PERCEPTION ON SYNCHRONIZATION OF PATIENT DATA AMONG HEALTH FACILITIES THROUGH ELECTRONIC MEDICAL RECORDS SYSTEM: A CASE STUDY OF KABGAYI DISTRICT HOSPITAL

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DECLARATION

I, Charité NIYITEGEKA, hereby declare that the thesis have been written by me without any external unauthorized help, that it has been neither presented to any institution for evaluation for previously published in its entirety or in parts. Any parts, words or ideas, of the thesis, however limited, which are quoted from or based on other sources, have been acknowledged as such without exception.

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This is to certify that this research work entitled

"Perception on synchronization of patient data among health facilities through electronic medical records system" is an original work, proposed and conducted by Charité NIYITEGEKA as a result of her academic efforts, and was done under my supervision.

……..

Dr. NIYOYITA JEAN PAUL

Date: June 23th 2016

DEDICATION

I dedicate this book to my almighty God, his Son Jesus Christ and the Holy Spirit. Through God's mercy and love I have been able to accomplish what I could not. God proved supremacy and faithfulness to me through this work.

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May God bless you all.

ABSTRACT

Background

Synchronization of patients' data in health facilities through Electronic Medical Records system (OpenMRS) have the potential of speeding up processing people's life, and avoiding multiple patients identification (PID) generated by EMRs that designer of the EMR system have been setting two ways for generates patients identification (generates automatically and writes number).

Methods

In this observational study design, quantitative and qualitative approach was used to meet the objectives through retrospective information on EMR data sharing. Pre-defined variables like strategy approach, innovation and data synchronization in the system was evaluated. Census method was conducted in HIV/ART department focusing on the EMR system. The EMR IT was also targeted and all questions were related to the synchronization of patients' data among different health facilities staff through Electronic Medical Records system.

Results

The study findings showed that healthcare professionals preferred using the EMR in sharing than paper based records and also that the overall package of the services provided by using the EMRs found it more effectiveness and efficient in sharing a patient' records.

The study results also indicated that the EMR Servers are hosted in local while the EMR package is web based system. On the other hands, the results also showed that there was currently EMR provided different patient's identification (PID) at each health facilities meanwhile the EMR system could be used one patients' identification in sharing patient's records. The study also showed that the proficient of EMRs were changed the qualities of healthcare deliveries and also the costly was reduced, short time in synchronized patient's information at different health facilities, and the security of patient' records was improved than paper based records.

Conclusion

This study presented by a cloud based computing approach for the synchronized a patients' data among health facilities through EMRs developments. The main idea need is for synchronizing an EMR system, which all patients' and caregivers from different places can easily access patients' information and use, as well as improve healthcare applications sharing the EMRs. The proposed model introduced in this study offers a flexible and portable platform for the sharing EMR applications development. Scalability and privacy were the major concerns in this data synchronized. Cloud based computing system successfully overcome these issues by implementing EMRs for efficiently and effectiveness and designing the system based upon cloud based server requirements.

We provided the healthcare with an easy way to share the patients' information via EMRs web server. Finally, promising output across the conducted tests was a good indicator for usability of the proposed cloud based server system.

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DEFINITION OF KEY TERM & LIST OF ABBREVIATION

AMPATH:	Academic Model for the Prevention and Treatment of HIV/AIDS
ASP:	Application Service Provider.
C:	Child
CHW:	Community Health Worker
D.H:	District Hospitals
E2CHRS:	Enterprise Electronic Cloud-Based Health Record System
eHMIS:	Electronic health Management Information System
EMR:	Electronic Medical Records
EPR:	Electronic Patient Record
EPRS:	Electronic Medical Record System
ETL:	Extraction Transformation Loading
H.C:	Health Centers
H.P:	Healthcare Provider
HER:	Health Electronic Record
HIT:	Health Information Technology
HL7:	Health Level Seven
HTML:	Hyper-Test-marker up Language
IaaS:	Infrastructure as a Service
ICT:	Information communication and Technology
ID:	Identification
MDGs:	United Nations Millennium Development Goals
MMRS:	Mosoriot Medical Record Systems
MoH:	Rwanda Ministry of Health
MRHC:	Mosoriot Rural Health Centre
NCDs:	Non-chronic Diseases
NICI:	National Information Communication Infrastructure
NIST:	National Institute of Standards and Technology
OpenMRS:	Open Medical Records System
P.C:	Private Clinics

P.H.O: Private Healthcare Organization

P.H: Private Hospitals

PaaS: Platform as a Service

PAC: Picture Archive Communication

PC: Personal Computer

PedInfoSys: Pediatrics information system

PHI: Personal Health Information

PID: Patients' unique identifier

PIH: Pertners in Health

PR: Patient Records

R.H: Referral Hospitals

RBC: Rwanda Biomedical Center

RDC: Republic of Democratic Congo

SaaS: Software as a Service

SMS: Short Message System

SSL: Secure Sockets Layer

SWOT: Strength Weakness Opportunity Threat

UIM: Unifier Interface Middleware

USD: Unit State Dollars

VPLS: Virtual Private LAN Service

VPN: Virtual Private Network

CHAPT I: GENERAL INTRODUCTION

1.0. Introduction to the study

In this chapter we will talk about background of the study, statement of the problem, general objectives objective, and research question, significance of the Study, limitations of the Study and finally a scope of the study.

1.1. Background of the study

The use of modern information technology in the healthcare delivery is to increase the reliability, accessibility and productivity(1). The implementation of EMR can be traced back over few decades and it has improved service delivery in health sector.

In description of this technology, the modules required by an EMR include: scheduling, patient registration, documenting patient encounters, writing prescriptions, managing documents, requisitioning and receiving lab and diagnostic imaging reports, managing interoffice communications, clinical decision support and billing. Benefits of EMR systems will be in decision support for drug ordering, support for clinical research, management of chronic diseases such as diabetes, hypertension and heart failure, data is accessible and shared at multiple sites, multiple users can enter data simultaneously, data can be backed up automatically at more than one site and Information can be communicated between multiple locations such as from laboratory to physician(2)

Since 1999, Haiti has been using the HIV-EMR system to effectively run a community based HIV treatment program with its organization Zanmi Lasante. This program has expanded to cover seven public health clinics in an area with virtually no roads, electricity or telephone service. The HIV-EMR system shows the feasibility of implementing a medical record system in remote clinics in a remote area with virtually no infrastructure and limited technical expertise(3).

Peru implemented a web based EMRs open source web system in 2001, backed by an oracle database that was developed to support a two-year treatment regimen for patients. The forms were supposed to be filled out and shared patient records by the chest physicians, as well as laboratory sharing the result forms. As results, medication order entry in the launched system was shown to produce significantly fewer errors than the previous paper based and spreadsheet approach 17.4% to 3.3%, $P < 0.0075$(4).

In Malawi since 2001, Kamuzu Central Hospital located in Lilongwe Central Region has made broad use of a Touch Screen Patient Management Information System (TSC-PMIS) for a wide-range of clinical problems in the 216-bed pediatric department. The extensive use of this system by healthcare workers in a poor country with limited IT skills is convincing enough to demonstrate EMRs potential and importance in enhancing the easy sharing of useful data among health workers in different facilities (5).

In November 2001, the MMRS was installed in a primary care healthcare center in rural area in Kenya. The software was adapted to support the AMPATH (Academic Model for the Prevention and Treatment of HIV/AIDS) project and renamed to AMRS(6). As results, MMRS showed patient visits reduced by 22%, health care provider's time per patient reduced by 58% ($P < 0.001$), and patients spent 38% less time waiting in the clinic ($P < 0.06$); clinic personnel spent 50% less time interacting with patients, two-thirds less time interacting with each other, and more time in personal activities(7).

In Uganda, the US Department of Health and Human Services has developed a medical record system to support HIV treatment via the Care Ware System. It is widely used in health centers and hospitals in the US, and was internationalized and deployed in Uganda in October 2003.

Challenges in implementing EMR systems have been identified by users. Lack of user training, poor initial design, limited capabilities and expansion potential, lack of systems and staff training to ensure data quality and completeness, lack of perceived benefit for users who collect the data are problems facing EMR system users. Technical problems are also identified as lack of back-up systems and sharing medical records in event of computer loss, poor system security leading to viruses, and spyware and lack of patient data flow between health facilities.

Another challenge identified is a limited synchronization of records, which incorporate more than simply basic information into healthcare organizations. There is a great demand for effective EMR systems by all stakeholders in healthcare provision to address a number of issues including (a) Medical record movement and updating problems, (b) realizing improvements in the quality and coherence of care process and to drive process improvement, (c) automation of guidelines and care pathways, and (d) assistance and facilitation of clinical research, outcomes, and management medical records are however very difficult to build as data is generally stored in distributed systems and locations in a diverse range of formats. These challenges are exacerbated because the current electronic data sources which include: hospital systems,

laboratory systems, pharmacy systems, and physician dictation systems reside on multiple data stores frequently with different structures, levels of granularity, and coding systems(8).

Like other country, Rwanda has been implementing electronic medical record system (OpenMRS) as a strategy in e-health. This one aims to share, store and retrieve all patients' information. However, the software provided by MoH is still unable to share patients' medical records. This means that all hospitals in Rwanda are not able to share patients' information. This means someone can have multiple patient identification (PID) number in one or all health facilities while the EMR system is a web based system to be accessible online. Table 1 below shows weaknesses of EMR system (Open MRS) in Rwanda based on three factors namely human resources, process, and technology before cloud based solution is proposed in this study.

Table 1.1. Challenges of EMR system in Rwanda

FACTOR	WEAKNESS
Human resources	1) Insufficient skilled staff for system analysis and development 2) Low level of end user input during system design
Process	3) Lack of national EMR road map 4) Lack of a regular and structured training program for end users
Technology	5) Insufficient infrastructure Interoperability 6) Interface and reporting are not user friendly for end users 7) Lack of ability to aggregate information at a national level 8) Lack of hardware and application level monitoring solution

Source: (Author, 2016)

1.2. Statement of the problem

The EMR system in Rwanda started in 2011. In 2014, the EMRs was implemented at 6% of 516 health facilities (health centers and district hospitals) (9). The Rwanda Ministry of Health target was to implement the EMR system up to 100% in 2015 and Patient data were expected to flow and be shared between health facilities. Some weaknesses were identified in human resources, process and technology used by EMR system. Different measures have been taken address this issue such as providing trainings facilities, internet connection, and ICT equipment, though the target has not been achieved yet(10). Lack of patient data flow and sharing between heath facilities in Rwanda is still a problem facing EMR system. This research seeks to shed light on perception about synchronization of patient data in Rwanda's health facilities.

1.3. Objectives of study

The main objective of this study is to identify factors associated to poor synchronization of patient data flow in health facilities.

1.3.1. Specific objectives

i. To identify the gap in EMR system data sharing.
ii. To identify the factors affecting patients' data sharing across district hospitals and health centers.
iii. To identify implementable solutions for smooth operation of patients' data sharing.

1.3.2. Research questions

i. What are the gaps in current EMR system data sharing?
ii. What are factors affecting patients' data sharing in Rwanda's health facilities?
iii. In which ways can sharing of Electronic Medical Records among health facilities be made more successful?

1.4. Significance of the study

Lack of EMRs , patients can have multiple unique identification ID number in different health facilities, yet the EMRs is a web based system that is be accessible online. The aim of this study is to suggest best ways of synchronizing patients' data flow amongst the health facilities in order to avoid multiple patients identification (Patient ID) generated by EMRs.

The study will contribute to the improvement of people's life by speeding up the healthcare process, data security and availability in health care service delivery. It will also provide valuable information on different type of EMR data sharing used in health care system. As secondary information source, this work will be a useful reference to researchers interested in the use of EMR system in healthcare service delivery in Rwanda. So far, none has done a similar study.

1.5. Subdivision of the study

This study will be composed of five chapters: chapter one, chapter two, chapter four and finally chapter five with general conclusion. Chapter one will focus on general introduction, background of study, objectives and research questions, significance and limitation of study. The chapter two will deal with theoretical framework composed of the definitions of key concepts, theoretical approach and literature review. The chapter three mainly concerns research methodology which is composed of the study area, study design, study population, sample size and selection, data collection instruments, and data analysis and management. The chapter four will discuss the results. Finally; chapter five will deal with the general conclusion and recommendation.

CHAPT II. LITERATURE REVIEW

2.0. E-health concept, theories and models

E-health is the use of information and communication technology for delivery of services in healthcare(11). In this study e-health will mean all health information systems related to medical records. E-health system is composed of EMR, HER, EPR, etc, and Therefore, the e-health system focus in this study is Electronic Medical Records (EMR). EMR system in Rwanda is designed based on open source with different modules related to patient's information in healthcare service provision. Some of them are OpenMRS to manage HIV/ARV and eHMIS to manager primary care in Rwanda. Briefly EMR in Rwanda is based on OpenMRS concept.

This section will accordingly reviews the concept of EMR/ EHR thus explaining its concepts, importance, market need and is also explained the data security and privacy relates to clinical data in electronic format which was a very important as any electronic data was prone to hacks and data loss(12).

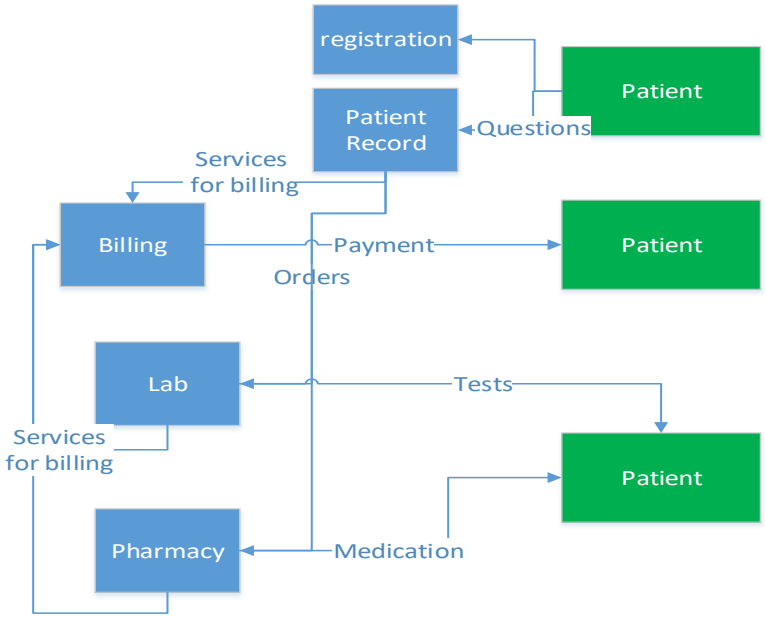

Figure 2.1. Show the patient process in OpenMRS system

OpenMRS modules utilized in services of the health facility are for the following purposes:

a) **Registrar:** Collect critical demographic information

b) **Primary Care**: Track critical clinical information for patients

c) **Lab:** Order lab tests and record results

d) **Pharmacy:** Order and dispense prescription medications

e) **Billing:** Collect service, medication and consumable fees

f) **System Reporting:** Indicator Reporting, Research, Operations management

2.1. Use of Open Medical Records System in developed countries

According to previous studies, OpenMRS began through a partnership with Indiana University School of Medicine and Moi University in Kenya with the aim of changing the quality of service delivery in health(13).The EMR system called OpenMRS was built using free, open source software and builds on common platforms and previous work, especially that of the Open Medical Record System(14). Some studies done in different countries were based on this platform, and were customized according to their healthcare guidelines. Some examples of studies were concerned with medical records management. MMRS was developed in Kenya (15), Careware in Uganda (Ransom, 2008) and Electronic Data Capture in RDC (Remya, 2012). The study conducted in Rwanda decided to maintain OpenMRS package for HIV data management and electronic heath information system package to manage primary care(18). The OpenMRS for HIV data management is the most functioning package in 80% of health facilities in Rwanda but Primary care implementation is still under process. The system was approved for use in Rwanda by the Ministry of Health and adheres to national EMR standards(18). Other studies have discussed the benefits of Electronic medical record (EMR) are to access in real time the patient's information. The EMR system is similar to the paper record, but the electronic format, it can creates usable data in medical outcome studies, improves the efficiency of care, enhances communication among caregivers, and easy management of health data(John Lubrano, 2009).

The study done in Implementation guide for Electronic Medical Record shows that a patient information recorded on paper based and then converts into an Electronic form to be able to store on digital devices(20). The patient information is created, gathered, managed, and consulted by licensed clinicians and staff from a single organization who are involved in the individual's health and care(12). According to an article from Health Management Technology (2002), EMR system saves time when it is used versus manual methods at California Pacific Medical Center (CPMC) in San Francisco.

Table 2.1. Benefits of EMR versus Manual Methods

Category	**Manual**	**With EMR system**
Complex NICU patient Discharge Summary	120-180 Min	30-45 Min
Complex NICU patient Daily Progress Notes	30-60 Min	20-40Min
Chart Coding of Uncomplicated Deliveries	5 Min/ Chart	1 Min/ Chart
Paper Office – Without EMR	**Paperless Office – With EMR**	
1. Lot of Paper Use	1. Minimal Paper Use	
2. Lot of Manpower Use	2. Minimal Manpower Use	
Not so Efficient	3. Very Efficient	
3. Not Portable	4. Portable	
4. Cost Inefficient	5. Cost Efficiency to its Maximum	
5. Prone to lot of Human Errors	6. Less prone to Human Errors	
6. Clinical Data might get destroyed	7. Less chances of Clinical Data getting destroyed	
7. Not so secure	8. Security at any extent is possible	
8. Decision Making is not so quick	9. Quickest reports for Decision Making	
9. Lot of dependency on staff	10. Less dependency on staff	
10. Same office revenues	11. Increases office revenues	
11. Less time effectiveness	12. Time saving at its maximum	
12. Data collection from different office is not so effective	13. Automated data retrieval from different offices	
13. The data in paper format is difficult to organize and retrieve.	14. Electronic data is very easy to organize and retrieve.	

Source:(12)

Electronic medical record (EMR) systems are increasingly being adopted to support the delivery of health care in developing countries and their implementation can help to strengthen pathways of care and close gaps in the HIV treatment cascade by improving access to and use of data to inform clinical and public health decision-making(21). There are different studies on EMR cloud based solutions

2.2. Studies done on use of Cloud technology in Open Medical Records System

A study done in Nigeria on Cloud Electronic Medical Records by Olutayo Boyinbode and Gbenga Toriola (2015) illustrated that the utilization of modern information technology in the delivery of healthcare is to enhance the availability and reliability of improved healthcare services to patients at a reduced cost. The proposed and implemented cloud based electronic medical record (CloudeMR) system was intended to improve the delivery of healthcare system in the rural communities of Nigeria. The adoption of new technologies had some benefits and opportunities to healthcare centers in rural areas in easy sharing advices and access to medical records from physicians that are not readily available in the rural areas(22)

Cloud computing designs and implementation can help provide a high level of availability and utility of EHR information. Thus, the integration and sharing in the cloud computing environment and Personal Health Record (PHR) services in the provision of EHR is one of solution to secure storage, usage, and access management of health data (23).

The technical perspectives on systematic literature review on security and privacy of electronic health record systems done by Fatemeh Rezaeibagha, Khin Than Win and Willy Susilo (2015) clarified that authenticity and integrity of HER are two essential factors to consider in data sharing policies in order to ensure confidentiality in healthcare Interchange and Exchange to various stakeholders(23). The implementation of a national EHR system using a semi centralized or centralized approach can aggregate EHRs from different systems, and this enhances the quality and controls the costs(23). This has been adopted in some countries, such as Canada, Australia, Denmark, Finland, England, India and Estonia.

In August 2015, John Haskew did a study on implementation of a Cloud-Based Electronic Medical Record solution to Reduce Gaps in the HIV Treatment Continuum in Rural Kenya.

The solution was adopted to support the delivery of healthcare in developing countries and their implementation and can help to strengthen path ways of care and close gaps in the HIV treatment cascade by improving access to and use of data to inform clinical and public health decision-making. Study implemented an over cloud-based electronic medical record system in an HIV outpatient setting in Western Kenya and evaluated its impact on reducing gaps in the HIV treatment continuum including missing data and patient eligibility for ART. The impact of the

system was assessed using a two-sample test of proportions pre-and post-implementation of EMR-based data verification and clinical decision support.

2.3. Challenges for synchronizing a patients data among health facilities

Interoperability services for the Health Cloud can be provided from multiple cloud service providers. For example, one provider may provide storage and processing services for high resolution medical images while another provider may provide storage and other services for storing patient electronic records or data mining and analysis services. The main issue here is interoperability which involves defining an agreed-upon framework or some open protocols/APIs that enable easy servers and data integration among different cloud service providers(24). According to the study done previously the challenges of EMR system implementation was identified by different countries. Studies done in Philippine was designed PedInfoSys as EMR system for the field of pediatrics but the technical support, implementation very expensive and usability of specialized medicine and healthcare services delivery was the problem faced by this process(25).

Similarly, studies done with implementing an efficient Electronic Medical Record (EMR) system is regarded as one of the key strategies for improving the quality of healthcare services. However, the system's interoperability between medical devices and the EMR is a big barrier to deploying the EMR system in an outpatient clinical setting(26).

Accordingly, to review the concept of EMR/ EHR thus explaining its concepts, importance, market need and is also explained the data security and privacy relates to clinical data in electronic format which was a very important as any electronic data was prone to hacks and data loss(27). The researcher explains the ways a patient’s data transferring from one health facility to another facility by using cloud computing network.

2.4. Transformation of health system

Innovation and technology efficiently used in business world caused a powerful transition of health care delivery to provide health care equity (28). In order to meet the global health challenges of the new century, transformation of health systems was anticipated. With the advancement of communication technologies and access of mobile phone even in the poorest villages(29).

Prompted policy makers to apply ICT applications into the health system. Since health system transitions caused an indirect impact on the economy and development of a country by improving health, ICT innovation caused an evolution of health system to e-health system and was easily adapted into the world (Sheikh, 2008). E-health solutions include a broad range of implements such as HER, PACs, e-prescription, laboratory information system, pharmacy management system, community based systems, hospital information systems, clinical decision support systems, e-learning tools and horizon technologies.

Researchers have identified that benefits of an e-health system depends on its design and sustainability. A concept model of five 'C' is proposed by Drury for a developing country to promote deployment of an e-health system. They are context, content, connectivity, capacity and community. In a developing country the context talked about is using the minimum infrastructure to maximum attainable function or in other words invest the minimum where more than one goal can meet. The author points out that training the users to utilize health information digitally motivates them to use the system and improve their knowledge. Open source software program using of simple infrastructure and knowledge management are suggestions for deployment of e-health system with minimum cost. Identifying and equipping with technological applications that mature, affordable, and pervasive and the potential to be extended will enhance the e-health system to thrive. Sharing of facilities between health facilities can further minimize costs. Innovation technologies can use simple applications that assist in capacity building of the clinical staff through individual and group learning. Empowering community health workers with access to health information initially paper based when digital solutions are not available(31) .

Collaboration and standardization of e-health systems is proposed when using business process engineering principles in implementation of e-health. Involving end users in the implementation process is an important principal relevant to developing countries. Positive reinforce through incentives on desired outcomes and sensitization could be achieved by developing countries for a favorable environment(32). A study done on HER proves benefits in clinical outcomes, organizational outcomes and society outcomes(33). Study done in developed and developing countries showed an improvement of health behaviors that was focused and physiological

outcomes. Controlled evaluations of patient response to SMS based follow up of clients in Australia, Brazil, China and United Kingdom found an increase in attendance and thereby improved quality of care. Whereas health behaviors like adherence to treatment guidelines improved use of text messages in malaria treatment by health workers in Kenya. Other studies in developed world like United States show improvement of health behaviors like asthma peak flow monitoring and self management of diabetes. in other case like analysis of blood pressure for hypertension showed no significant effect.

Research on use of synchronous telehealth was seen to be successful in diagnosis accuracy, reduced waiting time, better referral management and greater patient satisfaction. Interactive voice that uses mobile connectivity has improved patient's perceived health, depressive symptoms and medication related problems in United States. Cost saving studied in conventional care showed positive results. In larger projects like community wide systems benefits on costs and outcomes were dependent on the effective allocation of resources, interoperability, organization and professional supervision. Research evidence shoes e-health systems have a beneficial impact on the process of care, yet more research is required on the effects of health services on patient outcomes (23).

2.4.1. Open Medical Record System (EMR) in Rwanda

According to the studies done in Rwanda, the EMR was first implemented by Partner in Health (PIH) for HIV Electronic Medical Records in 2006 and Rwanda Ministry of Health began it implementation in all Health Center in 2010 specifically for HIV Installation after ongoing training of 3 classes of programmers in Java & EMR for support. Looking at its success, the MoH through 2009-2013 Strategic Plan, decided to add billing, pharmacy and laboratory management modules in EMR and then the system became eHMIS for the management of primary care in Rwanda(34).

The implementation of EMR and eMHIS in Rwanda was successful. However, like other countries, there are some challenges due to HR resistance to the new system and poor ICT infrastructure which impact negatively the data sharing in this system. This table 2.2 shows the hospital and health Center utilizing the EMR package.

Table 2.2. This table shows the hospital and health Center utilized the EMR package

EMR		**# of Hospitals Utilizing**	**# of HCs using**
OpenMRS (HIV management)		32	334
eMHIS	Registration	7	0
	Billing	7	0
	Clinical Data Management	2	0
	Laboratory	2	0
	Pharmacy	1	0
OpenMRS (PIH) for NCDs		3	10

Source (Authors' 2016)

2.4.2. Patient medical security and privacy

Security and privacy of patient information is the most important factor to consider when sharing patients' data. The EMR system customized for Rwanda has also considering this issue by offering privileges to system users based on their role in healthcare service provision. One of the objectives of this research is to design a cloud based solution to solve the data sharing problem facing the EMR system in Rwanda. This can be achieved because the EMR is a web based system which can be accessed online. Whenever the information gets online and runs through the web pool, it's prone to attacks(27). In addition patient data have strong security requirement rules because of the sensitive nature of the data involved like the business critical demands, regulatory constraints, and the need to securely and seamlessly share data among multiple parties including healthcare providers, payers, government agencies(35)(36). Today, the technology has evolved to a great level and the systems are made very secure. However, the strong privacy rules make EMR adoption difficult in various hospitals and institutions.

According to William.E (2011) the research done by University of Colorado Law School researchers found that the state where the privacy rules is stringent has less EMR adoption as compared to states with a little privacy rules.

2.4.3. Cloud computing concepts, theories and models

According to A. Alam (2012), Cloud computing in practice is the use of network to remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer (37). The cloud computing is a method of offering services for the end user, it is based on a number of characteristics: on-demand self-service, broad network access, measured Service, resource pooling and rapid elasticity (38). Although, Cloud computing services have a high impact for scientific applications, that mean cloud computing is flexible, reliable and usable due to the behind technologies(39). In this study it is a new technology in the field of health facility in Rwanda which means to host computer's applications so that the user can access them through internet everywhere at any time.

2.4.4. Cloud service models

According to the study done by Remco, a cloud model is composed of five essential characteristics, three service models, and four deployment models. The figure 2.2 shows the Cloud Service Models. The virtualization means (sharing physical instance of an application or resource among multiple organizations).

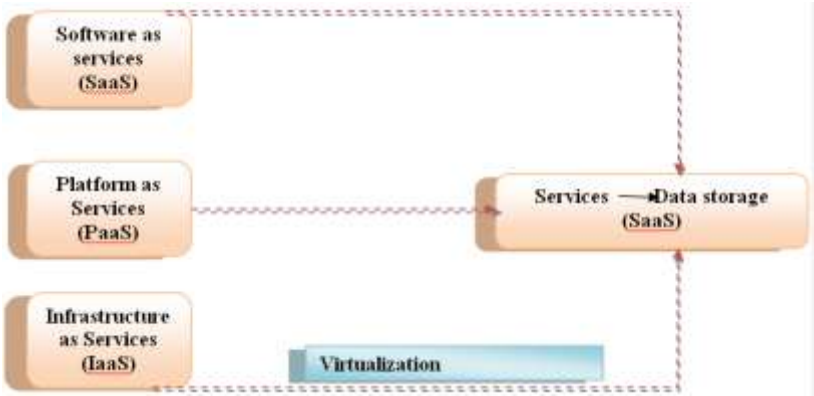

Figure 2.2. Cloud Service Model

Source: M.J.Kavis, 2014

Software as a Service (SaaS): The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud

infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user- specific application configuration settings(38).

Platform as a Service (PaaS): The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment(38).

Infrastructure as a Service (IaaS): The capability provided to the consumer is the provision of processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of selected networking components (38).

2.4.5. Deployment models

Private cloud: The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises (38)

Community cloud: The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises (40)

Public cloud: The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider(38)

Hybrid cloud: The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound

together by standardized or proprietary technology that enables data and application portability e.g.: cloud bursting for load balancing between clouds (40).

2.4.6. Used cloud computing to improve the quality in healthcare delivery

According to (40) cloud computing is a model for enabling everywhere, opportune, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services). The Cloud Computing can provide an open, flexible, and reconfigurable platform as services (PaaS) for monitoring and controlling application. Cloud computing provides low cost, high scalability, availability and disaster recoverability which can be a natural solution for some of the problems faced in storing and analyzing patients' medical records, the development of the Med Cloud model is illustrated through issues analysis followed by an in- strength performance evaluation (41)(42). Thus, cloud-based platform is used for securely managing and sharing healthcare information at long distance that aims to reduce the cost of adopting EHRs.

It also offers new opportunities to develop applications that can influence EHR data to improve quality of care, healthcare efficiency, and treatment outcomes (35). Previous studies done by "An Enhanced Cloud Computing Model for Patient Record Management in South Africa" shows the field of healthcare services is examined by a cloud computing due to its need of sharing of patient data in order to improve the processes of patient transfer and to share out health care resources in different health facilities. Cloud computing provides low initial cost for customers, offer several advantages, such as easier implementation and better system integration and the ability to optimally use and share computing resources which makes cloud computing particularly attractive for emerging countries, some examples are given where cloud computing has enabled the better provision of healthcare, education, and supply chain management with increased capacity for the sharing of data and with improved security (43).

Research conducted in Kenya with "Cloud-Based Electronic Medical Record in Rural Kenya" where a novel cloud-based electronic medical record system in an HIV outpatient setting in Western Kenya has been implemented and evaluated its impact on reducing gaps in the HIV treatment continuum including missing data and patient eligibility for ART. The impact of the system was assessed using a two-sample test of proportions pre- and post-implementation of

EMR-based data verification and clinical decision support. Significant improvements in data quality and provision of clinical care were recorded through implementation of the EMR system, helping to ensure patients who are eligible for HIV treatment receive it early. A total of 2,169 and 764 patient records had missing data in pre-implementation and post-implementation of EMR-based data verification and clinical decision support respectively. A total of 1,346 patients were eligible for ART, but had not yet started on ART, pre-implementation compared to 270 patients pre-implementation. EMR-based data verification and clinical decision support can reduce gaps in HIV care, including missing data and eligibility for ART.

A cloud-based model of EMR implementation removes the need for local clinic infrastructure and has the potential to enhance data sharing at different levels of health care to inform clinical and public health decision-making. A number of issues, including data management and patient confidentiality, must be considered but significant improvements in data quality and provision of clinical care are recorded through implementation of this EMR model.

Others studies done in Cloud-eMR, the utilization of modern information technology in the delivery of healthcare are to enhance the availability and reliability of improved healthcare services to patients at a reduced cost. The alternative in this context is to outsource the computing storage resources with the help of cloud infrastructure. The drastic reduction in the cost of healthcare services, utilization of resources, maintainability and the adoption of new technologies are some of the benefits that healthcare centers in rural areas can get from cloud-based medical information system. Also, new prospects such as easy and ever-present access to medical records and the chances to make use of services of physicians that are not readily available in the rural areas are some of the opportunities offered by a cloud-based medical information system. This paper proposes and implements a cloud-based electronic medical record (CloudeMR) system to improve the delivery of healthcare system in the rural communities of Nigeria (22) .

Research studies done in an Enterprise Cloud-Based Electronic Health Records System "Electronic Health Record systems (EHR) are increasingly being deployed within healthcare institutions to reduce the problems and limitations of the paper-based approach but its deployment have been slow due to high investment and maintenance cost. Cloud Computing has been widely recognized as the next generation's computing infrastructure and it offers several

advantages to its users. In this study, an Enterprise Electronic Cloud-Based Health Record System (E2CHRS) was designed, implemented and tested for recording, retrieving, archiving and updating of patients and other medical records. The Cloud database acts as the unified data bank for all the collaborating hospitals, the middleware provides a common platform for all the EHR systems between remote hospitals while an authentication server grants access to authorized users and denies unauthorized users access to records or resources on the system. An e-web portal serves as the front end of the system and it links the application with the cloud. Net bean IDE, Java development kit (JAD), WAMP server, Mysql, web browsers and other tools were used in developing the system. E2CHRS was deployed on twenty PC's and one server to simulate the enterprise network environment using different attack scenarios. The system performance was found to be satisfactory when tested (44)".

2.4.7. E-health cloud: opportunities and challenges

As the costs of healthcare services increase and healthcare professionals are becoming occasional and hard to find, it is imminent that healthcare organizations consider adopting cloud EMR(24)
It can help Rwanda health organizations:

(a) To streamline many of their processes and provide services in a more efficient and cost-effective manner.
(b) To provide a strong infrastructure and offer a true enabler for cloud EMR services over the Internet.
(c) To cope with current and future demands yet keeping their costs to a minimum. Therefore, analyzing and comparing the effectiveness of such schemes is important.

2.5. Conceptual framework

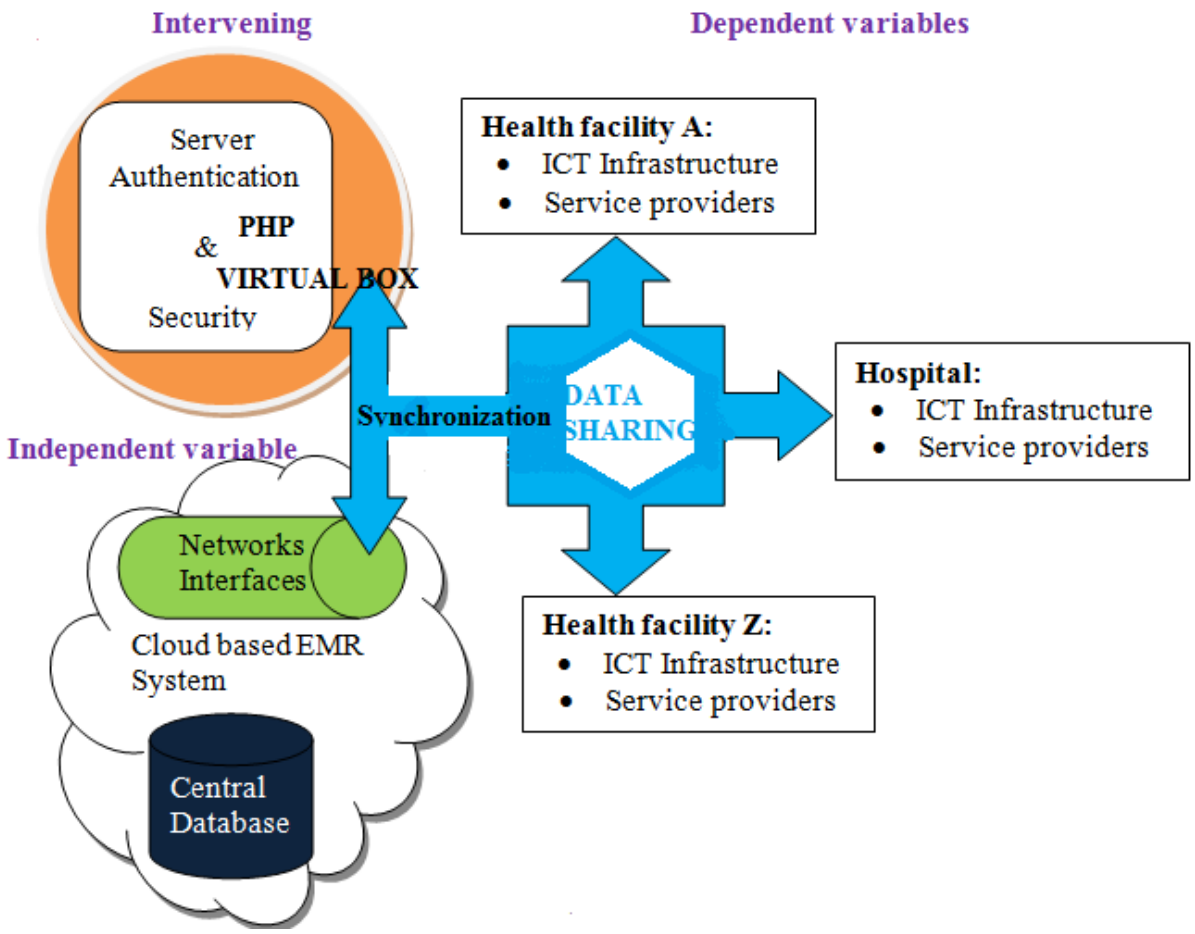

Figure 2.3. Architecture of a Cloud-based Electronic Medical Records System

Source: Author, 2016

The cloud based EMR system is an independent variable because it plays a major role in data sharing and security. It can influence the synchronization of the EMR system and interaction between patient and health service providers. In this framework, service providers are physician, nurses and midwifes as well as paramedical staff. It includes the central EMR database with all patient information and network interfaces.

The Central Database: This databases acts as the unifying data repository for all the collaborating hospitals. The cloud datacenter holds the central database server as the information bank which stores electronic medical records and also retrieves patients' information. The data is stored and hospitals access them via a web browser through authentication based on security standard. **Synchronization of data among h**ospitals is done through privacy, confidentiality and

authenticity by providing username and password as well as setting roles and privileges to system users and communication is via network connections. Therefore, each hospital does not need to have its own separate interface mask in order to benefit from the cloud; all it needs is just an interface.

The intervening variables is a based server with role of checking user ID and securing data using standardized security in network. **Health facilities** (Hospital and Health centers) are dependent variables because they are sharing information depending on the network status and EMR cloud server. The figure above highlights how EMR implementation is a multi-stage, continuous process: The initial phase is planning for the technology to use, the second stage is the workflow and software design, and third stage, training and user support. These stages are highly interrelated. Finally the final stage is the optimization and modifications based on the identified challenges. The success of the above framework may be a useful tool to identify areas for future research. The variables indicated here in this conceptual framework will help the researcher to analyze electronic medical records cloud server on health data sharing and data security in different health facilities in Rwanda.

2.6. Summary

Typical cloud computing providers deliver common business applications online accessible from a web browser, while the software and data are stored on servers. This system is commonly known as ASP or Application Service Provider(45). Furthermore, it is a method of offering services for the end user, it is based on a number of characteristics: on-demand self-service, broad network access, measured Service, resource pooling and rapid elasticity (38). On the other hand, cloud computing means to host computer's apps so that the user can access them through internet everywhere at any time.

EMR system is an Electronic Medical Record is patient information recorded on paper based and then convert into an Electronic form to be able to store on digital devices (46).

Patient data share is the web that enables data sharing for remote consultation, and several projects have established systems that can be used to support diagnosis and treatment decisions in remote sites with limited bandwidth(34).

ICT Infrastructure in healthcare of this study has a significant impact on the socioeconomic development of a country and changes the field of health system(47)

CHAPT III. METHODOLOGY

3.0. Introduction

This part of the research describes the methodology that guided this study; it provides the approach and techniques that were used for conduct study, this presents the methodology was used to collect and analyze data for purposes of using the findings to respond to research questions. It highlights the study area, study design, study population, study sample and sampling strategies, problems and limitations of the study and finally ethical considerations.

3.1. Study area

The study area was Kabgayi District Hospital especially in the department of HIV/ARV and all health centers under the supervision of Kabgayi District Hospital. This HIV/ARV Department was chosen because it had been implemented a full package of EMR system, and had been chosen sixteen health centers that had already implemented EMRs and also reporting to the district hospital

Source: Google earth, 2016

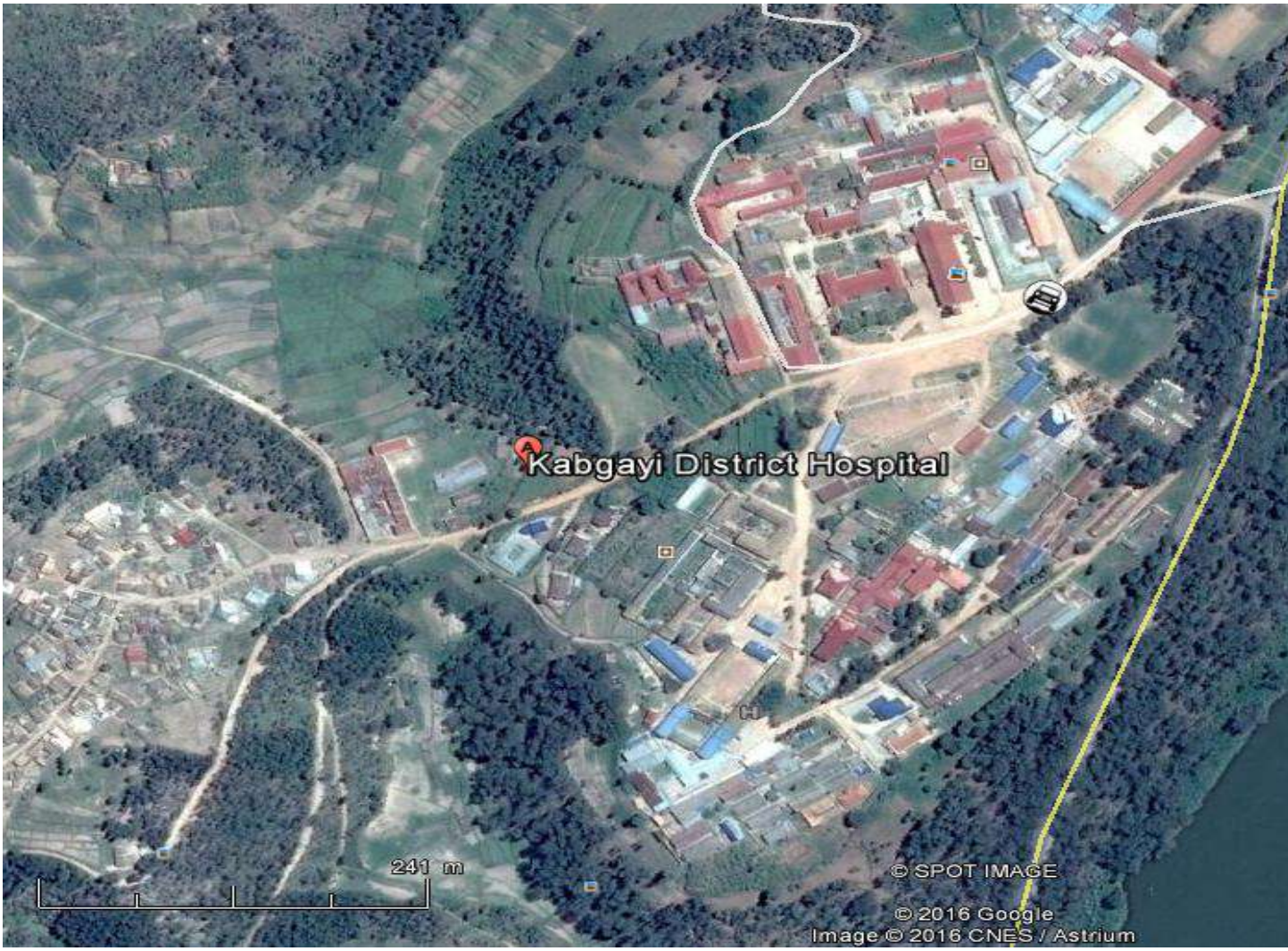

Figure 3.1. Kabgayi District Hospital in Rwanda

3.2. Study design

In this observational study design, quantitative and qualitative approaches were used to achieve the objectives through retrospective information on EMR data sharing. Pre-defined variables like strategy approach, innovation and data synchronization in the system were evaluated. Census method was conducted in HIV/ART Department focusing on EMR system. The EMR IT manager was also targeted and all questions were related to the synchronization of patients' data in health facilities through Electronic Medical Records system.

3.3. Target population

The target population of this study includes 42 health providers and EMR IT manager working in the district hospital and it was also health centers appearing on the payroll of March, 2016. Among them, one Medical doctor (1), and eight Nurses (8) from HIV Department were participated in this study. In addition, sixteen data managers (16) from health centers and sixteen supervisors from the health centers, and one EMR-IT manager for this hospital were also included in the study. The researcher was collected information from EMR IT managers, medical doctor and nurses who were purposively selected due to their perceived knowledge and involvement in EMR system.

3.4. Inclusion and Exclusion criteria

The inclusion criteria were based on participants' role in EMR usage and decision-making (Medical professionals, Nurses, Data managers, Health Centers Supervisors and EMR-IT manager). This study was excluded any one considered not familiar with EMRs system

3.5. Sample and Sampling Strategy

Due to low number of respondents, respondents were selected purposively. Researcher was selected HIV Department in Kabgayi District Hospital, and it was also health centers staff involved in ARV service as they had already implemented EMR system in their services since 2012, as well as the EMR IT manager.

3.6. Data collection methods and Procedures

After received the ethical clearance from UR-CMHS committee, the researcher obtained authorization to carry out research; was written letter to the Ministry of Health for authorized researcher to have a right in the system were deployed in the health sectors, and then after received permissions from the Honorable Ministry of Health and National Health Review Committee, and after that was deposited letters to the Director of the Hospital requested permission for data collection was drafted by the researcher and when approved, a pretest of the tools were done to one EMR-IT managers, one Medical doctor and one Nurse in order to check if all questions are understandable in Rwanda context. The questionnaire was administered as a researcher-assisted instrument. The data collection was achieved using questionnaire with closed-ended and a few open-ended questions. In a meeting with the medical professionals and

IT manager interacting with EMR system in their daily activities, the researcher was explained the purpose of the research and was asked to complete the questionnaire and researcher was collected filled questionnaires for record and data entry. The in-depth interviews were conducted to EMR IT and HIV/ART of department for their perception on the current system. The observation was made by the researcher by assessing the usability of the system in cited department and how data were shared between users and then how the do the backup.

3.7. Data analysis methods

Data collected were coded in excel worksheet and imported in stata version 13 for analysis. Graphs and charts will be created using variables. Qualitative data analysis for record was used fish born analysis techniques and solution was proposed base on factors like cost, effectiveness and feasibility. Tapes of interviews and focus groups were processed after each session; they were not allowed to accumulate.

3.8. Limitation of the study

The cloud computing is a new and vast technology. It was a best technology to centralize data in all domain of business. When apply this technology to the area of healthcare information systems, it must be vast and expensive(46). Oriented questionnaire were provided to EMR IT Manager of health facilities in data collection to analyze EMR cloud based server in all the aspects, but was not possible due to the huge existing researches, lack of IT officers in health facilities and expensive infrastructures. The research was limited to the data sharing and security. However, the researcher was used all efforts to achieve the objectives of this study.

3.9. Scope of the study

This study was conducted on EMR data sharing using of current EMR system implemented in different health facilities in Rwanda. The scope of the study was covered Content Scope, Geographical Scope and Time Scope.

3.9.1. Content scope

The present study was concerned to the current EMR system data sharing in Rwanda health sector.

3.9.2. Geographical scope

The study was conducted in Kabgayi district hospital in Rwanda. It was assumed that all components of the EMR system were used and were available at all health centers in district hospital.

3.9.3. Time scope

The study was only focused on EMR system on patient data sharing as it shall the period in which Rwanda MoH introduced OpenMRS as new EMR software to manager HIV program in Rwanda. The study was carried out within the five month.

3.10. Ethical considerations

The researcher was making sure that the questions set are clear and understandable to the respondents; interpretation and analysis of the collected data were done without any bias. A cordial relationship was maintained between respondents and the researcher in order not to affect or delay with the views of respondents. Respondents' views were used only for academic purposes and respondents were assured that information given during the study was accorded maximum confidentiality.

CHAPT IV. DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.0. Introduction

This chapter consists of the results of the study titled "Perception on synchronization of patients' data among health facilities through Electronic Medical Records system. A case study of Kabgayi District Hospital". The data are presented by means of tables, charts and percentage with their interpretations.

The analyzed data collected through in depth-interviews, questionnaires and observations are presented using qualitative and quantitative methods.

4.1. Socio-demographic characteristics of participants

The study had thirty-nine participants and all gave written consent to participate. Participants differed with respect to profession, experience, duration of use of the EMR, age, and were from Kabgayi Districts Hospital and all health centers under supervised by district hospital.

The study took place in one district hospital and sixteen health centers located in Kabgayi District Hospital. All were using the (Open MRS) EMR, and run by the Ministry of Health. The study had 62% female participants and 38% male participants.

Table 4.1. Age of users of Electronic Medical Records (EMRs).

Age in years	Frequency	%
26-30	4	10.26
30-35	18	46.15
36-40	11	28.21
41+	6	15.38
Total	**39**	**100**

Age of users of Electronic Medical Records is presented in figure 4.1. The minimum age group was 26 years and maximum age group was above 41 years.

Of the thirty- nine participants, 23.1% were Nurses, 51.3% were Data entry clerk, 15.4% were Supervisor, 2.6% were clinicians, 2.6% were EMR-IT Manager, 2.6% were Medical specialist And 2.6% were others (Social assistant)

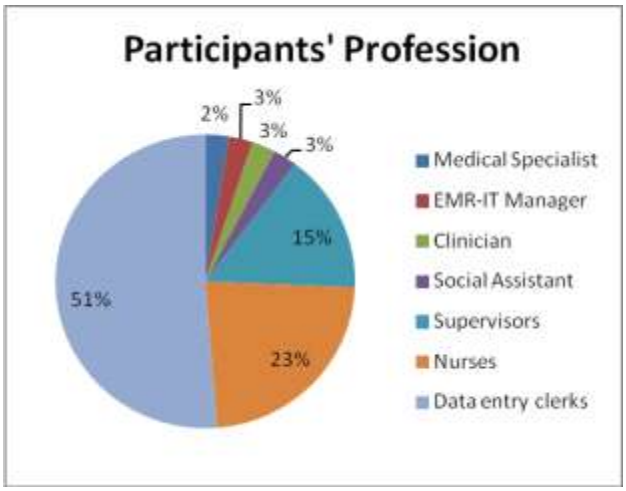

Figure 4.1. Summarizes the profession of participant that took part in the study.

The total numbers of participants were thirty-nine with different professionals including medical specialist, nurses, data entry clerks, EMR-IT manager, clinician, supervisors, and social assistant, some of them had synchronized patients' data in their department not outside the hospital; different professionals were presented in figure 4.1. The majority of participants were data entry clerk (51%) this high percentage is due to fact that data entry clerks that had
Entered and shared patients' information into the EMRs. Nurses ranked the second with 23% provides healthcare to patients'. Supervisors came to third place (15%). EMR-IT, Medical specialist, Clinician, Social Assistant took the last position with (3%) each.

4.1.1. Experiences of users with synchronized patients' data

Participants' in the study had different experiences on EMR shared; some had used the system longer than others. Table 4.2, summarizes the participants experience in sharing patients' data or reporting inside the ARV department to share EMR and shared paper based records.

Table 4.2. Experience of Users in sharing patients' information's

	Period worked in ARV department (%)	Period of sharing paper based system (%)	Period of sharing EMR system (%)
6_12 Month	-----	2(5%)	7(18%)
13_18Month	7(18%)	7(18%)	9(23%)
19_24 Month	16(41%)	8(21%)	15(38)
Above 24	16(41%)	22(56%)	8(21%)
Total	**39(100%)**	**39(100%)**	**39(100%)**

All participants (100%) had worked in the ARV department for more than twelve months and had synchronized patients' information's using paper based records. The study also revealed that 92% of participants had synchronized patient's information using EMR for more than twelve months on date of interview.

4.2. The current gaps for electronic medical record system in data sharing

During interviews, the participants explained the causes and effects which were affecting the synchronization of patients' data among the health facilities using Electronic Medical Records and also they evaluated the causes and effects using a root cause analysis.

Table 4.3. Problems affecting the synchronizations of patients' data

problem	Description
Lack of enough IT staff skilled in EMR system development	• Central Level Programming Skills: low numbers of skilled staff for system analysis and development • End User Input: low level of end user input during system design
Security, privacy and confidentiality	• Patient's data are more sensitive in sharing that needs enough confidentiality.
Digital divide among health care providers	• Some doctors and nurses don't have enough skills in ICT • Training :lack of a regular and structured training EMR program for end users
Poor internet connection	• Some health facilities are not connected to fiber. Usually they use modem • Infrastructure : insufficient infrastructure
Lack of enough Computers in the hospital	• Hospital and HC don't have enough computers
All the EMR system are installed local server (H.C)	• The servers of EMRs are managed in local server and were not hosted in web based.
Users resistance to new system	• Users sometimes resist to the new system • Different Deployment system with the same functions. • Interface and Reporting: interface and reporting are not user friendly to end users • EMR Road Map : lack of national EMR road map
Unstable power energy	• Some HF don't have a power backup

One of the barrier that researcher observed in the catchment area; each health center was managed by EMR system as local server yet EMR system is web based software.

In similar studies done in the developing world, some countries were trying to use their limited low infrastructure to create and implement EMR systems due to their few benefits. Some of the existing EMR systems include Computerized System for the Control of Drug Logistics (SICLOM) in Brazil, Lilongwe EMR in Malawi, Highly Active Antiretroviral Therapy (HAART) in Botswana, Partners in Health (PIH) EMR in Peru, HIV-EMR in Haiti, PEPFAR Sroject in Tanzania, Mosoriot Medical Record System (MMRS) in Kenya, and Careware system in Uganda(48) (49).

4.2.1. Effectiveness and Efficiency of emrs in data sharing

The findings on effectiveness and efficiency on the electronic medical system were all subjective to participants. The study used perceptions of the user's synchronization of patients' data in health facilities through EMR system. EMR effectiveness in this study is defined as the extent to which users felt the EMR was able to share patient's information, produce good quality data, help improve quality of healthcare, easy to find patients' information, reduced errors in records, reduction of data redundancy of service delivery and user friendliness and satisfaction. EMR efficiency is the ability of the EMR to produce quick and satisfactory results that are accurate, adequate, timely, user-friendly, available and reliable.

Table 4.4. System Perceived as Faster and Easy to share

Faster in sharing medical records	
EMR and Paper Based	**Percentage (%)**
EMR system	35(90)
Paper based	2(5%)
Both are about the same	2(5%)
Total	**100(%)**

The total numbers of participants were thirty-nine with different experiences, 90% (n=35) indicated that the EMR was faster in data sharing and easy to use compared to share in paper based records, 5% (n=2) indicated that paper based records was faster and easier while 3% (n=2) indicated that there was no difference between the two systems (EMR and paper based).

4.2.2. Effect of emr on the quality of care while in data sharing.

Quality of care is the extent to which users felt they were able to adequately look after and provide all the need s of their clients. The findings indicated that 62% (n=24) of participants thought that the quality of care has improved a little since the introduction of EMR while 38% (n=15) indicated that the quality of care has improved a significantly.

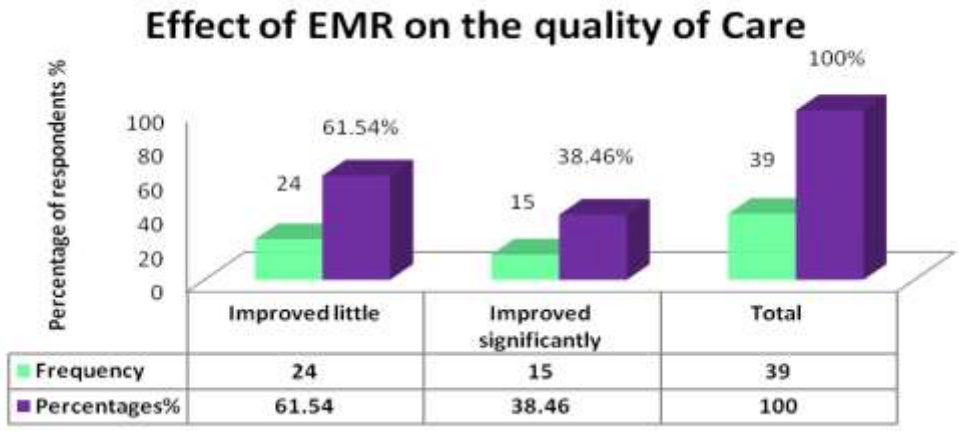

Figure 4.2. Reported effected of EMR on quality of care in data sharing

Respondents perceived that there has been an improvement in quality of care which they attributed to EMR based on the following benefits:

A. Providers spend more time taking patient's history and doing physical examination than wasting a lot of time with paper based work.

B. The EMR is able to automatically calculate dates of appointments and specific number of pills to be given to the patient instead of providers doing it; hence efficiency in task performance.

C. The EMR is able to automatically calculate Body Mass Index (BMI) of the patient at every visit and able to alert the provider if the BMI is low so the patient can receive nutritional support.

D. The EMR is able to automatically assess patients' adherence using the date of last appointment, number of pills dispensed and remaining pills on the date of the visit. If the patients has a lot remaining pills the EMR will remind/ alert the provider to refer the patient for adherence counseling.

E. EMR has a list of all antiretroviral side effects that have to always be checked at every visit by the provider. These act as checklist for providers to effectively monitor side effects on all patients.

F. With EMR the provider can easily get all information of patients' health even if the patient loses a health passport as long as they give the provider their full name and village and this helps promote the continuity of care.

4.2.3. Report generation

Table 4.5. Comparison of the report from EMR and manually generated report

Accuracy of the EMR and Manually generated report		
EMR and Paper based generated report	**Frequency (Data entry clerks)**	**%**
The EMR-generated report is significantly more accurate	25	81
The EMR-generated report is slightly more accurate	4	13
The accuracy of both reports is about the same	2	6
Total	**31**	**100**

Of the thirty-one participants of this study, 81% (n=25) of data entry clerks had generated reports from the EMR that were significantly accurate; 13% (n=4) had generated reports from EMR that were slightly more accurate while 6% (n=2) had only generated reports from the EMR that were as accurate as paper based ones, because EMR had just been introduced at their facilities. The majority of participants (94%) indicated that EMR generated reports were more accurate than reports generated from paper based records.

Thus data on report generation is on the thirty-one respondents that had generated reports using both EMR and paper based system reports. Ninety-five percent (n=31) of the respondents indicated that EMR reports are easier to generate, useful and easy to understand compared to paper based. 94% (n=29) indicated that it takes maximum of one day to generate monthly report, cohort analysis patients' treatment report and only 6% (n=2) indicated that it takes maximum of one day to generate monthly report, cohort analysis patients' treatment report including data cleaning from EMR while 100% (n=31) of the data entry clerks indicated that it takes more than three days to generate month report, Cohort analysis, patients' treatment reports from paper based records.

Participants also indicated that with EMR a user can generate a lot of other reports like daily, weekly, monthly, quarterly and cohort analysis reports within a very short time (as between six and ten minutes).

4.3. Factors affecting the patients' data sharing between district hospital and health centers.

Researcher observed the causes and effects by using fishborn analysis techniques. On the other hand, centralization of healthcare data they were prioritized by refering the people's usage, materials & equipments; work environment; standards and innovation & technology. The majority of the respondents like EMR- IT managers and healthcare professionals describe the most important barrier that affected them in synchronization of patients' data in health facilities was the fact that different facilities used the system differently due to incompatible trainings. There has been a problem with the adoption of the system by different users of the system; current hospital staff levels are often not sufficient for successful system implementation; too few staff to support, trains, implements, and develop new content; lack of adequate training for end users on data exporting, reporting, and analysis, system administration, bugs fixing, basic computer literacy and advanced training on modules; MOH mandate for clinician entry through difficulties of change, training, and ICT skills; data is entered after care leading to poor quality (inaccurate); current reports are limited and can't meet some significant, repeated needs; EMR need to be hosted as single server for accessibility, security and data sharing; EMR server hosted can allow better communication with patients, staff, and medical partners; EMR server hosted can provide dynamic and high service availability; an attitude towards EMR server hosted adoption is favorable for good implementations; EMR server hosted adoption is compatible with hospitals' infrastructure. EMR data sharing is the best strategy for good implementations. Current implementation of EMR on local server can help the financial income of hospital not medical record storing; EMR local servers in your catchment area are interconnected (All health facilities) in Rwanda; each patient has a single unique identifier(id) in your catchment area; the current EMR system implemented risk to be duplicated due to patient return over; internet connection (poor) affect the EMR data sharing; innovations (poor) in EMR system implementation affect the sharing process.

Furthermore analysis shows the problems that resulted from patients' records that were not centralized between two health facilities.

To solve the issues of the synchronized a patients' data in this study, researcher used a root cause analysis techniques.

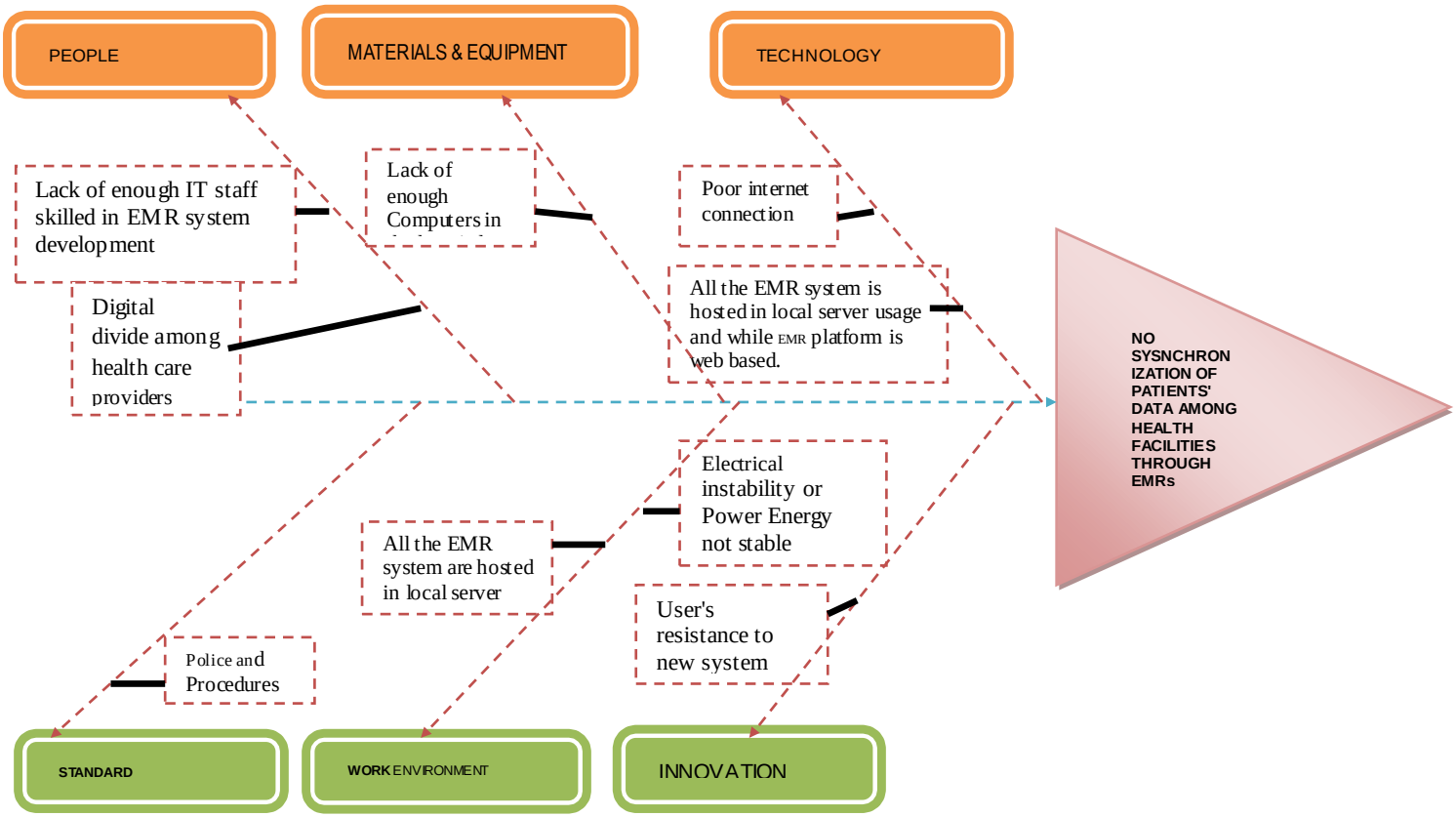

Figure 4.3. Cause-and-effect diagrams to analyze them the synchronization of patients' data among health facilities

The researcher brainstormed to identify various potential solutions. Solutions were selected, an action plan were developed and implemented. The finding showed that the network for the district hospital and health centers should be in place, and the virtual private network should be set up for district hospital and health centers to ensure exchange of patient information using HL7 to interchange Patient's data. The majority of the participants showed that 87% (n=34) sometimes experienced problems while using the EMR system. The most common problems that were reported include command not responding, provision of wrong patient's information at times, for example indicating that a patient has missed a follow up session yet he/she has not, printers not working at times and it is really difficult to continue working without a printer.

Most of these problems c resolved within a day. All the participants (n=39) had shared EMR system in their ARV departments but when they received a patients' from other health facilities; all of them had challenges of using the previous patients histories because the EMR systems were not connected, which affected the synchronization of the patients' data among the health facilities. All participants indicated that despite the challenges with EMR use, they prefer using the EMR than paper based records. They also indicated that EMR is worth the time, effort and investment. One of the commons reasons respondents gave for ranking the EMR higher than the paper based records was that with the ever growing number of patients' being enrolled in ARV department and still facing the human resources challenges in the health sector, there is need for an efficient way of collecting data than the current paper based system.

4.3.1. User training for synchronizing in EMRs

Overall participants expressed that trainings to prepare users to use EMR are not well structured and were different between departments.

All trainings to prepare users on EMR were done by Rwanda Ministry of Health. Of the thirty-one participants that took part in the study 85% (33) felt they were somewhat prepared to use EMR after the training, 15% (6) felt better prepared to use EMR after training.

Figure 4.5 below summarizes how adequate users felt prepared to use EMR after the training provided by Rwanda Ministry of Health.

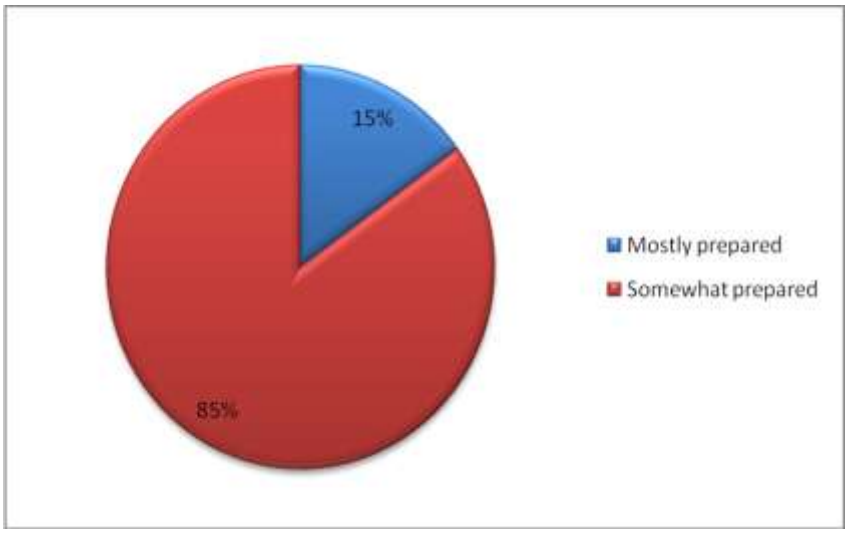

Figure 4.4. Preparation of healthcare professionals before they started to share EMR system

The figure above shows a gap that should be addressed to ensure users are more prepared before they start using the EMR. The person in charge of data clerks, and nurses felt least prepared to use EMR than professionals in data collection.The study also showed that Rwanda Ministry of Health provided all the support on EMR and the mojority 87% (n=33) of the participants indicated that they received enough support after the training and only 13% (n=5) of the respondents had not received enough support.. The most common support provided to users was: system repair, system upgrade, data cleaning, and generation of reports through cohort build. Most of the respondents understood that frequent power cut posed a challenge in using the EMR system that were affected EMR sharing with different location. In one of their views

> *"The main challenges is the electrical system at the facilities. They are either outdated and need to be refurbished or they are not up to standard. This results in networking equipment damage or malfunction." While some exclaimed " Technology can be efficient without electricity, when there is no electricity we can not do anything."*

The same findings were found in study done in rural ereas of the Malawi(50)

Three quarters of users showed interest to be trained in more skills and the head of Shyogwe Health Center mentioned that the few members of staff who knew how to operate EMR system were not sufficient at the level of health centers. In the health centers a data manager, EMR data officer, monitoring and evaluation officers, biomedical technician and human resources manager are trained to use their respective ehealth system (OpenMRS). To address the problem of lack of trained staff in using ehealth system (OpenMRS), the department from MoH in charges of training clinicians and nurses was expected to train them in the use of the system in following days.

The researcher found that some clinicians were unwilling or faced some barries in the use the EMR system. The researcher was also able to identify from the completed questionnaires of the data managers that the knowledge on the system and computer required improvements. Few health centers lacked computers and IT manager to accommodate computers. Problems of sychronization of patient's data and incomplete data entry, low reporting by CHW in some health centers were also identified as challenges. One of the respondent mentioned that

"If the system requires maintenance often they would have to wait for only one EMR-IT Manager from district hospital that serves about more that one health centers" "Another option is to approach private workers at an increased cost"

This indirectly increased the time required to solve technical problems in health centers in rural areas. The cost of training more staff and acquiring infrastructure is a challenges now but expected to be improved with time.

The researcher identified a great need to sychronize the patients' data in health facilities. This should be improved in both patients' and health care professioanls and to identify how much paper based work is remaining to be transformed electronically. Sensitazation was required for the users of (EMR) while others showed interest in sharing EMRs. Most of the data managers were not able to answer the questions appropriately on details of the system.

Though participants indicated receiving enough support from Rwanda Ministry of Health , they also indicated that they would appreciate if Rwanda Ministry of Health would do the following in all EMR sites:

a. Interconnection of EMR system from post facilities, lower health facilities and district hospitals up to national hospitals in Rwanda.
b. Upgrade the EMR system where the patients' information can be accessed by every health facilities while the caregives shall be need to records their informations.
c. Provide a more and better structured training with more time and some basics on the technical aspect of the EMR
d. Need to train more people on EMR because of the huge staff turnover within the Ministry of Health especially at operational level (district and within the department).
e. There is need for the development of a user manual or guidelines with all troubleshooting needed and what to do when a systemas well as the server have a problem.

The majority of participants indicated that EMR is well integrated and there was no change in the original work flow at different departments of the hospital not only ARV department. It was also observed that in Kabgayi , all the healthcare professionals were ranked an EMR on the top of the works. In all the health center in Kabgayi District Hospital, users still use paper-based records though they would prefer to use only the EMR. There is data backup in all the departments and it is outside the department. Data backup is done at a specific time automatically every day. For example in ARV department it was being done a backup at every end of the day.

4.3.2. Sharing EMRs in health facilities more successful

To make sharing EMRs among health facilities more successful, implementation of the following appropriate solutions can be considered. EMR sharing patients' data within departments with the use of Universal Serial Bus (USB) and Internet in the catchment areas. The technology that should help an Electronic Medical Records sharing among health facilities to be more successful is a Cloud based server.

The analysis of proposed model of the EMR Cloud based server was to analyze the synchronization of patients' data among the health facilities through EMRs. Later, these details could be used by the Ministry of Health as well as local governance institutions to follow up the health status of the citizen. In addition information stored in system could be used as proof in case of legal documents like birth certificate, certificate of celibacy, Identification card, passport, and so on. Kabgayi District Hospital and Health Centers in Muhanga district was randomly chosen to be used as a pilot of this research thesis.

Although, other related field of healthcare professionals are proposed to link the national identification number as well as Passport number was considered as Patients' unique identifier (PID) that proposition will be helping more successful implementation of EMRs in data sharing. For child the identification to consider is the ID for the parent plus character C as child and the N as number of the child in a family or they can use an insurance number for employer.

4.4. Summary of the results

Findings shows that healthcare providers prefer to share patients' information using the EMR system than paper based records and that overall they find it more effective and efficient. Although EMR is used in local server, it implies that each health center manages itself yet the EMR system is web based system it can be accessed via internet. The study reveals the need for a cloud based server to be hosted in national data center where the healthcare professional and patients will have accounts in the EMR system, which will lead to a more successful implementation of EMRs in differents catchment areas of the health facilities, efficient and feasible EMR data sharing, and cost effectiveness.

Similarly studies were done by Toriola on cloud based electronic medical system(45) and other study done by Rafael A. Calvo on the Secure Data Sharing in the Cloud(51) showed similar findings.

On the other hands the factors affecting EMR synchronization in health facilities include the different usages of the system due to incompatible trainings; current hospital staff levels are often not sufficient for successful system implementation; lack of adequate training for end users on data exporting, reporting, and analysis, system administration, bugs fixing, basic computer literacy and advanced training on modules; EMR need to be hosted as single server for accessibility, security and data sharing; EMR server hosted can enhance better communication with my patients, staff, and medical partners; EMR server hosted national data center can provide dynamic and high service availability; an attitude towards EMR server hosted adoption is favorable for good implementations; EMR server hosted adoption is compatible with hospital's infrastructure; EMR data sharing is the best strategy for good implementations; current implementation of EMR on local server can help the financial income of hospital not medical record storing; There were mixed feelings on the accuracy and completeness of informations collected using EMR shared among the healthcare professionals and paper based records. Results also showed that the time spent treating patients' using EMR were reduced, EMR-generated reports were faster to generate and considered more accurate. Study results also indicated that the training conducted to prepare potential users of EMR was not structured and the support given after the training was not uniform and was perceived by some participants and therefore are not

CHAPT V: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.0. Introduction

This chapter discusses the findings of the study in relation to the reviewed literature and Rwandan health system context. The order of the discussion is as follows: Firstly, currently gaps for Electronic Medical Record system in data sharing, perception on effectiveness and efficiency of EMR system that reduce the time consumed to paper based records in Kabgayi District Hospital including Health Centers with documented data from elsewhere. Perception of benefits of synchronization of patients' data and factors affecting in EMR shared in their AVR department and also other external ARV department use are discussed; types of the training provided to users before they start using EMR system and support they received after the training for potential EMR users. Thirdly, is to propose a single cloud based server hosted at national data center of the health for smooth operation of patients' data synchronized across the district hospital and health centers.

5.1. General information

The Rwanda Third Health Sector Strategic plan said that interoperability and integration of different e-health system must be adopted to improved the quality of care and therefore the systems shall be exchanging patient data both internally and externally(52).

Therefore the national e-health strategic plan (2009-2013) "*The mission of the Department of e-Health is to provide and maintain highly effective, reliable, secure, and innovative information systems to support clinical decision making, patient management, education and research functions of the health sector in Rwanda in a bid to improve healthcare service delivery"* (53) *and* also that the number of eight goal of the United Nations Millennium Development Goals (MDGs) is to develop a global partnership for the development" (54)

One of the key targets of this goal is to make available in health care settings the benefits of new technologies; especially information and communications technologies, in cooperation with the private sector. There has already been rapid progress in bridging the gap on the mobile phone sector, but large gaps and challenges still remain in improving access to key technologies that are essential to increase productivity, sustain economic growth and improve service delivery in areas

like health and education(54). The implementation of the EMR in health care system in Rwanda is one of the ways towards the achievement of this goal but also a way of improving service delivery in health service delivery in the face of increasing patients' demands and critical lack of, technology, Innovation, human and material resources.

5.2. The current gaps of electronic medical record system and their factors affecting data sharing

Findings on Perception on Synchronization of Patients' data among health facilities through EMRs clearly indicate that the innovation in healthcare of the sharing patients' data from the health centers to the district hospital using OpenMRS (EMR) directly does not use in the workflow, for example of a current situation: to transfer patients from lower levels of health facilities to the district levels of the hospital, it is paper based normally, then after that process, the district hospital will send the feedback to lower facility which transferred the patients; so one of the important barrier is that EMR servers at each health facility are not interconnected, that means all the EMR platform are hosted in local servers yet EMR system is web based platform.

Results on Perception on Synchronization of Patients' data among health facilities through EMRs clearly indicate that physicians are faced with the difficulties of accessing information about patients' treatments at lower level heath facilities. Accessing and tracking of patient information from many different healthcare sectors seem to be hard today, because for every health care sector there is a proprietary electronic health care application to manage responsible an EMRs. One health care center can hardly access to the electronic records of the patient from another health care center which leads poor treatment of the patient and loss of time solving the problem that has been solved before because of missing the previous information about the patient to be treated. The key issues are to synchronize the access to the EMR of patient through his/her patient identifier. Different softwares for electronic medical records were developed and Rwanda MoH recommends some of them. The modules of the EMR system were ready by end of 2006; this system contains registration, billing, pharmacy and Laboratory management modules for just helped the successful implementation of EMRs in data sharing.

The registration modules generate different types of ID's like primary care, track net and others as the similarly studies done in India like "case study of an EMR system at a large hospital in India: Challenges and strategies for successful adoption"(48). This is a solution to healthcare

service delivery in Rwanda because we have one ID for One patient. It may improve the correct patient identification and make follow-up. Considering the EMRs and its implementation, it is a web based application but each health facility use it locally. Based on this it is clear that one patient may have one ID in each health facility that can be successful in patients' data sharing.

For example "Patient may have an ID in Kibagabaga Hospital but when transferred in Kanombe Hospital; as referrer Hospital in the same region, this one get a new ID while they are using the same software, which is a web based application able to be accessible via network. This may cause the sharing of previous patient information, results of wrong and bad follow-up because of lack of the data sharing. Different strategies can solve this problem like synchronization of the system specially the registration module; but the problem of interoperability of different system used in health care it still the problem to MoH. While other study done shows the user satisfaction survey conducted in a headache specialty clinic documented that health care computerization is promoted on the basis of its many benefits. It saves time, improves record keeping, increases accuracy, enhances the flow of information, improves the quality of clinical data available, and reduces paperwork (55). Another study by Kaplan in 2001 also indicated that problems such as pulling paper-based charts, flipping through numerous files and papers to get patients' medical and drug history they introduced the EMRs sharing at different health facilities that helped to achieve efficiency mainly through the elimination of routine tasks(56).

Rotich et.al in his study done in Kenya found that patients spent substantially less time waiting to consult a care provider, and their total time per visit to the Mosoriot Rural Health Centre **(MRHC)** was marginally shorter after sharing patients' data through the Mosoriot Medical Record System **(MMRS).** Health care providers (nurses and other health professionals officers also spent less time with patients and had substantially more time to concentrate on physical examination and history taking than spending time filling in paper based records. It was concluded in their study that, for health care providers, the MMRS also saved time, creating a resource that the managers of the MRHC could harness for additional activities (e.g., patient education)(55).

The findings from the study by Rotich et.al also indicated that after they were integrated by sharing MMRS, clerks spent additional time registering patients but less time writing reports and interacting with other staff. For them, the MMRS was largely time-neutral for everyday tasks, although it was remarkably time saving in terms of producing monthly reports for the Kenyan

Ministry of Health(55). There have been studies that have shown that the introduction of EMR in health care settings has reduced providers' efficiency and the quality of care given to patients. A study of EMR system use by Israeli primary care physicians showed that "screen-gazing" occurred during an average of 25% of the patient contact time, with some providers spending close to 42% of the visit viewing their computers(57).

There have been few studies done on what the ideal training period for potential ICT skills to doctors and nurses undergo before they use any kind of system like EMRs sharing and therefore we can call digital divide among health care providers. There is no clear literature from both developed and developing countries that have well specify ICT skills training guidelines or recommendations developed to guide training preparation for all potential healthcare providers' sharing of the EMRs. Sanchez et.al indicated that training of healthcare professionals on new EMRs sharing or other technology should occur as part of a comprehensive implementation plan, not just time allotted on a certain day for what the user thinks they want to learn(58). A well-defined and clear training curriculum with well-defined and practical time frame is therefore crucial to successful implementation of sharing EMRs being introduced to health care professionals. The study found that this is lacking and needs to be developed sectors in the Ministry of Health. MOH and other partners plan to scale up implementation of EMR system to more ARV services and other health care services in Rwanda.

Sanchez et.al referred to education and training of EMR as the process of providing management and employees with the logic and overall concepts of the EMR system(58).

Users resistance to new system are the ones that produce results and should be held accountable for making the system perform to expectations. The main reason for education and training should be to increase the expertise and knowledge level of people within the health care system. Sanchez et al identified three aspects concerning the contents of training for example logic and concepts of EMRs sharing, features of the EMRs sharing and hands-on training.

Concept training shows the people why the EMRs sharing is be implemented and why changes to the EMR system are necessary, while functional training helps overcome the fear for computer systems since some potential users would fear that they are computer illiterate and they would lose power if manpower is reduced due to computerization, and the education can help overcome such fear(58).

To achieve this lack of EMRs implementers to do much effort needed to make EMR training effectives about data sharing using system.

This evidently had an impact on how they were adequate prepared before they started to share EMRs. The majority of them 15% (n=6) indicated that they were mostly prepared before they started to share the all modules of the EMRs and also 85% (n=33) indicated that they were somewhat prepared. It logically follows that the demonstrable and perceived benefits of the EMR sharing should have been improve the quality of healthcare delivery in this study if adequate training and support of EMR sharing was implemented in place.

Sanchez et al also pointed out that EMRs sharing themselves to gradual training, and they should consist modules for example one for the electronic chart, another for prescribing, and others for transcription, scanning documents, data cleaning, system repair and report generation(58). Training practices should start with one of the easiest modules, such as scanning, and work their way up to the more demanding modules that involve data entry(50).

Table 5.1. Prioritization grid which was disaffected a synchronization of EMR system.

Problems'	**Benefit/Effort**
All the EMR system are installed local server (each health center)	High Hard
Lack of enough IT staff, skilled in EMR system development	High easy
Digital divide among health care providers	High easy
Poor internet connection	Quick Fix
Lack of enough Computers in the hospital	Quick Fix
Users resistance to new system	High Hard
Unstable power energy	High easy

The majorities of the participants were demonstrated a list of the problems in the table 5.2 from the high easy and high hard of the ranked were discussed in interview and also researcher was observed the cause that disaffected the synchronization of patients' data across the health facilities.

The researcher was decided that; all EMR Server were hosted in local, no sharing a patients' data among health facilities through EMRs or were not exchanged EMR platform, users resistance to new technology, unstable power energy, Lack of enough IT staff, skilled in EMR system development, Digital divide among health care providers were the most problematic causes.

Table 5.2. Problems and solutions

Problem	#Solution 1	#Solution 2	#Solution 3
All the EMR system is installed local server at each health center while EMR platform is web based.	Proposed a cloud based server Using Virtual Private Network (VPN) technology for sharing patients' data.	EMR Server hosted at national level	Costs - OpenMRS is a free open source platform
Users resistance to new system	Customization – Ability to adapt the system to Rwanda realities Adopting of the system by single users of the system	Trained personnel with computer skills and changes their attitudes.	National Leadership Support – high political will and directives for the use of EMR
Unstable power energy	Backup electric power generator is working at HC and DH	Reliable Electricity Back	
Lack of enough IT staff, skilled in EMR system development	Increase the # of IT developers, Training for end users on data exporting, reporting, and analysis, system administration, bugs fixing, basic computer literacy and advanced training on modules.	Central Level Developers – availability of system developers at the central level	Facility IT Skills – availability of designated IT staff at hospitals
Digital divide among health care providers	Trained personnel with computer skills.	Awareness - improved end user and stakeholder understanding of EMR and e-Health	

5.3. The feasability model of the successful in emr data sharing

This analysis of proposed feasibility model of successful in the EMRs sharing using cloud based server that was to analyze the synchronization of patients' data among the health facilities through EMRs. Later, these details could be used by the Ministry of Health as well as local governance institutions to follow up the health status of the citizen. In addition information stored in system could be used as proof in case of legal documents like birth certificate,

certificate of celibacy, Identification card, passport, and so on.Kabgayi District Hospital and Health Centers in Muhanga district was randomly chosen to be used as a pilot of this research thesis. The national identification number as well as Passport number was considered as Patients' unique identifier (PID). For child the identification to consider is the ID for the parent plus character C as child and the N as number of the child in a family or used insurance number for employer. In this analysis was fully contributed to successful implementation of EMRs sharing.

On the other hand, the typical cloud computing providers deliver common business applications online accessible from a web browser, while the software and data are stored on servers. This system is commonly known as ASP or Application Service Provider.

Lack of e-Health Cloud design and development standards: There are no well established standards available for healthcare providers to use to design and build their systems.

This would include definitions of data types, forms and at times frequency of data capture in addition to defining how the data is obtained, stored, used and protected. Cloud-based Storage Solutions, HIT Applications and Systems There have been some work carried out in designing storage and file management systems for e-Health Cloud Guo et al.

5.3.1. Design considerations

EMR Cloud based solution to facilitate sharing electronic medical records easily. The authentication and security is achieved through the use of username and passwords as well as privileges and roles to users according to this position. To combat against hacking over network the virtual private network VPN will be used.

5.3.2. Architecture of the system

The system consists of two major components which are: the cloud-based system and the VPN for e Health system.

5.3.3. Proposed solution using cloud-based system

Feasibility model of successful in the EMRs sharing using cloud based server that was to analyze the synchronization of patients' data among the health facilities through EMRs. Later, these details could be used by the Ministry of Health as well as local governance institutions to follow up the health status of the citizen. In addition information stored in system could be used as proof in case of legal documents like birth certificate, certificate of celibacy, Identification card, passport or health insurance number.

This system consists of (a) Central Database Server, (b) a PHP virtual box and (c) an Authentication Server.

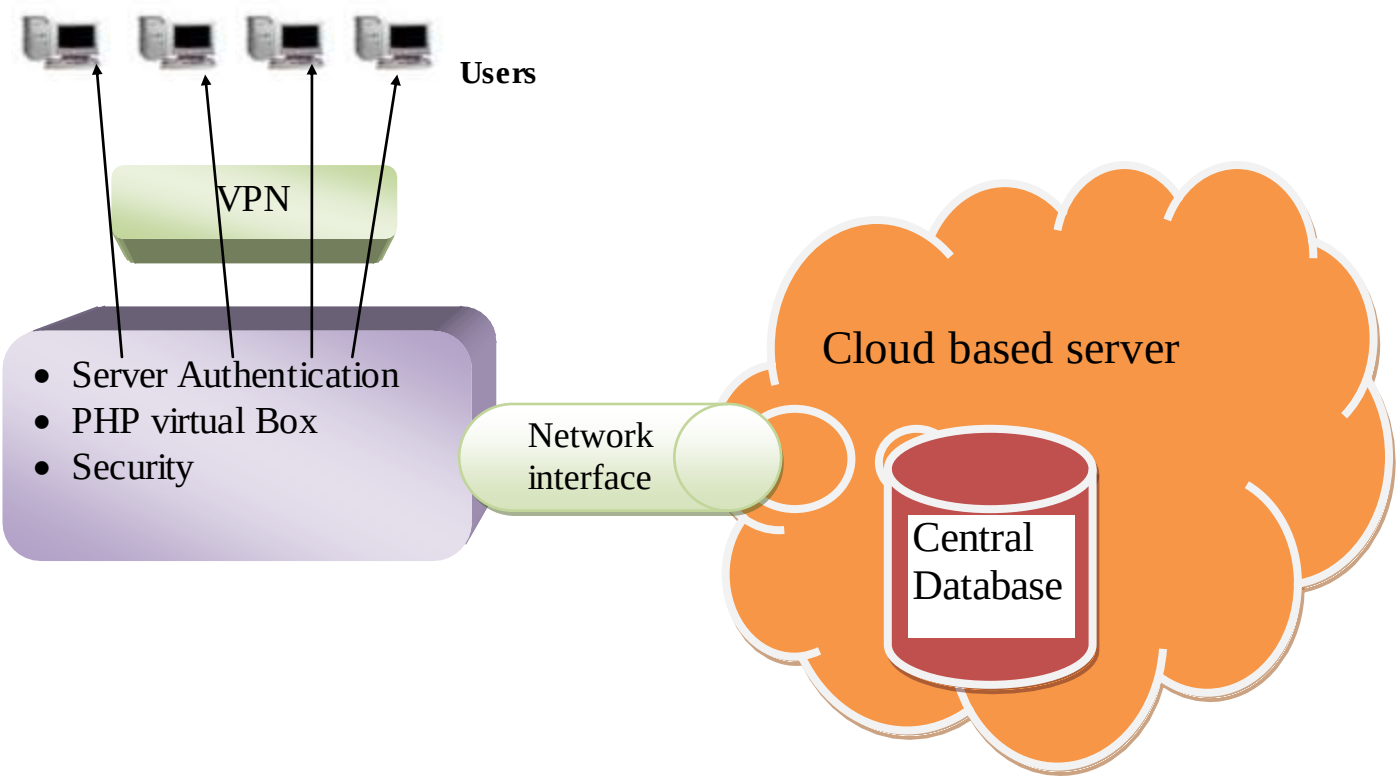

Figure 5.1. Architecture of a Cloud-based Electronic Medical Records System

Source (Authors, 2016)

5.3.4. The central database server

This server act as the join data repository for all the collaborating hospitals. The cloud datacenter holds the central database server as the information bank which stores electronic medical records and also retrieves patient information. The data is stored in a unified standard layout which can

be retrieved from the collaborating hospitals' Web Portal system through the Unifier Interface Middleware (UIM)

5.3.5. Middleware

This part of the cloud provides a common platform for all the EMR systems of the collaborating hospitals. The middleware has an interface that covers the heterogeneity of all the collaborating hospitals EMR standards, to ease the communication process between the Central Database and hospitals' systems. The middleware remains in the cloud and recognizes any type of EMR standard it interacts with. It communicates with each collaborating hospitals via network connections. Therefore, each hospital does not need to have its own separate interface mask in order to benefit from the cloud; all it needs is just an interface.

5.3.6. Authentication and authorization of cloud based server

This part of the system handles authentication and authorization are two tightly coupled and interrelated concepts which are used to keep transactions secure and help in protecting confidential information (59). The authentication verifies if an entity using the system has the right to perform the intended action such as (updating, retrieving, transferring, etc.) on the medical information provided. It grants access to authorized users and denies unauthorized users access to the records or resources on the system. The system generates usernames and passwords for doctors (or other members of staff) of the sharing hospitals that will serve as part of the admin. All the members of the admin are expected to log in to the system with their username and password. The system compares the username and password with those in the local database and grants access to the user if they match, otherwise, the user is denied access. **Authorization** is a process by which a server determines if the client has permission to use a resource or access a file. **Authorization** is usually coupled with **authentication** so that the server has some concept of which the client is that is requesting access (60)

5.3.7. The web portal using cloud server

In this study of the synchronization of patients' data, the web portal using cloud server is the front end of the whole cloud system, and the part of the cloud (top layer) that provides the application - Software as a service (SaaS) for the EMR system. The proposed cloud system presents a web portal configured for end users (authorized doctors, clinicians and the hospitals

administrators who serves as the cloud administrator) to navigate through the central database and the whole EMR system. The web portal communicates by sending messages and receiving response messages between the middleware and the hospital system. For each sharing hospital in the cloud, the web portal provides the user two ways to access the database, one for accessing the hospital's local EMR system, and the other for joining the cloud central database.

Every authorized user (cloud administrator) can retrieve, update and receive medical information from the cloud's central database through this web page with some degree of restrictions which depends on the end user's privileges. The web portal also shows where the information of a particular patient from a specific hospital resides, whether in the cloud or on the target hospital system and can decide to view medical information about the patient or even copy the information into its local database from the collaborating hospitals connected to the cloud.

Each collaborating hospitals allow its administrator and doctors to have different view of the patient's record in the database. The administrator can see the number of doctors and patients in the hospital and can also view their details. Only the bio-data of the patients will be displayed to the administrator and not the result of the different diagnosis and doctor's report, this will ensure some level of privacy to the patients. Such information can be viewed only by the doctors.

The application was developed with macromedia Dreamweaver and Wamp server technology, HTML, JavaScript, PHP and CSS and MySQL for data storage.

5.3.8. Solution of the security model for sharing patients' information's

From this study, to enable effective and secure information sharing, healthcare organizations require a transparent, consistent ability to identify information sensitivity and determine proper handling. This is achieved by developing an information protection strategy and framework that is comprehensive, but flexible enough to meet changes in healthcare infrastructure while achieving compliance requirements. As many organizations have learned, focusing on one set of compliance requirements at a time does not assist in building a comprehensive framework or strategy; it only increases the amount of time and resources which organizations have to spend on meeting requirements (61)

Furthermore, the information protection strategy/framework should look at a broad set of protection requirements including specific internal security and privacy requirements, risks to the business, applicable, compliance requirements and industry standards. (61)

A. Communication security measures between MoH cloud based server and different healthcare facilities are:

On the other hands, the communication between the Ministry of Health Cloud based server and different healthcare facilities is achieved with maximum security measures. The following are the security measures used:

- Health centers to district Hospitals: VPN and SSL
- District Hospital to MoH Cloud based server: VPN and SSL
- Referral Hospital to MoH Cloud based server: VPN and SSL
- District Hospital to Referral Hospital: VPN and SSL
- Private Clinics to Private Healthcare Organization: VPN and SSL
- Private Hospital to Private Healthcare Organization: VPN and SSL
- Private Healthcare Organization to MoH Cloud based server: VPN and SSL
- MoH Cloud based server Protection: Firewall, VPN and SSL
- Patients to MoH Cloud based server: SSL and accessed through MoH website portal
- Healthcare Providers to MoH Cloud based server: SSL and accessed through MoH website portal

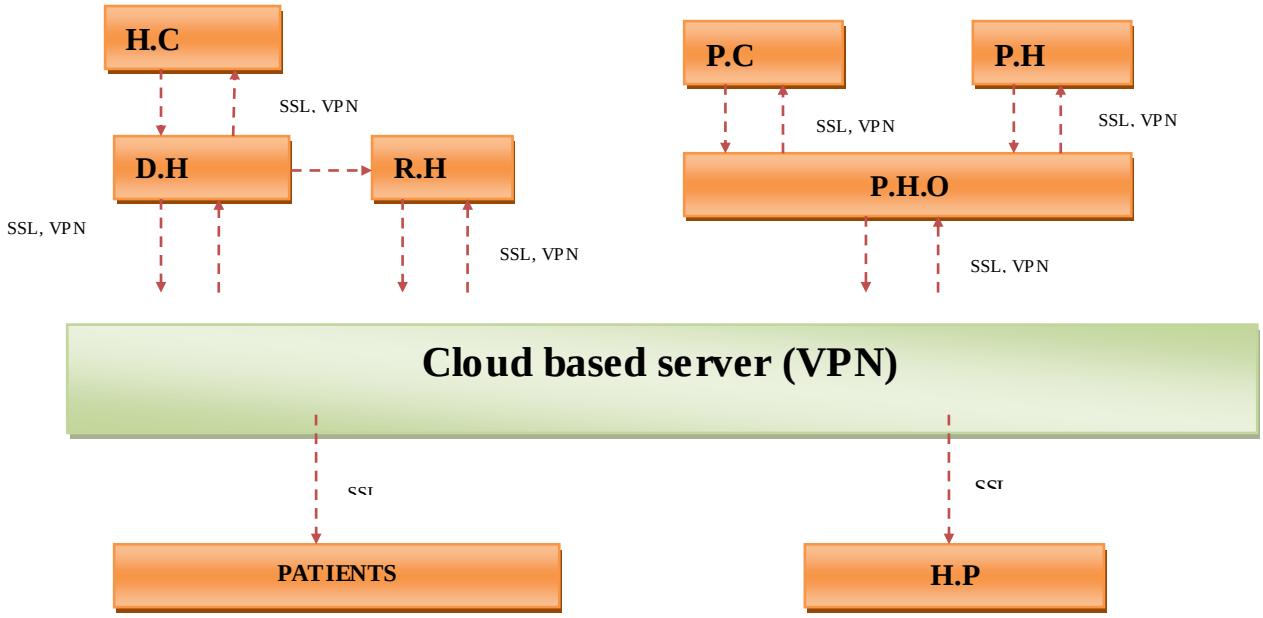

Figure 5.2 Diagram for the synchronization of patients' data and Security Framework

Source (Authors, 2016)

B. What these security measures are:

A virtual private network (VPN) extends a private network across a public network, Internet. It enables users to send and receive data across shared or public networks as if their computing devices were directly connected to the private network.

VPNs can provide functionality, security and/or network management benefits to the user(62).

Some VPNs allow employees to securely access a corporate intranet while travelling outside the office. Some can securely connect geographically separated offices of an organization, creating one cohesive network. Some VPNs can be used by individual Internet users to secure their wireless transactions, to circumvent geo-restrictions and censorship, and/or to connect to proxy servers for the purpose of protecting personal identity and location. But some Internet sites block access via known VPNs to prevent the circumvention of their geo-restrictions.

A VPN is created by establishing a virtual point-to-point connection through the use of dedicated connections, virtual tunneling protocols, or traffic encryption. A VPN available from the public Internet can provide some of the benefits of a wide area network (WAN). From a user perspective, the resources available within the private network can be accessed remotely. (63)

Traditional VPNs are characterized by a point-to-point topology, and they do not tend to support or connect broadcast domains, so services such as Microsoft Windows NetBIOS may not be fully supported or work as they would on a local area network (LAN). VPN variants, such as Virtual Private LAN Service (VPLS), and layer 2 tunneling protocols, are designed to overcome this limitation.

C. Secure Sockets Layer (SSL)

In this study, Secure Sockets Layer (SSL) is the standard security technology for establishing an encrypted link between a web server and a browser. This link ensures that all data passed between the web server and browsers remain private and integral (64).

SSL provides security, and more importantly, peace of mind. When using SSL, you can be fairly sure that your data are safe from eaves- droppers and tampering(65).

D. File wall

A firewall can be compared to as security guard who stands at the entrance of your house and filters the visitors coming to your place.

In this study a firewall is software program or hardware device that filters the information/ packets coming through the internet to end user personal computer or a computer network.

Firewalls are basically a barrier between an end user computer and internet (outside world) and they protect computers from web attacks and hackers(66)

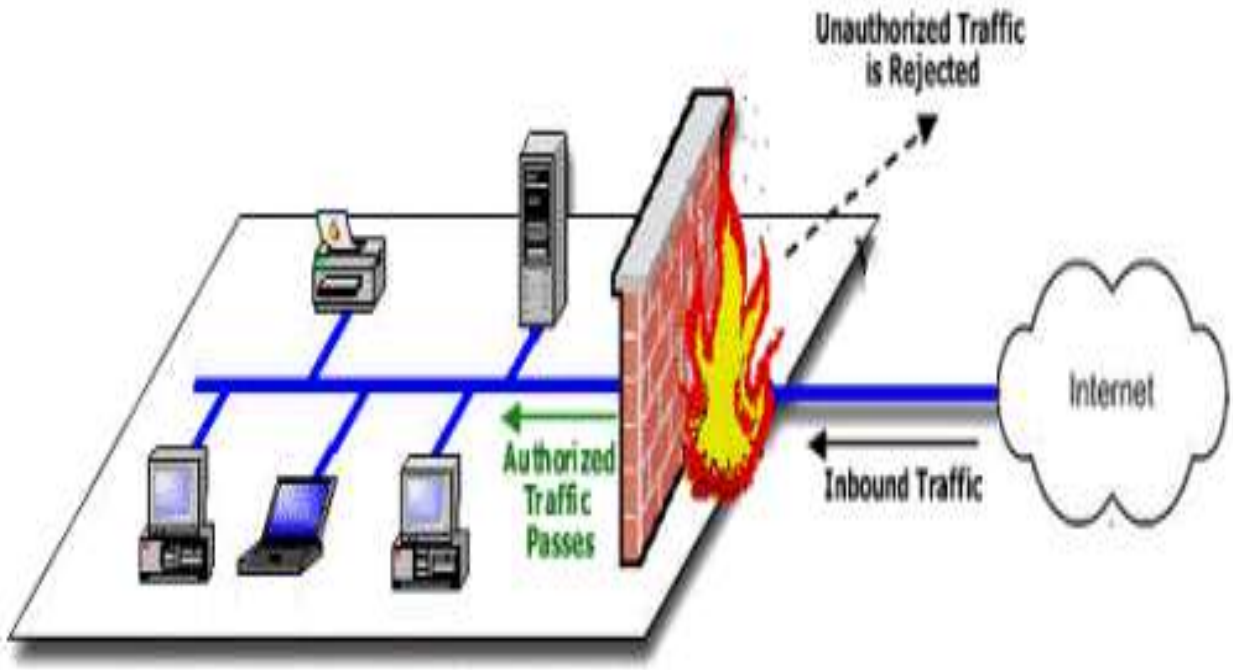

Figure 5.3. Network Firewall protection for protecting a cloud based server

CHAPT VI: CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

This study presented by a cloud based computing approach for the synchronized a patients' data among health facilities through EMRs developments. The main idea need is for synchronizing an EMR system, which all patients' and caregivers from different places can easily access patients' information and use, as well as improve healthcare applications sharing the EMRs. The proposed model introduced in this study offers a flexible and portable platform for the sharing EMR applications development. Scalability and privacy were the major concerns in this data synchronized. Cloud based computing system successfully overcome these issues by implementing EMRs for efficiently and effectiveness and designing the system based upon cloud based server requirements.

We provided the healthcare with an easy way to share the patients' information via EMRs web server. Finally, promising output across the conducted tests was a good indicator for usability of the proposed cloud based server system.

6.2. Recomandation

The study suggests the following based on the findings:

To Ministry of health,
Rural Areas in Muhanga district have problem with electrical instability and connectivity that frequently constraints the use of EMRs sharing.

The researcher would like to propose that

MoH have been hosting cloud server at the national level where every health facilities' can share their patients' information. As for an alternative source of energy, all the health facilities should have power backup.

All health facilities should be able to connect on the fiber optic network to receive enough internet connectivity that could provide more EMR effectiveness and efficiently.

The researcher would like highlight that EMR sharing was still a challenge. The management of EMR server especially in all health centers are managed EMR server as local yet EMR is web based system. Thus a patient may have an ID in Kibagabaga Hospital but when transferred in Kanombe Hospital; as referrer Hospital in the same region, this one get a new ID while they are using the same EMRs, which is a web, based application able to be accessible via network. This may cause to poor sharing of previous patient information, wrong results and poor monitoring because of lack of adequate data sharing.

The researcher would like to make the cloud based server aware that some EMRs although successful require the synchronization of patients' data and EMR sharing for its efficacy.

Other recommendations are:

a. Ministry of health need to fully adapt the EMR sharing to accommodate and all information captured in paper based system like patient medical history, physical examination findings, all laboratory findings and diagnosis of all opportunistic infections
b. Train all users on data cleaning, system repair, and report generation. Users need to be more empowered with knowledge and skills in order to use the EMR independently and effectively with minimal external support
c. Need to train more people on EMR because of the enormous staff turnover within the Ministry of Health, district hospital and within the departments
d. The Ministry of Health should come up with a clear scale up plan of the EMR to potential sites and users, be well prepared in advance and have a clear and realistic time frame.

REFERENCES

1. Yang JJ, Li J, Mulder J, Wang Y, Chen S, Wu H, et al. Emerging information technologies for enhanced healthcare. Comput Ind. 2015;69:3–11.
2. Silow-Carroll S, Edwards JN, Rodin D. Using Electronic Health Records to Improve Quality and Efficiency: The Experiences of Leading Hospitals. 2012;(July):1–40.
3. Jazayeri D. An information system and medical record to support HIV treatment in rural Haiti. 2004;329(7475).
4. Dietrich FS, Voegeli S, Brachat S, Lerch A, Gates K, Steiner S, et al. The Ashbya gossypii genome as a tool for mapping the ancient Saccharomyces cerevisiae genome. Science [Internet]. 2004;304(5668):304–7.
5. Douglas G. Engineering an EMR System in the Developing World Necessity is the Mother of Invention. 2009;1–154.
6. Harvard. The Academic Model for the Prevention and Treatment of HIV / AIDS. 2011;(November):976–7.
7. EINTERZ RM. Installing and Implementing a Computer-based Patient Record System in Sub-Saharan Africa: The Mosoriot Medical Record System. 2003;Volume 10:294.
8. Salerno. Collaboration through Patient Data Access and Sharing in the Cloud. International Conference on Intelligent Networking and Collaborative Systems (INCoS),. 2014. p. (pp. 205–12):
9. Ministry of Youth and ICT. Tracking ICT For Development Towards Rwanda Socio-Economic Transformation. 2014.
10. NICI. National ICT Strategy and Plan. 2015;
11. Kijsanayotin B, Kasitipradith N, Pannarunothai S. EHealth in Thailand: The current status. Studies in Health Technology and Informatics. 2010. p. 376–80.
12. Sharma S. Electronic Medical Records Concepts and Data Management. 2011;
13. Smith PS, Cushing HE. Indiana University School of Medicine. Acad Med. 2000;75(574):S118–21.
14. Lorenz S. Designing a Public Health Software Framework : Porting OpenMRS data to i2b2. Public Health. 2011;
15. Hannan TJ, Tierney WM, Rotich JK, Odero WW, Smith F, Mamlin JJ, et al. The MOSORIOT medical record system (MMRS) phase i to phase II implementation: An outpatient computer-based medical record system in rural Kenya. Studies in Health Technology and Informatics. 2001. p. 619–22.
16. Le Chair Dept Of Demography L, Tran Q, Ransom R. Patient monitoring information systems with CAREWare: a step-by-step approach in Vietnam. XVII International AIDS Conference 38 August 2008 Mexico City Mexico. 2008.
17. Das A, Remya R. A Novel Scheme of Orientation and Scale mapped RDC (OS-RDC) to improve compression in Document Images ensuring quality preservation. Int Conf Pattern Recognit. 2012;(Icpr):641–4.
18. Allen C, Jazayeri D, Miranda J, Biondich PG, Mamlin BW, Wolfe B a, et al. Experience in implementing the OpenMRS medical record system to support HIV treatment in Rwanda. Stud Health Technol Inform. 2007;129(Pt 1):382–6.
19. Murray Jennifer, John Lubrano DDM. Implementation Guide. Electronic Medical Record: The Link to a Better Future [Internet]. 2009;
20. On O, Building WL, Journal T, Law HT. J t & h t l. 2011;

21. Haskew J, Gunnar R, Turner K, Kimanga D, Sirengo M. Implementation of a Cloud-Based Electronic Medical Record to Reduce Gaps in the HIV Treatment Continuum in Rural Kenya. 2015;1–10.
22. Boyinbode O, Toriola G. CloudeMR : A Cloud Based Electronic Medical Record System. Int J Hybrid Inf Technol. 2015;8(4):201–12.
23. Rezaeibagha F, Win KT, Susilo W. A systematic literature review on security and privacy of electronic health record systems : technical perspectives. 2015;44(3).
24. Abukhousa E, Mohamed N, Al-jaroodi J. e-Health Cloud: Opportunities and Challenges. 2012;621–45.
25. Feria RSDC• DMAM• IRS• RP. PedInfoSys: An OpenMRS Based Pediatric Information System. 2013;pp 165–77.
26. Choi JS, Lee JH, Park JH, Nam HS, Kwon H, Kim D, et al. Design and implementation of a seamless and comprehensive integrated medical device interface system for outpatient electronic medical records in a general hospital. Int J Med Inform. 2011;80(4):274–85.
27. Sharma S. Electronic medical records concepts and data management. 2011;
28. Adams J, Bakalar R, Md M, Boroch M, Knecht K, Mouniband EL, et al. Healthcare 2015 and care delivery. 2008;32.
29. Deloitte. 2014 Global health care outlook Shared challenges , shared opportunities. 2014;1–24.
30. Overview AS. The Impact of eHealth on the Quality & Safety of Healthcare. 2008;(March).
31. African Development Bank. Innovative e - Health Solutions in Africa Award. 2014;
32. Healy J-CJ. Implementing e-health in developing countries: Guidance and principles. ICT Appl Cybersecurity Div CYB, … [Internet]. 2008;(September):1–53.
33. Fernández-Cardeñosa G, de la Torre-Díez I, López-Coronado M, Rodrigues JJPC. Analysis of Cloud-Based Solutions on EHRs Systems in Different Scenarios. J Med Syst [Internet]. 2012;36(6):3777–82.
34. Sf H, Mbchb F, Szolovits P. Refereed papers Implementing electronic medical record systems in developing countries. 2005;83–95.
35. Basu S, Karp AH, Li J, Pruyne J, Rolia J, Singhal S, et al. Fusion: Managing Healthcare Records at Cloud Scale. Computer (Long Beach Calif) [Internet]. 2012;45(11):42–9.
36. Torrey T. Limitations of Electronic Patient Record Keeping: Privacy and Security Issues [Internet]. [cited 2016 Apr 26].
37. Alam A. Business Information Management and the Cloud. 2012;
38. Boksebeld R, Utrecht H, Science F. THE IMPACT OF CLOUD COMPUTING ON THE IMPACT OF CLOUD COMPUTING ON ENTERPRISE ARCHITECTURE AND. 2010;
39. Cloud computing tutorial,Tutorials Points. :pp.12–25.
40. NIST. The NIST Definition of Cloud Computing Recommendations of the National Institute of Standards and Technology. Nist Spec Publ [Internet]. 2011;145:7.
41. Sobhy D. MedCloud : Healthcare Cloud Computing System. 2012;161–6.
42. Borzekowski R. Measuring the Cost Impact of Hospital Information Systems : 1987-1994. 2002;1987–94.
43. Millham R. An Enhanced Cloud Computing Model for Patient Record Management in South Africa. 2014 IEEE Int Conf Cloud Comput Emerg Mark [Internet]. 2014;1–5.
44. Abayomi-alli AA, Ikuomola AJ, Robert IS, Abayomi-alli OO. An Enterprise Cloud-Based Electronic Health Records System. 2014;2(2):21–36.

45. Boyinbode O, Toriola G. CloudeMR : A Cloud Based Electronic Medical Record System. 2015;8(4):201–12.
46. Rezaeibagha F. MASTER ' S THESIS Privacy and Data Security of Electronic Patient Records (EPR) Sharing. 2013;
47. Swar B, Khan GF. Mapping ICT knowledge infrastructure in South Asia. Scientometrics. 2014;99(1):117–37.
48. Scholl J, Syed-Abdul S, Ahmed LA. A case study of an EMR system at a large hospital in India: Challenges and strategies for successful adoption. J Biomed Inform [Internet]. Elsevier Inc.; 2011;44(6):958–67.
49. Ahlan AR, Isma B. User Acceptance of Health Information Technology (HIT) in Developing Countries : A Conceptual Model. Procedia Technol [Internet]. Elsevier B.V.; 2014;16:1287–96.
50. Msukwa MKB. User Perceptions on Electronic Medical Record System (EMR) in Malawi. 2011;(August).
51. Thilakanathan D, Chen S, Calvo RA. Secure Data Sharing in the Cloud. 2014;45–73.
52. No Title. 2012;(July).
53. Gakuba BR. THE NATIONAL E-HEALTH. 2013;1–53.
54. The Global Partnership for Development : A Review of MDG 8 and Proposals for the Post-2015 Development Agenda BACKGROUND RESEARCH PAPER Charles Kenny with Sarah Dykstra Submitted to the High Level Panel on the Post-2015 Development Agenda. 2015;(May 2013).
55. Freeman MC, Taylor AP AJ. Electronic medical record system in a headache specialty practice: A patient satisfaction survey. Am Headache Soc. 2007;212-215.
56. B. K. Evaluating Informatics Applications-Clinic Decision Support Systems Literature Review. IJMI. 2001;1:15–37.
57. Freeman MC, Taylor AP AJ. Electronic medical record system in a headache specialty practice: A patient satisfaction survey. Am Headache Soc. 2007;32:212–5.
58. Sánchez JL, Savin S V V. Key success factors in implementing electronic medical records in University hospital of Rennes. Eur / AESCULAPIUS Prof Study.
59. Borgohain T, Borgohain A, Kumar U, Sanyal S. Authentication systems in internet of things. Int J Adv Netw Appl [Internet]. 2015;6(4):2422–6.
60. Madhuri KL, Nair TRG. Authentication and Authorization in Server Systems for Bio-Informatics. 10014136 [Internet]. 2010;
62. AG. M. Cisco Secure Virtual Private Network. Cisco Press. 2002;
63. Technet M. Virtual Private Networking: An Overview [Internet]. [Internet]. Available from:
64. What is SSL? [Internet]. [cited 2016 May 29]. Available from: [Internet].
65. Ssl T, Internet-enabled T, Web-based S. Secure Sockets Layer (SSL) Protocol. :1–36.
66. Fdb C. InfoSec Reading Room In tu ll r igh ts. SANS about common criteria. 2001;(Cc.

APPENDICES

APPENDIX 1(Ethical Clearance)

UNIVERSITY OF RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 4/May/2016

NIYITEGEKA Charite
School of Public Health, CMHS, UR

Approval Notice: No 188 /CMHS IRB/2016

Your Project title ***"Perception On Synchronization Of Patients' Data Among Health Facilities Through Electronic Medical Records System"*** has been evaluated by CMHS Institutional Review Board.

		Involved in the decision		
			No (Reason)	
Name of Members	**Institute**	Yes	**Absent**	**Withdrawn from the proceeding**
Prof Kato J. Njunwa	UR-CMHS	X		
Prof Jean Bosco Gahutu	UR-CMHS		X	
Dr Brenda Asiimwe-Kateera	UR-CMHS	X		
Prof Ntaganira Joseph	UR-CMHS		X	
Dr Tumusiime K. David	UR-CMHS	X		
Dr Kayonga N. Egide	UR-CMHS		X	
Mr Kanyoni Maurice	UR-CMHS	X		
Prof Munyanshongore Cyprien	UR-CMHS	X		
Mrs Ruzindana Landrine	Kicukiro district		X	
Dr Gishoma Darius	UR-CMHS	X		
Dr Donatilla Mukamana	UR-CMHS		X	
Prof Kyamanywa Patrick	UR-CMHS		X	
Prof Condo Umutesi Jeannine	UR-CMHS		X	
Dr Nyirazinyoye Laetitia	UR-CMHS		X	
Dr Nkeramihigo Emmanuel	UR-CMHS		X	
Sr Maliboli Marie Josee	CHUK	X		
Dr Mudenge Charles	Centre Psycho-Social	X		

After reviewing your protocol during the IRB meeting of where quorum was met and revisions made on the advice of the CMHS IRB submitted on 3rd May 2016, **Approval letter has been granted to your study.**

Please note that approval of the protocol and consent form is valid for **12 months**.
You are responsible for fulfilling the following requirements:

1. Changes, amendments, and addenda to the protocol or consent form must be submitted to the committee for review and approval, prior to activation of the changes.
2. Only approved consent forms are to be used in the enrolment of participants.
3. All consent forms signed by subjects should be retained on file. The IRB may conduct audits of all study records, and consent documentation may be part of such audits.
4. A continuing review application must be submitted to the IRB in a timely fashion and before expiry of this approval
5. Failure to submit a continuing review application will result in termination of the study
6. Notify the IRB committee once the study is finished

Sincerely,

Date of Approval: The 5th May 2016
Expiration date: The 5th May 2017

Professor Kato J. NJUNWA
Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:
- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

APPENDIX 2 (Permission letter from the Honorable Minister of Health and National Health Research Committee)

REPUBLIC OF RWANDA

Kigali, on 31 MAY 2016
N° 20/2491/DGPHFIS / MPP/2016

MINISTRY OF HEALTH
P.O .BOX: 84 KIGALI
www.moh.gov.rw

NIYITEGEKA Charite
Principal Investigator

Re: Authorization of research

Reference is made to your letter dated 19 May 2016 requesting authorization to conduct a research entitled: "**Perception on Synchronisation of Patients'data amang health facilities through Electronic \medical records system**";

Based on Rwandan Health Sector Research Policy and approvals from the National Health Research Committee with Ref: NHRC/2016/PROT/014 dated 25/05/2016 and CMHS Institutional review board with Ref No: 188/CMHS IRB/2016 dated November 4, 2016;

I am pleased to inform you that the Ministry of Health has granted authorization to conduct this research and to collect data according to the approved protocol.

You are requested to share the results with the Ministry of Health and to provide the final report and datasets to the Ministry.

Sincerely,

MINISTERE DE LA SANTE

Dr. Agnès BINAGWAHO
Minister of Health
Cc:
- Dean of School of Health Sciences/UR/CMHS
- Director of Kabgayi District Hospital

Republic of Rwanda

MINISTRY OF HEALTH

National Health Research Committee
Ref: NHRC/2016/PROT/014

To: **NIYITEGEKA Charite**

Scientific Review Approval Notice

With reference to your request for approval of the Research Protocol entitled; "**Perception on Synchronisation of patients'Data among health facilities through Electrnic Medical records System EMRs)**", We are pleased to inform you that, following a thorough review and critical analysis of your proposal (**NHRC/2016/PROT/014**), your Research Protocol has been approved by National Health Research Committee.
However,

1) Changes amendments on approach and methodology must be submitted to the NHRC for review and approval to validate the changes.
2) A submission of quarterly progress report is mandatory
3) Submission to NHRC of final results before publication is mandatory
4) Failure to fulfill the above requirements will result in termination of study

Once again National Health Research Committee appreciates your interest in research and requests you to submit this proposal to the National Ethics Committee or IRB and then share a copy of the approval letter from them.

Your final approval reference number is **NHRC/2016/PROT/014.**

Sincerely,

MINISTERE DE LA SANTE

Dr. Parfait UWALIRAYE
Chairperson of NHRC

Date: 27/05/16

Note: voir, la lettre du Ministère autorisant sa collecte, pour lui donner accès aux données recherchées (Kabgayi DH, et tous les autres de santé)
Dr Espoir KAGIRABANYANA

APPENDIX 2 (QUESTIONNAIRE)

CONSENT FORM

Hello. My name is Charité NIYITEGEKA. I am a student of Masters in Health Informatics, School of Public Health at the College of Medicine and Health Sciences, University of Rwanda. I am doing a study entitled "**Perception on Synchronization of Patients' Data among Health Facilities through Electronic Medical Records System"** at Kabgayi District Hospital and its health centers.

Your hospital and health center has been selected to participate in this study. I would very much appreciate your participation in this study. The information that will be collected will help students to better improve the implementation of EMR (OpenMRS) system for scaling up the quality of patient data sharing in healthcare service delivery. Our discussion will take about 30 minutes. The information provided will be kept confidential and it will use only for academic purposes. Names on questionnaire are not obligatory because it has code.

Participation in this study is voluntary and we hope you will fully participate in this study. The researcher will take 15 minutes to explain to you the study before starting discussion. Thanks you very much.

Do you agree to take part in this study? Yes ☐ No ☐

Signature: _____

Names of Participant: _____

Date: _____

QUESTIONNAIRE FOR IN-DEPTH INTERVIEWS

Code number…….

Name of interviewer……..**Date of interview: ……./……../2016**

Time start……...Time finish:…….

PART A: Demographics. *First let's start with a little Information about you*

1. **Gender:** Male ☐

   Female ☐

2. **Age:**

   20-25yrs ☐

   26-30 yrs ☐

   30-35yrs ☐

   36-40 yrs ☐

   Over 41 yrs ☐

3. **What is your profession?**

   Nurse ☐

   Clinician ☐

   Pharmacy technician ☐

   Data entry clerk ☐

   Other ☐ Specify.....

4. **How long have you worked in this department?**

   Less than 6 months ☐

   6-12 months ☐

   13-18 months ☐

   19-24 months ☐

   Above 24 months

PART B:

5. **Have you used paper based medical records before?**

   Yes ☐

   No ☐

   If yes, for how long have you been using paper based medical records

   Less than 6 months ☐

   6-12 months ☐

   13-18 months ☐

   19-24 months ☐

   Above 24 months ☐

6. **How long have you been using the EMR (OpenMRS)?**

   Less than 6 months

   6-12 months ☐

   13-18 months ☐

   19-24 months ☐

   Above 24 months ☐

7. **Between OpenMRS and Paper based system, which one is faster in sharing data**

   EMR (OpenMRS) ☐

   Paper form ☐

   Both are about the same ☐

8. **In which is the information about patients more accurate and effective?**

   EMR ☐

   Paper form ☐

   Both are about the same ☐

9. **In which is the information about patients safer? (Privacy)**

   EMR (OpenMRS) ☐

   Paper form ☐

   Both are about the same ☐

PART C: OpenMRS (EMR) KNOWLEDGE AND TRAINING

10. Who trained you to use the EMR system?

No one ☐

Was never trained ☐

IT staff ☐

MoH staff ☐

By other …….....

11. How adequately did the training prepare you to use the EMR system?

Fully prepared ☐

Mostly prepared ☐

Somewhat prepared ☐

Not at all prepared ☐

12. Did you get enough support from ICT office or MoH?

Yes

No

If yes, which kind of support?

Data cleaning ☐

System repair ☐

System up grade ☐

Others ☐ Specify……..

13. When you need to use the EMR, is there always one available for you to use, or do you sometimes have to wait for someone else to finish using it first?

I strongly agree ☐

I agree ☐

I somewhat agree ☐

I disagree ☐

I strongly disagree ☐

14. If so, how long do you wait on average?

0-5 minutes ☐

6-10minutes ☐

10-15minutes ☐

More than 15 minutes ☐

15. Does this waiting discourage you from using the EMR?

Always ☐

Sometimes ☐

Rarely ☐

Never ☐

16. How long (on average) is the wait on line for patients?

0-20 minutes ☐

21-40 minutes ☐

41-60 minutes ☐

More than 60 minutes ☐

17. Where do patients have to wait longer?

Registration ☐

Consultation ☐

Billing ☐

Laboratory ☐

Pharmacy ☐

Other ☐ Specify……

18. Is wait time for patients any different now with EMR compared to paper based records?

Shorter ☐

Same ☐

Longer ☐

Please explain your answer above……

19. Think back to the way you did things before the introduction of the EMR, how much has the order in which you see patients using the EMR changed compared to before?

Significantly ☐

To a small degree ☐

Not at all ☐

20. How has the EMR changed the quality of care to your patients?

Decreased significantly ☐

Decreased a little ☐

Not changed ☐

Improved a little ☐

Improved significantly ☐

May you please explain your answer above……

21. Do you ever encounter problems when entering data?

Always ☐

Sometimes ☐

Rarely ☐

Never ☐

If you encounter problems please elaborate……

22. Overall, are you satisfied with the EMR system?

Always satisfied ☐

Mostly satisfied ☐

Somewhat satisfied ☐

Not at all satisfied ☐

Please explain your answer above……

23. Do you find EMR reports easier to generate than paper based report?

Always ☐

Sometimes ☐

Rarely ☐

Never ☐

24. How long (over all including data cleaning) does it take to generate a report using EMR?

One day ☐

Two days ☐

Three days ☐

More than three days ☐

25. How long does it take to generate a report from paper based records?

One day ☐

Two days S ☐

Three days ☐

More than three days ☐

Please explain the difference…….

26. Do you find the reports generated by EMR useful and easy to understand?

Always ☐

Sometimes ☐

Rarely ☐

Never ☐

27. What types of reports are/were you able to extract from paper based records?

Monthly report ☐

Quarterly report ☐

Cohort analysis ☐

Patient's treatment report ☐

Others Specify.....

28. What type of reports are you able to extract from EMR system?

Monthly report ☐

Quarterly report ☐

Cohort analysis ☐

Patient's treatment report ☐

Others Specify.....

29. How would you compare the accuracy of the manually generated reports to that of the EMR-generated report?

Paper is significantly more accurate ☐

Paper is slightly more accurate ☐

The accuracy of both reports is about the same ☐

The EMR-generated report is slightly more accurate ☐

The EMR-generated report is significantly more accurate ☐

30. DO you share EMR data in your department?

Yes ☐

No ☐

If, No which method are used…….

31. Sharing data helps you in decision making?

Yes ☐

No ☐

Explain above answer …….

32. .Do you share EMR information from other health facilities?

Yes ☐

No ☐

If No why? …….

33. What challenges are you facing when you receive patient from other facilities…….?

THANK YOU VERY MUCH FOR YOUR TIME

QUESTIONNAIRE FOR FOCUS GROUP DISCUSSION GUIDE

To be conducted to a group of 6-8 EMR users at selected in the department

Code number………………/FGD…………………….

Name of interviewer………………………………….. **Date of interview:**

………./……../2016

Time start……………………………...Time finish:…………………………….

- -

PART A: Demographics. *First let's start with a little Information about you*

1. **Gender:** Male ☐
   Female ☐
2. **Age:**
   20-25yrs ☐
   26-30 yrs ☐
   30-35yrs ☐
   36-40 yrs ☐
   Over 41 yrs ☐
3. **What is your profession?**
   Nurse ☐
   Clinician ☐
   Pharmacy technician ☐
   Data entry clerk ☐
   Other ☐ Specify......................................
4. **How long have you worked in this department?**
   Less than 6 months ☐
   6-12 months ☐
   13-18 months ☐
   19-24 months ☐
   Above 24 months

PART B

a) Tell us your name and how long you have been using the EMR system.

b) Think back to when you first became involved with EMR. What were your first impressions?

c) In what way is your work and performance different since the introduction of EMR?

d) What type of activities do you use the EMR for?

e) What are the barriers or challenges that you experience in using EMR at the department?

- What barriers have you observed your colleagues deal with while using EMR?

- What should be done to overcome these barriers?

f) In what way has the introduction of EMR helped to improve the quality of care given to patients?

g) What should be done to make the EMR more useful to you?

h) What should be done to make the EMR more useful to patients?

i) How would you assess your level of skill in using EMR?

Question to be answered by healthcare providers				
Gaps in current EMR system data sharing (Please answer by Yes or No and explain your idea if possible)				
		YES	**NO**	**Discuss**
j	Do you share EMR (OpenMRS) data in your department?			
k	Sharing (OpenMRS) data helps you in decision making?			
l	Do you share EMR (OpenMRS) information from other health facilities?			
m	**Tick the correct answer here** Which type of patient unique identifier (IDs) have you used in your healthcare services delivery?	Track net ☐ Primary care ☐ National IDs ☐ Other ☐ Specify……..		
n	**Tick the correct answer here** What challenges are you facing when you receive patient from other facilities during enrolment in (OpenMRS)?	➢Previous record(Information) about patients' ☐ ➢Regime ☐ ➢Patients' follow up ☐ ➢Patients' Address ☐		

THANK YOU VERY MUCH FOR YOUR TIME!

EMR USE OBSERVATION GUIDE

Code number…………………………………….

Date of observation EMR (Openmrs) System: ………./……./2016

Time start…………………………………………..End time……………………………...

Location…………………………………………….

- -

1. Is the EMR (OpenMRS) system well integrated into the normal workflow?
   - Yes ☐
   - No ☐
2. Is the EMR (OpenMRS) used for every patient that comes?
   - Yes ☐
   - No ☐
   - If NO, record when is it not used...
3. How long (on average) is the wait in line for patients? (Follow a few patients and calculate the average time spent on the queue.)
   - 0-20 minutes ☐
   - 21-40 minutes ☐
   - 41-60 minutes ☐
   - More than 60 minutes ☐
4. How much time do care providers (Clinicians and nurses) spend with the patient?
   - 0-20 minutes ☐
   - 21-40 minutes ☐
   - 41-60 minutes ☐
   - More than 60 minutes ☐
5. How much time do users spend on the computer entering data?
   - 0-20 minutes ☐
   - 21-40 minutes ☐
   - 41-60 minutes ☐
   - More than 60 minutes ☐

6. Do users have any problems with the use of EMR (OpenMRS)?

Yes ☐

No ☐

If yes, please describe the observed problems……

7. Do you share EMR (OpenMRS) data in your department?

Yes ☐

No ☐

If Yes, explain the benefit……

8. Do you share EMR (OpenMRS) information from other health facilities?

Yes ☐

No ☐

If no, explain the way they share patient data…….

9. Other than EMR, is there another form of data collection and record keeping at the centre?

Yes ☐

No ☐

If yes, describe it……..

10. How long does it take for users to extract information they need from the EMR?

0-20 minutes

21-40 minutes ☐

41-60 minutes ☐

More than 60 minutes ☐

11. Does the EMR system help highlight errors with data entered?

Always

Sometimes ☐

Rarely ☐

Never ☐

12. Check the back up and when it was last updated……..

Yes ☐

No ☐

If yes, when it was last updated

Less than 12 hours ☐

12_24 hours ☐

Above 24 hours ☐

13. Observe if EMR data collection tools can be modified and if they can, explain how?

Yes ☐

No ☐

If Yes, Explain how……

14. Observe if information in reports and the format of reports can be altered? Explain your observations……

Yes ☐

No ☐

If Yes, Explain your observations……..

15. Check how the last monthly, quarterly reports were generated…….

Daily reports ☐

Last monthly reports ☐

Quarterly reports ☐

16. Check how the EMRs (OpenMRS) are used to share patient records in their health centers to hospital (or services to another's)

Yes ☐

No ☐

If no, explain why…….

17. Check if Kabgayi District Hospital has enough infrastructure for better to run an EMR (OpenMRS)

Yes ☐

No ☐

Explain above answer…….

18. Discuss with EMR-IT if there are another technology use to interconnect many users at the same time.

Servers ☐

Cloud computing ☐

THANK YOU VERY MUCH FOR YOUR TIME!

EMR- IT Manager

Code number…………………………………….

Name of interviewer…………………………………**Date of interview:** ………./……../2016

Time start…………………… Time finish:………………………………….

Number of participants………….. Location.………………………………………..

- -

Questions to be answered by EMR ITs				
Gaps in current EMR system data sharing (Please answer by Yes or No and explain your idea if possible)				
		YES	**NO**	**Discuss**
Q1	Different facilities use the system differently due to incompatible trainings?			
Q2	There have been problem with the adoption of the system by different users of the system?			
Q3	Current hospital staff levels are often not sufficient for successful system implementation?			
Q4	Too few staff to support, trains, implements, and develop new content?			
Q5	Lack of adequate training for end users on data exporting, reporting, and analysis, system administration, bugs fixing, basic computer literacy and advanced training on modules?			
Q6	Moh mandate for clinician entry through difficulties of change, training, and ict skills?			
Q7	Data is entered after care leading to poor quality (inaccurate)?			

Q8	Current reports are limited and can't meet some significant, repeated needs?			
Q9	Code new features, forms and reports design with user input and approval?			
Q10	Need additional support at the health centers from hospital it			
Q11	EMR need to be hosted as single server for accessibility, security and data sharing			
Q12	EMR server hosted can allow better communication with my patients, staff, and medical partners.			
Q13	EMR server hosted can provide dynamic and high service availability.			
Q14	Attitudes towards EMR server hosted adoption is favorable for good implementations.			
Q15	EMR server hosted adoption is compatible with your hospital's it infrastructure.			
Q16	EMR data sharing is the best strategy for good implementations			
Q17	Current implementation of EMR on local server can help the financial income of hospital not medical record storing			
Q18	Privileges, and roles provided to user in EMR system are enough to securing EMR data and confidentiality			
Q19	EMR local servers in your catchment area are interconnected?			
Q20	EMR system help healthcare service provider to share patient information directly			
Q21	Each patient has a single unique identifier(id) in your catchment area			

Q22	The current EMR system implemented risk to be duplicated due to patient return over			
Q23	internet connection(poor) affect the EMR data sharing			
Q24	innovation (poor) in EMR system implementation affect the sharing process			
Q25	**Tick the correct answers bellow here:** Which types of technology have you used to share the EMR? VPN ☐ Cloud computing ☐ N/A ☐			
Q26	Which one between VPN and Cloud easy to maintain VPN ☐ Cloud ☐ N/A ☐			
Q27	Is the EMR system installed in your local server and able to share information with other in your district Yes ☐ No ☐			
Q28	If Yes, which kind of technology are you using in data sharing ☐ VPN Cloud Technology ☐ N/A ☐			
Q29	If not, what are challenges in data sharing? Lack of enough networks ☐ Poor internet connection ☐ Lack of innovation in new technology ☐ Lack of enough developers ☐ Lack of enough adequate infrastructures ☐ Other ☐ Specify……..			

Q30	**Security in emr data sharing is easy in local area network between end users in different department?** Yes ☐ No ☐
Q31	**IF YES WHICH KIND OF SECURITY USED IN DATA ACCESS** Authenticity with username and password ☐ Security using roles and privileges is EMR system usage ☐ Both username and password & roles and privilege ☐ Security using other network security tools ☐ **IF NOT, SPECIFY……**
Q32	**Confidentiality in EMR data sharing is easy and effective** **Yes** ☐ No ☐
Q33	**Techniques used EMR data sharing** Backup ☐ Data center ☐ Remote access ☐ Email ☐ Other ☐ specify……
Q34	EMR data are easy to share with department in your organization Yes ☐ NO ☐
Q35	To share EMR information, you usually use: USB ☐ Internet ☐ Email ☐ Other ☐

Q36	Are you able to access EMR database in your catchment area? Yes ☐ No ☐
Q37	Which types of network used in EMR data sharing VPN ☐ Internet ☐ Cloud ☐ Other ☐
Q38	Do you have a backup of all the facility in your catchment area Yes ☐ No ☐ If no, Why? …….Specify
Q39	EMR data sharing can help in patient follow-up Yes ☐ No ☐

THANK YOU VERY MUCH FOR YOUR TIME

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