ANALYZING DESIGN-REALITY GAPS INFLUENCE ON ELECTRONIC MEDICAL RECORDS USE: THE CASE OF MALAWIAN HEALTH CENTRES

MASTER OF SCIENCE (INFORMATICS) THESIS

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UNIVERSITY OF MALAWI

CHANCELLOR COLLEGE

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By

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DECLARATION

I, the undersigned, hereby declared that this thesis is my own original work which has not been submitted to any other institution for similar purposes. Where other people's work has been used, acknowledgements have been made.

_____

Full Legal Name

_____

Signature

_____

Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval

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Main Supervisor

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Second Supervisor

DEDICATION

To lovely wife Emmie and to my boy Ethan

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Firstly, I would like to acknowledge God for everything he has done to me; He has been my provider, my refuge and my comforter.

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ABSTRACT

Information Technology (IT) has changed the way we do our daily activities. The advancement of technology has resulted in the development of Electronic Medical Records within the health sector. Electronic Medical Records (EMRs) are patient level data management information systems. Globally, over 50% of Electronic Medical Records deployed are occasionally used or not used at all. In Malawi, EMRs use faces several challenges. EMRs like Chronic Care Clinic and Admissions, Discharge and Transfers have never been used after initial trainings. This study intended to analyse Design-Reality gaps that influence EMR use in Malawi. The research used Outpatient Department (OPD) and Antiretroviral Therapy (ART) EMRs found at Area 25 and Area 18 Health Centres. The study found that OPD EMR reporting features do not have reports required by the end users, OPD EMR require several complex steps to accomplish a single task. Another finding is that OPD EMR has distorted the workflows of the clinic. There is low staffing to use the EMRs than planned. The huge gaps have influenced negatively on the use of OPD EMRs whereas for ART EMRs the lack of gaps promotes the use of it. In this light, the study recommends the addition of necessary reports that are required by OPD EMR stakeholders, implementers should reduce OPD EMR steps to complete a task. In order to have workflow adherence, stakeholders should the EMR designs should mirror manual processes. MoH should ensure that staffing levels are sufficient in the hospitals to support the use of EMRs.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANC	Antenatal Clinic
A25HC	Area 25 Health Centre
A18HC	Area 18 Health Centre
ADT	Admission, Discharge and Transfers Clinic
AETC	Admissions, Emergency and Trauma Clinic
ART	Anti-Retroviral Therapy
ARV	Anti-Retroviral Drugs
BHT	Baobab Health Trust
BMI	Body Mass Index
CCC	Chronic Care Clinic
CDC	Centres for Disease Control and Prevention
CDS	Clinical Decision Support
CPOE	Computer-based Provider Order Entry
CPR	Computer-based Patient Records
CMED	Central Monitoring and Evaluation Department
DHIS	District Health Information System
EHR	Electronic Health Record
EMRs	Electronic Medical Records System
HIS	Health Information Systems
HMIS	Health Management Information Systems

DHMISO	District Health Management Information System Officer
MMRS	Mosoriot Medical Record System
ICT	Information Communication and Technology
IS	Information Systems
IT	Information Technology
KCH	Kamuzu Central Hospital
OpenMRS	Open Medical Record System
OPD	Out-Patient Diagnosis
MoH	Ministry of Health
NGO	Non-Government Organization
PHR	Personal Health Record
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

As technology is advancing, ways of keeping and managing data are also changing. In order to manage patient and other relevant data, health facilities started using Health Information Systems around 1960s. Health Information System can be categorized into the following categories: public health, patient care, hospital management, health education, health management and consumer health (Berg, 2001).

Systems that are used to manage patient data are called Patient Care Information Systems. These systems are categorized into two groups namely Computer Based Patient Records and Mobile Based Patient Records, based on the platform through which the users access the system (Fraser, Biondichi and Choi, 2005). This study looks at Computer Based Patient Records systems, as they are the ones that have been widely deployed in Malawi. Examples of known Computer Based Patient Records system include Electronic Medical Records (EMRs), Patient registration and Clinical Decision Support (CDS) (Douglas, 2009). These information systems have been implemented in different countries and their usage varies. EMRs have a clear significance in the medical field; they provide easy access of patient data to medical personnel, they reduce medication errors due to illegible handwriting, easy storage of data, easy report generation among other things (Chawani, 2014a).

Studies have highlighted some of the common challenges faced by implementers of Electronic Medical Records (EMRs) in various developing countries. Some of the common challenges include high cost of implementation, intermittent power supply, low computer literacy among healthcare workers and lack of perceived/anticipated benefits to the users (Fraser et al., 2005; Douglas, Mumba, Gadabu and Jahn, 2010). These challenges often lead to occasional use of EMRs and continued reliance on paper. This research looked, in-depth, at the gaps that exist between design and the actual system that affect the use of EMRs in Malawi. In this regard, this thesis focuses on systems implemented by Baobab Health Trust. Baobab Health Trust is the leading organization developing, implementing and supporting of EMR in Malawi.

The earliest EMRs in Malawi were introduced at Kamuzu Central Hospital in 2001, and these were Anti-Retroviral Therapy and Patient Registration Systems. The implementation of EMRs brought in a lot of benefits which include reducing medical errors that arise from typographical issues, improving completeness of data by reminding service providers of some fields that need to be collected, and easing the process of reporting as reports can be produced at a click of a button (Chawani, 2014b).

1.1 Background

Baobab Health Trust (BHT) is a Non-Governmental Organization (NGO) that develops and deploys Electronic Medical Recording Systems (EMRs) for Malawi's Ministry of Health, with funding from Centres for Disease Control and Protection (CDC), World Diabetes Forum, The Union against Tuberculosis and other donors. Its vision is to lead

the improvement of health-care through Information and Communication Technology (ICT) in the developing world (Baobab Health Trust, 2016).

Baobab Health Trust's most deployed systems are for National Anti-Retroviral Therapy and Out Patient Department. These applications are deployed at health facilities that have large volume of patients.

At the time of concluding empirical work for the thesis, BHT had developed 27 EMRS and these had been deployed in 125 health facilities. The core systems deployed were Anti-Retroviral (ART), Out Patient Department (OPD), Antenatal Clinic (ANC) and Demographic Data Exchange (DDE). Other systems that have been deployed include Maternity, Chronic Care Clinic (CCC), Patient Registration and Radiology Systems among others.

This study focused on Out Patient Department EMR and Anti-Retroviral Therapy EMR. Both EMRs are the widely deployed EMRs available in over 70 health facilities throughout the country.

1.1.1 Anti-Retroviral Therapy Electronic Medical Record

ART EMR was designed as system to be used in an ART Clinic. The clinic manages patients that are HIV positive and are receiving life-prolonging drugs called Anti-Retroviral drugs (ARVs).

The workflow of system is as follows; once a patient has been diagnosed HIV positive they are enrolled into the ART EMR. This enrolment/registration captures only demographic data (Name, Date of Birth, Gender, Location of residence, Village/Town, District and Region). At the end of registration a bar-code label is generated and pasted on the health passport and the ART register book. After this stage, the patient proceeds to nurses' station where vitals are collected (Temperature, Weight, Height and Pulse). After collection of Vitals, clients are directed to the clinician station where they get advice and drugs for that month. Users have to select drugs from a combination of nine drugs/regimens available in the EMR. The system recommends regimens to be given basing on age, height and weight of the patient. At the end of the visit the system generates a sticker to be pasted on the health passport detailing the next date of appointment. Figure 1 below shows the workflow of ART EMR.

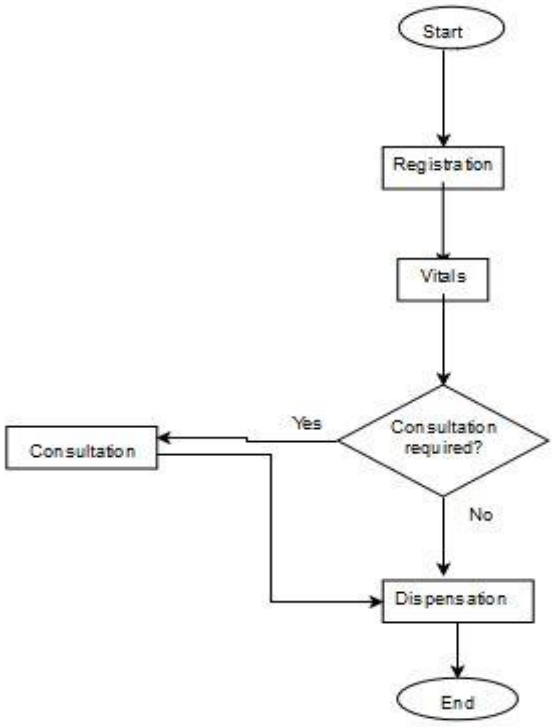

Figure 1: ART EMR workflow

Source: Researcher

The EMR was designed to be managed by the Health Centre management. When the clinic has challenges with the EMRs, facility management should liaise with Baobab Health Trust on the best way to resolve. Department of HIV/AIDS supervisors visit the clinic once every quarter to check quality of data. The HIV supervisor collects HIV cohort report generated at the end of the quarter for drug procurement and distribution planning.

Infrastructure wise, the EMRs were designed in a client-server model, where all computers are connected to a server that is located centrally. The computers are in a network with cables running from each computer to the server.

1.1.2 Out-Patient Department Electronic Medical Records

OPD EMR was designed as system that will be used in the OPD Clinic. The OPD clinic deals with walk-in patients with various medical conditions.

The general workflow of system is that once a patient arrives at the clinic for the first time they are registered into the system. Similar to ART EMR, this registration captures demographic data only (Name, Date of Birth, Gender, Location of residence, Village/Town, District, Region, Ancestral Region, Ancestral Districts and Ancestral Village) at the end of registration a bar-code is generated and pasted on the health passport. If a patient has a bar-code pasted on their health passport, the bar-code is scanned at the registration station before the patient proceeds to consultation instead of re-registration. After this stage, the patient proceeds to clinician's station where they are diagnosed and patient management plan is prescribed, for under-five children the system redirects to nurses' station for them to collect vitals (Temperature, Weight, Height and Pulse). After consultation, patients are sent to pharmacy to collect the prescribed medicines. The system is designed to produce several reports at the end of the month e.g. Attendance report, Diagnosis by Area, Outbreak report and Outcome report. Figure 2 below shows the above explained workflow.

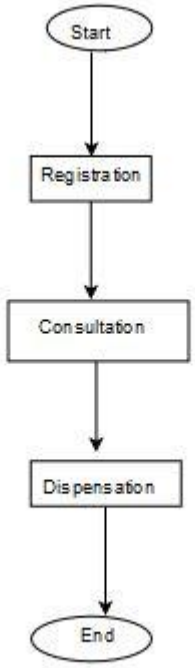

Figure 2: OPD EMR design workflow

Source: Researcher

Whenever the EMR encounters a challenge, management is supposed to inform Baobab Health Trust for them to resolve it. BHT provides user support once faults are identified and also provide training and refresher courses when rotations have taken place.

Similar to ART EMR, OPD EMRs were also designed in a client-server model, where all computers are located to a server that is located centrally. The computers are in a network with cables running from each computer to the server.

1.2 Problem statement

In Malawi, some EMRs are under daily use while others are used occasionally. One EMR may be used regularly while another may be rarely used or only a few functionalities/features are used.

Some of the systems that have been well accepted and regularly used include Anti-Retroviral Therapy, Radiology, Laboratory Information, Antenatal Clinic, Admissions, Emergency and Trauma Clinic (AETC) and TB-HIV Clinic systems. Other systems however have faced usage resistance and these are Out Patient Department, Chronic Care Clinic, Admission Discharge and Transfers, Electronic Pharmaceutical Inventory and Malaria Systems.

At Kamuzu Central Hospital, for example, Patient Registration System is always used whereas the Chronic Care Clinic System (CCC) faces resistance, although both EMRs were designed and developed by Baobab Health Trust. Chronic Care Clinic System has faced resistance to the point that Baobab Health Trust has conducted three user refresher courses to revive the system. EMRs usage meetings have been done between Ministry of Health officials, BHT and hospital administrators to map the best ways of ensuring that the EMR is being used to realize maximum benefits.

Users have indicated EMRs do not meet their expectations for the clinic or for the health centres. In other cases such systems do not have features that are required for user to use

the system. Typical example of an EMR not meeting users' expectations is the failure of the OPD EMR to produce desired electronic reports for monitoring and planning.

1.3 Research objectives

The overall research objective was to analyse socio-technical design-reality gaps that influence EMR use.

Design-reality gap in this context is defined as the difference between what was conceptualized before development of system and what is happening on the ground after the system has been installed for use. The Design-Reality Gap Model is an important contribution to the field of Health Informatics because it provides a systematic and uniform way to evaluate and monitor electronic projects and assess their success (Heeks, 2003).

1.4 Specific objectives

1. Identify technical design-reality gaps that affect the use of EMRs
2. Investigate organizational design-reality gaps that affect the use of EMRs
3. Analyze staffing and skills design-reality gaps that affect EMR use
4. Suggest strategies for minimizing design-reality gaps, to enhance EMR use

1.5 Research questions

The main research question of this study was "How do socio-technical design-reality gaps influence Electronic Medical Records use in Malawi?"

The following sub-questions helped us to find answers to main research question.

1. How do design-reality technical gaps influence EMR use?
2. How do design-reality organizational gaps influence EMR use?
3. How do design-reality staffing gaps influence EMR use?
4. How can design-reality gaps be minimized to enhance EMR use?

1.6 Assumptions

This thesis makes no assumptions on the design and the use of Electronic Medical Records in Malawi.

1.7 Personal motivation

I was motivated the time I was working at Baobab Health Trust as a Support and Deployment Officer[1] and later as a Product Owner[2]. One of the main problems I encountered as a Product Owner, after monitoring the investments that Baobab Health Trust was making in health facilities, was that in a health facility where two or more EMRs are deployed, some EMRs are used while some EMRs are not used or they are occasionally used. Quick discussions with the users indicated that some EMRs do not fit the environment where they are installed.

[1] Support and Deployment Officer is an officer responsible for installation of EMRs and providing user support when they have encountered challenges

[2] Product Owner is an officer responsible for managing software development and ensuring that are developed using defined standards.

1.8 Intended audience

This research targets Health Managers, Health Information System implementers, students, researchers and everyone who has interest in EMRs and Health Information Systems in general.

1.9 Key terms

Central concepts in this thesis are *system use*, and *socio-technical factors*, and *design-reality gaps*. A *Design–Reality Gap* refers to the difference between the theoretical expectation and the actuality of a technology that has been deployed (Tavares and Oliveira, 2017). *System use* can be defined as an individual's employment of one or more features of a system to perform a task (Chege, 2015). System use can be voluntary or involuntary. Voluntary use is facilitated by users' need to accomplish a certain task while involuntary use happens when users are required to use the system to perform some functions with no alternatives provided (Keshavjee, Bosomworth, Copen & Kucukyazici, 2016). Socio-technical factors refer to factors that arise from an interaction between people, processes and technology in a workplace (Jahwari, 2016). Socio-technical factors look at the involvement of human beings who work with different advanced tools in their day to day activities to achieve a certain goal (Cucciniello, Lapsley, Nasi & pagliari, 2015). When there is no smooth interaction between any of these elements the system as a whole fails (Douglas et al., 2010).

1.10 Structure of the thesis

The organization of this thesis is discussed below.

Chapter 1 presents introduction to the research project and it highlights on the study background, the problem statement, and the aim and objectives of the study, research questions, study motivation and intended audience of the study. Key terms that have been used in this research been presented as a final section of the chapter.

Chapter 2 presents literature review. It covers descriptions of similar studies done on Health Informatics, Electronic Medical Records, and Electronic Medical Records Implementations in developing countries, Electronic Medical Records use and challenges in Malawi.

Chapter 3 presents research design and methodology adopted for the study; it covers the research context, the research design, the approach, data collection techniques, data analysis and validations, ethical considerations and limitation of the study.

Chapter 4 presents findings and discussions of the study in relation to the literature and the employed theoretical framework.

Chapter 5 presents conclusions drawn from the research, the research contributions and finally presents recommendations made from the study.

1.10 Chapter summary

This chapter has presented introduction to the research area, it has made an attempt to present background to the topic, the research problem, study objectives and research questions that have guided this study. The chapter further looked at motivation that led to this research before looking at the intended users of this study. It also presents key terms that have been employed in this research. Finally, this chapter presents a layout on how this thesis has been organized.

CHAPTER 2

LITERATURE REVIEW AND THEORETIC FRAMEWORK

This chapter presents previous related work and the theoretical framework that has guided this thesis. The first section presents an overview of the Health Informatics discipline. This is followed by a review of literature specifically on Electronic Medical Record systems. Later, the theoretical framework adopted in this study is presented.

2.1 Health Informatics

Health Informatics is a combination of Computer Science, Information Science and Health Science; designed to assist in the management and processing of data, information and knowledge, to support healthcare and healthcare delivery (Conrick, 2006). Health informatics can also be defined as a study of information and communication processes and systems in health-care (Nelson & Staggers, 2017). Studies also notes that the term Medical Informatics is usually interchanged with Health Informatics, however, Medical Informatics focuses more on Information Technology applied in medicine and biology only (Coiera, 2015).

This research focused on health information systems particularly on patient care information systems. There are several types of patient care information systems which include Electronic Medical Record (EMR) systems, Clinical Decision Support systems (CDSS), Computer-based Provider Order Entry (CPOE) systems or Medication systems,

Pharmacy Information Systems, Laboratory Information Systems, Telemedicine systems, Radiology Information systems among other systems (Khomani, Mputeni & Gadabu, 2013). This research looked into issues surrounding EMRs.

2.2 Electronic Medical Record (EMR) System

The idea of keeping patient information electronically was introduced in 1968 by Larry Weed who developed a concept of Problem Oriented Medical Record into medical practice (Russell, 2012). By 1972, the Regenstreif Institute developed the first EMR in the United States of America (Sikhondze & Erasmus, 2016). From 1972 to date, developed countries have seen tremendous development of EMRs. There are established vendors that supply EMRs to health facilities that intend to install EMRs. Some of the popular EMRs include Epic Systems Corporation, Allscript, EclinicalWorks, NextGen Healthcare and Cerner (EMR Survey, 2015).

Electronic Medical Records (EMR), Computer-based Patient Record (CPR), Personal Health Record (PHR) and Electronic Health Record (EHR) are terms which are considered synonymous and they have been used interchangeably (Kelley, 2016). In as much as these terms are used interchangeably they are variations in their meanings, EMR is a digital version of traditional paper-based medical records for an individual within a single health facility, whereas EHRs, though capturing data similar to EMRs, have a use coverage that extends across health facilities. PHRs capture same data points as EHR/EMR, but the data is managed by an individual instead of a health facility. CPR is

electronically maintained information about an individual's lifetime health status and healthcare (*ibid*).

EMRs have clear advantages over paper-based records in several ways. Some of the main advantages of implementing EMRs over paper-based records are: 1)improvement in legibility of clinical notes; 2) Decision support for drug ordering, including allergy warnings and drugs incompatibilities; 3) Reminders to prescribe drugs and administer vaccines; 4) Warnings for abnormal laboratory results; 5) Management of chronic diseases such as diabetes, hypertension and heart failure; 6) Supporting for program monitoring, including reporting outcomes, budgets and supplies (Fraser et al., 2005).

2.3 Electronic Medical Records in developing countries

Developing countries are characterized by lack of basic resources such as potable water, food, electricity and clothing. In health setting, these countries have a huge patient-doctor ratio and they rely on donor aid to finance their health service delivery (WHO, 2016).

Developing countries' hospitals have been using paper based records when providing services to their citizenry. Patients are required to take their physical records to the next service provider e.g. to the laboratory or to a referral hospital (Kalogriopoulos, Baran, Nimunkar & Webster, 2009). After a service has been provided the papers/registers are collected and stored in a room within the health facility. In Malawi, patients are also required to have health passports where services offered to them are documented on top of the paper records that are kept by the hospital (Douglas, 2009). Patients are asked to

keep safe their health passports to ensure continuity of care next time the patient visits a hospital.

Overtime studies revealed the shortfalls of paper-based records. Shortfalls that were highlighted in many research findings included lack of enough storage space, difficult to transfer data from one provider to another, lack of back-up in cases of fire or natural disasters, medication errors due to bad handwritings, difficult to retrieve data that is in papers dating back months or years and challenges to produce reports.

In response to these challenges, Partners in Hope (PIH) started implementing open-source EMRs in Peru in 2006 (OpenMRS, 2017). The EMR introduced to serve a small community of 4500 people. The success of open-source EMRs resulted in Partners in Hope, replicating the technology to Haiti and other neighboring countries. Consequently a software platform was developed for developing countries called OpenMRS. OpenMRS platform is used as a framework for implementers who are developing EMRs (*ibid*).

With a platform of EMRs freely available, developing countries have seen a burst of different EMRs introduced. Some of the known EMRs that have been implemented in developing countries include Mosoriot Medical Record System (MMRS) implemented in Kenya, Partners In Health EMR deployed in Lima, Peru, HIV EMR system deployed in Haiti, Careware deployed in Uganda and finally Anti-Retroviral Therapy (ART EMR) implemented in Malawi (Fraser et al., 2010).

2.4 Challenges facing Electronic Medical Records in developing countries

Despite the obvious benefits, EMRs raise some concerns in the health sector. The concerns on EMRs in Malawi, include issues around privacy and confidentiality, hardware problems, system failures, time required to learn how to use it, and decreased patient-physician interaction as physician spend more time entering data on the computer other than interacting with the patient (Chawani, 2014a).

In developing countries, the implementation of EMRs faced challenges that have been classified into two groups namely; technical and general challenges (Jawhari, 2016). These factors are outlined below.

Unstable power supplies, some countries in sub-saharan Africa do not generate enough electricity to run for one full day (WHO, 2016). In Malawi, some areas have power outage for a period as long as 23 hours. This affect EMR usage as facility do not have power back up for the machines to run (Fraser et al., 2005). When there is no power facilities use paper to records patient visits.

Developing countries also face poor network/internet connection; this affects data sharing across facilities within the country. In developing countries internet connection is averaged at 50% despite that it is erratic (World Bank Group, 2016).

On general challenges, studies have presented the following as some of the findings. In Zimbabwe, Zambia, Malawi and Tanzania, there is about 40% migration of medical personnel to developed countries resulting in high shortage of staff (Sood et al., 2008). The shortage forces health personnel to focus on providing care and focus less on the tools that are used to collect, to retrieve and to use data. EMRs in these countries are heavily used by clerical staff and the data collected may be erroneous or even wrong at sometimes (*ibid).*

The other challenge that EMRs encounter in developing countries is computer illiteracy of intended users that leads to natural resistance towards the use. Most of the potential users of the EMRs encounter computers during trainings for the first time in their life. This challenge is amplified with the fact that most users are old since younger medical personnel prefer working outside their country in search for better perks (Douglas et al., 2010).

Another problem that EMRs face is lack of perceived benefits or usefulness (Fraser et al., 2005). Largely data that is captured in EMRs is used for decision making by senior staff or at ministry of health level: This situation is not easily understood by the actual users. Users themselves do not see challenges with paper based system and mostly wonder why they should go through EMRs to do something they can easily write.

2.5 Electronic Medical Records in Malawi

Malawi started piloting EMRs at Kamuzu Central Hospital in 2001. After successful piloting of EMRs in 2001 at KCH, CDC started funding the deployment of different EMRs throughout the country. Over the period, several EMRs have been introduced into the public health space. Below is Table 1 showing a list of EMRs that have been deployed in Malawi.

Table 1: EMRs that have been implemented in Malawi

Source: Douglas, 2009

Implementer	E-Health System(s)	Location
EMRs		
Baobab Health Trust	ART, Out-Patient Diagnosis (OPD), General Patient Registration, Antenatal, Maternity, Diabetes, TB-HIV, Pharmacy, HIV Testing & Counselling (HTC), Chronic Care Clinic, Lab, and so on.	All districts in Malawi, except two (common in most sites are the first two systems) – district hospitals, health centres and mission hospitals
Luke International	Paxi - radiology	Mzuzu Central Hospital in Mzuzu
MSF - France	Fuchia (ART)	10 health facilities in Chiradzulu
Nkhoma Mission Hospital	Afyapro (facility wide system)	Nkhoma Hospital in Lilongwe
Partners in Health	ART	Neno
Dream Project	ART	Dream Clinics in Lilongwe, Blantyre and Balaka

2.5.1 Benefits of Electronic Medical Records

The health industry in Malawi has witnessed several benefits that have come about due to the introductions of EMRs in health facilities. Some benefits that are very visible include; EMRs do not require a lot of space to store data (Msiska, Kumitawa and Kumwenda,

2017). One computer can keep millions of patients' records. This means space that was being occupied by patients' records can be put to other use.

The other benefit is that EMRs allow users to easily access/retrieve data that has been captured previously (*ibid)*. Before EMRs, users were supposed to search through several copies to find one record that they are looking for. Users only need to scan a bar-code of a patient for them to access the records of that patient.

EMRs have also improved the way users are generating reports. Prior to EMRs users were taking 2 weeks to compile an HIV/AIDS cohort report. These reports were usually not accurate and they were submitted late. With the EMRs, users can generate this report with accurate data upon clicking one button (CDC, 2016).

2.5.2 Challenges facing Electronic Medical Records

The deployment of EMRs in Malawi has not without challenges, some of the challenges that have been observed include the cost of EMRs implementation is prohibitive. For one health facility to have an EMR, it costs USD 9, 368.00 (Douglas, 2009) which is expensive for a low resource setting.

Another challenge that EMRs face in Malawi is the user attitude. Medical personnel perceive the use of EMRs as a clerical job (Msukwa, 2011) and therefore they do not use the EMRs.

Power supply is also a challenge that affects EMRs; Malawi does not generate enough power that runs for the whole day. One is guaranteed that there will be power outage at a certain time of the day: Meaning that EMRs will not be used at that particular time if no power back up is implemented.

The other challenge is computer illiteracy; most users see computers for the first time during EMRs training. Even with after user trainings, users do not feel comfortable using the system (Msiska et al., 2017).

2.5.3 Electronic Medical Records use in Malawi

Since the deployment of first EMRs in Malawi, there has been noticeable use of the system. Over 50 percent of patients receiving ARVs are assisted through EMR (Baobab Health Trust, 2016). Hospitals like Martin Preuss Centre and Lighthouse Centre have completely phased out the use of paper preferring EMRs when providing service to patients (Schuemie, Talmon & Moorman, 2009). At Bwaila Hospital in Lilongwe, mothers with new born babies are asked to show EMR generated bar-code sticker to indicate that they have been discharged at the exiting gate (Khomani et al., 2013).

Despite this usage levels, some EMRs are not used at all or are not used regularly. For example, Kamuzu Central Hospital has 6 EMRs that were installed but only two are in daily use (Msiska et al., 2017). The EMRs that are in use at KCH are Patient registration and Maternity EMR while Admission, Discharge and Transfers (ADT), electronic

Pharmacy Systems, Chronic Care Clinic (CCC), Radiology EMRs are not used daily (Msiska et al., 2017).

One of the reasons why EMRs are not is the failure of systems to do what users want (Msukwa, 2011; Msiska et al., 2017; Sood et al., 2008). EMRs do not meet the expected requirements for end-users to complete their daily tasks.

This study seeks to unearth the gaps that result in the non-use of EMRs particularly by looking at the design of the system against what is implemented in the health facilities.

2.6 Theoretical Framework

This research employed the theory of Design-Reality Gap model (Heeks, 2003) to guide in data collection, data analysis and discussions. The model seeks to evaluate the influence of gaps between design-time assumptions made by solution developers and actual context of use actualities, on success or failure of implemented systems. The Design-Reality Gap model has the following dimensions: Information, Technology, Processes, Objectives, Staffing and Skills, Management systems and structures and Other resources (Scholl, Syed-abdul & Ahmed, 2011) as its dimensions. Due to these dimensions that it considers some researchers call it ITPOSMO model. Heeks (2003) claims that if there is a big gap between the elements in design and in reality the system will likely fail and if there is a small or no gap the system will likely succeed.

The model can be applied as a predictive tool before system implementation or as an evaluation tool for systems that have already been in use (*ibid*). This model has been considered in this research because it address elements core to this study's objectives. In this research, this framework was used as an evaluation tool to identify where gaps exist including their magnitude. When using this model in this manner the researcher tries to establish the gaps that led to the failure or success of a technology (Sood et al., 2008). The gaps were used to help in interpreting the results that are shown after data analysis.

The gaps, in the Design-Reality Gap theory, range from 0 to 10. The 0 score is a score that represents no difference between the actual system and the design-time assumption. The score of 10 means that difference between what was conceptualized and what is happening is huge and would impact the system usage negatively. Table 2, below, depicts the dimensions that are considered in this theory and their constructs.

Table 2: Design-Reality Gap dimensions and their elements

Dimension	**Elements**
Information	Data collected, Report generated and data definitions
Technology	• Hardware (Computers, Processing Units, Printers, Scanners and other peripherals). • Software (System design, screen layout, system workflow, system response time and usability) • Network Infrastructure (Routers, Towers, Switches, cabling and access points)
Processes	Manual systems available and patient workflows
Objectives and Values	Departmental visions, mission, dreams and aspirations
Staffing and Skills	Number of staff, qualification of staff and competencies of staff
Management Systems and Structures	Managers, leadership, guidance and support
Other Resources	Funding and Technical Support

Basing on how previous studies have applied this model of Design-Reality Gap, one has to consider all dimensions because at the end you will need to sum all the median scores from the users and rate the summation to know whether the system in question experienced failure or success. Next, I explain all the elements of the model, as applied in this thesis.

2.6.1 Information

In this dimension, the model looks at factors affecting quality, quantity and flow of data and/or information and the prerequisites of system inputs and outputs (Khomani et al., 2013). In this element the focus is on data that is collected and information that is produced. The tools and methods used to collect the data and the way information is presented to the end user (Heeks, 2003). This dimension has been considered because of its importance. Primarily EMRs are designed to cater for information needs of users and other stakeholders (Douglas et al., 2010). The difference in how EMRs were conceptualized and how they are faring on the ground may influence whether users will use them or not.

2.6.2 Technology

Technology, in this model, was looked at in terms of availability and usability of software and hardware (Khomani et al., 2013). This may refer to the cost and size of the hardware and/or the design and use of the software (*ibid).* Technology may even extend to how compatible is the existing infrastructure. Can the technology integrate or interoperate with other system (Chege, 2015). This study looked at the technologies that have been implemented through the EMRs. The researcher paid close attention to whether the technologies are suitable tools for users to do their job and if they are not suitable how different are the tools from what the users expect for them to be effective (Fraser et al., 2010). This dimension is as important as information because the study is evaluating electronic systems which are computerized systems.

2.6.3 Processes

This element looks at how information is handled, how decisions surrounding the systems are made, action/transactions and other health care processes (Douglas, 2009). How are processes defined? Who defined them and who do the processes affect? The researcher looked at processes that were there before and after EMR implementation. The researcher took time to look at the magnitude of the processes changes that may have occurred and how they impacted the implementation and use of EMRs. Processes affect people and the way they do their tasks. Looking at Processes as a dimension that can affect the use of EMR is critical. Some processes may reinforce the use while other may hinder the use of EMRs (Jawhari, 2016).

2.6.4 Objectives and values

This element looks at the objectives of medical staff, non-medical staff and other stakeholders (Heeks, 2003). What do these groups value in order for them to do their daily activities and how do these objectives and values compare with technology that has been installed or that will be installed. In the light of this study, I made an observation on how EMRs were aligning to the objectives and the values of the respective departments and the hospital in general.

2.6.5 Staffing and skills

This may refer to factors to do with availability of enough skilled personnel to work with the implementation, the adequacy of training that was offered to the intended users before implementation of the new technology (Douglas, 2009). The researcher looked whether

medical personnel were using the EMRs in all points and whether the users possess sufficient skills to use the system. If the users do not have enough skills they will not use the system similarly if they do not have hardware to interface with the technology will be useless.

2.6.6 Management structures and systems

This dimension looks at factors that deal with management. In this dimension we look at who makes decisions? How do their decisions affect daily activities? How rigid are the decisions made? This study considered Ministry of Health officials and Health Centre management as some of the decision makers. It further explored how these agents support the use of EMRs.

2.6.7 Other resources

This may refer to all resources that have not been mentioned above including time, healthcare resources and investments. Investments may refer to availability of initial investments and ongoing expenditure. In this dimension, the researcher looked at this factor may have impacted the implementation and use of EMRs. The study focused on looking at, for example, how an EMR has been supported financially and how the system should have been supported for it to be considered successful in terms of system use. Other factors other than those mentioned above may play a vital role in influencing how EMRs are used. If an EMR has, for example, people who are paid to capture data it will likely succeed comparing to users that are using it as a choice (Jawhari, 2006). If an EMR

has funding, refresher courses can be done easily to ensure that knowledge of the system is maintained.

2.7 Application of Design-Reality Gap Model

The Design-Reality Gap has been applied in Health Informatics since 1999. Conrick notes that this model helps in understanding why there is a high failure rate of EMRs and Information system in general (Conrick, 2006). In a quest to evaluate why an EMR that was deployed in Kuwait failed, Almutairi used that Design-Reality Gap model (Almutairi, 2011). In his methodology he identified the gaps through the interviews that he conducted and he used the gaps to evaluate why some EMRs failed. The study identified gaps in all the elements of the model. Heeks (2003) developed a scale to aid in interpretation of the gaps, as indicated in Table 3 below.

Table 3: Gap meanings showing what each score mean in terms of the gaps

Source: Heeks, 2003

0	1	2	3	4	5	6	7	8	9	10
No Gaps				Middle Gaps			Serious Gaps			

The gap score of 0 – 3 means that the factor is not likely going to contribute to the failure of a system. Gaps 4 – 6 mean that the factor may possibly contribute to the failure of a system while gaps 7 - 10 mean that the presence of the factor will very likely contribute to the failure of the system (Heeks, 2003). For example, if the user scores 7 to a

dimension for Technology, it means that the user feels that there is a serious gap between the reality and the design.

The scores can be estimated through the analysis of the researcher, or can be derived directly from interviewees and finally can be a result of a consensus reached in a group discussion (*ibid).* When the scores are derived directly from the interviewees or group discussions, the researcher should ensure that the participants have been properly notified to avoid mistakes or misinterpretation of the gaps. To simplify the presentation of the scores, some studies have presented the score using bar graph (Khomani et al., 2013). This presentation helps readers to quickly identify which factors have huge gaps. This presentation was initially presented by Heeks when he was reviewing the model (Heeks, 2003). Figure 3 below is an example of how the gaps can be presented graphically.

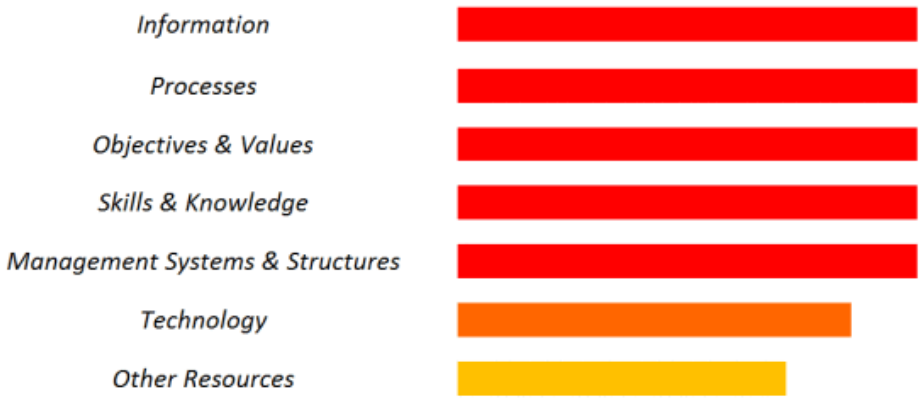

Figure 3: ITPOSMO Graphical Gaps for easy reference

Source: Heeks, 2003

In reality, some dimensions may require the researcher to break them into sub-dimensions in order for the participants to correctly score the gaps (Heeks, 2003). The dimension of Technology for example requires this sub division. Technology in computer world has three aspects namely software, hardware and network. The researcher has to ask the participant to score the three aspects and provide an average as a score for the dimension (*ibid).* The researcher can present the findings from gaps as a summation of all the scores that have been presented (Syamsuddin, 2016). In case the researcher collected scores from several participants, the researcher has to carefully use the median scores that users have presented. The researcher now can sum the median scores for each element to present the score of the system.

Generally, this model uses these scores to evaluate the results; Summation of scores between 0 – 14 means it will be successful. Scores of 15 – 28 might experience partial failure in some areas, scores 29 -42 might totally, or partially fail unless actions are taken to close the gaps. Scores from 43 - 56 mean EMRs will generally fail while scores 57 – 70 means the EMRs will almost certainly fail unless action is taken to close the gaps (Heeks, 2003; Rugchatjaroen, 2015). Similarly, in this study, I collected the median scores for all dimensions/elements. Each dimension was scored on a scale of 0 to 10 where 0 meant there is no gap while 10 translated a serious gap exists. The sum of all median scores per system was evaluated using the prescribed scale in the above paragraph.

2.8 Chapter Summary

This chapter has presented what has already been done in this field of study. The chapter started by looking at health informatics, electronic medical record systems, EMR implementations in developing countries. The chapter also looked at benefits of EMRs before looking at challenges that these system face in developing countries.

The second half of the chapter looked at the theoretic framework that was employed in this study. The section looked at what the theory is all about and how others have applied it. An attempt to explain each dimension of the theory was also made.

CHAPTER 3

METHODOLOGY

3.1 Approach

To seek a deep understanding on the influence of Design-Reality gap on EMR use the study adopted qualitative approach. This is a case study which looked at 2 EMRs deployed at the 2 study sites.

3.2 Research paradigms

In this study, the interpretive philosophical paradigm was adopted because the aim of the research was to explore the factors that influence the use of EMRs in their environment. This understanding gave insights and also enabled the researcher to make better recommendations which can be used improve EMRs uptake in the country.

3.3 Study sites

The research took place in Lilongwe, Malawi, a country in Central Africa. See Figure 4 below for the location of Lilongwe from an African Map. With a population of 18 million, Malawi is a landlocked country with agriculture as it main economic activity.

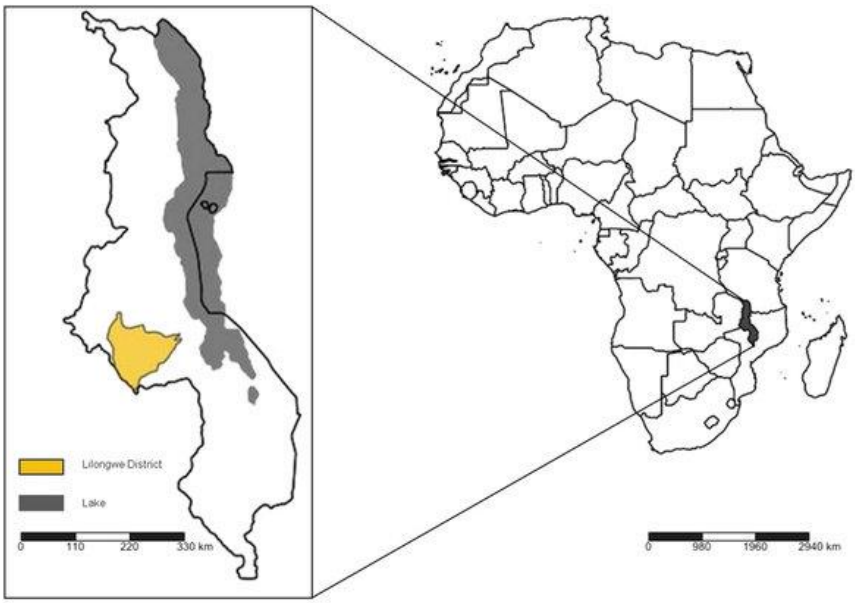

Figure 4: Location of the study district

Source: WHO, 2016

Lilongwe is the capital city of Malawi and it is a district with highest population of about 1.4 million (WHO, 2016). As a district, it is split into two sections; rural and urban areas. Lilongwe has 70 health centers that serve this population. All six public urban health facilities in Lilongwe have EMRs deployed. These are Lumbadzi Health Center, Area 25 Health Center, Area 18 Health Center, Kawale Health Center, Bwaila Hospital and Kamuzu Central Hospital.

3.3.1 Area 18 Health Center

Area 18 Health Centre is located 2 Km west of the Capital hill. It offers limited services such as Out-Patient Department (OPD), Maternity, Antenatal Clinic (ANC) and Anti-retroviral Therapy (ART). Mostly, patients are admitted on short stay basis and if the condition is critical, the patients are referred to KCH. The Health Centre has a catchment area of 200, 000 people. Area 18 Health Centre represents a standard Health Centre in

Malawi. On average, 300 patients seek OPD services while 80 patients seek ART Services per day.

3.3.2 Area 25 Health Center

Area 25 Health Centre is located 12 Km north-west of Capital Hill. The facility offers Out-patient (OPD), Chronic Care Clinic (CCC), Maternity, Antenatal Clinic (ANC) and Antiretroviral therapy (ART). Area 25 Health Centre provides services to the population of 400, 000 both from the urban areas and rural communities surrounding it. This Health Centre is a heavy burden Health Centre catering for population the same as some district hospitals cater. On average, 500 patients seek OPD service per day while 150 patients seek ART services per day.

3.4 Sampling

This research was biased towards qualitative and inclined towards non probability sampling. It used purposeful sampling method where I interviewed all system users and members of the implementation team that were involved in the deployment and support of these systems. The main aim was to identify central themes that cut across key informants. The total sample size was 36. The breakdown of the sample size is presented in Table 4.

Table 4: Number of interviewees who participated in this research

Position	**Area 25 Health Centre**		**Area 18 Health Centre**		**Other stakeholders**
	OPD	**ART**	**OPD**	**ART**	
Clerks	4	4	3	4	0
Nurses	2	2	1	2	0
Clinicians	1	1	1	1	0
Medical Doctor	0	0	0	0	0
In-charge	1	1	1	1	0
S and D Officer	0	0	0	0	2
BHT M&E[3] Officer	0	0	0	0	1
Helpdesk officer	0	0	0	0	1
HIV/AIDs Supervisor	0	0	0	0	2
HMIS[4] Officer	0	0	0	0	1
Total	**8**	**8**	**6**	**7**	**7**

3.5 Data Collection

3.5.1 Interviews

The researcher interviewed different users of the EMRs in the study sites. Table 4 above presents numbers of respondent that participated in the study.

[3] M & E Officer stands for Monitoring and Evaluation officers
[4] HMIS Officer for Health Management Information System Officers

3.5.2 Documents analysis

The research looked at different documents from the technical implementer to understand how the system was designed and the actual performance in the live environment. Some of the documents that were analysed during this research include Technical reconnaissance reports, User manuals, System usage reports, meeting minutes and email conversations for the systems. The Technical reconnaissance report shows the design of the EMRs. Table 5 below shows which documents were analyse where.

Table 5: Documents that were analyzed in this research

	Area 25 Health Centre		**Area 18 Health Centre**	
Document	**OPD**	**ART**	**OPD**	**ART**
Technical Reconnaissance	✓	✓	✓	✓
System Specification	X	X	X	X
User Manuals	✓	✓	✓	✓
Treatment guidelines	X	✓	X	✓
System usage reports	✓	✓	✓	✓
Meeting minutes	✓	✓	✓	✓
Email conversations	✓	✓	X	X

3.5.3 Observations

Observations were conducted at the sites of the study namely, Area 18 Health Centre and Area 25 Health Centre. The researcher made the observations during patient visits and during report preparation.

3.6 Empirical Data Analysis

This research was a qualitative research and interpretivism research approach was used, where necessary the researcher made personal assessments throughout the process to determine descriptions that fits the situation or themes that capture the major categories of information. Qualitative data collected was organized in the following way; the researcher made summaries for data collected through documents while data collected through interviews was transcribed. Codes were made on the data to indicate researcher's interpretation. The researcher developed themes for the data collected. Descriptions were developed to provide the reader with an understanding of the context in which the research was conducted.

3.7 Data validation

Participants were shown the preliminary report on the findings for them to verify whether the descriptions the researcher was presenting were complete and captured the realistic situation on the ground. This method of data validation employed in this research is called member checking.

3.7 Ethical considerations

A written permission/ethical clearance to conduct the study was obtained from the University of Malawi (Appendix C) and the Ministry of Health (Appendix D) before commencing data collection. During data collection, oral and written consent (Appendix E) was sought from individuals to participate in the study through interviews and to take pictures, tape record interviews as well as to access documents. All participants were informed of their option of withdrawing from participating in the interview at any time, as well as the option to not respond to questions they were not comfortable with.

Confidentiality and anonymity was maintained during the study, for instance by not disclosing names of participants in the submitted report of the fieldwork. Participants were given Interviewee ID numbers that were used during data collection. However, contact details of interviewees were obtained to enable further communication in case more clarity was needed in future following the interview or observations.

3.8 Limitation of the study

The main limitation faced is lack of funding. The research targeted facilities located in different districts but due to funding constraints two facilities located in one district were used.

3.9 Chapter summary

The methodology chapter aimed at presenting study approach and design. It looked at the research paradigms, study sites, sampling and data collection methods. The chapter then presented how the data collected was analysed. To show data collected was validated the

chapter has a section on data validation. It also talked about ethical clearance that was sought before the study was conducted. The chapter ends by presenting limitation that the research had.

CHAPTER 4

RESULTS AND DISCUSSIONS

This chapter presents results and discussions from the two study sites namely Area 18 Health Centre and Area 25 Health Centre. The results are divided into different themes per EMR. Similar findings were combined from the two study sites i.e. OPD EMR findings for Area 18 Health Centre have been combined with findings from Area 25 Health Centre OPD EMR findings.

The discussions section looks at the findings in the light of literature and the applied theoretical framework. It has made an attempt to respond to the research questions that have been guiding this study.

4.1 Results

The results section presents the situation on ground in terms of EMRs use. Themes were developed from the findings following the theoretical framework's dimensions. Later, the section shows the gaps that respondents presented per dimension in the study.

4.1.1 Out-Patient Department Electronic Medical Records findings

4.1.1.1 Information

This dimension has 2 elements that were investigated. These elements are data collection and reporting.

The first element to be examined was data collection. The data collection element looked at what data was collected, how data was collected and who was involved in the data collection.

Only Data clerks at the registration points use the EMR as nurses and clinicians consider the use of the system as a clerical job. The clerks capture demographics and later capture prescription and diagnosis from the health passport as written by the nurses or clinicians. Patients proceed to get another service and are asked to return to the registration clerks for them to capture the details in the EMR.

> "Nurses and Clinicians do not use the system....they consider the use of EMR as an inferior task. They have indicated that the use of EMRs is not part of their job description." (Area 25 Health Centre Data clerk)

Furthermore, the EMR requires the user to collect extra fields that are not collected when users are using manual registers. The fields that are required in the system but not in the manual registers include ancestral address (Region, District, Home Traditional Authority (T/A), Home Village) and Occupation.

> "The system collects unnecessary data such as region of origin, district, home Traditional Authority and home village. This delays the data collection time." (Area 18 Health Centre Data clerk)

After looking at the data collection element, the study gathered findings on reporting. In this element, focus was on reports produced by the system and the impact of these reports in to the health sector.

OPD EMR has several reports that users generate whenever required. The list of reports found in the EMR includes Attendance report, Diagnosis by Area, Outbreak report and Outcome report. Despite producing these reports, the system does not produce OPD's core report called Health Management Information System 15. Users copy figures from different reports in the EMRs into a paper based HMIS report. This report is required by the District Health Office monthly.

> "Generating an HMIS report takes much of our time as we have to refer to the system to fill the fields in the manual HMIS report. Due to human errors sometimes we under report or over report the figures." (Area 18 Health Data clerk)

4.1.1.2 Technology

This dimension has 3 elements that were considered namely usability, hardware and networking.

The first elements under technology to be presented will be usability elements. Usability element looked at the screen layouts, system design and predictability of the system flow.

Both Area 25 and Area 18 shared observations presented here. In terms of the software, the respondents indicated that the system flow is complex as it requires more steps to achieve one goal. An example of this is the way a user is presented with 7 interactive screens to dispense 2 Paracetamol tablets.

> On drug dispensation the system changes from how it flows, it shows pop-ups that as the user I have to be interacting with. This design, coupled with the number of steps one has to complete to dispense a drug makes the drug dispensation feature difficult to use. (Area 18 Data clerk)

Figure 5 below shows the screen with pop-ups on top of each other that appears during drug dispensation. The Xs on top right corner of each pop-up, in this figure shows that the user will select night dose and click Forward button. Another pop-up will appear after click Forward before the user completes the dispensation feature for one drug.

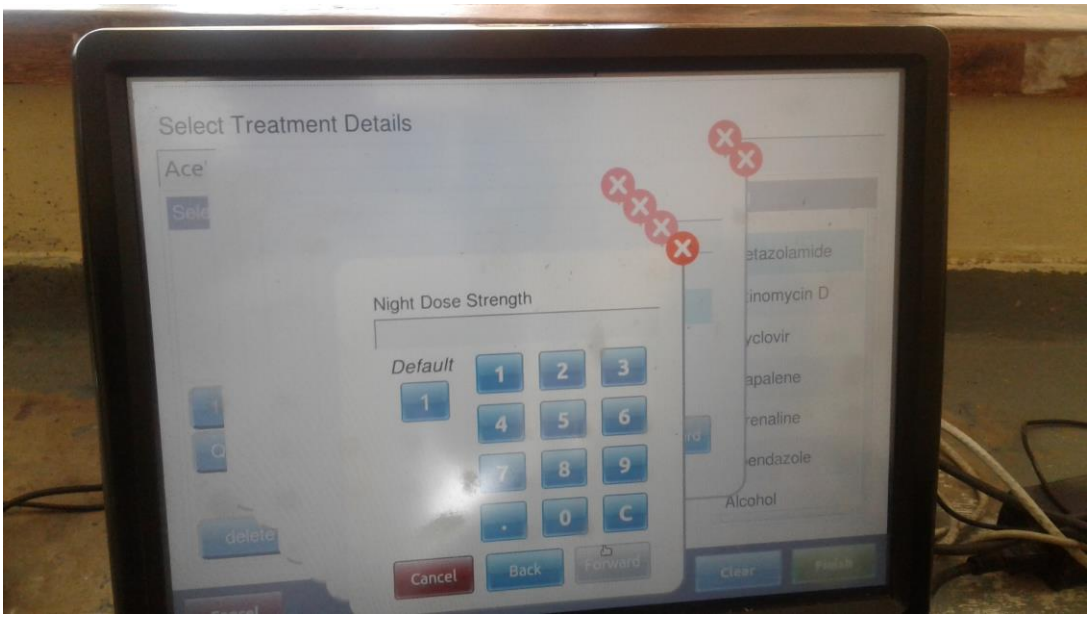

Figure 5: Drug dispensation feature showing numerous pop-ups user encounter.

Source: Researcher

The next element under Technology to be examined is networking. This is the communication between the J2 computers and the server machine.

The EMRs are deployed following a client-server[5] approach. The main problem encountered at Area 18 Health Centre is the poor network connection between the servers and the workstations (J2 computers). The computers frequently show a message "Unable to connect to the server. Users report to Baobab all the issues involving networking for them to rectify them.

[5] Client-server approach refers to configurations of computers that get and store data from one central computer called server.

The final element that was investigated under Technology dimension was hardware. This looked at the availability of J2 computers. The study revealed that not all clinicians and nurses have workstations at the OPD. In some cases touch-screen computers (J2s) which were installed there were removed by Baobab Health Trust without any explanation.

> "I have been without a touch-screen computer in my office for 2 years, when patients come I write manually in their health passports and refer them to the clerks for them to capture the data in the system." (Area 18 Health Centre Clinician-in–Charge)

4.1.1.3 Processes

At Area 18 Health Centre, one computer is in a consultation room which houses three clinicians. This means that clinicians have to use the computer in turns. The two clinicians simply write in patients and refer patients to the registration clerks for data entry into the EMRs. This is also similar to what is on the ground at Area 25 health Centre.

> "They installed one computer in our room but we have two or three clinicians in a room doing consultation so it meant the other clinicians should be writing in health passport while one should be inputting in the EMR" (Area 18 Health Centre Clinician).

This situation has distorted the OPD Workflow. As presented in chapter 1, OPD EMR was designed to be used wherever services are provided to the patients i.e. patients to move from registration point to the consultation points then to pharmacy. All these points

needed to have J2 computers. The EMR, however, is readily available at the registration points only forcing patients to visit back the registration after consultation and dispensation points. Figure 6 below shows how the workflow has been distorted.

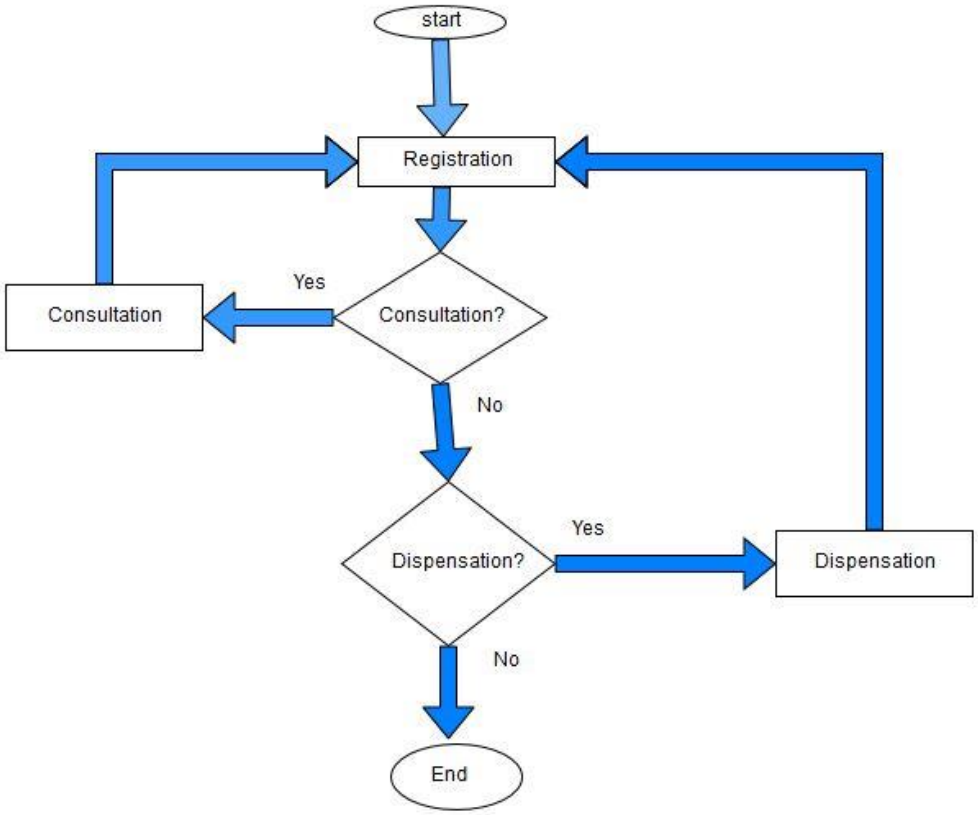

Figure 6: OPD EMR workflow on the ground
Source: Researcher

4.1.1.4 Objectives and values

The objectives of the OPD EMRs were not outlined properly to the Medical staff. Medical staff (Clinicians, Nurses and Pharmacy technicians) who are supposed to be the main users of the system do not see the essence of the systems in light of clinics

objectives. Some nurse perceive the use of EMRs as statistical clerk work while some nurses perceive the use of EMRs as Baobab Health Trust project or research which will phase out after a while. This resulted in medical staff not showing interest to use the EMRs when providing services to patient. Nurses and Clinicians stated that data entry into the EMR is a clerical job.

> "Medical personnel do not use EMRs because they do not see value of the system to their daily activities." (Area 18 Health Centre Data clerk)

4.1.1.5 Staffing and Skills

This dimension was examined under three elements namely staff rotations/transfers, workload and skills.

Firstly, we will examine staff rotations/transfers. EMR usage is largely affected by transfers that take place at the Health Centre. At Area 25 Health Centre, the district administrators twice moved all the users including the champion[6] of the system and brought in new people who did not know how to use the EMR. Clerks, nurses and clinicians are the cadres that are usually transferred or rotated at Health Centre level.

> "Transfers affect the OPD EMRs at the facility. In 2015 the system was not being used because all users who were trained to use OPD were transferred to other facilities." (Area 25 Health Centre Clinician-In-Charge)

[6] A champion is an expert user of that system that has had extra training for him/her to be able to assist fellow users in dealing with basic challenges

Area 18 Health Centre was not heavily affected by transfers but rotations. However, rotations have same effect as transfers as they leave untrained personnel to run the clinic.

The next element looked into was workload. The Area 25 Health Centre OPD clinic, on a daily basis attends to 500 patients seeking its services while Area 18 Health Centre has 300 patients. Due to the fact that other cadres (Clinicians and Nurses) do not use the EMRs, patients are forced to visit the registration point three times for registration, diagnosis and drug dispensation data to be captured. This creates pressure to the clerk at the registration point.

> Currently, only clerks are capturing data in the EMR. On average, we see 500 patients in a day it will require three clerks to be capturing all patient comfortably. One clerk will be registering patients; another one will be collecting vitals and diagnosis as written in the health passport while the other one will be capturing drug dispensation. (Area 25 Health Centre Data clerk)

Finally, we look at staff skills. OPD EMRs users were equipped with skills to use OPD EMRs during initial deployment of system. After the transfers, Baobab Health Trust provided training to the new users to empower them to use the system. Two refreshers courses have been at Area 25 Health Centre after the deployment of OPD EMRs. Area 18 Health Centre OPD EMR has never had a refresher course or trainings after deployment.

4.1.1.6 Management and Structures

Area 25 Health Centre Management provides general support to OPD clinic through the provision of adequate human resource. However, management is silent of the use of EMR as such users are at liberty of using or not using the system. Sometimes, management may even tell users, informally, not use the EMR because it is deemed that it is delaying service provision to the patients.

> "When we ask management to help in something to do with EMRs, we are told to call Baobab or to use manual registers. This discourages us from using the EMRs". (Area 25 Health Centre Data clerk)

For Area 18 Health Centre, there is some willingness by the senior management of the Health Centre to have users use the system and in monthly meetings the issues of system usage and reporting are discussed. The Clinician-In-Charge ensures that all patients are passing through the EMR data collection points by randomly checking patient's health passport.

The Area 18 Health Centre management has made further effort to inform patients that all their data must go through the EMRs through posters that has been pasted in strategic locations for them to read. Figure 7 below is a notice to all patients advising them that no service will be provided to them if they are not registered through the EMRs.

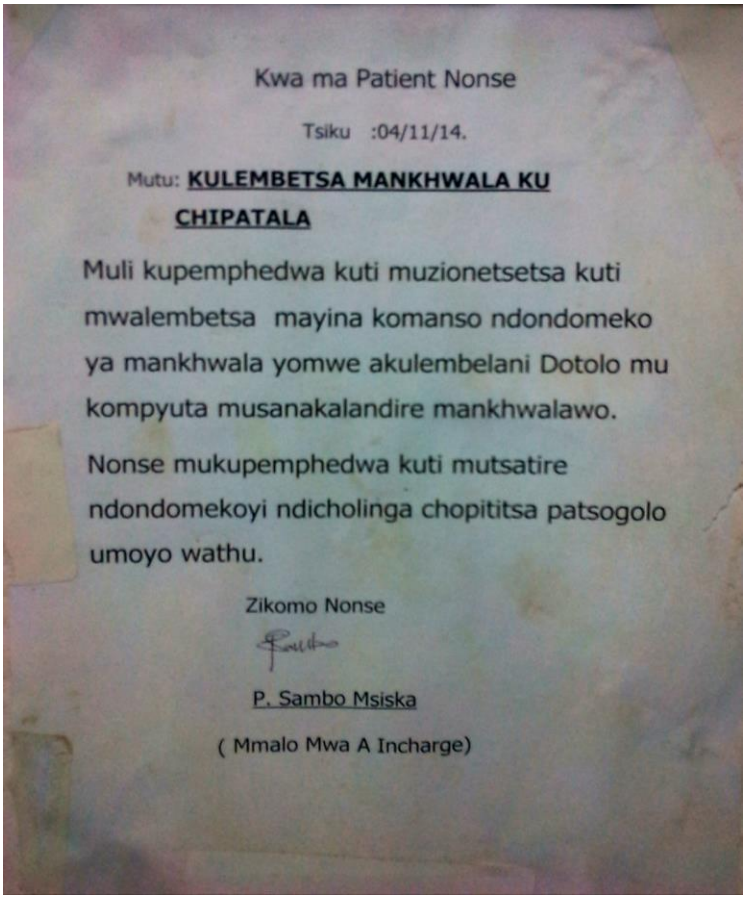

Figure 7: EMR usage enforcement poster
Source: Researcher

> "I ensure that my team is using the EMR to record patient's data, I want this OPD clinic to be a model of using the system". (Area 18 Health Centre Clinician-in-Charge)

4.1.1.7 Other Resources

Both Health Centres revealed that OPD EMR receives various resources from donors and partners. It had initial investments during the development of the system. During this period, funding was present for the development and deployment of the system, trainings and technical support. Funding was also provided to upgrade the EMR to a newer

platform. During its lifetime, on-going investments have been made in terms of provision of technical support.

4.1.2 Anti-Retroviral Therapy Electronic Medical Records findings

4.1.2.1 Information

This dimension was sub-divided into 2 elements namely data collection and reporting. The first element to be considered under Information dimension will be data collection. The findings look at how data is collected when users are using the EMRs.

When a patient/client visits the clinic, the clinic staff member scans the bar-code on the health passport to retrieve the existing record. Patient history is properly kept and easily retrieved when the patient re-visits the facility; at the click of a button you can pull the whole medical history. At the end of each visit, the EMR produces print-outs that contain details about that day's visit that have been captured. The print-outs are pasted on the health passport and on the master-cards[7].

> The EMR has simplified our work since we do not have to write on the health passport and on the master-cards. The system produces two print-outs, one for health passport and the other one for patients' master-card. The system has reduced our workload. (Area 18 Health Centre ART Data clerk)

[7] Master-cards are cards that contain medication and patient's demographic data. They are similar to health passports in terms of content. Master-cards are kept by the ART Clinic while the health passport is kept by the patient

The next element under this dimension is Reporting. The focus in this element is on the reports that are produced as output of the EMRs.

The Department of HIV/AIDs in the Ministry of Health collect reports every quarter. These reports required by the MoH are generated by ART EMR. These reports are used for planning purposes and Anti-Retroviral (ARVs) drug logistics and supply chain system. If the report is not correct or is not consistent with previous data, the Department of HIV/AIDs (DHA) team goes to the clinic and counts all tablets dispensed against all patients and also take a tally of all tablets remaining in each regimen/category.

> "When we have produced the report without errors we receive a certificate of excellence from the Secretary for Health in the ministry of health." (Area 25 Health Centre ART Coordinator[8]).

The quote above indicates how the Ministry of Health's motivates staff to ensure that data is properly collected and the reports are accurately produced. The system assists users to produce accurate reports on time.

> We (at least 4 ART clinic staff) used to spend 2 weeks to produce a Quarterly Anti-Retroviral Therapy Report before the system was implemented. After the deployment of an EMR, the report generation time has been reduced to 10 minutes (Area 18 Health Centre ART Data clerk).

[8] ART Coordinator is an officer who is responsible for ART clinic and its operations at a Health Centre or District Hospital.

4.1.2.2 Technology

This dimension has three elements that were considered namely usability, hardware and networking.

The first element of findings under Technology to be presented will be usability elements. This looked at the screen layouts, system design and predictability of the system flow.

The EMRs has total conformity to HIV/AIDs guidelines which guide health personnel when managing HIV cases. The system screens are designed to match the data items that are collected in the HIV guidelines step by step.

> "The system is easy to use for somebody who was trained in HIV management... It follows the [HIV] guidelines step by step". (Area 18 Health Centre ART Data clerk)

The system has been designed to pop up reminders for things like Viral Load[9] test to be conducted during milestone[10] visits. It would have been difficult for a clinician to remember milestones for some patients. Without the system, the clinicians would have been calculating Viral Load test dates.

One feature that is important is the automatic enrolment of pregnant women who are HIV positive. The Health Centre has Antenatal Clinic System (ANC) EMRs which has some

[9] Viral Load refers to the number viruses per blood sample.

[10] Milestone visit are visits that are done in the 6th, 12th and 24th month and thereafter months set by the clinician.

questions on HIV status, if the client is HIV positive the system checks if the patient was already registered in the ART system if not the system will re-route to ART EMR and allow ANC users to register the client into the system. This removes the need for the client to queue again at the ART to register and get ARVs. Before the system was implemented when women were told to go ART Clinic, most of them were not going there and that led to high level of loss to follow-up patients thereby risking the life of the unborn babies.

> "Enrolment of pregnant women into ART EMR from ANC EMR has reduced our workload as some patients are assisted at the Antenatal Clinic. This has also reduced the loss to follow-up figures." (Area 18 Health Centre ART coordinator)

The system has some feature that once you capture weight, height and age will plot a graph to show the progress of the patient in terms of response to the medication. With the graphs, the system help the users to make decisions such as enrolling the patient into therapeutic feeding program and inform the user to know which ARV regimen to dispense and also whether the patient should be moved to the next level of care. See figure 8 below.

> "It is easier to visualize the changes in the weight and height using the EMR this helps us to know whether the treatment is being effective and also to know whether to enrol our patient in therapeutic feeding." (Area 18 Health Centre ART Coordinator)

Figure 8: ART Patient Weight Graph showing EMR calculated BMI of 28.0 and patient's weight for previous 4 visits

Source: Researcher

The system has also bundled all the drugs into regimes that makes it very simple for users to dispense the drugs. With BMI[11] calculated and age captured, the system is able to suggest drug bundle that should be given to the patient following the HIV guidelines.

The system has a booking feature that helps users to identify which is a better day to book patient's next appointment. This helps in reduction of congestion on clinic days by ensuring that patients are evenly distributed across the week for their next appointments. In Figure 9 below, the user has selected 23 May 2017 as a date he intends to book the patient on. Once the date is selected the green colour shows with the number to the left

[11] BMI – Body Mass Index. The calculation of weight and height used for medical decisions

indicating how many patients are booked on that particular date. In this case no patients have been booked for 23 May 2017 hence the number 0 in it. Once an appointment has been made, the system will generate a print-out which is later pasted in the patient's health passport.

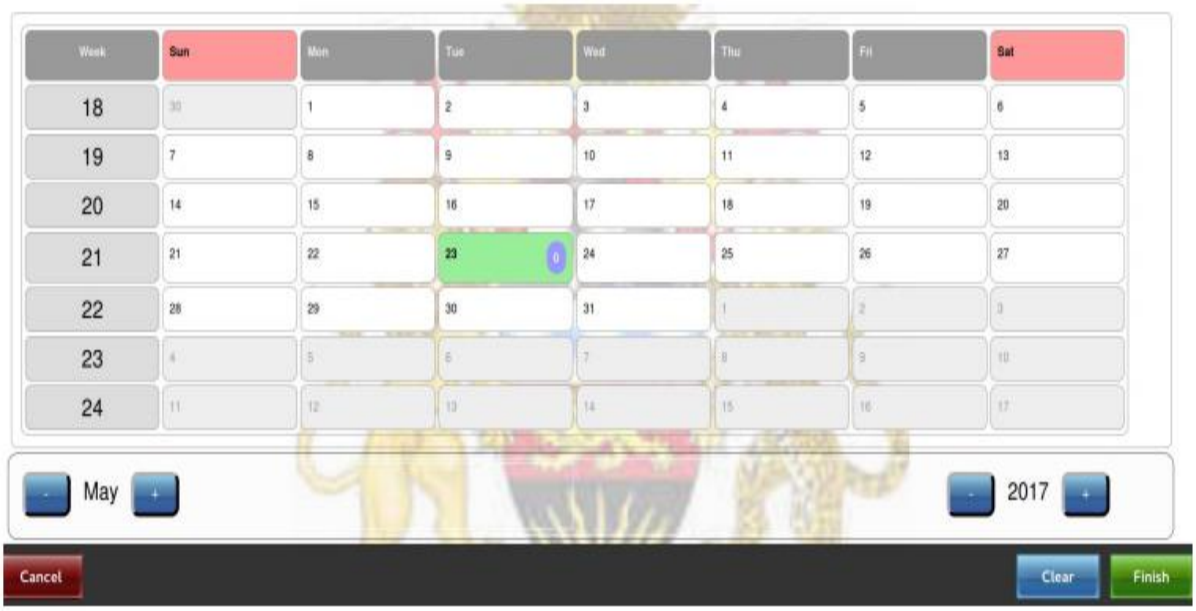

Figure 9: Patient booking feature showing that 0 patients have been booked on 23 May 2017

Source: Researcher

The next element considered under Technology is Hardware. This focuses on computers used to capture data.

J2 computers that are for data entry are installed in all rooms that provide ART services. All critical personnel to data collection have workstations deployed. When hardware

develops fault, Baobab Health Trust provide technical support in less than 24 hours or they replace the faulty hardware within the same timeframe.

Finally, networking finding is presented under Technology. This looks at how the J2 computers are able to connect to the server which provides data to the users. With the Client-server model at the study sites, computers are connected to one central computer (Server) that stores all the data. Both Area 25 and Area 18 Health Centre s' ART EMR have not experienced challenges with network.

4.1.2.3 Processes

The ART EMR was designed to mirror the processes that happen in an ART clinic and step by step procedures defined in the HIV/AIDS treatment guidelines. The system workflow simply followed the available manuals. This has resulted in processes in HIV management being equal to the EMR workflows.

> "The EMR follows the HIV/AIDS treatment guideline which makes the whole usage simple as we know what to expect in the system. Somebody with HIV management knowledge can easily use the system with little training." (Area 25 Health Centre ART Nurse)

4.1.2.4 Objectives and values

Before the introduction of ART EMR, users were consulted and sensitized on how the EMR helps them achieve the clinics objectives and values. The users were told that the EMR is a way through which quality data would be collected. Senior members of the HIV/AIDS department of Ministry of Health were the ones who introduced the EMR to the clinics followed by a communication from the Secretary for Health.

> "The officials from the HIV/AIDS department encouraged that the use of EMR is within the policies that the department follows and that the system is adhering to the HIV/AIDS guidelines". (Area 25 Health Centre ART Coordinator)

4.1.2.5 Staffing and Skills

Staffing and Skills dimension has 3 elements namely staff rotations/transfers, workload and skills.

The first elements presented here is staff rotations/transfers. All members of the clinic were trained in HIV/AIDS management to ensure that they provide quality service to patients. This situation spares the clinic members from rotations that are frequent with health centre. Rotations, therefore, do not affect the EMR use as trained members are rarely rotated.

The EMR is not very much affected by the transfers in comparison to other clinics/departments at the Health Centre. In a year, there may be one transfer in the clinic, the champion of ART EMRs will make sure that the new officer coming in is oriented into the system in order to ensure that the system is being used at all times.

> "When a new person has joined the clinic and they do not know how to use the system, we orient the person in-house. The champion creates a user account for that person." (Area 25 Health Centre ART Data clerk)

Under workload, the ART clinic has an average of 80 patients during clinic days for Area 18 Health Centre and 150 patients for Area 25 Health Centre seeking services. The clinic days are Tuesday, Wednesday and Thursday. The clinics are managed by 1 clerk, 4 nurses, and 2 clinicians. All cadres are available during a clinic day. At each cadre, the details of the patient are captured into the system. Clerks are involved in registering the patients only, nurses are responsible for capturing vitals while clinicians do consultations of the patients and then they do the prescription. The nurses will then dispense the drugs.

The final element under this dimension is skills. ART EMRs user trainings were conducted during the deployment of the system, refresher courses have also been conducted usually after an update of the system or when there is a significant change in the HIV guidelines.

> "Annual changes of the HIV guidelines require us to be retrained in the areas that have been changed in the system. BHT conducts these trainings yearly." (Area 18 Health Centre ART Data clerk)

4.1.2.6 Management and structures

All cadres at the Health Centre use the system to make sure that data is managed properly. The clerks, nurses, clinicians and pharmacist make sure they use the EMR when handling patients. The Health Centre Office in-charge ensures that all officers are available at the clinic during the clinic days[12]. These are Tuesdays, Wednesdays and Fridays.

> When ART patients are not properly treated they have many places to lodge their complaints and it does not take time for the issues to be in Newspapers. I try avoiding this at all cost; I make sure all required personnel and drugs are available on a clinic day. (Area 18 Health Centre ART Coordinator)

4.1.2.7 Other resources

HIV/AIDS Department receives a bigger share of all health aid coming into the country. Similarly ART EMR has a lot of funding streams for different areas. Baylor College of Medicine and The Lighthouse Trust provide human resources. CDC provides funding for technical support and trainings and refresher courses. Ministry of Health provides monitoring and evaluation support to the ART clinic.

> "To be frank with you, ART has enough human resource and we receive enough technical support when we have challenges with the system." – (Area 18 Health Centre ART Coordinator)

[12] Clinic days are days that the clinic sets to see patients. ART clinic usually see patient 3 clinic days a week.

4.1.3 The Gaps

This section presents gaps that were score by respondents for each dimension. Median scores were computed for each dimension per facility per EMR. The scores presented in Table 6 below are medians obtained from all the dimensions and EMRs.

As stipulated by the theory, respondents were properly advised to score each dimension from 0 to 10. 0 score means that there is no difference between what the EMR was supposed to do and what it is doing on the ground while 10 means that the EMR is doing very little or nothing of what it was designed to do. Clarifications were made on what the system was meant to do. Respondents were encouraged to ask questions before and during scoring.

Table 6: EMR Gaps as scored by respondents

ELEMENT	AREA 25 HC		AREA 18 HC	
	OPD	ART	OPD	ART
	Score	Score	Score	Score
Information	**6.5**	**0**	**8**	**0**
Technology	**7**	**0**	**7**	**0**
Processes	**5**	**1**	**4**	**0**
Objectives and Values	**2**	**2**	**2**	**1**
Staffing and Skills	**6**	**0**	**5**	**0**
Management and Structures	**4**	**2**	**2**	**2**
Other Resources	**0**	**0**	**0**	**0**
Sum gap	**30.5**	**5**	**32**	**3**

4.2 Discussions

This section discusses research findings in line with the study's research questions. The following are the research questions; *how do technical design-reality gaps influence EMR use? How do design-reality organizational factors influence EMR use? How do design-reality staffing gaps influence EMR use? How can design-reality gaps be minimized to enhance EMR use?* The discussions are guided by the Design-Reality Gap model (Heeks, 2003) that was employed in this research.

In brief, the Design-Reality gap model looks at seven dimensions that facilitate success of technologies. The factors that are considered in this model are Information, Technology,

Processes, Objectives and Values, Staffing and Skills, Management and Structures and Other resources (ITPOSMO) (*ibid)*. In this paper, all dimensions were scored on a scale of 0 to 10, where 0 means there is no difference between a technology's design assumptions and how the technology is working in reality. On the other hand, 10 means there is a huge difference between the design and the way the technology is working in reality (Scholl et al., 2011).

Design-Reality gap scale indicates that if the summation of the scores is between 0 – 14, it means the system will most likely succeed. Scores of 15 – 28 might experience partial failure in some areas, scores 29 -42 might totally, or partial failure unless actions are taken to close the gaps. Scores between 43 – 56 means EMR will generally fail while scores 57 – 70 means the EMRs will almost certainly fail unless action is taken to close the gaps (Heeks, 2003, Rugchatjaroen, 2015). Looking at Table 6 above it is right to conclude that OPD EMRs, with score in the range of 29 – 42, in both study sites need serious actions to reverse the status as they all have likelihood of experiencing failure ART EMRs have scores in the range of 0 – 14, meaning they will continue to enjoy massive system use by the users.

4.2.1 Influence of technical factors on Electronic Medical Records use

This section discusses the question*: How do design-reality technical gaps influence EMR use?*

This section looks at factors that affect a system technically. Technical factors that affect an EMR include software, hardware, System design and screen layout, Information needs and output (Msiska et al., 2017). The dimensions of Information and Technology, therefore, were considered as those forming technical theme of the study.

4.2.1.1 Information

Using Design-Reality theory, this dimension scored 0s in ART EMR for both facilities while for the same clinics OPD EMRs scored 6.5 and 8 for Area 25 and Area 18 Health Centres respectively.

The findings have shown that ART EMR produces relevant reports that are used by different stakeholders in the HIV/AIDS field. These findings agree with the Fraser's findings that assert that reporting is one of the most important tools of the EMRs (Fraser et al., 2005). Accurate reporting helps HIV department to send correct volumes of drugs that are dispensed to patients. Inaccurate reports results in some medication not being sent to facilities thereby inconveniencing patients to get the medication from nearest hospitals until the next circle of supply is done which usually is on quarterly basis (CDC, 2016). In OPD EMR, the case very different, the reports produced are not relevant to the clinicians and to the authorities at Ministry level. This force Data clerks to compile reports manually in as much they have all the data electronically. Users who have data in EMR and yet are compiling reports manually do not see any value in using the EMR (Douglas, 2009) as a result they abandon it.

The collection of unnecessary data elements has also contributed to the higher scores of Information in OPD EMRs. Data elements that are considered not necessary by users of the system include district of origin, ancestral Traditional Authority and Ancestral Village. Chawani (2014b) asserts that users use system properly when they know the essence of the data they are collecting. In OPD EMRs' cases users do not appreciate why they should labour collecting data elements not needed by them or by Ministry of Health. On the other hand, ART EMR collects data elements that are relevant to service provision and also these elements are defined as indicators in the HIV treatment guidelines.

4.2.1.2 Technology

The first element considered under technology in this study was system design. From findings in this study, users highlighted system design as one technical factor that has affected system use both negatively and positively. Literature suggests that system design plays a very important role in whether users will use the system or not (Jawhari, 2016; Sood et al., 2008). Systems that have simple screen layout and easy to use features are easily accepted and adopted by users (Msiska et al., 2017). OPD EMRs workflow has features that are difficult to use with several pop-ups that appear when one wants dispense drugs. The drug dispensation feature requires users to click over 7 times to dispense 2 drugs of Parcetamol (Schuemie et al., 2009). A good design of a system should be the one that minimises number of clicks for a user to complete a task (Horsky et al., 2012).

ART EMR has additional features that enhance how users do their daily activities e.g. reminders to users of what viral load tests are pending for patients, auto-suggestion of drugs to prescribe to a patient and clinician booking feature that helps users to distribute future workload. Early EMRs were designed to support decision making (Sikhondze and Erasmus, 2016). The ART EMR seems to have embraced this fact and users have shown strong preference to it. Due to the nature of OPD services, the systems do not have these enhancements like ART EMRs. OPD clinic is visited by walk-in patient whereas ART clinic manages patient which are registered who visit the clinic on regular basis.

The next element considered under technology was hardware. The findings have revealed that OPD EMR has a serious gap in hardware availability particularly at Area 18 Health Centre. Infrastructure plays a vital role in ensuring that EMRs are used regularly, where there is no hardware EMRs will not be used (Fraser et al., 2005).Users who have been trained to use the system have no workstations to use. On the other hand, the situation is different; ART EMR has enough hardware for users to use. This means that ART EMR will be used whenever users want to use it.

Looking at the above presented points it is indeed understandable that respondents scored technology dimension 7s for OPD – EMR for both facilities while 0s were scored for ART – EMR for all facilities.

4.2.2 Influence of organizational factors on Electronic Medical Records use

This section discusses the question: *How do design-reality organizational factors influence EMR use?*

Organizational factors that affect Information Technologies are a combination of factors such as work-flows and processes, management styles, ethics, organizational culture, policies and also objectives and values (Chege, 2015). Under organizational factors, this study discusses Management System and Structures, Processes and Objectives and values.

4.2.2.1 Management Systems and Structures

Ministry of Health closely monitors the ART clinics including data collection and reporting tools. Department of HIV/AIDS audit the reports that are submitted to it from health facilities in order for them to forecast drug distribution at the beginning of the next quarter in order for facilities not to run out of drugs (Baobab Health Trust, 2016). ART EMR is able to generate this required report accurately (Msukwa, 2011).

When Ministry of Health has monitored a facility for ART and they have discovered that data at the facility is of good quality, they reward the facility with a certificate of excellence in HIV management. If data is of poor quality the Ministry digs deep to see whether that is deliberate or as a result of lack of knowledge (MoH, 2016). If it is deliberate, it may mean there is drug pilferage which invites serious audits and police may be involved whereas if its lack of knowledge, trainings are organised to make sure

ART clinic staff is well trained. As observed by Douglas (2009) health personnel use the EMR in order to have accurate reports which attract a reward of a certificate from Ministry of Health.

In OPD EMR case, there are no rewards or penalties arising from data quality issues. Ministry of Health has other sources of data other than OPD EMR as such users do not see value in collection data using the system. Whether OPD data in EMR is correct or not, that does not matter to the user, since it is not used anywhere other than by the clerks for compilation of their manual report. In this case users are free to choose whether they will use an EMR or not.

On the other hand, OPD EMRs was designed with the assumption that it will be monitored by Central Monitoring and Evaluation Department (CMED) of Ministry of Health with emphasis that its outputs will be part of the Health Management Information System report. After implementation it has been discovered that the system does not produce the intended reports. CMED gets these reports through another system called District Health Integration System (DHIS 2) (Garets and Davis, 2017). OPD EMR is not integrated with DHIS 2 (Chawani, 2014a). In this situation, it seems CMED pays less attention to OPD EMR (*ibid*).

At Health Centre level, literature also suggests that if local management owns a technology and provides guidance and support, that technology will likely succeed other than when technology is considered as project or a research (Msiska et al., 2017). ART

EMRs get attention from facility management due to recognition that ministry of health does through certificates of excellences to well reporting facilities. Management ensures that systems are regularly used so that their facilities should report data accurately and timely (CDC, 2016). During a clinic day, management ensures that all required personnel are available and have taken their position in readiness to provide services to patients. Due to Management enforcement, users are forced to use the system at all points where patients interact with health workers. Health Centre management also encourages users to capture data into the system because data from the EMR is used for resource allocation from the ministry to them (Msiska et al., 2017). No data means no commodities e.g. drugs, test kits and condoms.

For OPD EMR, management for both for Area 18 and Area 25 Health Centres seems to have relaxed conditions if one uses the EMR or not. This is the case because the ministry does not directly enforce the clinics to use the EMRs. In this scenario, all medical personnel do not use EMRs preferring paper based data collection. The use of EMRs is left to the Data clerks. Data clerks in most case would choose to use manual registers as this appears to be simple and quicker (Csiszar, 2016).

The gaps presented above justify the OPD EMRs median scores of 4 and 2 for OPD EMRs in Area 25 and Area 18 Health Centres with median scores of 2 for each Health Centre.

4.2.2.2 Processes

Users have shown strong preference towards using ART EMR because of the following reason; ART EMR is the automation of manual system that was already in use in the sites of study. ART protocols are the same throughout the country whether private or public facility. There is a narrow gap between design and reality across contexts, which, according to literature, enhances chances of system success (Khomani et al., 2013). Area 25 Health Centre ART –EMRs scored 1 and while for the same dimension Area 18 Health Centre ART EMR had a median scored of 0.

On the other hand, OPD clinics vary from Health Centre to Health Centre in terms of patient workflows and processes. OPD EMRs that BHT deployed in the two study clinics follow a different workflow than that which was designed. The designed workflow assumed that all OPD clinics throughout the country are the same. Thus, the design of OPD EMR not only deviates from what people are used to, but also implements the same design across facilities which may not have the same OPD workflows (Peddada and Pettus, 2016). This widens the OPD EMR design-reality gap and is evidenced in the assessment scores presented in the results section. OPD – EMRs score are 5 and 4 for Area 25 Health Centre and Area 18 Health Centre respectively. With a wider gap between design and reality, the occasion use of OPD EMR is understandable and in agreement with previous studies (Almutairi, 2011).

4.2.2.3 Objectives and values

Findings show that medical personnel do not value the use of OPD EMRs. They perceive the system as a clerical tool for statistical purposes. These findings are in agreement with studies that have been done around EMR use (Msiska et al., 2017; Sood et al., 2008) which indicate that medical personnel consider EMR use as a task outside their job description. This perception results distortion of the workflow as patients have to move back and forth between Data clerks capturing data in the EMR and medical personnel providing services. ART EMR strives very easily as all users including medical staff consider EMR are an important tool which improves quality of service they offer to their clients. The dimension scored 2s for OPD at both facilities while Area 25 Health Centre ART EMR scored 2 and 1 for Area 18 Health Centre.

4.2.3 Influence of staffing and skills on EMR use

This section responds to the research question: *How do design-reality staffing gaps influence EMR use?*

Staffing and skills scored 0s for ART EMRs in both Area 18 Health Centre and Area 25 Health Centre whereas OPD EMRs scored 6 for Area 25 Health Centre while Area 18 Health Centre scored 5 as a median score. The scores of ART shows that the design and what was happening in reality had no major differences; users did not see any difference between the design and the situation in reality meaning that the EMR was bound to be used by regularly (Heeks, 2003). For OPD EMR the scores means that there are significant differences in the design and the situation on the ground and serious steps

have to be taken to address the gaps if the users are to use the system regularly (Syamsuddin, 2016). Findings from this study suggest that workload and staff rotations and transfers are key essential in the use of EMRs.

4.2.3.1 Workload

ART EMR has personnel that use the EMR in all the designated points. This evenly distributes the workload. The patient workflow is adhered to properly. On the other hand, OPD EMRs is only used by Clerks at the Registration points. The clerks are forced to capture three different times data belonging to one patient; registration, consultation and dispensation. This volume of workload clerks deal with is beyond the expected volumes the EMR was designed to handle per Data clerk. This results in the perception that the EMR is delaying the whole workflow. The finding that EMRs are largely used by clerks agrees with other studies (Sood et al., 2008; Chawani 2014b; Msukwa, 2011; Douglas, 2009). These studies also further note that such systems do not really succeed. For EMRs to succeed, all cadres must use them (Kelley, 2016).

4.2.3.2 Staff rotations and transfers

ART clinics have members that are trained in HIV management (WHO, 2017). It is very difficult for members of ART clinic to be rotated to other clinics of a health facility. The ART EMRs success builds on this because the users that are trained are not likely to move to another section of the health centre. The users reach competence level of a learning curve because they are not affected by rotations (Almutairi, 2011). EMRs were

design with this assumption and they are behaving in the same manner which means that the gap is not available.

OPD clinics deal with generalized members of staff that can be rotated at the discretion of management of the health centre or transferred by District Health Office. These rotations and/or transfers negatively affect OPD EMR use as the facility to the point that in some instances the clinic has no health personnel that were trained to use the EMR (Khomani et al, 2013). Studies (Frazee, Cames, Maldonado, Bittenbinder & Papaconstantiou, 2015) show that when users have spent more time with the system they get more comfortable, rotation and transfers do not allow users to mature in using the system while it introduces new users (*ibid*). Implementers did not consider that in the design which meant a bigger gap on staffing and skills. In such cases, users use manual register and abandon the fully working OPD EMRs.

4.2.4 Minimizing Design-Reality Gaps

This section looks at the following question: *How can these design-reality gaps be minimized to enhance EMR use?*

In order to minimize the gaps, implementers have to understand clearly where they are (Reality) and also appreciate where they desired to be (Design) (Heeks, 2003). The understanding of the magnitude of the gap will help implementers pay attention to issues that have resulted in occasional use of some EMRs by medical staff.

The findings of this study show that the OPD EMRs have serious gaps in dimensions namely Information and Technology. These dimensions scored a median above 6 individually. These are the dimension that may have most likely resulted in the non-use of OPD and need to be redesigned. Processes, Staffing and skills, Management and Structures might have influenced in the non-use of partial use of the EMR. These dimensions are between 4 – 6 gaps. Heeks (2003) asserts that scores of that range may likely affect the use of the EMR. Other resources, and Objectives did not affect the use of the system as respondents scored them between 0 – 3 gaps meaning they did not see big changes between the design and the reality. All ART dimensions scored between 0 – 3 and it is not surprising to note that ART system enjoy regular system while OPD is used occasionally.

This section presents 5 dimensions that significantly affected EMR use. These are dimensions that have scored above 3 in either OPD or ART EMR.

4.2.4.1 Information

There is a clear gap between the information that the OPD EMRs produces and the information that is required by stakeholders. One example in this regard is that OPD EMR does not produce Health Management Information System (HMIS 15) report that Ministry of Health requires every month. Since users run the OPD EMR different reports (Attendance Report, Cases Report and Demographics Report) and get figures to compile this HMIS 15 report, it will be important for BHT have this report as an in-built feature so that users can get it at a click of a button. When developing this report, BHT should

engage stakeholders such as Ministry of Health as which other reports should be added in the system. One of the basic principles in information systems is that information should be relevant and timely (Henrick and Healy, 2002). The OPD EMRs, in this regard, misses out on something that is important and therefore it is not surprising that this EMR is not regularly used.

Furthermore, the information gap is by removing the fields that require one to collect unnecessary data that users complain about. Users should complete their tasks with minimum effort as outlined by the human computer interaction principles (Kelley, 2016).

Another way of minimizing this gap would be to integrate OPD EMR with DHIS 2 system. This is necessary because users use OPD EMR to generate a manual report that is later entered into DHIS 2 system. If OPD EMR can send the figures directly, it will be one important system to the users and Ministry of Health since it will act as a primary source of data (Chawani, 2014a).

4.2.4.2 Technology

Technology gaps that exist in OPD EMR can be addressed in several ways basing on the findings. One of the gaps that this research identified is the lengthy steps that are required for a user to dispense a drug. Literature proposes that correct design of system features enhances system usage (Msiska et al, 2017). This drug dispensation feature should be redesigned to suit users' needs for this gap to be minimized. The EMR should allow users to simply input the select the drugs, duration, frequency and strength on one page. The

design should adhere to good design principle which indicates that clicks (in this case taps) should be reduced to perform one task. This is a plus in developing countries considering that there is a high computer illiteracy rate in Malawi (Fraser et al., 2005). Implementers should strive to simplify the design as much as possible (Chawani, 2014b).

The other gap identified in this study was the lack of hardware in some data collection points. Lack of hardware removes the opportunity from potential users who are willing to use the EMRs (Fraser et al., 2005). Implementers will need to do proper technical reconnaissance to know how many workstations you need and where to place them within a health centre.

For networking challenges experienced at Area 18 Health Centre, implementers need to rewire the network cables from computer to servers. This will ensure that the network challenges are eliminated like it is with Area 25 Health Centre.

4.2.4.3 Staffing and skills

One challenge EMRs face in developing countries is rotation and transfers (Msiska et al., 2017; Msukwa, 2011; Fraser et al., 2005). Most of the users have never used a computer; this becomes a huge challenge when users are rotated from other departments to OPD where we have an EMR. This is due to the fact rotations that happen twice a year at these two study facilities. This challenge can be resolved by BHT and facilities working together to arrange for trainings before staff rotations happen. Trainings provide an opportunity for users to know how different features of system work (Ngafeeson and

Midha, 2014). This will ensure that there is no knowledge gap as members of staff are moving from one department to another.

The other challenge raised is that of workload that clerks experience due to the fact that they have to capture data items that were not captured by clinicians and nurses. Studies have shown that medical personnel are less likely to use EMRs over paper system (Tavares and Oliveira, 2017). This challenge can be solved both in short and long term; for short term, management can deploy additional clerks to help in data capturing while for the long run should work on ensuring that all members are using the EMR to transact with patients. It can also be helpful if EMRs are taught at medical schools in order to prepare health personnel before they even join the workforce.

4.2.4.4 Management and structures

Management of an institution plays an important role in ensuring that EMRs are used regularly (Douglas, 2009). OPD EMRs have presented that management (national and facility) do not show much interest in the affairs of the system. At national level, management looks at DHIS which presents aggregated data from facilities and not the EMR. BHT can work on value propositions to the EMRs by integrating OPD EMR with the DHIS system. Another value that can be derived from integration is enhancement of data quality since they will be one point of data entry (Chawani, 2014a). This will mean that CMED will be concerned with how data is being captured at EMR level before it gets integrated with other sources.

4.2.4.5 Processes

The main gap in this dimension is that patient workflow was changed due to the installation of EMR as patients have to visit the registration points many times to have data captured in the system by data entry clerks. The workflow has been distorted due to the fact that clinicians and nurses not using the EMR when providing services and lack of sufficient hardware. This can be solved by the enforcement of management to have all potential users using the system. If all intended users were using the system, the normal patient workflow would be maintained (Kelley, 2016). Implementers should ensure that hardware is available in all relevant points of the clinics.

4.3 Chapter Summary

This chapter was divided into two sections; one for results and another one for discussions. Results presented the design of the system, the reality of what is happening on the ground and later presented the gaps scores that were presented by respondents.

Discussions on the other hand were organized in pattern of research questions. Each of the four questions has its own section where attempts to provide a thorough response were made.

CHAPTER 5

CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, this study shows gaps that exist between design and reality influence whether an Electronic Medical Record system will be used or not. Using Design-Reality framework, one can see that OPD EMR was affected by technical factors namely Information Gap and Technology gap. Organizational factors (Management systems and structures and Processes) and Staffing factors also affected EMRs use negatively.

Technical factors that affected EMRs are Information and Technology. Information gap that was experienced by OPD EMR was the failure to produce the much needed HMIS 15 report. Users are forced to manually tally records and produce the report. This is tedious and prone to human error. In contrast, ART EMR produces ART cohort report that is required by Ministry of Health for procurement and distribution planning. Another Information gap identified was OPD EMR's collection of unnecessary data by data clerks. ART EMR, on the other hand, data collected is the same as data collected when users are using manual systems.

Technology wise, OPD EMR has a feature that requires several clicks to complete one task such dispensation of Paracetamol. ART EMR, on the hand, has bundle common dispensed drug that a single click one is able to dispense drugs. ART EMR, furthermore, suggests prescription based on the conditions that the patient is presenting.

Organizational factors that affected EMRs are management systems and structures and Processes. Under Management systems and structures, the findings show some gaps on OPD EMRs. ART EMR has favourable support from partners, government and facilities management which encourages users to use it regularly while OPD EMRs is not supported to full potential by different stakeholders. This difference implied that ART EMR will be used regularly as human, financial, technical and management resources are available whenever needed while for OPD EMR it meant that any challenged users may face will not be dealt with in a timely manner to ensure smooth running of the system.

Furthermore, Processes also influence the use of EMR. The ART EMR was designed to adhere to the ART treatment guidelines. The mirroring of the treatment guidelines has resulted in the maintenance of patient workflow. The study found that OPD EMR has deviated from the design which was has distorted patient workflow thereby creating heavy workload to Data clerks.

The final factor that has been noted to have affected the use of EMR is staffing and skills. OPD EMR is heavily affected by staff rotation and transfers which is not the case in ART EMRs. OPD personnel are rotated at least once a year while ART staff is not generally rotated. ART staff is not rotated because they are specifically trained for HIV management. This implies that OPD EMRs sometimes suffer in terms of use when all trained members have rotated to other clinics within the facility and the clinic has untrained personnel. OPD is also affected by transfers as new personnel have to learn the

workflow and the processes while for ART EMR the workflow is uniform therefore no need for further training.

5.2 Contributions

This study provides theoretical and practical contributions.

5.2.1 Practical Contributions

The findings and discussions of this research will be presented to Baobab Health Trust informatics directorate to inform them how their solutions are performing and how they can address the challenges identified. Baobab Health Trust and other EMRs implementers in Malawi do not have a Research and Development Department, so this research can be used as an evaluation tool for them.

This research's findings can be used by students and other researchers to complement their work in the area of EMRs and Health Information Systems in general.

5.2.2 Theoretical contributions

This study builds on the already existing knowledge of EMR use in Malawi. Studies have presented challenges that affect EMR use in Malawi (Douglas, 2009; Msiska et al., 2017; Msukwa, 2011). Despite the availability of these studies, none of them considered comparing the design of the EMR and the actual implementation on the ground. This study, therefore, offers a different view on challenges affecting EMR use by indirectly

considering requirements engineering and the delivered EMR in the production environment.

5.3 Further research

One area that can be explored further is comparing why EMRs succeed or fail looking at EMRs deployed by different implementers e.g. ART EMR by BHT and EMR developed by Afyapro. This will possibly give another perspective why EMRs are used regularly or not.

5.4 Recommendations

Looking at the findings as presented in the previous sections, the study makes the following recommendations.

To address the information gap, implementers have to work towards developing systems that produces output as required by stakeholders. OPD EMR, in this regard, needs to have an added report of HMIS 15. This will remove the need to manually generate this report by EMR users. On unnecessary data collection, implementers need to remove fields from OPD EMRs that are deemed to collect data that is not needed.

On the technology gap, where the EMRs have shown some usability gaps, implementers need to redesign the OPD EMRs drug dispensation feature. This feature should allow users to get a task done within few clicks. One way this can be done is by combining tasks on one page. In so doing, number pop-ups may be reduced. On insufficient

hardware in some locations, implementers and Ministry of Health should ensure that all the intended location have fully functioning workstations installed.

Gaps on Management System and Structures such lack of support and monitoring from both MoH and Health Centre management can be reduced by developing a proper OPD EMR support plan by both implementers and stakeholders. They should be a deliberate plan to reward all Health Centres that are managing data well similar to the Ministry of Health HIV/AIDS department approach.

Reducing the gap on Processes will require the management to enforce the use of EMRs when providing services to patients. Once all patients are treated and data is captured at each workstation patient workflow will not be distorted as it is at Area 18 and Area 25 Health Centres.

The final recommendation this study makes is on reducing the Staffing and Skills gap. On clear challenge is lack of trained personnel due to transfers and rotations. Implementers and Health Centre management should communicate whenever transfers and rotations are planned so that trainings should be arranged to impart knowledge to the incoming users. Implementers and health centre management should also ensure that all intended users are using the OPD EMR because doing so will distribute the workload evenly and clerks will be able to comfortably do their job.

5.5 Chapter summary

The chapter gives a reader the conclusion of the study, its practical and academic contributions and finally it presented recommendations that were made from the findings that were presented in chapter 4.

REFERENCES

Almutairi, B. (2011). *A Strategic Roadmap for Achieving the Potential Benefits of Electronic Health Record System in the State of Kuwait* (Doctoral dissertation). University College London.

Baobab Health Trust. (2016). *Baobab's Mission & Vision*. Retrieved 17th August 2016 from http://baobabhealth.org/?page_id=245

Berg, M. (2001). Implementing information systems in health care organizations: myths and challenges. *International Journal of Medical Informatics*, 64(2-3), 143-56

CDC. (2016). *Innovative Electronic Medical Record System Expands in Malawi.* Retrieved 28th July 2017 from https://www.cdc.gov/globalaids/success-stories/innovativemalawi.html

Chawani, M. (2014a). *A Cross-case Analysis of the Effects of EMR Deployment on Antenatal Care Services in Rural Health Centers in Malawi*. Journal of Health Infromatics in Africa, 2(1). https://doi.org/10.12856/JHIA-2014-v2-i1-89

Chawani, M. (2014b). *Development of Electronic Medical Record Systems for Maternal Health Services in Rural Settings An Action Research Study from Malawi (*Doctoral dissertation*).* University of Oslo, Norway

Chege, S. (2015). *Application of the Design–Reality Gap Model to Enhance High Availability of Systems for Health Care Providers in Nairobi, Kenya* (Masters Thesis). University Of Nairobi, Kenya.

Coiera, E. (2015). *Guide to Health Informatics (*3rd ed.). London: CRC *Press*

Conrick, M. (2006). *Health informatics: Transforming healthcare with technology*. London, United Kingdom: Thomas Nelson Australia.

Csiszar, J. (2016). Paper vs. Electronic Medical Records. Retrieved 30 July 2017 from http://smallbusiness.chron.com/paper-vs-electronic-medical-records-40354.html

Cucciniello, M., Lapsley, I., Nasi, G., & Pagliari, C. (2015). Understanding key factors affecting electronic medical record implementation: a sociotechnical approach. *BMC Health Services Research*, *15*(1). doi: 10.1186/s12913-015-0928-7

Douglas, G. P. (2009). *Engineering an EMR system in the developing world Necessity is the mother of invention (*Master's thesis). University of Pittsburg, USA.

Douglas, G. P., Mumba, S., Gadabu, O., & Jahn, A. (2010). Using Touchscreen Electronic Medical Record Systems to Support and Monitor National Scale-Up of Antiretroviral Therapy in Malawi. *PLoS Med.*, 7(8), e1000319. doi: 10.1371/journal.pmed.1000319.

EMR Survey. (2015). Medscape EHR Report 2015: Physicians Rate Top EHRs. Retrieved 15th June 2017 from https://www.medscape.com/features/slideshow/public/ehr2016#page=5

Fraser, H., Biondich, P., & Choi, S. (2005). Implementing electronic medical record systems in developing countries. *Inform Prim Care*, 13(2), 83-95.

Fraser, H., Habib, A., Goodrich, M., Thomas, D., & Khan, A. (2010). E-Health systems for management of MDR-TB in resource-poor environments: A decade of experience and recommendations for future work. London: Sage Publication.

Frazee, R., Cames, A., Maldonado, Y., Bittenbinder, T., & Papaconstantiou, H. (2015). The impact of electronic medical record implementation on operating room efficiency. *Journal of Hospital Administration*, *5*(1). doi: 10.5430/jha.v5n1p48

Garets, D., & Davis, M. (2017). EMRs and EHRs. Concepts as different as apples and oranges at least deserve separate names. *Healthc Inform.*, 22(10), 53-4.

Heeks, R. (2003). Health Information Systems: Failure, Success and Improvisation. *International Journal of Medical Informatics*, 75(2),125-37.

Henricks, W., & Healy, J. (2002). Informatics Training in Pathology Residency Programs. *American Journal Of Clinical Pathology*, *118*(2), 172-178. doi: 10.1309/4ce8-n2mx-dfg6-n8h9

Horsky, J., Schiff, G., Johnston, D., Mercincavage, L., Bell, D., & Middleton, B. (2012). Interface design principles for usable decision support: A targeted review of best practices for clinical prescribing interventions. *Journal Of Biomedical Informatics*, *45*(6), 1202-1216. doi: 10.1016/j.jbi.2012.09.002

Jawhari, B. (2016). *Benefits and Challenges of Implementing an Electronic Medical Record System in an Urban Slum in Kenya* (Master's thesis). University of Alberta

Kalogriopoulos, N., Baran, J., Nimunkar, A., & Webster, J. (2009). Electronic medical record systems for developing countries: Review. *Annual International Conference of The IEEE Engineering In Medicine And Biology Society*. doi: 10.1109/iembs.2009.5333561

Kelley, T. (2016). *Electronic health records for quality nursing & health care*. United States: DEStech Publications.

Keshavjee, K., Bosomworth, J., Copen, J., & Kucukyazici, B. (2006). *Best Practices in EMR Implementation: A Systematic Review*. Retrieved 23rd June 2018 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1839412/

Khomani, P., Mputeni, C., & Gadabu, O. (2013). Use of Electronic Medical Records System to Enforce Adherence to Maternal and Infant Health Treatment Protocol in Malawi: A Pilot Case Study at at Bwaila Maternity Hospital. In *UbuntuNet Alliance Annual Conference* (pp. 103-109). Tanzania.

Msiska, M., Kumitawa, A., & Kumwenda, B. (2017). Factors affecting the utilisation of electronic medical records system in Malawian central hospitals. *Malawi Medical Journal*, *29*(3), 247. doi: 10.4314/mmj.v29i3.4

MoH. (2016). *Health Challenges*. Retrieved 12th April 2016 from http://www.health.gov.mw/index.php/78-demo/slides/74-health-challenges

Msukwa, M. (2011). *User Per ceptions on Electronic Medical Record System (EMR) in Malawi (*Master's thesis). University of Malawi, College of Medicine, Blantyre.

Nelson, R., & Staggers, N. (2017). *Health informatics* (2nd ed.). London: Sage Publication.

Ngafeeson, M., & Midha, V. (2014). An exploratory study of user resistance in healthcare IT. *International Journal Of Electronic Finance*, *8*(1), 74. doi: 10.1504/ijef.2014.064003

OpenMRS. (2016). *Introduction to OpenMRS.* Retrieved 16th June 2017 from https://wiki.openmrs.org/display/docs/Introduction+to+OpenMRS

Peddada, A., & Pettus, A. (2016). *EMRs and Paper Records: Co-existing in Hospital Ecosystems.* Retrieved 20th August 2017 from https://www.thoughtworks.com/insights/blog/emrs-and-paper-records-co-existing-hospital-ecosystems

Rugchatjaroen, K. (2015). Success of Electronic Government Project in Bangkok Metropolis: An ITPOSMO Approach. *International Journal Of Social Science And Humanity*, *5*(9), 783-787. doi: 10.7763/ijssh.2015.v5.556

Russell, K. (2012). Implementing an Electronic Medical Record to Reduce Medical and Medication Errors. *The Journal of Global Health Care System*, *1*(1), 69-77

Scholl, J., Syed-Abdul, S., & Ahmed, L. (2011). A case study of an EMR system at a large hospital in India: Challenges and strategies for successful adoption. *Journal Of Biomedical Informatics*, *44*(6), 958-967. doi: 10.1016/j.jbi.2011.07.008

Schuemie, M., Talmon, J., & Moorman, P. (2009). Mapping the domain of medical informatics. *Methods Inf Med.*, 48(01), 76-83. DOI: 10.3414/ME0576

Sikhondze, N. & Erasmus, L. (2016). *Electronic medical records: a developing and developed country analysis.* Retrieved 30th September 2017 from https://researchspace.csir.co.za/dspace/handle/10204/9204

Sood, S., Nwabueze, S., Mbarika, V., Prakash, N., Chatterjee, S., Ray, P., & Mishra, S. (2008). Electronic Medical Records: A Review Comparing the Challenges in Developed and Developing Countries. *Proceedings Of The 41St Annual Hawaii International Conference On System Sciences (HICSS 2008)*. doi: 10.1109/hicss.2008.141

Syamsuddin, I. (2016). Novel gap analysis framework for cloud health information systems. *Journal of Theoretical and Applied Information Technology*, *86*(3), 415-21

Tavares, J., & Oliveira, T. (2017). Electronic Health Record Portal Adoption: a cross country analysis. *BMC Medical Informatics And Decision Making*, *17*(1). doi: 10.1186/s12911-017-0482-9

WHO. (2016). Electronic medical record systems, data quality and loss to follow-up: survey of antiretroviral therapy programmes in resource-limited settings. Retrieved September 19th September 2016 from https://www.who.int/bulletin/volumes/86/12/07-049908/en/

World Bank Group. (2016). *The World Bank In Malawi*. Retrieved 17th August 2016 from http://www.worldbank.org/en/country/malawi/overview

APPENDICES

Appendix 1: Data Collection tool- Interview guide

***Interviewer**: …….…… Meeting Place: ……*

Date: …….…… Start Time: …….. End: ……

Attended by:……

Interviewee ID:

Institution: …….

User's questions

Section 1: General questions

1. What are your daily activities?
2. What data do you collect?
3. How is the data (Patient details) collected i.e. what instruments are used?
4. Do you use the J2s computers (Baobab system) when registering patient or capturing data? If No, why not?
5. How would you describe how you use the data collection tools (Hardware and Software)?
6. How much time (hours/days) do you spend in when recording data for one patients?
7. How has the system design help when doing data collection?
    a) How did the user interfaces (The appearance of the screen, the layout of buttons and design of data entry fields) help in data collection?

b) How did the system features (The capability of a system to perfom a certain activity) help in the data collection?

8. What challenges do you face with network connection to the computers (J2)
9. Can you explain the challenges that you face with power to the computers (J2) that you use?
10. What were you using to collect data before the implementation of the system?
11. What reports are generated?
12. Who uses the reports from EMRs?
13. How different were the reports before and after EMRs deployment?
14. How often are reports generated?
    a) Weekly
    b) Monthly
    c) Quarterly
    d) Yearly
    e) Other

    If other specify_____
15. Do you get feedback on the data that has been collected?
16. What strategies were used to introduce the new system?
    a) Phased approach
    b) Pilot approach
    c) Parallel approach
    d) Total change-over approach
17. How did the system deployment change the workflow of patients?

18. Did the change in the workflow change the way clinicians provide their services to the patients?
19. How did the deployment of the EMRs affect the objectives and values of the department?
20. How many people were manning the clinic before the system implementation?
21. How many additional staff did the system require?
22. How many people were trained to use the system?
23. Was the training adequate?
24. How often are refresher trainings done?
    a) Once a quarter
    b) Bi-annual
    c) Once a year
    d) Never
    e) Other

    If other specify_____
25. How has staff rotation affected the operations of the clinic including the use of the system?
26. How did the system change management and structures of the clinics where they were deployed?
27. Did the system use the same processes that were followed before the system deployment?
28. What are the other factors that you think affected the clinic or the system after the deployment?

Section 2: Scoring of the system

No	Questions	Score
1	How much change would you want to see in the system regarding how the information is collected and presented for it to match what you would consider desired?	
2	How much did technical issues (software, hardware and technology) affect the EMR?	
3	Was the change in the patient workflow in the system significant that it adversely affected the work processes?	
4	How much has management and systems been affected EMRs?	
5	How do you rate the effect of Objectives and values of the clinic against the EMR?	
6	How would you rate the staffing and skills affected the EMR?	
7	How much gap did the facility lack in terms of other resources to support the EMR?	

Key: The scores are in the range of 0 – 10. 0 means no change before system installation and after system installation while 10 means there was massive changes which were introduced to support the system.

Appendix 2: University Data Collection Approval

PRINCIPAL
Richard Tambulasi, B.A (Pub Admin), BPA (Hons), MPA, Ph.D

CHANCELLOR COLLEGE
P.O. Box 280, Zomba, Malawi
Telephone: (265) 524 222
Fax: (265) 524 046
E-mail: principal@cc.ac.mw

18 January 2017

REFERENCE FOR MR. MATTHEW KUMBUYO (MSC/INF/18/15)

As per the subject matter, Mr. Matthew Kumbuyo registration number MSC/INF/18/15 is a student at Chancellor College pursuing an MSc in Informatics under the Computer Science Department. He seeks to collect data for his research titled "*Electronic Medical Implementation Challenges In Malawi: The Case Of BHT Emrs*"
Any assistance rendered to him for the same would be greatly appreciated.

Yours faithfully,

Kondwani Godwin Munthali (PhD)
Coordinator, MSc Informatics
Kmunthali@cc.ac.mw – 0999387701 / 0884 112 001

Appendix 3: Ministry of Health Ethics Approval

Telephone: + 265 789 400
Facsimile: + 265 789 431

All Communications should be addressed to:

The Secretary for Health and Population

In reply please quote No.

.....

MINISTRY OF HEALTH AND POPULATION
P.O. BOX 30377
LILONGWE 3
MALAWI

7th March, 2017

Matthew Kumbuyo
Chancellor College
Zomba

Dear Madam,

RE: PROTOCOL # 17/03/1741: IMPLEMENTATION OF ELECTRONIC MEDICAL RECORD SYSTEMS CHALLENGES: THE CASE OF BAOBAB HEALTH TRUST SYSTEMS

Thank you for the above titled proposal that you submitted to the National Health Sciences Research Committee (NHSRC) for review. Please be advised that the NHSRC has **reviewed** and **approved** your application to conduct the above titled study.

- **APPROVAL NUMBER : 1741**
- The above details should be used on all correspondences, consent forms and documents as appropriate.
- **APPROVAL DATE : 07/03/2017**
- **EXPIRATION DATE**
  This approval expires on **06/03/2018**. After this date, this project may only continue upon renewal. For purposes of renewal, a progress report on a standard form obtainable from the NHSRC Secretariat should be submitted one month before the expiration date for continuing review.
- **SERIOUS ADVERSE EVENT REPORTING:** All serious problems having to do with subject safety must be reported to the NHSRC within 10 working days using standard forms obtainable from the NHSRC Secretariat.
- **MODIFICATIONS**: Prior NHSRC approval using forms obtainable from the NHSRC Secretariat is required before implementing any changes in the protocol (including changes in the consent documents). You may not use any other consent documents besides those approved by the NHSRC.
- **TERMINATION OF STUDY**: On termination of a study, a report has to be submitted to the NHSRC using standard forms obtainable from the NHSRC Secretariat.
- **QUESTIONS**: Please contact the NHSRC on phone number *+265 888 344 443* or by email on mohdoccentre@gmail.com.
- **OTHER**: Please be reminded to send in copies of your final research results for our records (Health Research Database).

Kind regards from the NHSRC Secretariat.

SECRETARY FOR HEALTH
2017 -03- 07
P.O. BOX 30377, CAPITAL CITY, LILONGWE 3

.....
For: **CHAIRPERSON, NATIONAL HEALTH SCIENCES RESEARCH COMMITTEE**
Promoting Ethical Conduct of Research[1]

Executive Committee: *Dr B. Chilima (Chairperson), Dr B. Ngwira (Vice-Chairperson)*
Registered with the USA Office for Human Research Protections (OHRP) as an International IRBIRB Number IRB00003905 FWA00005976

Appendix 4: Participant Research Consent

Consent Form for Participation

Title of Study: Analyzing design-reality gaps influence on electronic medical records use: the case of Malawian health centres

Principal Investigator: Matthew Kumbuyo

Email Address: msc-inf-18-15@cc.ac.mw

Telephone number: 0999492201

What are some general things you should know about this case study?

You are being asked to take part in a qualitative research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research is designed to obtain new knowledge. This new information may help health information management in the future which may contribute to improved provision of health services. However, you may not receive any direct benefit from being in this study.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this study. You may ask any questions you have about this study at any time.

What is the purpose of this research ?

The purpose of this study is to learn about the data collected in your organisation, how it is analysed and used in order to understand how it could possibly be improved to support and meet the information needs of your organisation and other stakeholders.

How many people will take part in this study?

The study intends to interview some health workers at the health facility and some technical people at Baobab health who were responsible for the deployment of EMRs at your health facility.

How long will your part in this study last?

If you decide to be in this study, you will first be asked to participate in one initial interview that will last for not more than one hour. Later I would like to observe work routines in your work place and based on observations I might have more questions at a later date, or (if appropriate) during observation.

What will happen if you take part in the study?

You will be asked to participate in an initial interview with myself. I am a master's student under the University of Malawi. The interview is made up of a series of questions related to data collection, reporting and use of electronic medical recording systems. There are no wrong answers or bad ideas, just different opinions. If you agree to participate in the interview I will record your response on a piece of paper. Also, if you do not object, I would like to tape record the discussion to make sure I do not miss anything. Only I will listen to the tapes. Your name will not be attached to the

interviews. You can ask to turn off the tape recorder at anytime. If you have any questions about the study, you can ask me at any time. You also have the right to stop the interview at any time.

What are the possible benefits from being part of this study?

You will have the opportunity to share your thoughts about your work related to the information system and ways to improve the system. You will not be paid to participate in this study. There are no costs for participating in the study other than your time spent.

Although you may not experience any direct benefits, your participation may help to improve the development and implementation of EMRs in your work place in future. However, there is a possibility that you may receive no direct benefit.

What are the possible risks or discomforts involved from being in this study?

The main risk is that you may feel uncomfortable answering some of the questions during interviews. You may be embarrassed or afraid to disclose information about your work relations or colleagues. You may refuse to answer any question that you do not want to answer. You can also stop participation at any time. You should report any problems to the researcher.

How will your privacy be protected?

Names *will not* be attached to interviews and the data will be kept confidential. To protect your privacy, all of the information you provide will be stored only with an identification

code, not with your name. Participants will not be identified in any report or publication about this study. The notes and audiotapes containing your interview responses will be accessible to only myself (/and co-investigator) and all the data will be destroyed when the study is over.

What if you have questions about this research?

You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the principal investigator listed on the first page of this form.

- -

Written Consent Verification

I have read the information above and have agreed to participate in this study.

_____ _____

Signature of Person Giving Consent Date

_____

Printed Name of Person Giving Consent