficial to the study. This was used in this study to reveal participant's experiences and the meaning that they attribute to these experiences and social words.

A total population sampling was used to examine the entire population of SmartCare HIS users (82 Assistant M&E Officers) in Lusaka district of Lusaka province. A total population sampling was used because the size of the population that had a particular set of characteristics of interest was small. Creation of the list of entire population was done with assistance from the Strategic Information (SI) Lead and Database Administrator at the Lusaka Provincial Health Office (LPHO) under the MoH Zambia.

Purposive sampling was further used in this study to select the study participants that were seen as best to provide information that was required from the research structured interviews. Twenty (20) participants were approached. Eligibility and location of candidates helped me to narrow-down the list to the required number. Purposive sampling was used to collect data from a sample of ten (10) SmartCare HIS users (Data Associates) and nine (9) SmartCare system Coordinators and Technical Support Officers. Recruitment of study participants was done with assistance from the SI Manager and Data Coordinator of one of the implementing partner organisations of MoH. The implementing partner organisation assists MoH in implementing and providing technical assistance.

Before we started data collection, we went to LPHO to seek permission about our planned study. Upon getting clearance, we sought assistance from the assigned Data Coordinator who assisted me with information of all Data Associates, Assistant M&E Officers, as well as Data Coordinators and Technical Support officers in Lusaka province. Before the interviews, we would clearly explain the purpose of the study and if a participant indicated that they were interested in participating or in getting further information, we would ask for their phone numbers to call them later to set an appointment. At the first meeting with participants, we would provide information about the study through the information sheet and would confirm their age, whether active users of the system and their work experience. After assessing eligibility and if agreeable to participate in the study, formal consent would be obtained using the consent forms approved by the Research Ethics Committees. Thereafter, we conducted the interviews.

For the online structured questionnaire form, which was created, distributed, and stored online via an online application called Google forms, it equally indicated the purpose of the study as well as guaranteed observation of research ethics such as upholding of confidentiality, anonymity etc. Information collected was stored online on Microsoft OneDrive, which is a cloud solution with restricted, password-protected access. The information was also backed up on an encrypted MacBook computer accessed only by us and kept in our office with restricted entry.

3.8 Data Collection Instruments

Both primary and secondary data collection were used for this research. Primary data is data that has been observed, experienced, or recorded close to the event and is nearest that one can get to the truth (Ghosh, 2011). Secondary data is data from written sources that interprets or record primary data (Kothari, 2004).

3.8.1 Primary data

Appropriate instruments should be designed to make it easy and consistently elicit and record the required information during visits to selected facilities and offices. Data collection methods which are commonly used in health information system assessments include: reviewing and extracting records; checking equipment and supplies; observing and recording consultations; interviewing staff; and holding focus group discussions with staff and clients (Sapirie, 2000).

During this study, primary data was collected using Questionnaires and In-depth interviews (IDI). Information from IDI helped with creating questionnaires which were distributed online. The questionnaire and IDIs were used respectively in this study to obtain the participant's experiences and the meaning that they attribute to these experiences and social words.

A. Questionnaire

A questionnaire is a research instrument consisting of a series of questions for the purpose of gathering information from respondents through survey or statistical study. It is commonly used because it is less expensive, reaches a larger number of respondents, represents an even larger population, allows for comparison, and generates standardized and quantifiable. Some of the disadvantages are it can be difficult gathering in depth data, often difficult to get a representative sample to respond to the questionnaire, needs proficiency in statistical analysis, may require going back to respondents if more data is required, capturing the quantifiable data required etc.

There are three basic types of questionnaires namely, open-ended, closed-ended or a combination of both.

A1. Open-ended Questionnaire

Open-ended questionnaires are used in qualitative research, although some researchers will quantify the answers during the analysis stage. These questionnaires have blank sections for respondents to write an answer on to and allow for recording of any response to a question provided by the respondent. Ghosh (2011) noted that data analysis is more complex with open ended questionnaires due to the non-standard answers to the questions in it. This study did not adopt this type of questionnaire.

A2. Closed-ended Questionnaire

This type of questionnaire is used to generate statistics in quantitative research. Close ended questionnaires have already predefined answers that the respondent answers to. These questionnaires follow a set format and can be scanned straight into a computer for ease of analysis. A Likert scale was used in this study to allow for respondents to indicate answers according to the predefined list. Likert scale is used to measure attitudes to set statements put by the questionnaire (Wilkinson and Birmingham, 2003).

During this study, a self-administered closed-ended questionnaire for quantitative data was used to collect data from the SmartCare users within the 1st Level health system category of Lusaka district of Lusaka province Zambia. The questionnaire was created, distributed, and stored online using an application called Google forms. The study chose to use an online questionnaire because of movement restrictions that came with the Coronavirus (COVID-19) pandemic. Other reasons of choosing an online questionnaire were because it is much more effective and efficient as compared to paper-based questionnaire. Closed-ended questions were asked to obtain information for quantitative data.

A3. Combination of Open-ended and Closed-ended Questionnaire

A combination of both questionnaires is used by many researchers because they capture the qualitative and quantitative data requirements of the subject area being researched on. This study did not adopt this type of questionnaire.

B. In-depth Interviews

In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. IDIs are useful when one wants detailed information about a person's thoughts and behaviours or want to explore contemporary issues in depth. Interviews are often used to provide context to other data such as outcome data, offering a more complete picture of what happened in the program and why (Boyce and Neale, 2006).

Some of the challenges of IDIs are time consuming, as interviews must be transcribed, organized, analysed, and reported. They are very expensive method compared to other methods; if the interviewer is not highly skilled and experienced, the entire process can be undermined and most participants typically expect an incentive to participate, and this must be carefully selected to avoid bias. Despite these disadvantages, the IDI have a higher quality of sampling compared to some other data collection methods, they are useful for providing much more detailed information, researchers need fewer participants to glean useful and relevant insights, iinterviews have greater opportunity to ask follow-up questions, probe for additional information, and circle back to key questions later in the interview to generate a rich understanding of attitudes, perceptions, motivations, etc. IDIs can also allow interviewers to monitor changes in tone and word choice to gain a deeper understanding and because IDI can potentially be so insightful, it is possible to identify highly valuable findings quickly. It is because of these reasons that IDIs were used in this study to involve asking open-ended questions to the research participant to discover their precepts on the topic of interest.

Interviews are classified into distinct categories namely, unstructured, structured, and semi-structured interviews.

B1. Unstructured Interviews

Unstructured interviews according to Kumar (2018), provide complete freedom in terms of content and structure. The interviewer is free to order their questions in whatever sequence, words used and the way the questions are explained to the respondent. Unstructured interviews are prevalent in both quantitative and qualitative research the only difference is in how information obtained through them is used. This type of interview technique was found not suitable for this research.

B2. Structured Interviews

In structured interviews the researcher asks predetermined set of questions, using the same wording and order of questions as specified in the interview schedule. An interview schedule is defined as a written list of questions, open ended or closed prepared for use by an interviewer in a person- to- person interaction, by telephone or by any other electronic media. The main advantage of structured interviews is that it provides uniform information which assures the compatibility of data, and it requires fewer interviewing skills than does unstructured interviewing (Kumar, 2011).

For this study, structured technique was used to get detailed information from respondents. The IDIs were conducted with various SmartCare system users (data associates), data coordinators, and technical support officers. Open-ended questions were asked to obtain information for qualitative data. Purposive sampling was used to select participants for interviews that were seen as best to provide information that was required from the research questions. Eligibility and location of candidates helped to narrow-down the list to the required number. The interview guide helped the researcher outline issues that the researcher felt were important which made respondents give valid and detailed raw data.

B3. Semi-Structured Interviews

Semi-structured interviews combine both the structured and unstructured interview styles and offers the advantages of both. This type of interview allows for the objective comparison of candidates, while also providing an opportunity to spontaneously explore topics relevant to that candidate. Semi-structured interview technique was found not suitable for this research.

B4. Stages used to Develop an Effective Interview

The six stages used to develop an interview according to Wilkinson and Birmingham (2003) were:

Stage 1: Draft Interview Questions

This involved the construction of questions that the interviewer would like to ask. The number, type and format of the questions was determined by the design structure of the interview.

Stage 2: Pilot Questions (Validity)

This involved the actual testing of the interview questions with a select few people to assess whether the interview questions were clear or needed any revisions. Piloting assisted in identifying, eliminating, and correcting any imperfections noted before the actual interview.

Stage 3: Select Sample Interviewees

The research questions were used to help in identifying probable interviewees. Open ended questions were used as these provided more information from the interviewees.

Stage 4: Conduct Interviews

This were the actual and final interviews conducted with the credible interviewee. To ensure effective communication was taking place between the interviewer and interviewee, the interviewer needed to restate part of interviewees' responses to make clarifications to statements that were said.

Stage 5: Transcribe Data

This involved repeated carefully listening and conversion of the audio recordings of interviews to text format. The process included but not limited to judgements about what level of detail to choose data interpretation and data representation.

Stage 6: Analyse Interview

This was the final stage of the interview which involved consolidating the transcribed data and structured it in a way that it could be analysed. The analysis involved grouping the responses to each question from all interviewees to make comparison between respondents easy.

3.8.2 Secondary data

The secondary data of the study was collected through literature review. Literature review offered justification for the research topic 'Investigating the implementation of SmartCare Electronic Health Information System project using tenets of project management' and provided the basis for comparison and contrast of ideas among already researched work. It also reviewed other researchers work to refine ideas for use in the research study.

Literature review was focused on defining and assessing projects with focus on HIS projects to determine amongst other issues, critical success factors and challenges of HIS as well as determine the standard components of a strong HIS. The standard key components of a HIS were compared with the actual key components of SmartCare HIS. Information was abstracted from journals, relevant books, papers, and other written materials and SmartCare system records/technical reports. The collection was done by the principal investigator. These sources of data provided the most and recent up to date information on the topic. Only verified and approved data was reviewed and incorporated into this document. Due to scarcity of literature on SmartCare HIS in public institutions, the internet was the main source of secondary data.

3.9 Data Analysis Plan

3.9.1 Quantitative Data Analysis Technique

For quantitative arm, data was analysed using STATA software (Stata Corporation, College Station, TX, USA) and Microsoft Excel tools. The data was collected using closed-ended questionnaires. The excel formulas was used to aggregate data to create meaningful reports. Data was presented in form of tables and graphical presentations in information.

3.9.2 Qualitative Data Analysis Technique

For qualitative arm, in-depth interviews were transcribed and analysed using the thematic analysis approach. Interviews were recorded with participant permission and transcribed verbatim. Throughout the interviews, probes were used to solicit reasons and explanations to understand the meaning participants attached to their experiences. Interview scripts were iteratively read to identify concepts that were labelled as codes. A codebook was then created inductively and deductively using the interview guide. Transcripts were coded and grouped into categories for further exploration and interpretation of the findings. Categories were organized into themes capturing the key functional components of SmartCare HIS in Zambia and its recommended practice. Using the themes, summaries of findings were created to help further refine, organize, and reflect on the findings.

3.10 Ethical considerations

The information obtained for this study was solely collected to assist with this study. Information pertaining to an individual or institution was not used for any other purpose without their consent.

Approval to conduct the research was sought from the Natural and Applied Sciences Research Ethics Committee (NASREC) and the National Health Research Authority (NHRA), who's responsibility is to promote and regulate research in Zambia. The research bordered on issues of health systems strengthening hence permission to conduct the research was approved by the MoH through the Lusaka Provincial Health Office (LPHO), who are responsible for the data and the HIS in the province. No personally identifying information was collected. Respondents were assured of their privacy and confidentiality in that no titles or names were reflected in the interview guide.

3.11 Chapter Summary

The chapter looked at the methodology used to achieve the objectives of the research. It presented the research methodologies whose purpose was to describe the plan used in collecting the relevant evidence to achieve the objectives. The next chapter discusses and analyses the findings.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

The previous chapter discussed the methodology used to achieve the objectives of the research. This chapter discusses the presentation of the results collected and analyses the findings. The chapter presents the information obtained from all respondents using self-administered closed-ended questionnaire and structured in-depth interviews which allowed use of quantitative and qualitative approach. Information presented includes results in form of bar charts, pie charts and tables.

4.2 Response Rate of Respondents

The target group for quantitative closed-ended questionnaire was eighty-two (82) Assistant Monitoring and Evaluation Officers (M&E Officers) in the 1st Level Health Systems located in Lusaka district of Lusaka province Zambia. A total population sampling was used to examine the entire population of the SmartCare HIS users, and 100 percent of the intended respondents responded and participated in the study. The questionnaire was created and distributed online via Google forms application.

For qualitative structured interviews, the target group was ten (10) SmartCare system Data Associates, and ten (10) SmartCare system coordinators and technical support assistants from various health facilities and districts in Lusaka province. However, only nine (9) in-depth interviews were conducted because of saturation levels. No additional data was being obtained. The interviews were conducted in various physical locations as well as online using Zoom and Microsoft Teams applications. Some interviews were conducted with minimal disturbances whilst others took long because of disturbances during the interviews.

To address credibility and unbiased results, the eighty-two (82) questionnaire and nineteen (19) interview respondents were unlike.

4.3 Questionnaire Results

The primary data was collected through a questionnaire survey. The questionnaire was developed based on an extensive literature review. The purpose of the questionnaire was to determine the critical success factors and challenges of SmartCare HIS, and to measure the performance and functionality of the system in Zambia. The SmartCare users, Assistant M&E Officers, were targeted to respond to the survey questionnaire.

The questionnaire was divided into four (4) sections. Section 1, consisted of socio-demographic characteristics which included gender, age in years, qualifications, years in work experience and current work location.

Section 2 to 4 of the questionnaire consisted of technical questions. Section 2 captured how users viewed the technical performance of the SmartCare system. Section 3 collected information on the technical functionality of the system. The performance and functionality of the system were in comparison to the set global standards captured in literature. And finally, section 4 was about the success factors and challenges of the system observed by the users. The full questionnaire is shown in Appendix I.

4.3.1 Socio-Demographic Profile of Respondents

Frequency distribution was to display the socio demographic profile of the respondents.

A. Gender

Figure 4.1 shows the gender distribution. It shows the number of participants by gender. Out of 82 respondents, 35 were male representing 42.68 percent and 47 were female representing 57.32 percent.

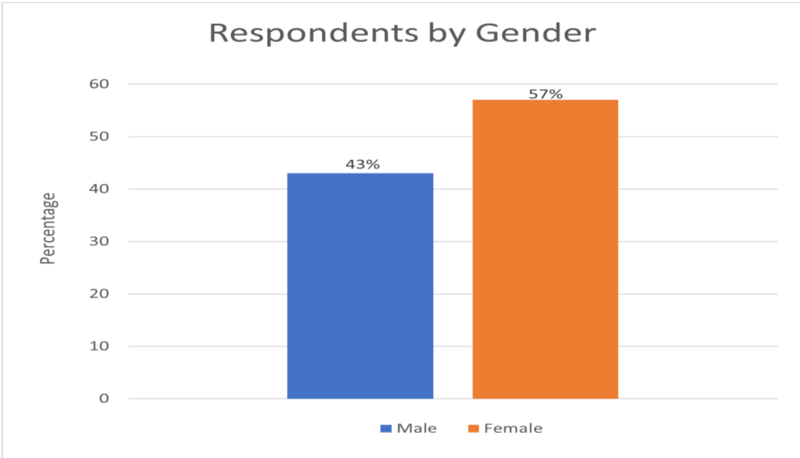

Figure 4. 1: Questionnaire Respondents by Gender

B. Age Group

Figure 4.2 shows the Age group distribution. Most respondents representing 40.24 percent were between 30 and 34 years. The second highest age group of respondents were ages between 25 and 29 years with 36.59 percent of the sample frequency 30, followed by the age group 35 to 39 years with 12.20 percent. Whereas 7.32 percent were aged 40 years and above and the least age group was between 18 to 24 years with 3.66 percent of the sample.

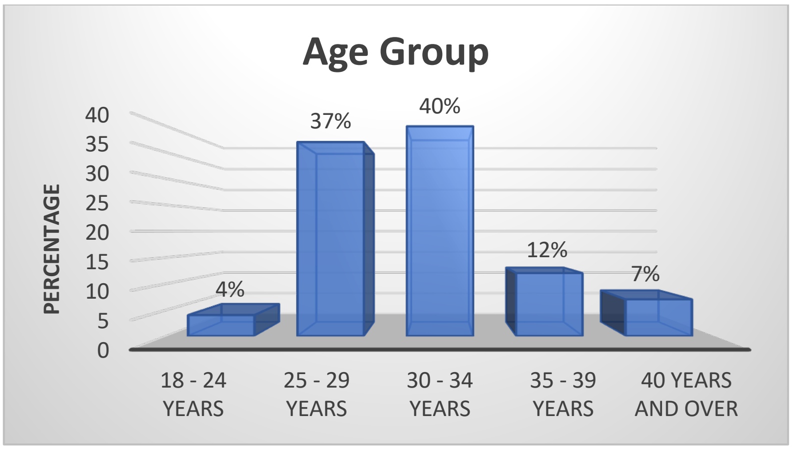

Figure 4. 2: Age Group Distribution of Questionnaire Respondents

C. Level of Education

The highest level of academic education of respondent's as shown in Figure 4.3, is bachelor's degree with 68.29 percent at a frequency of 56. This was followed by diploma holders with 26.83 percent at a frequency of 22. The least were master's degree holders with 4.88 percent at a frequency of 4.

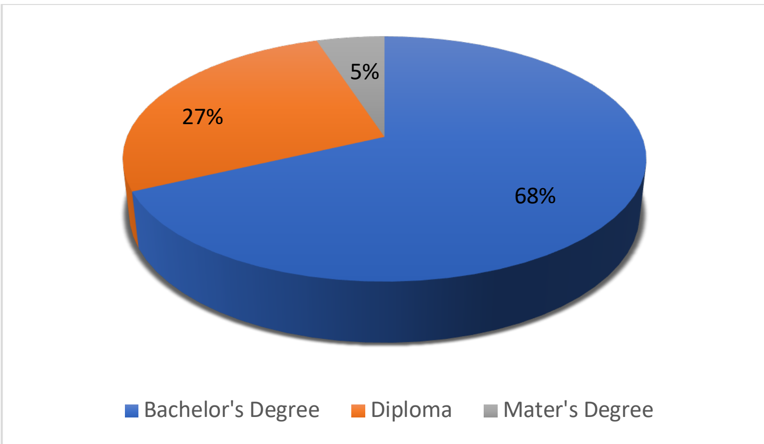

Figure 4. 3: Questionnaire Respondents Academic Qualifications

D. Years of Work Experience

Most respondents as seen in Figure 4.4, had 2 to 3 years' work experience representing 34.15 percent of sample frequency 28. The graph also shows 26 percent had 4 to 5 years' experience. 20.73 percent of respondents had less than one year of experience and 19.51 percent had over 6 years of experience. This is acceptable as most of the SmartCare users are new with less than 5 years' work experience. This is because the MoH recently took charge of managing SmartCare system from implementation partners (IPs) at health facility level across the country, where in most cases the ministry employed new system users. The IPs (Implementing Partners) assist the MoH in implementing goals and providing technical assistance.

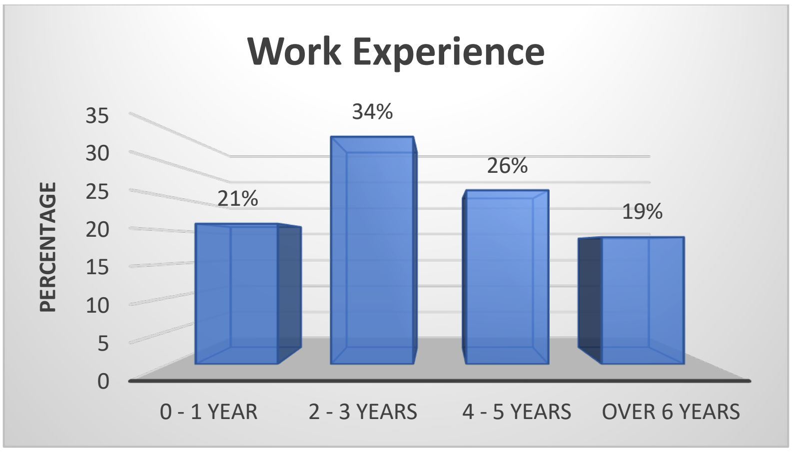

Figure 4. 4: Questionnaire Respondents Work Experience

E. Respondents Location

Another characteristic used to categorize the respondents was the location per sub-district. Figure 4.5 shows that, most of the respondents were coming from Chelstone at 28.05 percent with a frequency of 23. The second highest group of respondents were from Kanyama at 20.73 percent with a frequency of 17, followed by Chilenje and Matero both with 15.85 percent, whereas 12.20 percent were from Chawama with the sample frequency of 10. The least group of respondents were from Chipata at 7.32 percent.

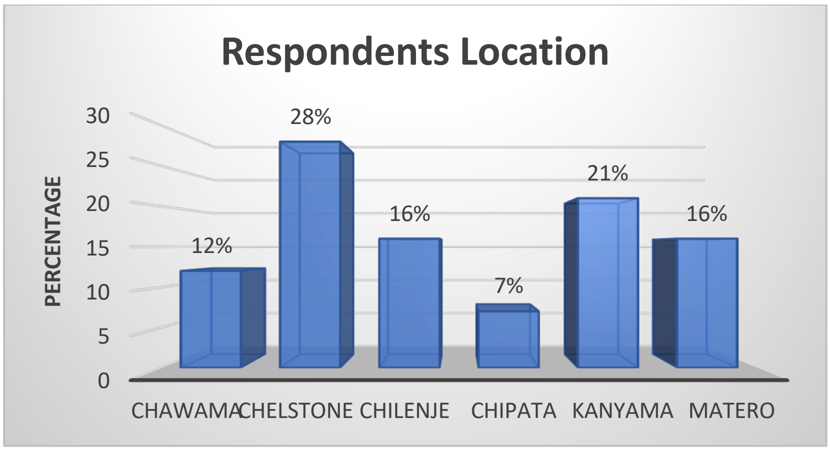

Figure 4. 5: Location - Questionnaire Respondents

F. Summary of Socio-Demographic Data

Table 4.1 summarizes the respondent's socio-demographics, with majority of respondents being female with an age group of around 30-34 years, with an education level of first degree with about 2-3 years of work experience, with majority of them coming from Chelstone 1st Level health systems. Therefore, the information given by is considered credible.

Table 4. 1: Characteristics of SmartCare users that responded to Questionnaire

Characteristics	Percentage (%)
Gender	
Male	43
Female	57
Age Group	
18-24	4
25-29	37
30-34	40
35-39	12
40 and above	7
Level of Education	
Diploma	27
Bachelor's Degree	68
Master's Degree	5
Work Experience	
0-1 Year	21
2-3 Years	34
4-5 Years	26
Over 6 Years	19
Location	
Chawama	12
Chelstone	28
Chilenje	16
Chipata	7
Kanyama	21
Matero	16

4.3.2 SmartCare System Success Factors and Challenges

This area of the survey focused on measuring the success factors and challenges of the SmartCare HIS. Success factors and challenges are the different internal and external influences which impact the potential success of a project. To measure the systems' success factors, the Likert scale of 1 to 5 used were: 1 = Strongly agree; 2 = Agree; 3 = Disagree; 4 = Strongly disagree; 5 = Neither disagree nor agree. Table 4.2 shows measures of success factors.

Table 4. 2: Measures of SmartCare System's Success Factors

Measurement		**Variables**					
		Strongly agree	Agree	Disagree	Strongly disagree	Neither disagree nor agree	Mean Score
Satisfied with quality in terms of system dependence	Freq	1	51	20	1	9	16.4
	Percent	1%	62%	25%	1%	11%	20%
SmartCare allows more than one user to access at the same time	Freq	44	34	2	1	1	16.4
	Percent	54%	42%	2%	1%	1%	20%
Satisfied with availability of interfaces that allow access information like lab results	Freq	13	65	2	1	1	16.4
	Percent	15.9%	79.3%	2.4%	1.2%	1.2%	20%
Satisfied with information quality and information system effectiveness	Freq	2	59	16	0	5	16.4
	Percent	2%	72%	20%	0	6%	20%
Satisfied with compatibility of system with other systems	Freq	2	56	14	2	8	16.4
	Percent	2.4%	68.3%	17.1%	2.4%	9.8%	20%

The results in table 4.2 show that most of the respondents were satisfied with the quality of SmartCare system in terms of dependence at 62 percent and very satisfied at 1 percent. A combination of 62 percent and 1 percent of 'agreed' and 'strongly agreed' make a total percent of 63 percent. The mean score of the five variables is

20%, therefore, 63 percent of the users found the quality of the system to be very dependable.

The results further showed that 42 percent of the respondents agreed, and 54 percent strongly agreed that the system allows more than one user to access it at the same time. A combination of agreed and strongly agreed rating represents 96 percent of respondents with a frequency of 78, and a mean score of the variables as 20%. Meanwhile, 79.3 percent of respondents were satisfied and 15.9 percent very satisfied with the availability of the system interfaces that allow access to information like lab results. The total percent of agreed and strongly agreed rating therefore is 95.2 percent.

A total of 61 out of 82 respondents, a combination of 72 percent and 2 percent were satisfied and very satisfied with the quality of the information and the effectiveness of the health system. In terms of the system's compatibility with other information systems, 68.3 percent and 2.4 percent of respondents agreed the system was compatible.

In summary, table 4.2 shows the mean scores, at 20%, of variables used to measure the systems' success factor. The table also shows all five critical success factors rated as 'agreed'. The average percent of the ratings 'strongly agree' and 'agree', of the critical success factor measures is 80 percent. The rate 80 percent of the parameters is interpreted as excellent (University of Pretoria, 2015). This indicates that an extremely respectable number of users felt the system works according to the required qualities and/or having high standard and reflects the said success factors. The average percent of 80 percent of the rates rated as 'strongly agree' and 'agree' is as calculated below:

Critical success factor Average Percent = (63 percent + 96 percent + 95.2 percent + 74 percent + 70.7 percent)/5 = 80 percent.

The global scoring guide as observed by the University of Pretoria (2015) is as follows

- Outstanding 90 percent - 100 percent
- Excellent 80 percent - 89 percent
- Very good 70 percent - 79 percent
- Good 60 percent - 69 percent
- Average 50 percent
- Poor 40 percent - 49 percent
- Below minimum standard expected 0 percent - 39 percent.

Overall, good is interpreted as having the required qualities and/or having high standard, excellent and very good are interpreted as superb, very high standards, and poor is interpreted as performance below required standard. Manikandan (2011) notes that average represents the middle point (mean) and is interpreted as a proper balance of conflicting interests or defined as acceptable.

To measure the SmartCare systems' challenges, the Likert scale of 1 to 5 used were: 1 = Strongly agree; 2 = Agree; 3 = Disagree; 4 = Strongly disagree; 5 = Neither disagree nor agree.

Table 4.3 shows measurements done to highlight the challenges of SmartCare HIS. This section consists of various deliverable topics.

Table 4. 3: Measures of SmartCare System's Challenges

Measurement		**Variables**					
		Strongly agree	Agree	Disagree	Strongly disagree	Neither disagree nor agree	Mean Score
SmartCare has high initial costs such as physical infrastructure like backup power electricity	Freq	30	48	3	1	0	16.4
	Percent	37%	58%	4%	1%	0	20%
Private sectors hesitant to share health information with public hospitals	Freq	15	30	15	3	19	16.4
	Percent	18%	37%	18%	4%	23%	20%
SmartCare-cards lack encryption security feature that can prevent hackers	Freq	10	49	9	0	14	16.4
	Percent	12%	60%	11%	0	17%	20%
SmartCare is linked and integrated with other Health Systems in other facilities	Freq	3	23	38	9	9	16.4
	Percent	4%	28%	46%	11%	11%	20%

Table 4.3 shows SmartCare system challenges measured with variables with mean scores of 20%. When asked if SmartCare system has a high initial cost such as physical infrastructure, 58 percent of respondents agreed and 37 percent strongly agreed. A total of 95 percent, representing agreed and strongly agreed ratings, therefore agreed that high initial cost of equipment's such as computer and other physical infrastructure like backup power electricity is among the main challenges of

SmartCare system in Zambia. Most respondents representing 37 percent and 18 percent, agreed, and strongly agreed that private sector health institutions are hesitant to share health information with public hospitals as they perceive them as competitors. The table further show that most respondents at 60 percent and 12 percent agreed and strongly agreed that SmartCare-cards lack encryption security feature that can prevent hackers from hacking the online system. The total agreed rating is 72 percent. However, the majority of respondents representing 46 percent and 11 percent disagreed and strongly disagreed, that SmartCare system is linked and integrated with other health systems in other facilities. A combination of 57 percent therefore observed that the system is not linked and/or integrated with other systems.

In summary, table 4.3 show the mean scores, at 20%, of variables used to measure the systems' challenges. The table also show one out of the four system challenges, rated as 'disagreed'. The average percent of the ratings 'strongly agree' and 'agree,' of the system challenge measures is 64 percent. The rating between 60 percent to 69 percent according to the university of Pretoria (2015), is interpreted as good. This means a sizeable number of respondents agree the system exhibits the challenges. The average percent of the rates rated as 'strongly agree' and 'agree' of the system challenges is as calculated below:

System Challenges Average Percentage = (95 percent + 55 percent + 72 percent + 32 percent)/4 = 64 percent.

A. Discussion of Results

Critical Success Factors (CSFs) and challenges are the different internal and external variables or conditions which are critical to the success or failure of a project. According to PRINCE2's definition, CSFs are elements in a project that are critical to the project achieving its mission or goal. The CSFs help focus on the elements that are vital to the project success. The degree of project challenge depends on the way constraints are applied and interpreted within the organization. The measures of SmartCare System's Success Factors and challenges as seen from table 4.2 and 4.3 are:

A1. Satisfaction of System Quality in terms of Dependence

Dependability is one of the most important facets of a computer system. It is the trustworthiness of the system. Not only does dependability refer to confidence in the system, but it also outlines reliability, security, integrity, availability, and resilience. Acceptability of a HIS by health care professionals is very often influenced by technical characteristics mainly linked with system's speed and reliability, stability, and security issues (Adler, 2007). The SmartCare system is reported to be safeguarded using staff login username and password credentials which are not exposed. The modular product architecture of SmartCare provides the added advantage for simultaneous and phased development of various components of the application, without affecting the stability and integrity of the application (Mengesha, 2011). In literature chapter of this study, the scope and quality attributes of SmartCare HIS was recognized in various categories. The attributes were system security, system stability, system usability, system scalability and network requirements.

An investigation in this study revealed that SmartCare system is dependable. Not only did the 63 percent of respondents express confidence in the system, but they accepted the availability, security, and integrity of the system. The respondents also established that an average percent of respondents representing 50 percent felt the system is stable.

A2. Multi-user Access of SmartCare

A multi-user access system is one that can be accessed by more than one user at a time while running on a single machine. Different users access the machine through networked terminals (devices). Soegaard (2018) reported that SmartCare system allows more than one user to access it. Finding seen in this study was that in the centralized mode, SmartCare system hosts the database on a central server connected to networked computers running SmartCare system which could be in different departments of the facility. This allows accessibility and communication among different clinical services (Mengesha, 2011). An investigation in this study established that SmartCare system is a multi-user system. The system allows more than one user to access it at the same time. It permits several users to access the central server system database. This is according to 96 percent of study respondents. This means that the system can handle requests from different connected users at the same time.

A3. Availability of System Interfaces

An interface is a shared boundary across which two or more separate components of a computer system exchange information. The exchange can be between humans, software, computer hardware, peripheral devices, and combinations of these. The user and system thus relate to each other with the help of interface. SmartCare system offers a touch screen interface. The screen interface menus help to navigate through the different modules/components (Adler, 2007). An investigation in this study revealed that the systems interface is available and allows access to information in SmartCare such as Lab information. The computer system allows the user to interact with components of the system. Most respondents, 95.2 percent, alluded that the interface allowed them to access electronic forms that are used to record information stored in the system database.

A4. Information Quality and Effectiveness of information System

According to Rai et al., (2002), information quality is one of the prerequisites of information system success. Clarke et al., (2019) argued that potential benefits of some SmartCare system modules were frequently unrealized due to infrastructure, workflow, and data flow challenges that resulted in low module use and poor information quality. Several studies have raised concerns about the performance of HIS suggesting its information system ineffectiveness and production of poor-quality data (Hahn et al., 2013), in this study however, it was revealed that SmartCare system is effective and produces good-quality data. 74 percent of respondents were satisfied with the quality of the information and the effectiveness of the health system. Out of the five constructs needed to have a successful information system, information quality of SmartCare system is considered as success.

A5. Satisfaction of SmartCare Compatibility

Software compatibility is a characteristic of software systems which can operate satisfactorily together on the same computer, or on different computers linked by a computer network.

Some of the issues that surround the performance of HISs are system compatibility (Hamamura et al., 2017), system quality (Topaz et al., 2016; O'Donnell et al., 2018) and system inefficiency (slow response) (Nguyen et al., 2014). Compatibility testing allows one to check whether the software can run on different hardware, operating systems, applications, network environments or mobile devices.

It was observed in this study however that SmartCare system is compatible with other systems or network environment. The study instead found that the HIS can run on different computer hardware, computer operating systems, applications, network environments or devices. SmartCare system works under different configurations.

A6. SmartCare has High Initial Cost

Despite the growing literature on benefits of HISs, some authors in literature highlight drawbacks associated with HISs, which include the high initial costs and ongoing maintenance costs. According to Miller et al. (2004), one of the main challenges of SmartCare system in Zambia is the high initial cost. Some of the costs are computer costs and backup electricity power costs which has proved to be expensive. This study found that the variables used to determine this in the questionnaire were valid. A total rate of 95 percent of respondents agreed that high initial cost of equipment's such as computer and other physical infrastructure like backup power electricity is among the main challenges of SmartCare system in Zambia. The study therefore established that the high initial costs create a barrier to adoption and implementation of the HIS, especially in rural areas.

A7. Private Sectors hesitant to share Health Information

The use of government or private health data for secondary purposes can be good for research and development. Although there is broad public support for the secondary use of health data, the idea however does not extend to implementation. A study by Mweebo (2014) revealed that most doctors operating in the private sector in Zambia are hesitant to share patient health information with other hospitals they perceive as competitors. Investigations in this study uncovered that private sector health institutions are hesitant to share the health information with public hospitals.

Although just over half of all the respondents, 55 percent, supported this. Sharing public health data with the private sector would require more and better engagement to build community understanding about how facilities can collect, share, protect, and use the data. A well-planned plan and strict conditions and tightly controlled circumstances on sharing data is highly recommended.

A8. SmartCare-cards lack Encryption

Encryption is a form of data security in which information is scrambled from plain text into a type of secret code that hackers cannot read, even if they intercept it before it reaches its intended recipients. When the message does get to its recipients, they have their own key to unscramble the information back into plain, readable text. Studies by Neame (2013) and Mweebo (2014), observed that it is a challenge to ensure privacy and confidentiality through access to health information, using SmartCare system in Zambia, which is restricted and only allowed to those authorised by the patient. An investigation in this study established that SmartCare system cards called SmartCare-cards, lack the encryption security feature. Most respondents, 72 percent, alluded that SmartCare-cards do not have the encryption feature, thus stored information is in plain text and is prone to be hacked (for client/server mode SmartCare which works with internet connection) or information on a lost SmartCare-card can be accessed by anyone if inserted into a computer, through a card-reader, with SmartCare software.

In view of this security concern, a secret key that should be entered before access to data on the SmartCare-card is recommended.

A9. Integration of SmartCare System

System Integration is a process that connects the various IT systems and applications in an enterprise so that they work cohesively in a coordinated and unified manner. Integration is central for HIS. Research by Tsai et al., (2013) highlights the concerns concerning poor interoperability and integration between different health systems and the hindrance of implementation. BroadReach (2020) revealed that the goal of SmartCare programs was to support the integration of data from multiple healthcare systems around a country. Unfortunately, there has been no evidence at the time of this study that the SmartCare sub-systems are integrated. CDC (2010) also stated that the system supports integration of district, provincial and national system databases which could make monitoring and evaluation of HIV programs easier. An investigation in this study however, established that SmartCare system is not linked and/or is integrated with other SmartCare sub-systems or health systems in other facilities. Although, a few district, provincial and national databases are linked through SmartCare plus system. SmartCare plus is the web-based system of the EMR (HIS). This is however in its incredibly early stage, and most health facilities are found to have SmartCare legacy system which stores data on a saver at the respective health facility, whilst the SmartCare plus has the saver remotely located at the central location at the ministry of health headquarters in Lusaka.

4.3.3 SmartCare System Performance (Stability) Characteristics

This area of the survey focused on measuring the performance of the SmartCare system in terms of stability. Aguirre et al., (2019) states that system performance testing ensures the response times and process interactions are within the system timely and within acceptable limits as stated in the project deliverables. The testing evaluates the system usage during peak loads for accessibility and timely process of requested data, and timely generation of reports and evaluation of time for data dumps on system performance. To measure the systems' performance in terms of stability, the Likert scale of 1 to 5 used were:

1 = Excellent; 2 = Good; 3 = Fair; 4 = Poor; 5 = I Don't Know.

Table 4.4 shows measurements done to highlight the performance (stability) of SmartCare system. This section consists of various deliverable topics.

Table 4. 4: Measures of SmartCare System's Performance

Measurement		Variables					
		Excellent	Good	Fair	Poor	I Don't Know	Mean Score
System user-friendliness in terms of ease access and usage	Freq	15	51	16	0	0	16.4
	Percent	18%	62%	20%	0	0	20%
Time taken to fully load and function	Freq	5	37	35	4	1	16.4
	Percent	6%	45%	43%	5%	1%	20%
Availability of system during heavy demands	Freq	5	36	34	7	0	16.4
	Percent	6%	44%	41%	9%	0	20%
Effectiveness of response time of system interactions	Freq	7	49	24	2	0	16.4
	Percent	9%	60%	29%	2%	0	20%
Accessibility and timely process of requested data from System	Freq	8	39	32	3	0	16.4
	Percent	10%	47%	39%	4%	0	20%
Effectiveness of functions of SmartCare-card reader	Freq	0	19	28	30	5	16.4
	Percent	0	23%	34%	37%	6%	20%
Effectiveness of recovery time from failures such as crush, hang	Freq	0	14	50	14	4	16.4
	Percent	0	17%	61%	17%	5%	20%

Table 4.4 illustrates user-friendliness ratings, in terms of ease access and usage of the system, at 18 percent excellent and 62 percent good, which gives a total rate combination of 80 percent. Therefore, 80 percent of the users found the system to be user-friendly. A total of 42 respondents representing rates of 6 percent and 45 percent, which is 51 percent in total, rated the time it takes for the system to fully load and function as fair. The availability of the system during heavy loads was rated as 'excellent' by 6 percent of respondents and 'good' by 44 percent of the respondents. A combination of excellent and good rates represents 50 percent of respondents rated the system as available during heavy loads.

The effectiveness of response time of system interactions was rated at 60 percent and 9 percent as good and excellent, respectively. This meant a total rate of 69 percent respondents found the response time of system interactions of SmartCare as effective. Meanwhile, a combination of good and excellent rating of 57 percent, which is 47 percent and 10 percent in order, found the requested data from the system as accessible and timely processed.

However, 37 percent of respondents rated the functions of SmartCare-card reader as ineffective, having rated it as 'poor'. This represented a frequency of 30 respondents. There is a need to resolve issues that come with this component of the system to avoid efficiency. Most respondents, as seen from table 4.4, with a percentage of 61 percent, rated the system's recovery time from failures as ineffective. The respondents rated it as 'fair'. This represented a frequency of 50 respondents.

In summary, table 4.4 shows the mean scores, at 20%, of variables used to measure the systems performance. The table shows the SmartCare system performance that is moderately good or acceptable. Out of the seven systems performance measures as shown above, five were rated as good. Table 4.4 therefore, reveals an average percent of the ratings 'excellent' and 'good' of the performance of SmartCare system at 50 percent. 50 percent is representing the middle point (mean) which is the average of the given percentages. Average is interpreted as a proper balance of conflicting interests or defined as acceptable (Manikandan, 2011).

50 percent of the parameters therefore indicates that half of the respondents felt that the system is average, sufficient and works according to the required minimum qualities and performance standards. The average percent of the rates rated as good, which is a combination of 'excellent' and 'good,' is as calculated below:

Average Percent = (80 percent + 51 percent + 50 percent + 69 percent + 57 percent + 23 percent + 17 percent)/7 = 50 percent.

A. Discussion of Results

Aguirre et al., (2019) observes a good performing system as one that ensures response times and process interactions are within system timely and within acceptable limits as stated in the project deliverables. The system must be accessible and able to timely process requested data, and timely generate reports. The measures of SmartCare System's performance as seen from table 4.4 are:

A1. User-friendliness of SmartCare

User satisfaction is a significant measure of information system success. User satisfaction is the attitude and opinion of users to the software system which they use (Mullany et al., 2006).

A study by Mutale (2017) reviewed that health workers perceptions and experiences on SmartCare HIS was good, dependable, and user-friendly. This study investigated the satisfaction of facility Assistant M&E officers on the utilization of SmartCare system. The investigation uncovered that user satisfaction of the system in terms of ease access and usage is extremely high. Most users responded positively. Finding seen in this study showed that the system is an easy, efficient, and more convenient way to store and retrieve patient records than paper records.

A2. Time to Load and Function

Software system performance in terms of time taken to fully load and function, or program execution time is measured from program initiation at presentation of some inputs, to termination at the delivery of the last outputs. Aguirre et al., (2019) observes that testing the performance of a system ensures the response times and process interactions are within the system timely and within acceptable limits. The testing evaluates the system usage for accessibility and timely process of requested data. An investigation in this study reviewed that time taken for SmartCare system to fully load and function is fairly good. This is according to 51 percent of respondents. Although slightly over half of respondents responded positively, users could be disgruntled if such expectations are not met or fulfilled. The system's response times and process interactions, when loading, are within the system timely and within acceptable limits.

A3. Availability of SmartCare during Heavy Demands

Availability of software refers to a property of software that is there and ready to carry out its task. This is a broad perspective and encompasses reliability.

Software quality specifications for the performance of a software service includes elements such as availability rate, etc. (Spacey, 2017). The vision of SmartCare HIS is to have an improved availability of access to, and utilization of both patient and management information. SmartCare aims to enable electronic data entry of patient health information so that health facility staff do not have to manually collect and aggregate data (Sanja, 2013). According to Gumede-Moyo et al., (2019), despite the good system architecture, SmartCare system has been reported of slow system response and software system crashes. Signs of unavailability. Finding seen in this study was that the system experiences software failure, system hangs every now and then and data entry is often interrupted. Investigation found that respondents were uncertain about availability of SmartCare system during heavy demand. Only half of the respondents, 50 percent, responded positively.

A4. System Interaction Response Time

System interactions are processes that are accomplished by clicking user interface buttons or links. SmartCare system usable interface has three main outcomes; it should be easy for the user to become familiar with and competent in using the user interface on the first contact with the system, it should be easy for users to achieve their objective through using the system, and it should be easy to recall the user interface and how to use it on subsequent visits (Soegaard, 2018). Clarke et al., (2019) argues that potential benefits of some SmartCare interface modules such as vaccination module were frequently unrealized due to infrastructure, workflow, and data flow challenges that resulted in low interface module use. An investigation in this study revealed that SmartCare accomplishes various processes by way of clicking the interface buttons or links on time. Most of the respondents representing 69 percent, felt the system was effective.

A5. Accessibility and Timely process of requested Data

System performance testing evaluates and ensures the system usage during peak, loads for accessibility and timely process of requested data, and timely generation of reports (Aguirre et al., 2019). One of the main objectives of SmartCare system is to provide timely data for patient management while providing automated information flow into the government's existing Health Management Information System (HMIS) trend reporting and analysis for health officials (MoH, 2013). An investigation in this study found that SmartCare data is accessible and processed timely via various reports when requested through interactions, which saves time and helps monitor and evaluate HIV programs easier. 57 percent of respondents confirmed access and timely process of SmartCare stored data.

A6. Effectiveness of SmartCare-card Reader

A SmartCare Card and Card Reader are computer requirements of SmartCare system. SmartCare card is used to store patient data via the card reader from SmartCare software system installed on the computer. Neame (2013) reviewed that information on a lost SmartCare-card can be accessed by anyone if inserted into a computer, through a card-reader.

In view of this security concern, and in addition to using a SmartCare-card, there should be a secret key that should be entered before access to data on the SmartCare-card. Such a feature could give the patient control of access to their records because the SmartCare-card will act as an index and access key to the SmartCare system database. An investigation in this study also revealed the functions of SmartCare-card and reader as ineffective. Some of the reported challenges of SmartCare-card and reader are: The software system sometimes does not respond to the reader, the software system hangs or freezes when using the reader, and sometimes the reader does not detect SmartCare-cards.

A7. System Recovery time from Failures

This study revealed that SmartCare system's recovery time from failures or crashes is ineffective and never produces the desired outcome. This was consistent with studies by Nguyen et al., (2014) and Goldberg et al., (2012) which found that the system was inefficient (slow response) and experienced system failures and server crashes. Most respondents revealed that the recovery time is not as expected. Other issues that surround the performance of HIS(s) are system quality (Topaz et al., 2016; O'Donnell et al., 2018), and system compatibility (Hamamura et al., 2017). The most significant causes of software failure are system overload, resource exhaustion and complex fault recovery routines. System failures or crashes are mostly experienced during heavy demands during which copious amounts of energy and resources are required by the system. The system should however be designed to recover from failures or crashes at the earliest time after such occurrences.

4.3.4 SmartCare System Functionality (Usability) Characteristics

This area of the survey focused on measuring the functionality of the SmartCare system in terms of usability. To measure the systems' functionality, the Likert scale of 1 to 5 used were:

1 = Yes; 2 = Sometimes; 3 = Rarely; 4 = No; 5 = I Don't Know.

Table 4.5 shows measurements done to highlight the functionality of SmartCare system.

Table 4. 5: Measures of SmartCare Systems' Functionality

Measurement		**Variables**					
		Yes	Sometimes	Rarely	No	I Don't Know	Mean Score
System load with errors or experience system failures	Freq	5	44	25	8	0	16.4
	Percent	6%	54%	30%	10%	0	20%
Users gain access as per assigned user privileges	Freq	81	1	0	0	0	16.4
	Percent	99%	1%	0	0	0	20%
System function offline without online infrastructure such as LAN and Wireless LAN	Freq	35	2	10	35	0	16.4
	Percent	43%	2%	12%	43%	0	20%
SmartCare's major components, e.g., ART, work as required	Freq	61	9	3	4	5	16.4
	Percent	74%	11%	4%	5%	6%	20%
Electronic forms used to record patient information perform as required	Freq	56	18	2	6	0	16.4
	Percent	68.3%	22%	2.4%	7.3%	0	20%
System exhibit errors or experience system failure when storing data	Freq	21	42	10	8	1	16.4
	Percent	26%	51%	12%	10%	1%	20%
SmartCare reports provide accurate, up-to-date, and complete information	Freq	23	48	6	5	0	16.4
	Percent	28%	59%	7%	6%	0	20%
SmartCare-card reader function without errors and system failures	Freq	9	33	13	21	6	16.4
	Percent	11%	40%	16%	26%	7%	20%

In table 4.5, Out of 82 respondents, only 6 percent indicated that the system loads with errors or experience failures. Users were able to gain access to the system as per assigned user privileges. This was according to 99 percent of respondents. The system met the users' needs accordingly. With reference to the system able to function offline without online infrastructure such as LAN and Wireless LAN, an equal percent of 43 percent of respondents responded 'yes' and 'no' respectively. Which meant that an equal number of respondents felt that the system could and could not function offline without any online infrastructure.

The study also found that 74 percent of the respondents agreed that SmartCare's major components, for instance ART (Antiretroviral Therapy), work as required and 68.3 percent agreed electronic forms used to record patient information perform as required. Respondents were asked if the system exhibited errors or experienced system failures when storing data, 26 percent indicated that the system exhibits such issues when storing data. Table 4.4 further shows 28 percent respondents who agreed to the system providing accuracy, up-to-date, and complete information, however most respondents at 59 percent indicated that this did not always happen. The result in the table also shows that only 11 percent of respondents indicated that a SmartCare-card reader functions without errors and system failures.

Table 4.5 in summary shows the mean scores, at 20%, of variables used to measure the systems functionality. The table show the SmartCare system functionality (usability) that does not fit user needs. Out of the eight system functionality measures, four were rated as 'sometimes. Most of the respondents did not agree that the system usability met their needs respectively, with an average percent of the rates indicating 'yes' at 44 percent. Between 40 percent and 49 percent, as observed by the University of Pretoria (2015), is interpreted as poor, functionality below required standard, and therefore depicts a poor number of respondents who felt the system works according to the required qualities and having functional standard. The average percentage of the rates rated as 'yes' is as calculated below:

Average Percentage = (6 percent + 99 percent + 43 percent + 74 percent + 68.3 percent + 26 percent + 28 percent + 11 percent)/8 = 44 percent.

A. Discussion of Results

System functionality is the ability of the system to do the work for which it was intended. It ensures that the HIS's major functions perform as required and the customizations work as requested. The measures of SmartCare System's success functionality as seen from table 4.4 are:

A1. Users Access Rights

A username is a name that uniquely identifies someone on a computer system. It is always paired with a password. The username/password combination is known as a login and is required for users to log in to systems such as SmartCare. Lee et al., (2013) observed that SmartCare system is safeguarded using staff login username and password credentials which are not exposed. Soegaard's study in 2018 found that SmartCare system allows more than one user to access it. This study established that users (Assistant M&E officers and Data Associates) could gain access to SmartCare as per assigned user usernames and passwords created by SmartCare coordinators. The usernames and passwords assist maintain privacy and confidentiality by ensuring that access to health information is restricted and only allowed to those authorized. Most of the respondents representing 99 percent, were able to gain access as per assigned usernames and passwords.

A2. System Errors and Failures

System load is a measure of the amount of computational work that a computer system performs. Investigation in this study revealed that SmartCare system sometimes loads errors or experience system failure. Slightly over half of respondents, at 54 percent, agreed with this. The software errors or system failures such as hanging and freezing caused by system bugs. This was consistent with a report by MoH (2009) which stated that the system contains bugs which cause such errors and failures. Bugs in software can also arise from mistakes and errors made in any computer hardware. Re-designing part of the format of the system or changing computer hardware can resolve the challenge.

A3. SmartCare online and offline Infrastructure Functionality

Online or internet infrastructure consists of physical computer hardware, transmission media, and software used to interconnect computers and users on the Internet. Neame (2013) reported that SmartCare system can function either as a distributed (standalone) or as a centralized (client/server) mode. Finding seen in this study was that the distributed mode is used mostly, and used in the absence of internet communication infrastructure. In this study, an equal percent of respondents agreed and disagreed that SmartCare functions offline without internet infrastructure such as LAN and Wireless LAN, which meant that an equal number of respondents, felt that the system could and could not function offline without any online infrastructure. Respondents were uncertain.

A4. Performance of SmartCare's Components

Guidance on key components that a HIS should possess promotes patient healthcare data. The development of a common set of requirements for the functional capabilities of various HIS software components allow providers to compare the systems that are available and enable vendors to build systems more in line with providers' expectations (Aspdenet et al., 2004). Various HIS globally are developed in line with the HIS global standard components. The Ministry of Health (2020) reported that the SmartCare HIS includes different components that includes Out-Patient (OPD), Antenatal Care (ANC), ART, Laboratory, Pharmacy etc. Investigation in this study established that SmartCare's major components work as required. This is according to 74 percent of respondents, who also highlighted that some components such as Inventory, Survey Modules etc. are not functional and/or have not been implemented.

A5. Performance of SmartCare's Electronic Forms

In 2013, the World Health Organization emphasized that health information systems contain electronic forms that clinicians or data entry personnel use to record patient information that include initial history and physical examination, medication, and long term follow up (WHO, 2013). This study revealed that SmartCare system contains such electronic forms, for example Antenatal Care (ANC), ART, pharmacy, and Laboratory. Most of the respondents for this study agreed and further concluded that this objective fits their needs. The association between the systems electronic forms and systems major components are adamantly supported by users.

A6. Systems Errors and Failures when Storing Data

Yazdi-Feyzabadi et al., (2015) alludes to how the HIS is used to collect, process, store, and report patient information using electronic forms in various health facilities. This is supported by many studies in literature. In Zambia, SmartCare system contains bugs which cause hanging (MoH, 2009). A software bug is an error, flaw or fault in the design, development, or operation of a software that causes it to produce an incorrect or unexpected result, or to behave in unintended ways. An investigation in this study uncovered that SmartCare systems sometimes exhibit such errors and experience system failure when storing data during data management. Re-designing part of the format of the software or changing computer hardware may resolve the issue.

A7. Accuracy of SmartCare Reports

Information is only useful if it is up-to-date, accurate and complete. Inaccurate data could mean making a fatal mistake in patient care. Though SmartCare system is viewed as dependable and user-friendly, Clarke et al. (2019), uncovered that SmartCare database contained incomplete and incongruous data. Several other studies have raised concerns about the performance of HIS(s) suggesting the system produces poor-quality data (Hahn et al., 2013). An investigation in this study revealed that SmartCare system does not always provide accurate, up-to-date, and complete information. This is according to 59 percent of respondents. Availability, accuracy, and integrity of the patient health information data, while ensuring timely, and regulatory compliant generation of reports is outmost critical.

A8. Errors and Failures of SmartCare-cards

SmartCare-cards as stated by the Ministry of Health (2020) are used to store patient data through the Card Reader device from SmartCare system software installed on the computer. Patient data can be copied and stored to a SmartCare-card that can be accessed from any SmartCare facility. However, findings in this study indicate that the Card Reader sometimes functions with errors and system failures. Most respondents indicated Card Readers as ineffective and exhibits such issues, which shows that there is a need to improve the SmartCare system. Some of the reported challenges of SmartCare-cards and reader devices are that SmartCare system sometimes hangs or does not respond to the reader device. SmartCare-cards are sometimes non detectable.

4.4 Interview Results

Primary data was collected through IDIs. The interview guides were created based on an extensive literature review as well as insights from questionnaire results. The purpose of the IDIs was to compare the international HIS standard components to the components of SmartCare HIS in Zambia. The target groups for the interviews were the Data Associates, Data Coordinators and Technical Support officers. The respondents were different from the Assistant M&E Officers.

The interview guides were divided into two (2) sections. Section 1, consisted of socio-demographic characteristics which included gender, age in years, qualifications, years in work experience and current work location. Section 2, of the guides consisted of technical questions. The full interview guides are shown in Appendix II

4.4.1 Summary of Thematic Analysis

Table 4.6 represents the thematic analysis themes that relate to the data and address the research. Codes were developed to represent the identified themes and linked to the raw data.

Table 4. 6: Summary of Themes and sub-themes

Theme	Code	Sub-code	Description
SmartCare data management	SmartCare collection SmartCare completeness SmartCare analyses SmartCare compiles SmartCare processing SmartCare stores		Anything mentioned on how SmartCare collects, stores, compiles, analyzes, and processes data including the processes taken to achieve this.
Effectiveness of SmartCare	Overtime changes to Ministry of Health Indicators	Examples of indicators that have changed	The effectiveness of SmartCare System when it comes to improving the Ministry of Health indicators that show change that has taken place over time. Include examples of indicators.
SmartCare system architecture	SmartCare data source Data storage Hardware configurations and information back up		This includes descriptions of the logical organisation of the various components of SmartCare and their inter-operations including where the SmartCare data is stored and the internal data source of SmartCare System e.g., Database, Online web services.
Data security for SmartCare	Privacy and confidentiality of SmartCare data Physical security of data centre		Includes descriptions of how data security, privacy and confidentiality are upheld in SmartCare including the physical security of the data centre.
SmartCare service functionality	Management of orders		Descriptions of SmartCare functioning to manage orders e.g., electronic prescribing, referrals to hospitals.
	Management of results		Include descriptions of the management of results e.g., from laboratory, pharmacy.
	Scheduling management and eligibility determination		Include descriptions of scheduling management and eligibility determination e.g., clinical trial recruitment, drug recall, chronic disease management.

Theme	Code	Sub-code	Description
	Patient support system		Refers to explanations of patient support system including patient education. patient data used for home monitoring.
	Management of patient safety and quality reporting		Refers to how patient safety and quality reporting is done in Smart Care e.g., clinical dashboards, disease registries, reportable diseases.
	Management of expert decision-making		Descriptions of how expert decision making is done, e.g., drug alerts, reminders, diagnostic decision support.
	SmartCare System electronic communication		Explanations of how SmartCare System provides electronic communication e.g., between provider-provider, inpatient-outpatient, medical devices, trading partners.
Disaster recovery plan	Business continuity plan	Staff awareness of business continuity plan	Include all descriptions of SmartCare data recovery plans and processes.
	Response and recovery time of SmartCare system		
	SmartCare stability		
	Back-up of data	How many times and time taken to back-up	
		Back-up responsibility	
	SmartCare features of stability and recovery		

4.4.2 Socio-Demographic Profile of Participants

A total of 10 Data Associates, and 9 SmartCare Data Coordinators and Technical Support (TS) Officers agreed to participate in this study and completed in-depth interviews. Participants were distributed across the various study sites in Lusaka province. All Data Associates who participated had been trained to use SmartCare system, with full user rights and had experience in the utilisation and coordination of the system in Zambia. All Data Coordinators and Technical Support officers who participated had been trained and had at least 5 years' experience of coordinating and/or managing SmartCare HIS project in Zambia. The Participants were coming from five locations namely Lusaka district, Chongwe district, Chilanga district and Kafue district of Lusaka Province Zambia.

A. Gender

Figure 4.6 shows the number of respondents by gender. The gender distribution for the Data Coordinators and Technical Support (TS) officers were 100 percent Male. All 9 respondents were male. Figure 4.6 also shows gender distribution for Data Associates. Out of 10 respondents, 3 were male representing 30 percent and 7 were female representing 70 percent.

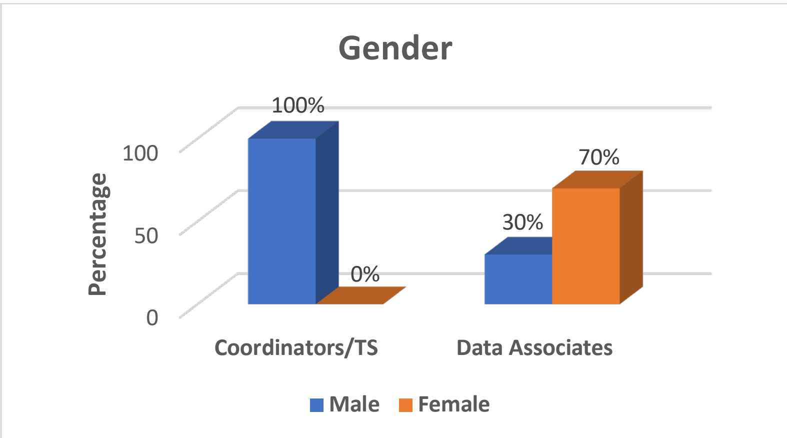

Figure 4. 6: Respondents by Gender - Interviewee

B. Age Group

Figure 4.7 shows the Age group distribution of Data Coordinators, TS officers and Data Associates. The majority of Data Coordinators and TS Officers were between the age group of 35 and 39 years having a percentage of 78 percent whilst above 40 age group had 22 percent. Most Data Associates were between age 30 to 34 years, with a percentage of 60 percent of the sample frequency 8. This was followed by the age group 35 to 39 years representing 20 percent, and lastly 25 to 29 years age group with the least percentage of 10 percent.

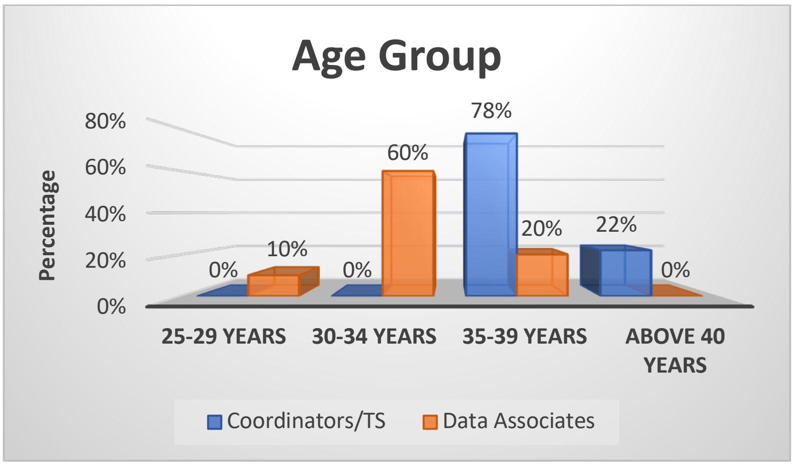

Figure 4. 7: Age Group Distribution of Interview Respondents

C. Level of Education

The highest level of academic education of Data Coordinators and TS officers' as shown in Figure 4.8, is bachelor's degree with 56 percent. This was followed by diploma holders with 44 percent at a frequency of 4. The majority of Data Associates had diploma having a percentage of 70 percent whilst those with bachelor's degree were only 30 percent with a frequency of 3.

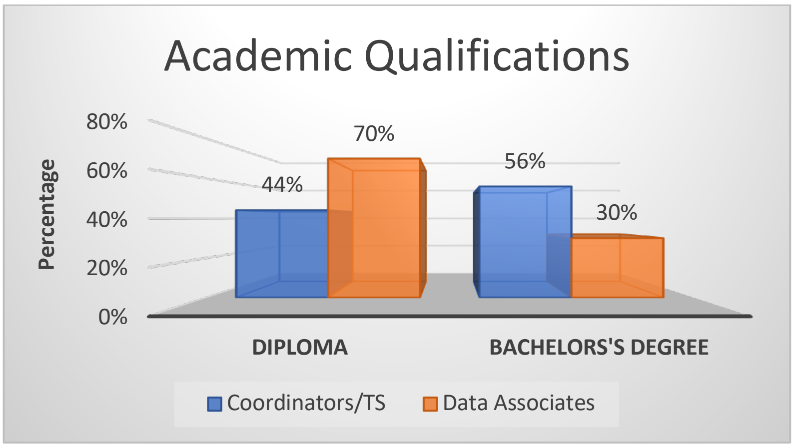

Figure 4. 8: Interviewee Academic Qualifications

D. Years of Work Experience

As illustrated in figure 4.9, all Data Coordinators and TS respondents had above 6 years' work experience representing 100 percent. Most of the Data Associates had above 6 years' work experience as well. Out of 10 Data Associates respondents, 6 had above 6 years work experience representing 60 percent and 4 respondents had 4 to 5 years' experience representing 40 percent.

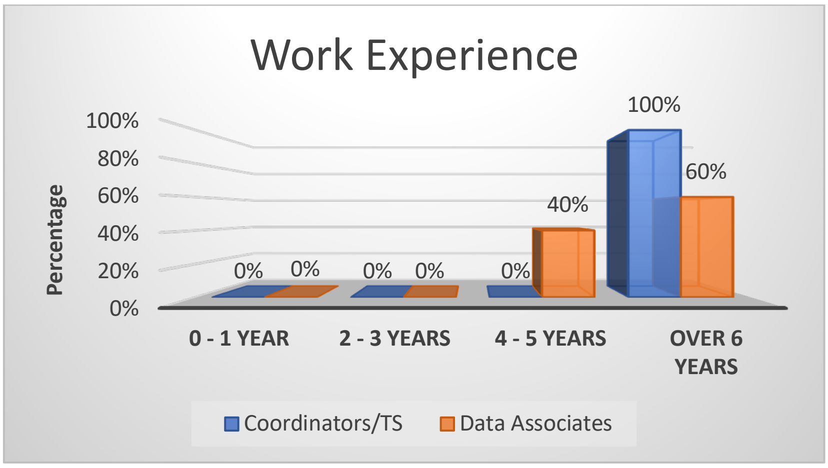

Figure 4. 9: Interviewee Years of Work Experience

E. Respondents Location

Location characteristic was used to categorize the respondents' location per health system category and district. Figure 4.10 shows most Data Coordinators and TS respondents were coming from Lusaka district with 67 percent, whilst the rest of the districts namely Kafue, Chilanga and Chongwe each equally represented 11 percent.

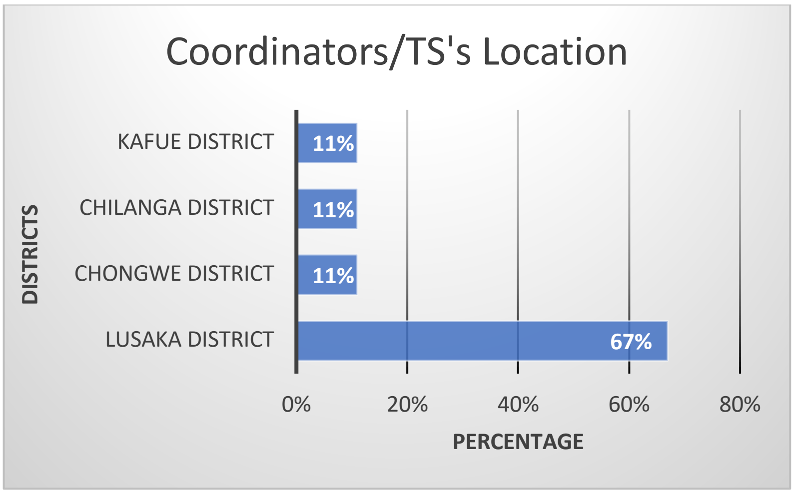

Figure 4. 10: Location - Data Coordinators and Technical Support Officers'

Figure 4.11 shows an even distribution of Data Associates of 20 percent, coming from Matero, Kanyama, Chelstone and Chawama facilities. Whereas 10 percent of the respondents were coming from Chipata facility and Chilenje facility subsequently.

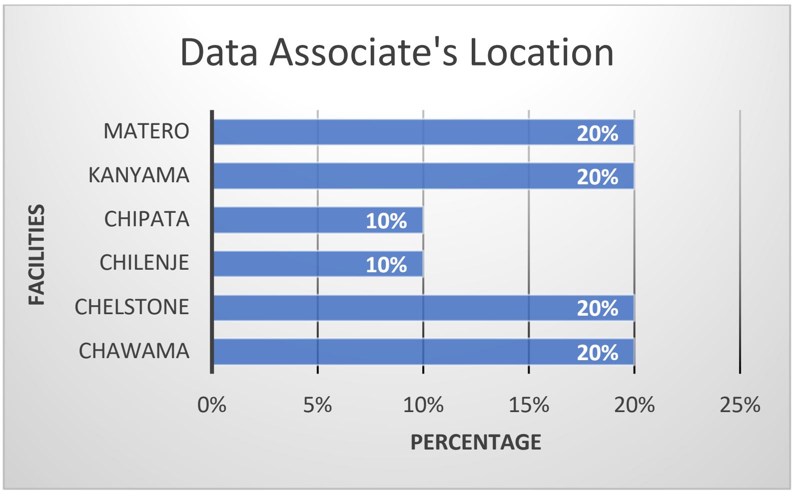

Figure 4. 11: Data Associates' Location

F. Summary of Socio-Demographic Data

Table 4.5 summarizes the respondent's socio-demographics, with majority of the Data Coordinator/TS respondents being male with an age group of around 35-39 years, with an education level of first degree with over 6 years of work experience, with most of the respondents coming from Lusaka district. The majority of Data Associates were female, with an age group of around 30-34 years, with an academic qualification level of diploma with over 6 years of work experience as well, with majority of them coming from Matero, Kanyama, Chelstone and Chawama facilities.

Table 4. 7: Characteristics of Interviewed SmartCare Users and Coordinators

Characteristics	**Percentage (%)**	
Gender	**Coordinators/TS**	**Data Associates**
Male	100	30
Female	0	70
Age Group	**Coordinators/TS**	**Data Associates**
25-29	0	10
30-34	0	60
35-39	78	20
Above 40	22	0
Academic Qualification	**Coordinators/TS**	**Data Associates**
Diploma	44	70
Bachelor's Degree	56	30
Work Experience	**Coordinators/TS**	**Data Associates**
4-5 Years	0	40
Over 6 Years	100	60
Coordinator/TS Location		
Kafue District	11	
Chilanga District	11	
Chongwe District	11	
Lusaka District	67	
Data Associate Location		
Matero Facility	20	
Kanyama Facility	20	
Chipata Facility	10	
Chilenje Facility	10	
Chelstone Facility	20	
Chawama Facility	20	

4.4.3 SmartCare System Security, Privacy and Confidentiality

The SmartCare EMR HIS is provided with physical, ethical, privacy and confidentiality safeguards of the data and hardware. The hardware equipment supplied to health facilities is mounted with security mechanisms such as locks. All the machines stored in data rooms and screening rooms are secured with locks and keys are kept by selected facility management team members. To limit unauthorized access to patient records, the data is usually encrypted, with access credentials held by a select few personnel like data coordinators, M&E officers, and data associates. Each facility and its authorized personnel have a unique username and password generated by a system administrator either at the facility or health district level to access the SmartCare system. All personnel entrusted with username and passwords are mandated not to share with anyone. The patient records. Personnel with access to SmartCare are trained and sensitized to uphold patient privacy by protecting against access and misuse of patient information by unauthorized persons:

'All the machines are password-protected, just to switch on the machine you need to have a password and only facility people know the password and each facility has a password. Then from there, SmartCare itself has limited access for each facility, and we train them not to share their credentials with anybody. And on the machines, they all have lockers, those cables to lock the laptop and the desktop to their tables.' (Data Coordinator)

This was consistent with the guidance by the American Public University (n.d.) which recommends having a HIS with set key components that among others includes data management that allows easy access to relevant stored information while maintaining privacy and confidentiality. This was also consistent with a study by Lee et al., (2013), which found that the username and password combination known as a login, is required for users to log in to SmartCare system.

However, despite having the security mechanism that ensures hardware machines are stored in data rooms and screening rooms that are secured with locks and keys, maintaining the security was sometimes a challenge as some health facilities had experienced thefts of laptops and computers: In some cases, these thefts were believed to be orchestrated by health workers within the health facility:

'The places where they store this equipment is very secure, but we have also encountered some theft from the secure places where someone from the inside with access gives access to another person to come in to steal. The password combination was shared to another person outside the facility who came in and managed to unlock some laptops and they walked away with those laptops.' (Data Associate)

4.4.4 SmartCare System Infrastructure

The SmartCare EMR HIS found in health facilities is in two forms called legacy and SmartCare plus. The SmartCare plus refers to a new web-based system of the EMR. Most facilities were found to have SmartCare legacy with SmartCare plus rolled out in fewer facilities. The legacy system stores data on a saver at the respective health facility while the SmartCare plus has the saver remotely located at the final database is located centrally at the ministry of health headquarters in Lusaka.

'Right now, we have two types of SmartCare, there is SmartCare legacy and SmartCare plus, Smartcare legacy is stored onsite while Smartcare plus is online from the ministry headquarters, that is where the main savers are. So, whenever data is entered at the end of their interaction, they need to save that interaction and it will be saved on the saver either at the facility or at health headquarters' (Technical Support Officer)

This was consistent with the study by Neame (2013) that reported that SmartCare system can function either as a standalone (legacy) or as a centralized client/server mode (SmartCare plus). Each computer in legacy mode has its own database. Finding also found in questionnaire results of this study, found that legacy mode is used in the absence of internet communication infrastructure. Computers running SmartCare system work independently without any network connection to each other.

For the health facility team to aggregate the data in facilities with SmartCare legacy, the database must be shared with the data teams. The channel is such that at a facility level, the Data Associates send information to the district Electronic Health Record Officers (EHRO) who pass the information to the district office which relays to the provincial and finally health national office. At the facility level, Data Associates back up the data daily and the EHRO essentially manage the systems, the savers, and all system configurations. All operations of SmartCare are guided by standards that everybody is expected to follow. This is in accordance with a report by CDC (2010) which states that in this mode, SmartCare system provides database merges by using any electronic data storage and exchange methods, for example flash disk drives.

The web based SmartCare plus was considered more stable with automated data backup and data recovery processes. The SmartCare legacy involved manual data backup processes that included keeping data copies on computers or external hard drives periodically in case of a system crash:

'The SmartCare plus is web-based whereby the database is hosted on the central location, so I think with SmartCare legacy, even with the database hosted at the facility, if at some intervals maybe at 17 or 20:00 hours, it uploads to the central facility or the central saver, I think that one will help us in the recovery of data because now staff must make a back-up on Monday, Wednesday, Friday. So, we need a feature whereby on its own, it can make a backup its stays on the PC or sends to the central location.' (Technical Support Officer)

4.4.5 Disaster Recovery Plan

To manage system failures and enforce data recovery plans, facilities implemented certain strategies that include backing up data on an external hard drive. Identifying a Data Associate/Assistant M&E officer conversant with networking and training in SmartCare applications for troubleshooting simple and frequent problems was another strategy identified to support data recovery and system malfunctions. This is in accordance with a study by Lumetra (2006), that revealed the need to develop a disaster recovery plan of HIS. The study further emphasized the need of testing the ability to restore the system from backups, ensuring that the system backup plan is in place and running and arrange for regularly scheduled pick up and off-site storage of backups. This study, however, revealed that regular recovery tests were not carried out.

Participants also mentioned plans to establish standard operating procedures (SOPs) to tackle common errors. A power backup has also been built to provide alternative power in instances of electricity power disruptions. Further, facilities are oriented and sensitized on potential problems with the SmartCare system, processes, and procedures in case of system downtime. They are further given contact details to reach out for assistance to ensure there is business continuity.

'So, the plans which were put in place to prevent these challenges (SmartCare) were, we had to identify one data associate who is conversant with networking and with the application. I remember last time, we had to create local administrator accounts, like for Kanyama facility, we had to identify somebody who has some knowledge in networking and SmartCare because at one point, there are some classes or workshops which are organized to discuss issues with networking or setting up saver client environment, and how to troubleshoot simple or most frequent errors regarding SmartCare system.' (Technical Support Officer)

When faced with a SmartCare failure, facilities were supported by DHIO through a phone call or video call. Recovery time varied between 4-24 hours depending on the complexity of the problem, the distance of the facility from district offices and the SmartCare skill capacity of health workers at the facility. Participants gave examples of data recovery exercises undertaken:

'It's been a while since we conducted or did a full recovery test and, in this instance, one of the facilities had reported saying that they were unable to, for some reason, they were unable to run the application and I do recall a team from the data team was deployed and they were able to identify where the challenge was and using data recover technics, they were able to fully restore the corrupt database the same day.' (Data Coordinator).

4.4.6 SmartCare System Functionality

The SmartCare software was described to be robust with many features that supported electronic forms that clinicians could use to record patient information including counselling and testing, initial history and physical examination, investigations, medication, and long-term follow-up. The system was structured to support the management of expert decision making to ascertain patient treatments, patient orders and results, and for management of patient safety and quality reporting. It had in-built intelligence which guided diagnosis depending on the data provided:

‘SmartCare works for a lot of things, for making diagnostic decisions, I will give you an example of when a patient presents themselves with symptoms when those are entered into SmartCare, SmartCare gives up popups. So, depending on the symptoms that are presented by the patients and then entered by the doctor into the system, it will pop up and suggest a certain diagnosis. It can help the clinicians make decisions based on that and from the ART perspective, it also does popups when a patient is due for viral load testing.’ (Data Associate)

This was consistent with the guidance by the European Union of General Practitioners (2004) which calls on having a HIS with mandatory capabilities that among others include health information and data, results management, patient support, administration proceses, decision-making expert systems and reporting statistics.

SmartCare was said to facilitate patient support through monitoring clinic visits and medicine collection. This helped to highlight patient treatment adherence or disengagement:

‘When you run a report for example a pharmacy report, the report indicates who missed the appointment. When that report is run, some people are designated to make follow up like some counsellors, so they start giving some counselling sessions to such patients who are missing appointments, so I can say there is a support system there.’ (Data Associate)

The system allowed for appointment scheduling which could be shared across the different treatment points in the health facility:

‘SmartCare has appointment reports to show you that these certain clients are due for this, and certain clients are due for that, the appointment reports in SmartCare can do that even on a daily, or weekly intervals, these people are supposed to come for such a service.' (Data Coordinator)

However, SmartCare system was stated to have some limitations. It did not contain dashboards and certain reports could not be extracted about patients. A Data Associate reported:

'It does not have dashboards, and then it extracts data for most of the information about patients, but the problem is that we have limited reports when it comes to extracting, for example, when we are entering data in SmartCare, we enter like your exact age but when we are extracting reports, it will pull like 1-4 putting like 45-49 and then it will have 50 plus as a lump sum. So, you have now to get from the backend the raw data which you have to run some analysis with' (Data Associate)

Other reported limitations were lack of electronic communication that can assist improve sharing of patient information among healthcare providers, and lack of order management that consists of electronic prescription, orders for medicines, referrals to specialists or hospitals, and other related results.

4.4.7 Effectiveness of SmartCare System

The European Union of General Practitioners (2004), American Public University (n.d.), and Valdez (2007) described system indicators as mandatory component of a HIS.

Discussions on the effectiveness of SmartCare however invoked some mixed reactions. Most of the participants shared that SmartCare system had improved management of indicators such as viral load monitoring, preventive medicine for tuberculosis among HIV patients:

‘I can use the same example of viral load, for a particular facility, with SmartCare you can tell at the end of the period of 6 months or a year, how many people were enrolled during that particular period and how many people had their viral load done, how many people will need like more follow-ups if their viral load keeps going high, also any of those who are lost to follow or have fallen of and need to be followed. It generally can ensure that the wellbeing of the clients that are enrolled at the facility is maintained.’ (Data Associate)

On the other hand, it was pointed out that the usefulness of SmartCare at the optimal level was hampered by slow updates and a slow pace to fix bugs that appeared on the system.

‘So one thing I can say with SmartCare is like the system perspective, the way it is intended to work, it's supposed to be so helpful when it comes to the ministry of health, collecting data as well as analysis and other things, but the problem is that the system implementation, like how updates are done as well as fixes, they are done at a very slow pace, so to some extent, it is effective but again because of how fixes are done, it will hinder work because if you are unable to run certain reports, it becomes very difficult for you to know the next steps.’ (Data Coordinator)

4.4.8 Advantages of SmartCare System

The SmartCare EMR program was noted to have several advantages. Advantages were premised on the ideas that quick access to patient records saves time for physicians, sharing of patient HIV records has been made easier by integrated district or national databases and updated patient SmartCare-cards; and the presence of national, provincial, and district databases has made HIV program monitoring and evaluation easier. Other benefits include lower costs due to reduced paperwork and the elimination of several investigations. SmartCare allowed for data completed collection, processing and analysis which made data utilization easier by allowing health professionals to quickly filter and select important reports to make timely decisions. Another benefit of employing SmartCare system is that it is now easier to generate the list of patients scheduled for review by simply running a database summary report, as opposed to using a paper-based system where nurses had to manually compile the list from the case register. A complete list of patients scheduled for review also aids in identifying and following up on those who fail to show up for their appointments, reducing the number of people who skip treatment and the emergency of medication resistance. Since SmartCare can store data that can easily be sifted through, it has made it easier to analyse the entire cohort of patients at a hospital instead of sampling which would be done for paper-based systems.

'SmartCare facilitates data collection at the facility to a considerable extent because most of the indicators that the facility tracks and the indicators the partners track at the facility are entered in SmartCare system. The system has all, it has all the modules comprising of most of the services that are offered at the facility, so it starts at the registration when you go to the facility. From the registry you deliver the information and then when you go to test for HIV, there is a module so, at the end of the day, you will find any information that you want, for example, if you want the number of people that the clinic registered in a specific period, it is possible to extract that information. It can also help us to see our attendants, whether OPD, in-patient or ART attendants. It facilitates data collection processes because it has all the information, in other words, it acts as a report for the facility with all the information that you would want' (Data Associate).

This is consistent with numerous studies in literature.

4.5 Chapter Summary

This chapter discusses the results of the research and their analysis. The data presented was gathered using in-depth interviews and questionnaires. The presentation of the results was done using figures, tables, and charts. Findings from the qualitative and quantitative data were compared, interpreted, and discussed to provide a recommendation. The next chapter of the study provides conclusions and recommendations.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The previous chapter presented the analysis and discussions of the results of the study. It presented the primary data obtained from the questionnaire survey and structured in-depth interviews. The data was analyzed, and the results were presented in the form of bar charts, pie charts, figures, and tables. This chapter presents the conclusion of the study drawn from the research objective and subsequently from the analysis and discussion of research findings. The chapter further makes recommendations which could improve current and future development of SmartCare Electronic Health Record System (EHRS) HIS. This concluding chapter finally outlines limitations of the research study and points out areas for further research.

5.2 Conclusions

The aim of this study was to investigate the implementation of SmartCare HIS project in Zambia using tenets of project management. The objectives of the study were achieved. The conclusions are discussed in the following sections as stated in the findings and achievements of the objectives.

5.2.1 Critical Success Factors and Challenges of Health Information System.

The first study objective was to determine the critical success factors (CSF) and challenges of health information system (HIS). This objective was addressed by creating and composing nine (9) factors from the CSF and challenges of various HIS studies globally and cited in literature chapter. The factors were accessed and measured to answer the research question, and it was established by an extremely sizeable number of users, at 80 percent, that the system consists key CSFs that are critical to its successful implementation. Some of the key CSFs are:

Dependence, multi-user, compatibility, availability of interfaces, data management, and information quality. These CSFs help focus on the elements of the system that are vital to the project success.

The study also found, evident of 64 percent of respondents, that the system challenges and constraints may limit the system efficiency and sustainability. The average 64 percent is according to the average percentages of the Likert scale 'Strongly agree' and 'agree' ratings. The degree of project challenges depends on the way constraints are applied and interpreted. It is vital to practice risk management to prevent challenges from occurring. Risk management is the practice of identifying, evaluating, and preventing or mitigating risks of a project, such as a HIS, that has the potential to impact the desired outcomes.

5.2.2 Performance and Functionality of SmartCare HIS in Zambia.

The second study objective was to establish the performance and functionalities of SmartCare HIS in Zambia. This objective was addressed by measuring the seven (7) performance factors and eight (8) functionality factors composed from different HIS studies stated in literature chapter. The factors were measured, and it was revealed that the performance of SmartCare system is acceptable. However only half (50 percent) of respondents responded positively. According to University of Pretoria (2015), 50 percent parameter is referred to as a proper balance of conflicting interests or defined as average and moderately good. Therefore, the performance of SmartCare system is sufficient and meets minimum requirements.

Further results in the study indicated that only 44 percent of the respondents felt the system works according to the required qualities and having functional standard. Between 40 percent and 49 percent, as observed by the University of Pretoria (2015), is interpreted as poor, and depicts a poor number of respondents who agreed. Meaning most of the respondents of this study did not agree that the system usability met their needs, respectively. SmartCare system functionality thus is below required standard.

The findings correspond with results from similar studies in literature.

5.2.3 Health Information System (HIS) Standard Components.

The third study objective was to compare the Health Information System (HIS) standard components to the components of SmartCare HIS in Zambia. This objective was addressed by reviewing the aspect of standard HIS components and SmartCare system components. The results from the in-depth interviews revealed that eight (8) out of twelve (13) SmartCare components were consistent with the global standard components. The compliant system components are infrastructure, health information and data components, security (which also includes privacy and confidentiality), system indicators, decision-making expert systems, data management, patient support, results management.

However, out of the total assessed components, three SmartCare components invoked some mixed reactions. Most of the participants shared that the system consists of health information and data components (patient's problem list, medication list, risk factors, allergies, procedures and test results, referrals, preventive programs, issued prescriptions, certificates, etc.), order management components (electronic prescribing, diagnostic procedures, referrals to specialists), and reporting & population health statistics components (patient safety and quality reporting (clinical dashboards). On the other hand, it was pointed out that SmartCare system did not contain such components.

Results from the interviews also showed that SmartCare system has some limitations. It did not contain the following three standard components: Data platforms (survey, disease surveillance), disaster recovery and electronic communication.

5.2.4 Summary

According to the study, while the implementation was successful, it was evident by 64 percent of users that the system challenges and constraints limited the system efficiency and sustainability. Furthermore, half the users indicated that the performance of SmartCare system was sufficient and met minimum requirements. However, 44 percent indicated that the functionality of the system was below the required standard. It was further established that only eight (8) SmartCare components were compliant with the set global standards of Health Information Systems. The results of the study hence show that the system performance, functionality, and components are barely meeting software design expectations according to tenets of project management.

5.3 Research Contributions

One of the practical contributions of this research is the detailed insight provided by the various similar studies, particularly in literature. The studies reveal the various system CSFs, challenges, system performance and functionalities, and standard HIS components. This implies that for effective implementation, HIS such as SmartCare system should emphasize the importance of understanding the stated contexts of work.

Another practical contribution of this research is to understand how the SmartCare EHR system development, and other HISs globally, can be developed and build more in line with expectations. This can allow providers to compare with the systems that are available. The due process model established in this study can be used as a practical tool.

5.4 Recommendations

Arising from the conclusions documented, the following are the key recommendations focused on implementing and managing SmartCare Electronic Health Record System (HIS) project in Zambia:

1. The SmartCare HIS development team to proactively enhance and improve the system functionality (usability) in order to improve productivity standards.
2. The SmartCare HIS development team should continuously monitor the project qualities and carry out regular maintenance and improvement.
3. SmartCare system is designed to accommodate other modules for other diseases. Hence the Ministry of Health and supporting partners should invest in infrastructure, workflow, and data flow challenges to create new disease modules, for example for Coronavirus (COVID-19) disease or implement other SmartCare modules such as vaccination module.
4. To manage system failures and enforce data and disaster recovery plans, SmartCare system users and Coordinators should carry out periodic testing of the data and disaster recovery plans. For example, testing the ability to restore the system from backups, ensuring regularly scheduled pick up and off-site storage of backups, regular testing of power backups etc.

5. To resolve bugs or issues such as slow software response or software hangs when using the card reader, the SmartCare development team should constantly update the software with patches that can quickly-repair functionality issues or add new features. Quick response will assist with efficiency levels.
6. To safeguard data, the SmartCare-card should be encrypted, and the card should have a secret security key that can be entered before access to data on the SmartCare-card.
7. Despite having the security mechanism on data rooms and screening rooms that are secured with locks and keys, there is need to restrict and limit access to the said rooms to avoid thefts of hardware machines such as laptops and computers.
8. To have a successful project, the development team must comply with the key HIS standard components to ensure that SmartCare system components work to the set standards.
9. The SmartCare system development team should consult all stakeholders during improvement of the system to ensure stakeholders, especially users' expectations, are met. If the level of expectations is provided, users would be satisfied.
10. Before sharing health data between public and private sector is actualized, there should be better engagement and understanding about how health facilities can collect, share, protect the data. There should be a well-set plan and strict conditions and tightly controlled circumstances.

11. Integration is central for Health Information Systems. The Ministry of Health and supporting partners should implement and roll out SmartCare plus (web-based system) in all health facilities to support system integration.
12. As the pros of SmartCare EHR system outweigh its cons, it is imperative that Ministry of Health and supporting partners roll-out the health system to facilities/health centers without the system.

The recommendations are likely to enhance long-term outcomes of the SmartCare system project.

5.5 Limitations of the Study

In undertaking this study, the following limitations were encountered:

1. The scarcity of literature on the SmartCare EHR system proved to be a challenge.
2. Administrative and ministerial policies that delayed collection of data due to clearance from the Ministry of Health (MoH), Natural and Applied Sciences Research Ethics Committee (NASREC) and the National Health Research Authority (NHRA).
3. The study focus was on one province, therefore, did not target other participants from other regions.
4. The study questionnaire was created, distributed, and stored online using an application called Google forms. Some targeted respondents however, delayed responding hence affected study timeline.
5. Generalizability of the findings of some research questions. A small sample of respondents to document experiences among SmartCare Data

Coordinators and Technical Support Officers. Similar studies are therefore essential in other settings for comparability of research findings.

5.6 Recap of Chapters

Chapter One – presented an overview of the research study followed by the problem definition, research aim, research objectives, the research questions, significance of the study, and ethical considerations.

Chapter Two – gave an overview of what is known about the problem. It described earlier studies done on the topic to date. It presented an overview of Health Information System (HIS) globally and within Zambia. It reviewed the HIS SmartCare Electronic Health Information System and further outlined its benefits, outputs, success factors and challenges.

Chapter Three – discussed the methodology. The study design, study settings, study population and study sample were subsequently described with a review of the instruments used and their properties. The chapter outlined the data collection procedure and timeline followed.

Chapter Four – presented the research findings and discussions. The chapter addressed a comprehensive description and interpretation of the research findings and presented the discussion and a detailed analysis of the data.

Chapter Five – presented the research conclusions, contributions, and addressed the research limitation as well as recommendations of areas of further research.

5.6 Chapter Summary

The chapter presents the conclusion of the study drawn from the research objective and subsequently from the analysis and discussion of research findings. The chapter outlines the research contributions and further makes recommendations, which could improve current and future development of SmartCare EHRS. The chapter further indicates the limitations of the research study.

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APPENDICES

APPENDIX I: SURVEY QUESTIONNAIRE

A STUDY QUSTIONNAIRE TO GATHER INFORMATION TO ASSIST THE INVESTIGATION OF THE IMPLEMENTATION OF SMARTCARE ELECTRONIC HEALTH RECORD SYSTEM PROJECT IN ZAMBIA.

The information you are providing in this questionnaire will be used for academic purposes as well as in line with research ethics such as upholding of confidentiality, anonymity etc. Please tick(s) [✓] for the appropriate answer(s).

SECTION 1: SOCIO – DEMOGRAPHIC

1. **Date**: ___/___/___
2. **Gender**:
   - (a) Male [ ]
   - (b) Female [ ]
3. **Age**:
   - (a) 18-24 years [ ]
   - (c) 25-29 years [ ]
   - (d) 30-34 years [ ]
   - (e) 35-39 years [ ]
   - (f) 40+ [ ]
4. **Highest Academic Qualification**:
   - (b) Certificate [ ]
   - (g) Diploma [ ]
   - (h) Bachelor's degree [ ]
   - (i) Master's degree [ ]
   - (j) PhD [ ]
5. **Work Experience**:
   - (a) 0 – 1 Year [ ]
   - (b) 2 – 3 Years [ ]
   - (c) 4 – 5 Years [ ]
   - (d) Over 6 Years [ ]
6. **Name of Health Facility**:

   ____

SECTION 2: SYSTEM PERFORMANCE

Please rate (tick) your level of agreement with each question below about SmartCare HIS.

	Excellent	**Good**	**I don't know**	**Fair**	**Poor**
7. How well are you copping with SmartCare System user-friendliness in terms of ease access and usage of the software?					
8. During software load, how well does SmartCare System perform in terms of time taken to fully load and function?					
9. Software heavy demand is the requirement of large amounts of energy and resources. How well is the availability of SmartCare System during these heavy demands?					
10. SmartCare processes are accomplished by clicking user interface buttons or links. How effective is the response time of such interactions?					
11. How well is the accessibility and timely process of requested data from SmartCare System?					
12. How effective is the response time of the functions of Smart-Card reader?					
13. How effective is the recovery time of SmartCare system from failures such as crush, hang?					

SECTION 3: SYSTEM FUNCTIONALY

	Yes	Sometimes	I don't know	Rarely	No
14. During system load, does SmartCare System load with errors or experience system failures (e.g., crush, hang)?					
15. Do you gain access to SmartCare System as per assigned user privileges (username and password)					
16. Is SmartCare System able to function offline on a computer without online infrastructure such as Local Area Network (LAN) and Wireless LAN?					
17. Does SmartCare's major components such as Out-Patient (OPD), Antenatal Care (ANC), ART etc., work as required?					
18. Does SmartCare's electronic forms used to record patient information, such as initial history, physical examination etc., perform as required?					
19. Does SmartCare System exhibit errors or experience system failure when storing data?					
20. Does SmartCare reports provide accurate, up-to-date, and complete information?					

21. Does the Smart-Card reader function properly without errors and system failures?					

SECTION 4: SUCCESS FACTORS AND CHALLENGES OF SMARTCARE HIS

Please rate (tick) your level of agreement with each question below about SmartCare HIS.

	Strongly agree	**Agree**	**Neither disagree nor agree**	**Disagree**	**Strongly disagree**
22. I am satisfied with SmartCare system quality in terms of system dependence.					
23. SmartCare system allows more than one user to access it at the same time.					
24. I am satisfied with the availability of electronic interfaces that makes it easier to access information like specific lab results.					
25. I am satisfied with the availability of information quality and information system effectiveness of the system.					
26. I am satisfied with the compatibility of SmartCare system					

with other system					
27. One of the main challenges of SmartCare system in Zambia is high initial cost such as computer and other physical infrastructure like backup power electricity.					
28. Private sectors are hesitant to share health information about their patients with public hospitals they perceive as competitors					
29. SmartCare-cards lack a key security feature called encryption that can prevent hackers.					
30. SmartCare System is linked and integrated with other Health Systems in other Health facilities.					

Thank you for your time!

APPENDIX II: INTERVIEW DISCUSSION GUIDES

DATA COORDINATOR AND TECHNICAL SUPPORT OFFICER INTERVIEW GUIDE

Interviewee Details:

Participant ID: ……………………………………………………………

Date of interview: ………………………………………………………….

1. What is your sex?
    (a) Male [ ]
    (b) Female [ ]
2. What age range are you within?
    (a) 18-24 years [ ]
    (c) 25-29 years [ ]
    (d) 30-34 years [ ]
    (e) 35-39 years [ ]
    (f) 40+ [ ]
3. What is the highest level of education you completed?
    (b) Certificate [ ]
    (g) Diploma [ ]
    (h) Bachelor’s degree [ ]
    (i) Master’s degree [ ]
    (j) PhD [ ]
4. What is your work experience:
    (a) 0 – 1 Year [ ]
    (b) 2 – 3 Years [ ]
    (c) 4 – 5 Years [ ]
    (d) Over 6 Years [ ]
5. Name of Health Facility:

    ____

TECHNICAL QUESTIONS:

6. Can you tell me more about your work and the role you play here? What do you find interesting about your job? …………………………………………

7. Could you describe the disaster recovery plan in place, that involves a set of policies, tools, and procedures, to prevent SmartCare system loss and data loss in facilities? Please tell me more? ……………………………………………

8. A business continuity plan can allow a facility to continue the delivery of services at pre-defined acceptable levels after a system disruptive incident. What plans have been put in place to avoid major disruption? …………………

9. Could you talk about the awareness of staff about business continuity plan? Probes: Its process? Its procedures? Roles played by staff? Awareness of roles? ……………………………………………………………………………

10. What is the amount of time with regards to the response and recovery of SmartCare system and data, by facility and application? What happens if one of your intended processes fails? Probe: Please tell me more. ……………………………………………………………………………

11. Could you please tell me about the features that can make the SmartCare system to be stable and able to recover on time from failures such as crush or run into errors? …………………………………………………………………

12. How do you backup all important data of SmartCare system? …………………

    Probe: How many times is this done? How much time does this take? Whose responsibility is it to do it?

13. How do you currently backup crucial system functions of SmartCare system? How many times is this done? Whose responsibility is it to do it? ……………

14. Could you describe how SmartCare system data is stored? Probe: Is this stored off-site? Who is responsible? …………………………………………………

15. How are the SmartCare server hardware configurations information backed up? How is this done? Who is responsible? ………………………………………

16. When was the last time a full recovery test was completed? How was this documented? ………………………………………………………………

17. How do you currently protect the facility and application for SmartCare?

    Probe: Are both the facility and application physically protected e.g., lock key? How secure is this? …………………………………………………………

Thank you for your time!

DATA ASSOCIATE INTERVIEW GUIDE

Interviewee Details:

Participant ID: ……………………………………………………………

Date of interview: ……………………………………………………………

1. What is your sex?

   (a) Male [ ]

   (b) Female [ ]

2. What age range are you within?

   (a) 18-24 years [ ]

   (c) 25-29 years [ ]

   (d) 30-34 years [ ]

   (e) 35-39 years [ ]

   (f) 40+ [ ]

3. What is the highest level of education you completed?

   (b) Certificate [ ]

   (g) Diploma [ ]

   (h) Bachelor's degree [ ]

   (i) Master's degree [ ]

   (j) PhD [ ]

4. What is your work experience:

   (a) 0 – 1 Year [ ]

   (b) 2 – 3 Years [ ]

   (c) 4 – 5 Years [ ]

   (d) Over 6 Years [ ]

5. Name of Health Facility:

   ____

TECHNICAL QUESTIONS:

6. Can you tell me more about your work and the role you play here? What do you find interesting about your job? …………………………………………

7. Could you share with me how SmartCare Health Information System supports data collection, data completeness and data process?……………………………
8. Can you describe the effectiveness of SmartCare System when it comes to improving the Ministry of Health indicators that show change that has taken place in a country's health profile over time? **Probe**: Could you give me 2 examples of indicators that changed? Can you please tell me more? ……………………………………………………………
9. What is the internal data source of SmartCare System e.g., Database, Online web services? Can you briefly describe how this works? ……………………………
10. Can you please describe how SmartCare System collects, stores, compiles, analyzes, and processes data? …………………………………………………
11. How do you access information from SmartCare system while maintaining privacy and confidentiality of the stored information? How is this done? **Who is responsible**? ……………………………………………………………………
12. Could you describe how SmartCare System manages results e.g., laboratory, pharmacy? ……………………………………………………………………
13. Could you describe how the order management (e.g., electronic prescribing, referrals to hospitals) works in SmartCare System? How does this work? ……………………………………………
14. Could you describe how a decision-making expert system (e.g., drug alerts, reminders, diagnostic decision support) work in SmartCare System? ………………………………
15. Could you share with me on how SmartCare System provides electronic communication e.g., provider-provider, inpatient-outpatient, medical devices, trading partners etc.?
    Can you briefly describe how this works? ……………………………………
16. Could you describe how the scheduling management and eligibility determination is done in Smart Care e.g., clinical trial recruitment, drug recall, chronic disease management?? How does this work? ……………………………………………………………………

17. Could you tell us more about patient support system in Smart Care that can comprise of patient education, patient data used for home monitoring?
……………………………………………………………………………

18. Could you describe how patient safety and quality reporting is done in Smart Care e.g., clinical dashboards, disease registries, reportable diseases etc.? Can you please briefly describe how this works? ……………………………………

Thank you for your time!

APPENDIX III: UNZA DRGS ETHICAL CLEARANCE APPROVAL LETTER

THE UNIVERSITY OF ZAMBIA

DIRECTORATE OF RESEARCH AND GRADUATE STUDIES

Great East Road Campus | P.O. Box 32379 | Lusaka 10101 | Tel: +260-290 258/291 777
Fax: (+260) 211 290 258/253 952 | Email: director.drgs@unza.zm | Website: www.unza.zm

APPROVAL OF STUDY

10th December, 2021

REF NO. NASREC-2021-NOV-001

Katayi Francis Pande
The University of Zambia
School of Engineering
Department of Civil and Environmental Engineering
P.O. Box 32379
LUSAKA

Dear Mr. Pande,

RE: "INVESTIGATING THE IMPLEMENTATION OF SMART CARE ELECTRONIC HEALTH RECORD SYSTEM PROJECT IN ZAMBIA USING TENETS OF PROJECT MANAGEMENT"

Reference is made to your protocol dated as captioned above. NASREC resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	Ordinary Review	Approval No. NASREC-2021-NOV-001
Approval and Expiry Date	Approval Date: 10th December, 2021	Expiry Date: 9th December, 2022
Protocol Version and Date	Version - Nil.	9th December, 2022
Information Sheet, Consent Forms and Dates	• English.	To be provided
Consent form ID and Date	Version - Nil	To be provided
Recruitment Materials	Nil	Nil
Other Study Documents	Questionnaire.	

Towards Improving Service and Excellence in High Education Beyond Fifty Years

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to NASREC within 5 days.
- All protocol modifications must be approved by NASREC prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to NASREC within 5 working days.
- All recruitment materials must be approved by NASREC prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. NASREC will only approve a study for a period of 12 months.
- It is the responsibility of the PI to renew his/her ethics approval through a renewal application to NASREC.
- Where the PI desires to extend the study after expiry of the study period, documents for study extension must be received by NASREC at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Documents received within 30 days after expiry will be labelled "late submissions" and will incur a penaltyfee of K500.00. No study shall be renewed whose documents are submitted for renewal 30 days after expiry of the certificate.
- Every 6 (six) months a progress report form supplied by The University of Zambia Natural and Applied Sciences Research Ethics Committee as an IRB must be filled in and submitted to us. There is a penalty of K500.00 for failure to submit the report.
- When closing a project, the PI is responsible for notifying, in writing or using the Research Ethics and Management Online (REMO),both NASREC
- and the National Health Research Authority (NHRA) when ethics certification is no longer required for a project.
- In order to close an approved study, a Closing Report must be submitted in writing or through the REMO system. A Closing Report should be filed when data collection has ended and the study team will no longer be using human participants or animals or secondary data or have any direct or indirect contact with the research participants or animals for the study.
- Filing a closing report (rather than just letting your approval lapse) is important as it assists NASREC in efficiently tracking and reporting on projects. Note that some funding agencies and sponsors require a notice of closure from the IRB which had approved the study and can only be generated after the Closing Report has been filed.
- A reprint of this letter shall be done at a fee.
- All protocol modifications must be approved by NASREC by way of an application for an amendment prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address or methodology and methods. Many modifications entail minimal risk adjustments to a protocol and/or consent form and can be made on an Expedited basis (via the IRB Chair). Some examples are: format changes, correcting spelling errors, adding key personnel, minor changes to questionnaires, recruiting and changes, and so forth. Other, more substantive changes, especially those that may alter the risk-benefit ratio, may require Full Board review. In all cases, except where noted above regarding subject safety, any changes to any protocol document or procedure must first be approved by NASREC before they can be implemented.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of NASREC, we would like to wish you all the success as you carry out your study.

Yours faithfully,

Dr. Mususu Kaonda

VICE CHAIRPERSON

THE UNIVERSITY OF ZAMBIA NATURAL AND APPLIED SCIENCES RESEARCH ETHICS COMMITTEE - IRB

cc: Director, Directorate of Research and Graduate Studies
Assistant Director (Research), Directorate of Research and Graduate Studies
Assistant Registrar (Research), Directorate of Research and Graduate Studies

APPENDIX IV: MINISTRY OF HEALTH APPROVAL LETTER

All correspondence should be addressed to the
Provincial Health Director
Telephone: +260 211 256813
Fax: +260 211 256814
Telephone: +260 211 256815
Cell: +260 956 399643
+260 963 908260

REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH

In Reply please quote:
PHOLSK/101/8/1
File No.:....................

Lusaka Provincial Health Office
P.O. Box 32573
LUSAKA

17th January, 2022

Katayi Francis Pande
The Principal Investigator
C/O Francis Kapembwa
P O Box 38738
LUSAKA.

RE: PERMISSION TO SHARE STUDY QUESTIONAIRE TO ASSISTANT M & E OFFICERS

Lusaka Provincial Health Office is in receipt of your request for permission to conduct research titled **"Investigating the Implementation of SmartCare Electronic Health Record System Project in Zambia using Tenets of Project Management".**

My office is glad to inform you that it has no objection to your request provided that;

1. The relevant Institution Director where the study is being conducted are fully appraised;
2. Progress updates are provided to Lusaka Provincial Health Office and the District Health Office biannually from the date of commencement of the study;
3. The final study report is cleared by NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University Leadership and all key respondents.

Kindly ensure minimum interruption in health service delivery to the selected health facilities.

By copy of this letter, the District Health Office / institutions are advised to allow you undertake the above mentioned research and provide you with the relevant support.

Yours faithfully,

REPUBLIC OF ZAMBIA
MINISTRY OF HEALTH
LUSAKA PROVINCIAL HEALTH OFFICE
18 FEB 2022
PROVINCIAL HEALTH DIRECTOR
P. O. BOX 32573, LUSAKA

Dr Consity Mwale
Provincial Health Director
LUSAKA PROVINCE

CC. Lusaka District Health Director
CC: Medical Superintendents – Chipata, Matero, Kanyama, Chawama and Chilenje

Physical Address: 3 Saise Road, Longacres, Lusaka, Zambia.

APPENDIX V: NATIONAL HEALTH RESEARCH AUTHORITY APPROVAL LETTER

NATIONAL HEALTH RESEARCH AUTHORITY
Paediatric Centre of Excellence, University Teaching Hospital, P.O. Box 30075, LUSAKA
Chalala Office Lot No. 18961/M, Off Kasama Road, P.O. Box 30075, LUSAKA
Tell: +260211 250309 | Email: znhrasec@nhra.org.zm | www.nhra.org.zm

Ref No: NHRA000009/14/02/2022 **Date: 14th February, 2022**

The Principal Investigator,
Mr Katayi Francis Pande,
University of Zambia
Lusaka, Zambia.

Dear Mr Pande,

Re: Request for Authority to Conduct Research

The National Health Research Authority is in receipt of your request for authority to conduct research titled **"Investigating the Implementation of SmartCare Electronic Health Record System project in Zambia using tenets of Project Management."**

I wish to inform you that following submission of your request to the Authority, our review of the same and in view of the ethical clearance, this study has been **approved** on condition that:

1. The relevant Provincial and District Medical Officers where the study is being conducted are fully appraised;
2. Progress updates are provided to NHRA quarterly from the date of commencement of the study;
3. The final study report is cleared by the NHRA before any publication or dissemination within or outside the country;
4. After clearance for publication or dissemination by the NHRA, the final study report is shared with all relevant Provincial and District Directors of Health where the study was being conducted, University leadership, and all key respondents.

Yours sincerely,

Prof. Godfrey Biemba
Director/CEO
National Health Research Authority

APPENDIX VI: CONFERENCE AND JOURNAL ACCEPTANCE LETTER

DII-2022 FULL PAPER ACCEPTANCE

Dear K.F. Pande,

Congratulations on the acceptance of your manuscript, Paper 074, "**Implementation of SmartCare Electronic Health Record System Project in Zambia Using Tenets of Project Management**" by K.F. Pande & B. Mwiya for the 8th International Conference on Development and Investment in Infrastructure (DII-2022). With great pleasure, we thank you for your interest and submission to the DII-2022 conference.

The DII-2022 conference is part of the DII conference series on Infrastructure Development and Investment. It aims to provide a forum for leaders, researchers, practitioners, and stakeholders in infrastructure development to discuss, evaluate and devise ways of maximizing the benefits of infrastructure development and achieve outputs that will inform policy and wider development goals.

We invite you to present your accepted paper at the DII-2022 conference by registering here.

Time
Oct 6, 2022, 07:30 AM
Oct 7, 2022, 07:30 AM

With best wishes
I. Musonda, PhD.
Professor - Construction Management
Chairman: DII-2022 Scientific Committee
Director: Centre for Applied Research + Innovation in the Built Environment
University of Johannesburg, South Africa
https://diiconference.org/

Theme:
Building Smart, Resilient and Sustainable Infrastructure in Developing Countries.

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