A COMPARATIVE STUDY OF OpenMRS AND OpenClinic
eHEALTH SYSTEMS IN THE PROVISION OF HEALTH CARE
SERVICES.
Case study Kacyiru Police Hospital and Nyamata District Hospital.

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by

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DECLARATION

“I do declare that this dissertation contains my own work except where specifically acknowledged.

UWAMARIYA Josée

24th May 2015
DEDICATION

I dedicate this work to the Almighty God

To my husband

To my children

To my colleagues.

To my friends and relatives.
ACKNOLEGDEMENT

First of all glory be to the almighty God for giving me life, resources and strength to conduct my studies.

Special thanks go to the administration of UR-CMHS polyclinic former KHIPD, my colleagues in particular the former Managing Director Dr Moses Isyagi for the help during my study.

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May the God bless all!
ABSTRACT

Background: The implementation of e-Health is one of the key pillars in strengthening health care systems in Rwanda. Among different forms of e Health systems, HMIS has been adapted by MoH to help in management of hospital in great effective and efficient manner.

Problem Statement: OpenClinic and OpenMRS e-Health systems are two open source software commonly used as Hospital management information system. However from the time of their deployment there is no study done to find out which one is better. This study aims to compare both system in term of functionality, effectiveness, and efficiency.

Objective: This study aims to compare two open source e-Health systems currently used; OpenMRS in and OpenClinic in terms of functionality, effectiveness, and efficiency.

Research question: Which one is the best between OpenMRS and OpenClinic in term of functionality, effectiveness, cost effectiveness and efficiency?

Significance: The comparative information will help in health sector by guiding the MoH, decision makers, Advisors; investors; Stakeholders and Health facilities in selection while choosing which is appropriate, effective and efficient for deployment in their daily activities to manage hospital information.

Methodology: The study was a comparative cross sectional study in which interviews, observation and questionnaires was used. There are three restricted forms in English and Kinyarwanda: one related to end-user appreciation, the second for hospital administrator related to administrative related outputs, and the third for ICT personnel related to technical performance of the system.

Results and conclusion: Funding results show that the two systems have similar functionality, but, OpenMRS appear more effective and efficient than OpenClinic; p value is <0.05. This finding can’t be generalised in other Health facilities.

Recommendations: MoH should keep deployment of OpenMRS in other hospitals. To administrators: follow up is highly recommended as administrative conditions determine the usage and effectiveness of the system.
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LIST OF ABBREVIATIONS

ADT: Admission, Discharge and Transfer

AIDS: Acquired Immune Deficiency Syndrome

ADSL: Asymmetric Digital Subscriber Line

BMC: Bio Medical Center

CHUK: Centre Hospitalier Universitaire de Kigali

CHW: Community Health Workers

DRC: Democratic Republic of Congo

EHR: Electronic Health Records

EMR: Electronic Medical Records

FOSS: Free Open Source Software

HF: Health facility

HIV: Human Immunodeficiency Virus

HMIS: Hospital Management Information System

ICT: Information communication Technology

ICPC-2: International Classification of primary care 2nd edition

ICD-10: International classification of Diseases 10th edition

KHI: Kigali Health Institute

KPH: Kacyiru Police Hospital

MoH: Ministry of Health

MV: Millennium Village

MVP: Millennium Village Project

PIH: Partners In Health
TCB: Technician Cooperation Belgium

TB: Tuberculosis

SMS: Short Message System

WHO: World Health Organisation
CHAPTER 1. INTRODUCTION

1.1. DEFINITIONS OF KEY TERMS PERTINENT TO THE STUDY

**E health system: e-Health** is a relatively recent term for healthcare practice supported by electronic processes and communication, dating back to at least 1999 (Vincenzo 2001).

It is used interchangeably with health informatics which has a broader definition covering electronic/digital processes in health (Healy 2008).

**OpenClinic:** OpenClinic is an Open Source software for the management of hospital information flows. This program has been developed since 2006 by a team of doctors and IT professionnals from the Belgian company Medical eXchange Solutions. The source code has been put in the public domain in December 2008. Since that date, the OpenClinic software can be freely downloaded from SourceForge (MXS 2010).

**OpenMRS:** is an Open Medical Record System. It is a community-developed, open source, enterprise electronic medical record system intended to improve health care delivery in resource-constrained environments by coordinating a global community to create and support this software (Cecily et al. 2010).

**Effective:** Adequate to accomplish a purpose; producing the intended or expected result (Cambridge dictionary 2008).

**Efficient:** Performing or functioning in the best possible manner with the least waste of time and effort (Cambridge dictionary 2008).

It is a level of performance that describes a process that uses the lowest amount of inputs to create the greatest amount of outputs. Efficiency relates to the use of all inputs in producing any given output, including personal time and energy (Busse et al. 2011).

**Functionality:** The range of operations that can be run on a computer or other electronic system (Cambridge dictionary 2008)

**Interoperability:** Interoperability means the ability of health information systems to work together within and across organizational boundaries in order to advance the
Effective delivery of healthcare for individuals and communities (HIMSS Dictionary 2010).

1.2. BACKGROUND

Rwanda is among the poorest countries in the world; over 64% of the population live below the poverty line of 1US$/day/person. Its economy is mainly agricultural and over 90% of the population live on subsistence agriculture in rural areas (Romain & Hughes 2006).

The GoR has a vision to move Rwanda from a low income country to a middle income country by year 2020 (the vision 2020). To contribute to that realisation, the Government of Rwanda (GOR) recognized the role that information and communication technologies (ICTs) can play in accelerating the socio-economic development of Rwanda towards an information and knowledge economy. The GOR believes that Rwanda is equally placed to take advantage of these technologies to facilitate her socio-economic development process. One of the key objectives is to help overcome the challenges and problems across all sectors; hence the GoR is committed to integrate the use of ICT in all sectors; Smart health health sector is among 4 sectors that were chosen to be 7 pillars of ICT in Rwanda as part of vision 2020 (Ignace 2011).

The MoH has the duty to integrate the system, the health of the population plays an important role to overall economic growth and development in of country. E-Health system has been chosen to help in health sector. The term health is used broadly and does not refer exclusively to medicine, disease, healthcare or hospitals. The scope of e-health is health in general, with its two major facets, namely public health which is the responsibility of States and is geared towards preventing and responding to disease in populations; and healthcare, which is geared towards individual patients and the treatment of disease (Healy 2008).

The implementation of e-Health in Rwanda will enable significant progress towards improved continuity and coordination of care, easy access to healthcare services, early detection of disease and illness, and better information on healthcare needs and outcomes. Progress in these fundamental areas will move Rwanda closer towards having a health system that is sustainable, affordable, publicly funded and delivering excellent quality healthcare to its citizens (Erick 2014).
1.2.1. Why is it important to use eHealth or HMIS?

The deficiency of health information registration seems to be a reason why most countries fail to extend to efficiently, collect detailed complete and accurate health indicators in order to get a grip on their health system status (Frank 2012).

There are many problems related to health management systems in low resource countries mainly:

- Poorly documented health information: Inadequate documentation can take many forms: incorrect information, incomplete information, lack of data concordance, and lack of structure, lack of standards, poor patient identification, and absence of unique patient record.

- Insufficient Knowledge guideline and pathways, poorly adapted international standard and guidelines, lack of inter-facility of communication, lack of documentation, libraries.

Belong those problems, in Rwanda different significant forms of E-health systems are running to date trying to solve those related information problems. These programs are: TracPlus and TRACnet– Monthly monitoring of infectious diseases including HIV/AIDS, TB, and Malaria, CAMERWA Drug and medical supply management system, Telemedicine – Information and communication technology (ICT) used to deliver health and healthcare services, information and education to geographically separate parties, E-Learning – use of ICT in instruction of A2-level nurses for promotion to A1 (Frasier et al. 2008).

- M health or m-Health (M-ubuzima): includes the use of mobile devices in collecting aggregate and patient level health data, providing healthcare information to practitioners, researchers, and patients, real-time monitoring of patient vitals, and direct provision of care; this system is used by CHW (WHO 2013).

- Rapid SMS: is an application used by CHW to monitor and promote maternal and neonatal health, identify potential risks, and promote antenatal care at health center facilities.

Rapid SMS helps track pregnant women and mUbuzima to collect and report MDG indicators at the community level (WHO 2013).
Hospital Management Information system: There are many different activities and functions carried out in the acute care hospital setting. The extent to which these activities are supported by electronic systems varies from hospital to hospital and from activity to activity (Richard 2009a).

Up to date different public and privates hospitals have started use of HMIS; OpenClinic eHealth system is deployed and are offering different information mainly needed directly in healthcare delivery and by the MoH in statistics, management and reporting (Frank 2012). OpenClinic has 20 implementations in Rwanda. In some hospitals funding was provided from Belgian Technical Cooperation to implement OpenClinic tools (case of Nyamata, Rutongo, Kibagabaga, Muhima and KTUH) at Rwamagana it is Luxemburg development Agent, for Gihundwe it is Rwandan Diaspora, for private hospital it is their own initiative (Frank 2012). OpenClinic is also deployed in different countries: 5 in DRC, 4 in Mali and 5 in Burundi covering hospitals with 5 up to 700 users. Country specific localizations for Albania, Bangladesh, Belgium, Brazil, Burundi, Congo-Brazzaville, Democratic Republic of the Congo, Ivory Coast, Kenya, Mali, Uganda, Rwanda, Sri Lanka and Tanzania (Frank 2012). The Government of Rwanda has chosen to use OpenMRS as a national electronic medical record system (Erick 2014).

In the beginning OpenMRS software was a longitudinal electronic medical record system being implemented by a diverse team is mainly used for the follow-up of patients suffering HIV/AIDS (50,000+ patients in Kenya alone), malaria and tuberculosis (Frank 2013). Hence OpenMRS was like open-source Medical Records System that tracks patient-level data (Frasier et al. 2008) to date OpenMRS has been integrate at Kacyiru Police Hospital and it is used in different service offered by Hospital not only as EMR also as HMIS (Erick 2014).

OpenMRS in Rwanda, we find it at Rwinkwavu Hospital in the beginning; now is running into 250 health facilities under support of MoH and Partners. It is also in use in clinics in Argentina, Botswana, Cambodia, Congo, Ethiopia, Gabon, Ghana, Haiti, Honduras, India, Indonesia, Kenya, Lesotho, Malawi, Malaysia, Mali, Mozambique, Nepal, Nicaragua, Nigeria, Pakistan, Peru, Philippines, Rwanda, Senegal, South Africa, Sri Lanka, Tanzania, The Gambia, Uganda, United States, Zanzibar, Zimbabwe, and many other places in Europe U.K (Fraser et al. 2006).
The aim of this study is to determine if this OpenMRS which now works as an Hospital Management Information System has the same level of functionality as OpenClinic which is used in different Hospital currently because by observation: OpenMRS was the first to be deployed in Rwanda followed by OpenClinic which appears to be powerful consequential OpenMRS seem being forgotten while elsewhere in other developing country is very used. This can due to the different vision of suppliers of both system,OpenMRS has public aspect (deployment is done by GoR) and OpenClinic, private aspect(deployment is done by MXS SA).

The comparison of these two systems is intended to guide advisors and planners in the MoH, decision makers, stakeholders and others interested in deployment of e-health system while choosing which e-health system is suitable for Rwanda, in terms of advantages (benefits).
1.3. PROBLEM STATEMENT

Since 2000, the Government of Rwanda (GoR) has invested in ICT as a crosscutting area that will help the country to achieve Vision 2020 (to transform Rwanda into a middle-income country and transition from an agrarian economy to an information-rich, knowledge-based society by 2020). In order to accelerate social and economic development, Rwanda is committed to integrate the use of ICT in all sectors (Ignace 2011). Thus the MoH integrated the use of ICT in Healthcare which is known as E-Health system (Marc 2012). Also, is planning that all referral hospitals will have an integrated Hospital Management Information System that supports the following functions and District hospitals will have a selection of the functions depending on the size of the hospital and the services that are offered in that hospital (Richard 2009b).

Worldwide, there are a number of e-Health systems running and the delivering various functions in different manner. In Rwanda, on the basis of National e health Strategic Plan, MoH (Ministry of Health) has started the implementation of different e-Health systems in health facilities. Like other developing countries the GoR has chosen to deploy Open Source due to limited income (Frank 2013).

To date e-health systems commonly used in hospital management information system are OpenClinic and OpenMRS and are installed under external partners funding. OpenMRS in the beginning was used specifically in tracking clinical encounters and follow up of patient suffering from tuberculosis, malaria and HIV/AIDS, and MoH has choose to deploy it as an Hospital management Information system in addition to using OpenClinic .

There were no comparative study done between OpenClinic and OpenMRS. This study aims to compare both systems to find out which one is better, in terms of functionality, effectiveness, cost effectiveness and efficiency and inform decision makers of which is suitable for Rwanda. This information is vital for the sustenance of e-health systems by the GoR.
1.4. OBJECTIVES

1.4.1 Main objective

The purpose of this study was to compare OpenClinic and OpenMRS e-Health systems currently used in Rwanda in terms of functionality, effectiveness and efficiency.

1.4.2 Specific objectives.

1. To evaluate the functionality, effectiveness and cost effectiveness of OpenClinic and OpenMRS each one.
2. To assess the efficiency of OpenClinic and OpenMRS.
3. To identify the challenges, weakness of each one.
4. To compare OpenClinic and OpenMRS in terms of functionality, effectiveness and efficiency.
5. To determine which one is the best to recommend to MoH.

1.5. RESEARCH QUESTIONS

1. Between OpenMRS and OpenClinic which one is the best in term of functionality, effectiveness, cost effectiveness and interoperability?
1.6. SIGNIFICANCE OF THE STUDY

This study has compared OpenClinic and OpenMRS, the e-Health systems commonly used in Rwanda’s health facilities; in correlating them.

The aim of this study is to determine which one is the best between the OpenMRS and OpenClinic which are now work as Hospital Management Information System in provision of healthcare services. Actuality, OpenMRS and OpenClinic are the commonly used as Hospital Management Information system deployed in Rwanda. From the time their deployment no study done to compare them and to determine which one is the best in term of functionality, effectiveness, cost effectiveness and efficiency. OpenClinic has a private aspect OpenMRS run under government through MoH with trained personnel to deploy it (Fraser et al. 2006).

The study has compared those e-Health systems from two hospitals which use the systems as Hospital management information system. Those Hospitals are Kacyiru Police hospital (KPH) and Nyamata District Hospital.

The study will help to unveil in detail the functionality of each one of the systems in terms of user friendliness; training requirement of each one; the complexity of maintenance; the level of automation, the completeness, the interoperability, usability at various stages, degree of paper use reduction, speed of service delivery, the total cost of Installation (deployment) and cost effectiveness. Also it will help to expose the weakness and strength of each one and challenges influencing the effectiveness and efficiency of each system.

This comparative information will help in health sector by guiding the MoH, decision makers, Advisors; investors; Stakeholders and Health facilities in selection while choosing which is appropriate and efficient for deployment in their daily activities.
1.7. SUBDIVISION OF THE PROJECT

This present project is subdivided in 5 main chapters and each chapter has also its subchapters.

The following are those main parts:

Chapter one (Introduction): which contains definitions of key term, background of the study, problem statement, objectives, research questions, significance (i.e. Rationale) of the study and subdivision of the project.

Chapter two (Literature review): this part which describes the previous studies done, on this study, either related and/or the same in different countries, continents and regions.

Chapter three (Methodology): this part shows in the details the way the study was conducted, it includes the study area, study design, study population, sample size, sample strategy, data collection procedure, ethical consideration and limitations and problems.

Chapter four (Results and discussion): will present the results obtained, and gives its implication on the results.

Chapter five (Conclusion and recommendation): this part is the last one which gives and points out where there is a need of encouragement, and improvements like doing researches, it gives also suggestions on the use of this current study.
CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

Rwanda is leveraging ICTs in all sectors of the economy and has registered tremendous progress since 2000 (Ignace 2011). In health Sector after deeply observe a profound transformation in how services are delivered in other sectors such as financial, communications and hospitality services within and outside the country. Information management and technology have helped these sectors achieve significant increases in productivity quickly. If the goal in the healthcare system is to be successfully managed, it is necessary that established innovations in information technology be implemented and similar improvements in effectiveness, efficiency and productivity be realized in the health sector (Richard 2009).

The ministry has set e-health as one of the key pillars in strengthening health care systems, says Dr. Richard Gakuba, the national e-health coordinator at MoH. “. Investment is still needed because this technology does not come cheaply and we still face infrastructure challenges. Among different forms of e Health systems, Hospital information managements systems has been adapted by MoH to help in management of hospital in great efficiency manner (Richard 2009a).

The MoH is planning that all referral hospitals will have an integrated Hospital Management Information System that supports the following functions and District hospitals will have a selection of the functions depending on the size of the hospital and the services that are offered in that hospital.

Table 1. HMIS functions requirement.

<table>
<thead>
<tr>
<th>1.Medical Record Number (MRN)</th>
<th>18.Infection Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.Registration and Booking</td>
<td>19.Surgery</td>
</tr>
<tr>
<td>3.Pre-Admission</td>
<td>20.Casualty / ER</td>
</tr>
<tr>
<td>4.Admissions</td>
<td>21.Physiotherapy</td>
</tr>
<tr>
<td>5.Transfers and Discharges</td>
<td>22.Obstetrics</td>
</tr>
</tbody>
</table>
(Richard 2009b)

Also MoH expect to this HMIS the Costs reduction by avoiding duplicative or unnecessary diagnostic or therapeutic interventions, through enhanced communication possibilities between health care establishments, and through patient involvement (Eysenbach G 2001). Others purposes of eHealth is: To reduce errors, to reduce or eliminate falsifications, to reduce the required manpower, Guide towards “best known practice” (Marc 2012).

In developing countries due to low income generation; free open source software (FOSS) are mostly chosen for Hospital Information Management but at KFH, they use NAPPIER eHMIS which is classy and require licence from developer to use.

OpenClinic and OpenMRS are commonly used in different hospitals and are both Free open Source software (Frasier et al. 2008)

2.2. OPEN SOURCE SOFTWARE IN HOSPITAL INFORMATION MANAGEMENT

2.2.1. Characteristics of Open Source

The term FOSS covers a series of software applications that share some important characteristics including freedom to run the program for any purpose, freedom to study how the program works and to adapt it to one’s needs, freedom to redistribute copies of the software, freedom to modify/improve the software and release the modifications to the public (Frank et al. 2013). Obviously, source code access will be a precondition for
some of these freedoms. Furthermore, key characteristics of open source software (OSS) also include that it’s free (obtaining the software goes without costs); it’s open (the source code being readable by anyone, it can be modified by anyone) and it’s collaborative which means that OSS draws its strength from the fact that people who improve or modify it must make the result of their efforts available to the other members of the opensource community (Ngoc Nguyen 2007).

OpenMRS and OpenClinic eHealth systems are the open source commonly used in Rwanda’s Hospitals from 2006.

Worldwide, according to the literature there is no comparative study done comparing the e-Health systems between them. In this study I am going to compare OpenClinic and OpenMRS which are open source software commonly used in Rwanda HF

2.2.2. Benefits of FOSS to developing countries

The fact that open source software is cheaper than proprietary software due to the absence of license fees.

The adaptability of the freely available source code to local functional, cultural, organizational or language related needs is a second important advantage of FOSS.

The opportunity for developers to freely experiment with open source software will help to develop local technology skills at marginal cost (for free in fact), fostering a local ICT software and services economy (Frank et al. 2013).

Open source software allows evaluation of the quality of the way the program is written: skilled programmers can evaluate the product and the source code itself is part of the documentation so that programming errors can be addressed at once, without depending on external parties.

FOSS development has been associated with parallel development rather than linear, involving large communities of globally distributed developers (Mcpherson et al. 2008).
2.3. OPENMRS

2.3.1. History of OpenMRS

The origin of the initiative is linked to the 2004 development, by the medical informatics research centre Regenstrief Institute, in partnership with Boston’s Partners in Health philanthropic organization, of Open Medical Record System. OpenMRS grew out of the critical need to scale up the treatment of HIV in Africa but from the start was conceived as a general purpose electronic medical record system that could support the full range of medical treatments. The first ideas and prototype of OpenMRS were conceived by Paul Biondich and Burke Mamlin from the Regenstrief Institute, Indiana on a visit to the AMPATH project in Eldoret, Kenya in February 2004. Around the same time the EMR team at Partners In Health led by Hamish Fraser and Darius Jazayeri were looking at ways to scale up the PIH-EMR web-based medical record system developed to manage drug resistant tuberculosis in Peru, and HIV in rural Haiti. Paul, Burke and Hamish met in September 2004 at the Medinfo conference in San Francisco, and recognized they had a common approach to medical information systems and a similar philosophy for healthcare and development and OpenMRS was born. Later, Chris Seebregts of the South African Medical Research Council (MRC) became the fourth founding member (Tanasie 2011). The OpenMRS community has grown from a handful of organizations to a massive collaborative effort by both groups and individuals, all focused on creating medical record systems and a corresponding implementation network that allows self-reliance in system development, even in resource-constrained environments. Since its beginning, OpenMRS has been based on the principles of openness and of sharing ideas, software and strategies for deployment and use. The system is designed to be usable in very resource-poor environments and can be modified with the addition of new data items, forms and reports without the need to write complicated application code. It is intended as a platform that organizations can adopt and modify, avoiding the need to develop a system from scratch. And indeed, organizations around the world are doing just that. OpenMRS is now in use in clinics in Argentina, Botswana, Cambodia, Congo, Ethiopia, Gabon, Ghana, Haiti, Honduras, India, Indonesia, Kenya, Lesotho, Malawi, Malaysia, Mali, Mozambique, Nepal, Nicaragua, Nigeria, Pakistan, Peru, Philippines, Rwanda, Senegal, South Africa, Sri Lanka, Tanzania, Gambia, Uganda, United States, Zanzibar, Zimbabwe, and many other places. This work is supported by many individuals and
organizations, including international and government aid groups, NGOs, and for-profit and non-profit corporations. OpenMRS is not only in use in many different places, but it is also being used to meet many different needs. In Kenya, it is used to support health care delivery for hundreds of thousands of patients at a network of over 50 clinics--some connected by typical networks, but many where the connection requires offline synchronization to external storage that can be physically transported between sites! Another NGO uses a central OpenMRS server connected to clinics in multiple countries via satellite Internet connections. In Malawi, creative individuals with a talent for technology have created a mobile cart running OpenMRS that physicians roll around their clinic, interacting with the system using a touchscreen. In Rwanda, the national ministry of health has worked to roll out a connected national health care system using OpenMRS (Micheal et al. 2013).

2.3.2 Description of OpenMRS

The Open Medical Record System (OpenMRS®) is an open source medical record platform for developing countries. At the heart of OpenMRS is a convention module framework which can be extended and modify the default functionality of the OpenMRS core in accordance to your needs. Modules are also structured like the OpenMRS core, and consist of user interface, data access and service layers. It is a common platform upon which medical informatics efforts can be built. The system is based on a conceptual database and can be customized for different uses (Micheal et al. 2013). It allows implementers to design a customized medical records system with little or no programming skills (Anokwa 2013). OpenMRS features include a Central concept dictionary, Modular architecture and Standards support.

**Licensing:** OpenMRS is distributed under the OpenMRS Public License 1.1. This license is based on the Mozilla public license version 1.1, but contains certain terms and conditions that differ (Miklos et al. 2010).

**Cost:** Free open source software

**Support:** OpenMRS volunteers, core developers and implementers maintain developer and implementer mailing lists. OpenMRS has its own answer support system. The core team also hosts weekly calls to share knowledge. However, free support is not guaranteed for implementations. Alternatively, they (implementers) may open tickets and ask for guidance on https://jembiprojects.jira.com (OpenMRS community 2010).
Since its beginning, OpenMRS has been based on the principles of openness and of sharing ideas, software and strategies for deployment and use. The system is designed to be usable in very resource-poor environments and can be modified with the addition of new data items, forms and reports without the need to write complicated application code. It is intended as a platform that organizations can adopt and modify. And indeed, organizations around the world are doing just that. In the last several years, use of mobile technology has increased dramatically, particularly in the developing world. Facilitated by other open source projects, OpenMRS can be integrated with SMS messaging, allowing community health workers to add information about adherence to medication regimens to a patient's record, as they make rounds through villages in rural Africa (Cecily et al. 2010).

2.3.3. Features of OpenMRS

**Central concept dictionary:** Definitions of all data (both questions and answers) are defined in a centralized dictionary, allowing for robust, coded data

**Security:** User authentication.

**Privilege-based access:** User roles and permission system

**Patient repository:** Creation and maintenance of patient data, including demographics, clinical observations, encounter data, orders, etc.,

**Multiple identifiers per patient:** A single patient may have multiple medical record numbers, **Data entry:** With the Form Entry module, clients with InfoPath (included in Microsoft Office 2003 and later) can design and enter data using flexible, electronic forms. With the HTML Form Entry module, forms can be created with customized HTML and run directly within the web application.

**Data export:** Data can be exported into a spreadsheet format for use in other tools (Excel, Access, etc.)

**Standards support:** HL7 engine for data import.

**Modular architecture:** An OpenMRS Module can extend and add any type of functionality to the existing API and web application.

**Patient workflows:** An embedded patient workflow service allows patient to be put into programs (studies, treatment programs, etc.) and tracked through various states

**Cohort management:** The cohort builder allows you to create groups of patients for data exports, reporting, etc.
Relationships: Relationships between any two people (patients, relatives, caretakers, etc.)
Patient merging: Merging duplicate patients.
Localization / internationalization: Multiple language support and the possibility to extend to other languages with full UTF-8 support.
Support for complex data: Radiology images, sound files, etc. can be stored as “complex” observations.
Reporting tools: Flexible reporting tools.
Person attributes: The attributes of a person can be extended to meet local needs (Maurice 2010)
OpenMRS uses MySQL database, Java APIs, Microsoft InfoPath for forms development, and HL7 data standard for messaging (Miklos et al. 2010).

2.3.4. OpenMRS in Developed Countries.

In the United States and some countries in Europe, OpenMRS is used to track patients at large sporting events, for mobile providers of health care to homeless people, and as a personal health record that allows cancer patients to share treatment and home health care information with caregivers and family members (Micheal et al. 2013).

2.3.5. OpenMRS in Developing country.

OpenMRS has been launched in several country worldwide and has showed a success and serve well according to needs of users that means that the modules or functionality depends on healthcare center expectation, here we have chosen one example of Health facility one of HCF using OpenMRS. It is healthcare facility called "Amani Clinic" located at Kisiizi is a small town in Southwest Uganda, it is relatively a large hospital funded by an European-based NGO, that hospital handles most of the health care for the region. This clinic was opened specifically to address the need for maternal and child health (MCH) care in Kisiizi and the surrounding areas. Therefore, the funding agency has requested that the clinic work to implement an information system, to help better monitor and evaluate the health care outcomes of the patients over time, and to help the clinic scale up to see more patients more efficiently. The agency recommended that the clinic consider using OpenMRS, which had been successfully used by other projects funded by that agency in other countries (Rafal et al. 2011). After receiving the grant funding, the director of the site hired a graduate of a medical informatics training program
in to help lead the effort. Since the clinic was opened, doctors and nurses have used paper forms to collect data about their patients. These forms are stored in folders and kept in a locked file room until a patient's appointment. When the patients arrive, they are given their folder to carry with them as they talk with the various health care providers they will see during their visit. Each of these providers completes the relevant paper forms to add information about the visit. The forms are added to the patient's folder, which is returned at the end of their visit. Clinical staff were worried when they heard about the upcoming deployment of OpenMRS, because of the possibility of changes to the way they are used to working. However, the informatics manager has assured them that they can continue to use the familiar paper forms. When a patient arrives at the clinic, they will be registered by a patient registration clerk. After the patient's visit is complete, a data entry clerk will enter the information from that visit into OpenMRS. Many people in Kisiizi have basic ICT skills, and there is a local Internet cafe, supported by an NGO that provides basic ICT training to local residents. Two recent students have been hired as the first patient registration and data entry clerks for the clinic. Meanwhile, the system administrator has finished his preparation work and has deployed a basic local area network (LAN) to connect a server that will host the OpenMRS application to PCs in the file room, in the clinic manager's office, and in the ICT room. The LAN is connected to the Internet, although the connection isn't very fast and often goes offline. The server is powered by an uninterruptible power supply (UPS) that will ensure it stays running despite any fluctuations in the local power grid. The progress continue at Amani Clinic as they install OpenMRS, customize it to fit the needs of their clinic, and use OpenMRS from day to day, first to enter data and then to extract it for patient visits and for reporting to their funding agency on an ongoing basis (Rafal et al., 2011). The secret was first to be patient and keep in mind that it is not a project of one day it has to be adopted to organizations change and to fix a goal before is a crucial steps. Medical record system should evolve with organisation, otherwise it will eventually become out-of-sync with the organization. That was one example of success of OpenMRS in developing country but there are many countries which have HCF using OpenMRS as information management system for the moment many use as EMR Argentina, Botswana, Cambodia, Congo, Ethiopia, Gabon, Ghana, Haiti, Honduras, India, Indonesia, Kenya, Lesotho, Malawi, Malaysia, Mali, Mozambique, Nepal, Nicaragua, Nigeria, Pakistan, Peru, Philippines, Rwanda, Senegal, South Africa, Sri Lanka, Tanzania, The Gambia, Uganda, United States, Zanzibar, Zimbabwe, and many other places.
The following table shows some installation of OpenMRS in Africa

**Table 2. Installation of OpenMRS in Africa**

<table>
<thead>
<tr>
<th>Africa</th>
<th>Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botswana National TB Control Programme</td>
<td>Lumumba Health Centre - Kenya</td>
</tr>
<tr>
<td>Koegni-eHealth in Cameroon</td>
<td>Millennium Villages Project (2 sites) – Kenya</td>
</tr>
<tr>
<td>Medical Research Council (UK) - The Gambia</td>
<td>AMPATH - Kenya</td>
</tr>
<tr>
<td>Connaught Hospital – Sierra Leone</td>
<td>Jembi Headoffice – South Africa</td>
</tr>
<tr>
<td>Mali Health Organizing Project</td>
<td>Frontier Hospital – South Africa</td>
</tr>
<tr>
<td>Millennium Villages Projects (3 sites) – Mali</td>
<td>Africa Centre PCIS – South Africa</td>
</tr>
<tr>
<td>Millennium Villages Project (1 site) – Nigeria</td>
<td>University of South Africa</td>
</tr>
<tr>
<td>Millennium Villages Project (1 site) – Senegal</td>
<td>SAMedical Research Council/UKZN – South Africa</td>
</tr>
<tr>
<td>Millennium Villages Project (1 site) – Ethiopia</td>
<td>University of the Free State Department of Virology – South Africa</td>
</tr>
<tr>
<td>Millennium Villages Project (1 site) – Ghana</td>
<td>Partners In Health (1 site) – Lesotho</td>
</tr>
<tr>
<td>Ghana Health Service</td>
<td>Monyeta Centre – Lesotho</td>
</tr>
<tr>
<td>Shehu Idris College of Health Sciences &amp; Technology - Nigeria</td>
<td>University of Dar es Salaam (3 sites) - Tanzania</td>
</tr>
<tr>
<td>CANTAM Project - Congo</td>
<td>Ministry of Health and Social Welfare - Tanzania</td>
</tr>
<tr>
<td>Antananarivo - Madagascar</td>
<td>Millennium Villages Project (1 site) – Tanzania</td>
</tr>
<tr>
<td>Partners In Health (1 site) – Rwanda</td>
<td>Opportunistic Infection Clinic – Zimbabwe</td>
</tr>
<tr>
<td>TRACplus Clinic - Rwanda</td>
<td>OASIS: South African Medical Research Council - Zimbabwe</td>
</tr>
<tr>
<td>Millennium Villages Project (1 site) – Rwanda</td>
<td>City Medical Center – Uganda</td>
</tr>
<tr>
<td>Moi + Medical Missions for Children – Rwanda</td>
<td>Kitovu Mobile AIDS Organisation - Uganda</td>
</tr>
<tr>
<td>Partners In Health (1 site) - Mozambique</td>
<td>Masaka Regional Referral Hospital - Uganda</td>
</tr>
<tr>
<td>Partners In Health (1 site) – Malawi</td>
<td>Millennium Villages Project – Uganda</td>
</tr>
<tr>
<td></td>
<td>Immune Suppression Syndrome (ISS) Clinic - Uganda</td>
</tr>
</tbody>
</table>
2.3.6. OpenMRS deployment in Rwanda

The Government of Rwanda is committed to having a strong national EMR program. MoH has announced that OpenMRS will be used for national roll out to health centers and hospitals. From those issues ten students have had training program for one year about web development, Java programming, OpenMRS programming, Medical informatics, now supporting OpenMRS rollout as well as building software development capacity in Rwanda (Fraser et al. 2006).

OpenMRS is used by Partners In Health/Clinton Foundation (PIH) at Rwinkwavu for example and the United Nations Millennium Village Project (MVP) in Bugesera District. PIH currently operates in seven sites (as of May 2008) and their OpenMRS installation contains data for nearly 7,000 HIV patients, over 4,000 on HIV or TB (Frasier et al. 2008).

The Government of Rwanda has chosen to use OpenMRS as a national electronic medical record system (Erick 2014).

2.3.7. Open Medical Record (OpenMRS) system at Rwinkwavu.

Frasier in his report has showed how OpenMRS works has been deployed at Rwinkwavu under support of Partners In Health/Clinton Foundation (PIH) and the United Nations Millennium Village Project (MVP). PIH currently operates in seven sites (as of May 2008) and their OpenMRS installation contains data for nearly 7,000 HIV patients, over 4,000 on HIV or TB treatment (Frasier et al. 2008).

The OpenMRS installation that PIH-Rwanda uses includes many country-specific features. Specifically, it can generate reports that meet Rwanda reporting requirements, including submissions to TRACnet, the national aggregation system. It also contains templates for quality monitoring and administrative overview reports. Patient information is available across sites, and the data synchronizes automatically when a computer goes online (though information is available offline as well). OpenMRS uses Secure Socket Layer Protocol and role based authentication to ensure confidentiality of medical data –
the combination represents the same industry-grade security used by banks and other highly-secure institutions around the world. There are data export, report building, and patient form building tools in the software package as well. It includes patient information lookup tools, and a variety of visualizations of patient data to help clinicians quickly assess a patient’s progress over time.

As a result of the flexible nature of OpenMRS and the number of different functions implemented at PIH sites, installation and maintenance of the system requires substantial technical expertise. For example, PIH employs two full-time IT technicians to maintain all hardware system, and these technicians also have the part-time responsibility of troubleshooting EMR hardware issues across the seven sites. Particularly challenging issues have been stable power (now mainly addressed with solar systems), and lightening. This information is usually printed on paper and delivered back to a member of the clinical team. PIH has implemented patient summaries and flow sheets within the software, and is now working to make them directly accessible during clinical visits by clinicians. They are also working to capture data on patient follow-up and medication collection directly from clinic staff into the EMR. It was planned that by the end of 2012 over 100 health centers and 20 hospitals will be using the system in their clinical practices (Frasier et al. 2008).

2.4. OPENCLINIC

2.4.1. History of OpenClinic

Open Clinic is an integrated Hospital Information System consisting of a series of modules that have been built on the OpenIT Medical Information Architecture (OpenMIA). The system automates information management for all basic functions of small to medium-sized hospitals (50-1,000 beds). Open Clinic is the result of more than 15 years of experience brought together by computer engineers and physicians with high-level ICT-training at MXS (Belgium). The Open Clinic program was first started in 1990 and has been on the market until 2001(MXS 2010b). In 2004, the OpenMIA architecture and the OpenClinic modules have been completely redesigned and reprogrammed in the Java programming language, one of the most popular programming languages in the world today (Cecily et al. 2010).
The source code has been put in the public domain in December 2008. Since that date, the OpenClinic software can be freely downloaded from SourceForge http://sourceforge.net/projects/open-clinic (MXS 2010a).

This software covers several aspects of data management. The most important ones being:
Administrative patient record management, Financial patient record management, the electronic health record, Health insurance management, Cash and payment management, Pharmacy stock management, Laboratory management, Radiology management, Statistics and epidemiology (MXS 2010a).

2.4.2. Description of OpenClinic

OpenClinic is a Web application. This means that a user can access the application through a web browser. OpenClinic is compatible with several types of web browsers: Microsoft Internet Explorer version 5.5 or later, Mozilla Firefox version 2.5 or later, Opera version 10.0 or later, Safari version 4 or higher, Google Chrome version 5 or later. The presentation of some screens may differ depending on the browser. This is normal and depends completely on the browser in question. To take full advantage of the functionality of OpenClinic, utility programs may also be installed on the client computer: Software for viewing and printing PDF documents (Acrobat Reader 8.0 or later, Evince ...).

Webcam software for managing photos. Software playback and recording of fingerprints (Microsoft Fingerprint Reader software, G Finger ...). Software for processing of radiological images (Nyssen 2012).

2.4.3. Features of OpenClinic e-Health system.

The OpenClinic focused on limited resource hospitals, Multilingual: English, French, Dutch, Spanish and Portuguese available. Highly customizable uses java class extensions. Full billing system with Central African public and private health insurance management integrated. It has sophisticated statistics on mortality, co-morbidity and costs of care. It also has human resource management module in its components. Full scheduling system integrated. 3BT clinical thesaurus with validated coding aid for ICD-10 and ICPC-2. SNOMED CT coding (diagnoses) starting from version 4.0. Full lab order entry and

Security: User authentication
Cost: is Free open source software.

2.4.4. OpenClinic in developing countries

As Frank reported in his thesis, OpenClinic software tools has been deployed in more than 25 African sites including in Sub-Saharan Hospitals including Rwanda, Burundi, RDC (Frank 2012) 5 in DRC, 4 in Mali and 5 in Burundi covering hospitals with 5 up to 700 users. Burundi, Congo-Brazzaville, Democratic Republic of the Congo, Ivory Coast, Kenya, Mali, Uganda, Rwanda, Sri Lanka and Tanzania, we can find it also in Albania, Bangladesh, Belgium, Brazil (Frank 2012).

2.4.5. OpenClinic in Rwanda

Implementation of OpenClinic tools started at Kigali University teaching Hospital in 2007. Funding was provided by Belgian Technical cooperation aiming in rehabilitation of this Hospital after 1994 Genocide, early the BTC decided to fund OpenClinic. Implementation in Districts Hospital Nyamata and Rutongo then came Muhima and Kibagabaga Hospitals. After the Luxemburg development agency (Lux Development) agreed on funding similar implementation in Rwanagana District Hospital. The OpenClinic Tools also has been implemented at Gihundwe and Ndera Neuro-psychiatric Hospitals under support of Rwandan Diaspora and MIDA-funding (Frank 2012). Also different private hospital decide to implement the OpenClinic in their Hospital, those are Carrefour, Bien Naitre, La Medicale, BMC, Croix du Sud.

There is a study done in three Hospital using OpenClinic in Rwanda; Kigali University Teaching Hospital (KUTH), Neuro-psychiatric hospital Caraës-Ndera (NPH-CN) and Gihundwe district hospital (GDH). These projects aimed to empower hospital staff in collecting and analyzing hospital information by using OpenClinic, an open source
hospital information management system the results show that routine OpenClinic utilization increased by 20% (from 36.0% to 56.3%) at CHUK between 2010 and 2012 and skills levels increased significantly in admission (+9.2%) and laboratory (+10.0%) departments where the training programs were run. The results obtained from the hospitals of Gihundwe and Ndera showed that the 2 hospitals almost doubled their income one year after implementation and indicators like case load, encounter load and numbers of provided health care deliveries continue to increase linearly, demonstrating the continuity of OpenClinic utilization (Gustave et al. 2013).

The major functional categories founded in OpenClinic tools are:

Patient identification: (Patient ID): this module concerns a master patient index; patient identification badge. This is the scope in all sites of implementation.

Admission Discharge and Transfert module (ADT), take care of all administrative information related to outpatient visits and in patients admission.

Financial management: this category covers module such as administration and encoding, patient and insurer invoice, payment administration and account receivable follow up and interfacing with third part accounting solutions and provision of financial fraud detection.

Reason for encounter (RFE): registration of ICPC-2 coded patients reason for coming to the HF.

Diagnostic: ICD-10, ICPR-2 and DSM-4 based clinical information classification for coding of patients diagnosis.

Outcome: give simple semi quantitative scale: recovery, improvement, deterioration death, unknown and escaped. Clinical content: OpenClinic toolkit to replace paper based system

Lab: Full laboratory information management system exploiting full traceability and support for work-list functionality. Reporting: which include Internal reporting, External reporting and Global Health Barometer (full automatic health and performance indicator).

Other modules from the above should be added according to the need of HF (Frank 2012)
2.4.6. OpenClinic at Nyamata Hospital

At Nyamata Hospital the OpenClinic e-Health system was funded by TCB, in 2008; 20 thin client were provided and connected through a mixed wired/wireless network to a central Linux based server running the OpenClinic toolkit. A priority for deploying workstation was given to administrative, financial and clinic coding departments, then approach for ICD-10 based reason for encounter and diagnosis code. In the beginning there was a problem of internet connectivity but from 2011, the site has been connected to the internet using a more stable ADSL connection, which solves the problem. Nyamata hospital is among the Health facility where OpenClinic e-health system has success (Frank 2012).

2.5. EFFECTIVE E HEALTH SYSTEM OR HMIS

Rafal says again that the eHealth system to be effective, staff must be comfortable with it, then take advantage of additional functionality(Rafal et al. 2011). Each improvement or new piece of functionality that is decided to implement in OpenMRS will take resources, so you'll want to plan ahead for these. Even if an organizational needs don't change, it is need to plan for ongoing support of OpenMRS, including: Keeping the system up-to-date with security patches Upgrading to the latest version of OpenMRS (not always necessary, but OpenMRS is improving all the time and the users will thank for the improved usability and functionality each time of upgrading). Upgrading the modules you use to fix bugs and improve features. Maintenance of server and network infrastructure: Also training to new staff, being patient to resistance to change, give people time to accept and support each change so that they share in ownership of the new system, rather than feeling as if something has been forced on them. Focus on simple tasks at the beginning of deployment and introduce more difficult tasks as people start to better understanding OpenMRS. It also shows staff how the new system will make their work easier and where their feedback has been incorporated. Good planning can minimize the risks around change, but it is important to be flexible within the plan. Unforeseen things often occur, and a plan that is too rigid could prevent from reaching the best solution (Tănasie 2011).
2.6. CHALLENGES OF EHEALTH (HMIS)

The eHealth raises issues of confidentiality, privacy and security (HIMSS Enterprise, 2008). Advances in information technology, the need to cut costs of health care delivery, and consumer demands for more effective and better-quality care have all hastened the exploration of alternatives for storing and retrieving health care information, and yet the implementation of EMR faces several technical challenges. Compared to other industries, the acceptance of information technology in health care has been slow (Carter M 2000). Compounding this is the limited experience available in deploying applications, which has resulted in a steeper learning curve for health care organizations. A number of problems have been identified with the eHealth, including increased provider time, computer down time, lack of standards, and threats to confidentiality. Studies at some institutions in America have shown that electronic order entry increases the amount of time physicians spend entering a prescription. In a study by Powner, physician residents required 44 more minutes per day using computerized order entry, although internal medicine residents using the order entry gained half of that time back in cost savings elsewhere (Powner D 2006).

Furthermore, the study showed a high overall rate of user satisfaction of the system. Developing means to streamline order entry for residents are now a priority.

Another concern with EMR systems is computer down time and problem of security and patient confidentiality. This problem, of course, exists independent of the EMR, as a great deal of medical information abstracted from paper records, already exists in electronic repositories. Well-known privacy experts have documented the threats that misuse of this information has on personal privacy.

As noted above, the paper record is no barrier to duplication, as medical records are routinely copied and faxed among health care providers and insurance companies already. While some fear the EMR will exacerbate this problem, others note that computer-based records, with appropriate security, are potentially more secure than paper based records. Most medical centers already have security (Powner D, 2006).
This conceptual framework shows us the independent, dependent variables and moderating variable where it indicates that the functionality, effectiveness and efficiency as dependent variables will depend on different variable like user friendliness, willingness of users, user skills, training requirement, automation, interoperability and network.
CHAPTER 3: METHODOLOGY

3.1. STUDY AREA

The study was conducted within health facilities using the compared e-Health systems. Those Health facilities are Kacyiru Police Hospital and Nyamata Hospital.

Kacyiru Police Hospital is located in Kacyiru sector Gasabo District, Kigali City. Nyamata Hospital is located in Bugesera District Eastern Province. Nyamata and Kacyiru are both Hospitals offering the same services using OpenClinic and OpenMRS e health systems respectively.

Nyamata because is among Hospital using OpenClinic as an Hospital Management Information system with success, and Kacyiru Police Hospital because is the first one using OpenMRS as an Hospital Management Information System.

3.2. STUDY DESIGN

This was a comparative cross-sectional study which was conducted in June 2014.

3.3. STUDY POPULATION

The study population included the users (Clinicians, cashiers, receptionist..) administrators and ICT managers of the e-Health systems. The estimated size of study population was 47 at Nyamata Hospital and 41 at Kacyiru Police Hospital.

3.4. STUDY SAMPLE

In this study, only 71 users have responded to the questionnaires from both sides (clinicians, nurses, receptionist, cashiers...) The qualitative data was collected from administrators of Hospital and ICT technicians.
3.5. SAMPLE STRATEGY

The study population was selected using consecutive purposive sample strategy from the list of all users. Each of the following categories was studied: clinicians, finance, nurses, reception, pharmacists, administration and ICT staff.

Inclusion criteria:

Study population who is the user of the system and who consented to participate.

Exclusion criteria: Participants (user of the system) who declined to consent

3.6. DATA COLLECTION METHODS AND PROCEDURES USED

Table 3. Baseline of comparison.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User friendliness</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Training requirement</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>Level of automation</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>Usability at various stages</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Reduction of paper use, error and falsification</td>
<td>10</td>
</tr>
</tbody>
</table>

Interview, open questionnaire and observation were be used. Three (3) Self structured forms in English and Kinyarwanda (some staffs don’t know English) were used as follows:

Questionnaire for End users (clinician, nurse, cashier, and pharmacist) related to appreciation,

Interviews for Hospital Administrators related to administrative related outputs and

Interview for ICT personnel related to technical performance of the system.

The interviews was conducted based on informal appointments (face-to-face) this for administrators and ICT technician.

3.7. DATA ANALYSIS
The questionnaires were reviewed for completeness; they were corrected and numbered serially. Questions were coded and entered into the computer. Quantitative data was analyzed by using the SPSS software and the cross tabulation techniques have been used to test some relationship that may exist between variables, the p value has taken under consideration

Qualitative data was analysed using an interpretative (Analysis of the data was interpretive (explain meaning of words said and actions) and iterative (repetition of uttered words) approach to interpret the results. Transcription of recordings and typing of field notes was done soon after each data collection event.

3.8. PROBLEM AND LIMITATION

Lack of willingness to the population (participants),

Schedule of population: Some participants work at night; others have had off day which led to failure of some participants to fill the questionnaires.

Bias of population ( ICT staff, Administrators) only one person from each side has responded to the interview.

Due to limited fund and time, the study was conducted in only one Hospital user of OpenClinic, which means that the finding could not be generalized to the other Health facilities users of OpenClinic HMIS.

3.9. ETHICAL CONSIDERATIONS

The scientific and ethical approval for conducting the research was granted by UR-CMHS Ethical Committee. Likewise, permission to collect data was obtained from different sites where data were collected. Informed consent form was signed by each participant willing to participate before answering the questionnaire. The participation in the study was on voluntary basis and confidentiality of the identity of the participants was assured by using codes instead of real names of participants on the questionnaire.
CHAPTER 4: RESULTS

4.1. QUANTITATIVE DATA

4.1.1. Description of Participants

The study had seventy one participants and all gave written consent to participate. Participants differed with respect to profession, service they work in, and were from two different Hospitals; also eHealth systems used are different. The study took place in those two Hospitals Nyamata Hospital and Kacyiru Police Hospital were using the two different eHealth systems in comparison: OpenClinic and OpenMRS respectively as Hospital Management System.

Of the seventy-one participants, 33 were from Kacyiru police Hospital, 38 from Nyamata District Hospital. The study had 45.1% female participants and 54.9% were males participants.

At Kacyiru users of OpenMRS among all participants, 12(36.3%) were females 21(63.7%) were Males. At Nyamata 20(52.6%) were females and 18(47.4%). See table.

Table 4.Gender of participants according to eHealth system in use.

<table>
<thead>
<tr>
<th>Gender</th>
<th>OpenMRS</th>
<th>OpenClinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>12(36.3%)</td>
<td>21(63.7%)</td>
</tr>
<tr>
<td>Male</td>
<td>20(52.6%)</td>
<td>18(47.4%)</td>
</tr>
</tbody>
</table>

Of the thirty-one participants, among 33 users of OpenMRS 14(36.84%) and 24out of 38 (63.15%) users OpenClinic were nurses, other were staff with different title. See the following table:
### Table 5. Participants' title.

<table>
<thead>
<tr>
<th>Title of respondent</th>
<th>OpenMRS</th>
<th>OpenClinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaesthetist</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Cashier</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Dentist</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Doctor</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Lab/Tech</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Midwifes</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Nurses</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>Physiotherapist</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>33</td>
<td>38</td>
</tr>
</tbody>
</table>
Of thirty three respondent users of OpenMRS are distributed in different departments/services, the same as for the users of OpenClinic. 36.36% users of OpenMRS were from Gyneco/Obstetric. 15.78% users of OpenClinic were from Billing. See table below

**Table 6. Department/Service of participants**

<table>
<thead>
<tr>
<th>Department of respondent</th>
<th>System in use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OpenMRS</td>
</tr>
<tr>
<td>Admission</td>
<td>4</td>
</tr>
<tr>
<td>Anaesthesia</td>
<td>2</td>
</tr>
<tr>
<td>ARV</td>
<td>0</td>
</tr>
<tr>
<td>Billing</td>
<td>3</td>
</tr>
<tr>
<td>Dental</td>
<td>2</td>
</tr>
<tr>
<td>Gyneco/obst</td>
<td>12</td>
</tr>
<tr>
<td>Internal medicine</td>
<td>-</td>
</tr>
<tr>
<td>Isange</td>
<td>5</td>
</tr>
<tr>
<td>Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>Mental Health</td>
<td>-</td>
</tr>
<tr>
<td>OPD</td>
<td>-</td>
</tr>
<tr>
<td>Ophtalmology</td>
<td>-</td>
</tr>
<tr>
<td>Pediatry</td>
<td>-</td>
</tr>
<tr>
<td>Pyhisiotherapy</td>
<td>-</td>
</tr>
<tr>
<td>Registration</td>
<td>2</td>
</tr>
<tr>
<td>Surgery</td>
<td>-</td>
</tr>
<tr>
<td>Theatre</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>33</td>
</tr>
</tbody>
</table>

Of 33 participants users of OpenMRS at Kacyiru all 33(100%) have responded that they often use ehealth , at Nyamata 27 out 38(71.05%) participants whom use OpenClinic did and other did not often use often system 11/38 (28.95%)
Of 33 participants at Kacyiru user of OpenMRS, 31 out of 33 (93.9%) have responded that the system is easy to use while at Nyamata the users of OpenClinic 20 out of 38 (52.6%) have responded that the system is easy others 18 (47.4%) have responded that the system is not easy.

Of 33 participants users of OpenMRS at Kacyiru 25 out of 33 (75.5%) have responded that they are satisfied with eHealth, at Nyamata 21 out of 38 (55.3%) participants whom use OpenClinic were satisfied with the system.

Of 33 participants at Kacyiru user of OpenMRS 24 out of 33 (72.7%) have responded that a simple demonstration is enough to be initiated to the system, then it is 20 out of 38 (65.8%) users of OpenClinic at Nyamata.

Of 33 participants at Kacyiru user of OpenMRS 28 out of 33 (84.8%) have agreed that the system give more accurate results than paper based, while it is 29 out of 38 (76.31%) users of OpenClinic at Nyamata.

See table below:
Table 7 Effectiveness of the eHealth systems.

<table>
<thead>
<tr>
<th></th>
<th>System in use</th>
<th></th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use often e-health system</td>
<td></td>
<td>OpenMRS</td>
<td>OpenClinic</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>33(100%)</td>
<td>27(71.06%)</td>
<td></td>
<td>0.001</td>
</tr>
<tr>
<td>No</td>
<td>0(0.00%)</td>
<td>11(28.94%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System ease to use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>31(93.94%)</td>
<td>20(52.64%)</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>No</td>
<td>2(6.06%)</td>
<td>18(47.36%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction with system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>25(75.75%)</td>
<td>21(55.27%)</td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>No</td>
<td>8(25.25%)</td>
<td>17(44.73%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initiation to the system</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simple demonstration</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24(72.72%)</td>
<td>25(65.78%)</td>
<td></td>
<td>0.402</td>
</tr>
<tr>
<td>No</td>
<td>9(27.28%)</td>
<td>13(34.22)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28(39.4%)</td>
<td>29(40.8%)</td>
<td></td>
<td>0.453</td>
</tr>
<tr>
<td>No</td>
<td>5(7.0%)</td>
<td>9(12.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Of 33 participants at Kacyiru user of OpenMRS 33 out of 33 (100%) have responded that the system is less time consuming than paper based system., while it is 19 out of 38 (50 %) users of OpenClinic at Nyamata

Of 33 participants at Kacyiru user of OpenMRS 25 out of 33 (75.75%) have responded that cash payment the system is the most delaying stage, while it is 20 out of 38 (52.63%) users of OpenClinic at Nyamata.

Of 33 participants at Kacyiru user of OpenMRS 28 out of 33 (84.84%) have responded that the system is mixed not totally automated, while it is 37 out of 38 (97.76%) users of OpenClinic at Nyamata

Of 33 participants at Kacyiru user of OpenMRS 19 out of 33 (57.67%) have responded that the most used module is keeping patient history., while it is 35 out of 38 (92.10%) users of OpenClinic at Nyamata. Also at Kacyiru OpenMRS also help to give appointments.

Of 33 participants at Kacyiru user of OpenMRS 32 out of 33 (96.96%) have responded that the system is rarely not available, while it is 38 out of 38 (100%) users of OpenClinic at Nyamata meaning that the system is available.

See Table below:
### Table 8 Efficiency of eHealth system.

<table>
<thead>
<tr>
<th></th>
<th>System in use</th>
<th></th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OpenMRS</td>
<td>OpenClinic</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Less time consuming</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper based</td>
<td>0(0.0%)</td>
<td>19(50%)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>eHealth system</td>
<td>33(100%)</td>
<td>19(50%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Delaying stage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash payment</td>
<td>25(75.75%)</td>
<td>20(52.64%)</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>Anywhere</td>
<td>8(24.25%)</td>
<td>2(5.26%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost everywhere</td>
<td>0(0.0%)</td>
<td>16(42.10%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System totally automated</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5(15.15%)</td>
<td>1(2.64%)</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td>28(84.85%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>37(97.36%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Usability of the system</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient appointment</td>
<td>12(36.36%)</td>
<td>0(0.0%)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Give results</td>
<td>2(6.06%)</td>
<td>3(7.89%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keeping patient history</td>
<td>19(57.57%)</td>
<td>35(92.11%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System not running</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td>1(3.03%)</td>
<td>0(0.00%)</td>
<td>0.228</td>
<td></td>
</tr>
<tr>
<td>Rarely</td>
<td>32(96.96%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9 Weakness of eHealth system

Of 33 participants at Kacyiru user of OpenMRS 7out of 33 (21.2%) have responded that the system delay work,14(42.4%) pointed network problem,3(9%)pointed complicated system,6(18.1%) said that there are missing data . At Nyamata 24 out of 38 (63.1%) users of OpenClinic have pointed that the system delays work none reported problem of network, 6 (15.8%) said that the system is complicated,3() said that there are missing data..Some users of both system reported that nothing to accuse the system

See table below:

<table>
<thead>
<tr>
<th>System in use n (%)</th>
<th>OpenMRS</th>
<th>OpenClinic</th>
<th>χ2, p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaying work</td>
<td>7(21.21%)</td>
<td>24(63.15%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Network problem</td>
<td>14(42.42%)</td>
<td>0(0.00%)</td>
<td></td>
</tr>
<tr>
<td>Complicated</td>
<td>3(9.09%)</td>
<td>6(15.78%)</td>
<td></td>
</tr>
<tr>
<td>Missing data</td>
<td>6(18.18%)</td>
<td>3(7.89%)</td>
<td></td>
</tr>
<tr>
<td>Nothing</td>
<td>3(9.09%)</td>
<td>5(13.15%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33(100%)</td>
<td>38(100%)</td>
<td></td>
</tr>
</tbody>
</table>

At Both sites all users; ether users of OpenMRS or OpenClinic responded that the system allow them to communicate with others services. See table

Table 10 Interoperability of the system

<table>
<thead>
<tr>
<th>System in use</th>
<th>OpenMRS</th>
<th>OpenClinic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>Yes</td>
<td>33(100%)</td>
</tr>
</tbody>
</table>
4.2. RESULTS FROM QUALITATIVE DATA

There are others results from question asked to the ICT staff and Administrator at both sites: Kacyiru which use OpenMRS and Nyamata which use OpenClinic.

The following responses are received during interview with ICT staff and administrators at both side one from Kacyiru and one from Nyanata Hospital.

1) Administrators

a) The administrator of Nyamata Hospital during interview has given the following information: “the eHealth system is here since 2008 founded by BTC and implemented by MXS”. For one of Kacyiru he has respond “the eHealth system is here since 2012 implemented and follow up is done by GoR through MoH.”

b) The benefits to the system, at Kacyiru, he said “that the system help mostly in reporting, (medical record) but also in finance to evaluate income generated by hospital and each department, on follow up of activity in general, in payment etc...The evaluation and control is quick and easy. Also we are reducing paper in use like file, and documents of patients hence we call it paperless. another issue is reduction of personnel like one whom was in charge of archiving. Also there is no duplication and repetition of examen. At Nyamata, the administrators has said :” the system is mostly help in finance(income generated)evaluation is quick and easy, also it help in archiving, it reduce time of looking to the patient file and duplication as patient ID is saved in the system...for medical record they have another system which is not OpenClinic”. 

c) The Challenges they have; at Kacyiru he said “the staff keep changing and are not permanent due to their jobs (many are Police staff) whom rotate so the new come don’t have skills on the system, another challenge is network problem which some time discourage users due to heavy scheduler they reduce patience to the on and offline which make unavailability on the system”. At Nyamata, the administrator said:” the big problem is the resistancy to change of many staff whom don’t agree to use the system mostly clinicians and nurses so due to concentration of financial issue and hiring many cashiers, also like at Kacyiru familiars staff whom have been trained are going the new don’t have skills on the systems.”

2) ICT staff
From ICT staff we get the following information about the system during interview

At Kacyiru, ICT staff has responded: “there were some modules which are not in use because they are not yet finished to learn, they learn step by step if the users finish to be familiar with one program or functionnality they go to another one but they plan to use all modules” At Nyamata, the ICT staff said “many module or programs are not in use as ICT staff reported staff are resistant to change and the experienced clinicians keep on leaving so the new come without skills on the system. He mentioned also that there is another staff from MoH who is in charge of medial record and other report that is needed.”

About training given to the staffs, he has responded: “on the beginning all staff has been trained about the system according to the what they will need at least the basic skills. Also the one from Kacyiru confirm the same: “all the staff were trained, we have formed group according the service then they rotate to participle in the training”.

Concerning the interoperability, ICT staff at Nyamata during the interview has said “Here the system is interoperable within the hospital, but it mostly help communication and reporting between financial team, for outside systems the OpenClinic should do that but her we didn’t yet reach that step”. The one from ICT staff at Nyamata has said “The system here is interoperable within and out of the hospital it help as to request from other service specifically laboratory and pharmacy, about outside the hospital the system help in reporting to the MoH concerning the medical reports”.

About interruption of the system, during the interview, the ICT staff from Nyamata has said “for the moment the system is rarely interrupted because now the site is connected the internet using a more stable ADSL to minimise network problem, problem occur when the electricity slash “The one from Kacyiru also said: “interruption is rare but it happen sometime and we run to the paper based but we are in way to resolve the problem, we are working with RDB to increase the network capacity”

For maintenance and configuration of the system, ICT staff from Nyamata has said “there some minor problem we resolve our self but to configure or add data we have to call the designer of the system I means MXS representers” The one from Kacyiru has said “The maintenance is done here, we have a trained qualified staff from MoH who has been trained in system implementation who intervene when there is a problem.”
About challenges ICT staff from Nyamata has said “The main challenge is the resistance to change; nurse and doctors are very unassailable always they said that the system delay their work here it seem like they don’t use the system, the admistration has decide to focus on the finance otherwise the system should be at the moment may be used at different usage as it has many modules” At Kacyiru Hospital the ICT staff said” the challenge using the system is that the experienced clinicians keep on leaving so the new come without skills on the system like that it impede with the progress of starting using new program and mixing with paper based system.
CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

This chapter discusses the findings of this cross-sectional prospective study which involved seventy one (71) participants from two hospitals, KPH with thirty three participants and Nyamata District Hospital with thirty eight participants. Two hospitals are among the one using HMIS in Rwanda. This study was done with the aim to compare OpenClinic and OpenMRS e-Health (HMIS) systems currently used in Rwanda in terms of functionality, effectiveness and efficiency. The order of the discussion is as follows based on study objectives. Firstly demographics data, users’ perception on effectiveness and efficiency of eHealth in comparison to paper based methods. Secondly, functionality, weakness and interoperability of each one. Thirdly, to evaluate the strengths and weaknesses of each one. It is based also to the results of qualitative data.

5.2. DEMOGRAPHICS DATA.

Gender. In this study, users of OpenMRS at Kacyiru Police Hospital males were many than females. This is probably due to the fact that Kacyiru is for Polices, many staff are polices and in police the number of males is greater than one of females, while at Nyamata District Hospital Female were many than male as in health sectors we observe a great number of females

Titles & Department: results from this study, show that many participants were nurses (table 2), this to both sites. We realise again that there some titles which are not seen to one of the sites, this is due to the fact that some department are not available at one site. For example there is no physiotherapy department at Kacyiru Police Hospital and there is no Isange (the one in Charge of rape) at Nyamata District Hospital. The other reason is the denial of some staff to participate in study.
5.3. EFFECTIVENESS AND EFFICIENCY OF EHEALTH SYSTEM.

On user’s perception on effectiveness and efficiency of the eHealth system, the eHealth system effectiveness in this study is evaluated based on userfriendliness and satisfaction of users, accuracy of the results produced by the system, complexity of the system (if it is easy to initiate on it, easy to maintain...). Efficiency is measured timeliness, reduction of paper in use, reduction of stress during work, also under base of other institution’s benefits from the system like cost effectiveness and weakness of the system.

In this study, eHealth system considered are OpenClinic in use at Nyamata Hospital and OpenMRS in use at KPH both serve as Hospital Management Information System.

About effectiveness of the system, the responses from table 4 were put under consideration. What is find out is that at KPH eHealth system in use which is OpenMRS is appreciated by user because 100% are using the system, reported that it is easy to use and that the system is the best compared to the paper based used before; 100% prefer to use it. At Nyamata Hospital where they use OpenClinic eHealth system thing is different, users 71.1% use often OpenClinic, 56.6% reported that is easy to use and 50% prefer to use eHealth system meaning that another 50% continue to use paper based. p value related to question 1 related to the use of eHealth system is <0.05 that is significant, meaning that there is a difference between how OpenMRS is used compared to OpenClinic, OpenMRS is more used than OpenClinic. P value is also <0.05 on the question asking if the system if eHealth system is easy to use meaning that user of one system find it easy other find it not easy hence according to the results OpenMRS users find it easy and those of OpenClinic perceive thing differently, but to the question about satisfaction and initiation to the system, the p value is >0.05 which means there is no significant difference between satisfaction of users of OpenMRS and OpenClinic users. Here we cannot pass without commenting on those founding. At Nyamata, as reported Dr Frank was the site of success of OpenClinic staff liked it and has successes quickly (Frank 2012) in the beginning but now according to that administrator in interview mostly the system is used in financial issue, that should express the negligence of administration of other fields or else resistance to change of clinicians and lack of severity to staff of administration, in his book Frank also has said that one of the cause of implementation fail is discontinue follow up (Frank 2012). We said this because at Kacyiru Police Hospital to use the system is mandatory attend this goal the system is almost paperless, clinician cannot use
paper unless there is a general problem known. In a study by Powner, physician residents required 44 more minutes per day using computerized order entry, although internal medicine residents using the order entry gained half of that time back in cost savings elsewhere. Furthermore, the study showed a high overall rate of user satisfaction of the system. Developing means to streamline order entry for residents are now a priority (Powner D 2006).

Freeman et.al in their patient and user satisfaction survey conducted in a headache specialty clinic documented that health care computerization is promoted on the basis of its numerous benefits. It saves time, improves record keeping, increases accuracy, enhances the flow of information, improves the quality of clinical data available, and reduces paperwork(Freeman MC et al. 2007). This study has found that related to the efficiency of these system users of both system reported that the system delay services at Nyamata (OpenClinic) many have pointed much work in the system and at KPH many have pointed network problem which delay service, also they still filling some information on paper which give more work and take time but we cannot be limited to this user responses and saying that the system is not efficient definitely because during interview with administrators at both sits they, mention many benefits to the system including easy control, reduction of stress to find the patient file, reduction of duplication of patients exams which was done when the patient lost his ID, forget the results, the bill. At both sites also many user agree that results from eHealth are more accurate than those from paper based system. During the interview also administrator and ICT staff point out unwillingness and resistance to change of clinicians, they mention the problem of experienced staff who keep leaving then the new come without enough skills to use the system due also to heavy schedule they are integrated without training to be initiated to the system so they use paper based. This problem is very seen at Nyamata Hospital, on observation the researcher has realized that, into service where they do night and day they don’t use the system but those on day time they do but at their will because if there many patient to treat they don’t. Glasgow in his article, has said that the staff must be trained and updated on new functionality introduced in the system (Glasgow 2012)

About completeness of these eHealth systems both system many modules meeting the requiremen of MoH as sited by Richard Gakuba the former Coordinator of National eHealth in Rwanda(Richard 2009b).In this study the researcher has found that these eHealth systems has many module which is not used, during interview ICT staff at both
sites have said that there some module which are not in use. From Rafal ’s book he told about modules involved in OpenMRS (Rafal K. et al 2011) and MXS talk about the module involved in OpenClinic tools (MXS 2010b). In this study the researcher has realize that the level of usability is related to hospital scope, because like at Nyamata after the OpenClinic has implemented many module were in use but now only financial is the mainly used due to the system which is not totally automated to according the answers given by users (or some needed module not initiate) the system is mixed to the paper based, when some information (data). This issue affect the efficient and effectiveness of both system. Relating to p value on this question is > 0.05 which means that there is no significant difference between OpenClinic and OpenMRS; both are not totally automated the users. Keep mixing both systems. The question related to initiation to the system, p is > 0.05 which not significant meaning that there is no difference between initiation to OpenClinic and to OpenMRS. Evaluation done by Frank in Sub Sarah countries, the ignition to OpenClinic is easy even training is for few days (Frank 2012). To the question related to accurate result, p value is > 0.05 meaning that the responses from users of both system don not show a difference, hence OpenClinic and OpenMRS give more accurate results. Frank also in His in his book says that the OpenClinic give accurate results in efficient and effective manner (F. VERBEKE, 2013), the same to OpenMRS as reported Fraser saying that OpenMRS has much help in reporting HIV case (Fraser et al. 2006).

5.4. INTEROPERABILITY OF THE SYSTEM

About interoperability of the system, reference to results from table 6, at both side KPH (OpenMRS) and Nyamata Hospital (OpenClinic) users confirm that the eHealth system help to communicate between with other service, this also is supported by ICT staff and administrator. Also on researcher side, by observation, we have realized that when a user from one service fills information in the system one from another service should access on that information. This at both side where OpenClinic (Nyamata Hospital) and OpenMRS (KPH) are in use. For example at Nyamata Hospital any Doctor in consultation should access on Labo results. At KPH there every service has to communicate with another in the system as every services use the system. At KPH things are serious because it is another to use the system every staff must use the system to communicate unless if information is not yet in the module learnt, this push the concern to make the system userfriendly and evaluate the system so resolve problem on time.
every staff who meet a problem call immediately for help the problem be resolved then continue without stopping use the eHealth system. From table 6 100% of users of both systems agreed that the system help the communication between service. Note that during interview, the administrator of Kacyiru Hospital has said that the system help them in reporting to the MoH, meaning that the system allow them to report even outside the hospital (External reporting). Erick Gaju, now the coordinate of National eHealth has said that OpenMRS should report to MoH’s HMIS (Erick, 2014)

5.5. THE STRENGTHS AND WEAKNESSES.

About the strengths of this systems, both OpenClinic and OpenMRS according to the results they give more accurate results, no difference between both system as noted above and showed in table 4, the p value is >0.05 which means there are no significance difference between how OpenClinic offer accurate result and how OpenMRS do. During interview also the administrators of both sites of implementation mention many benefits, including reduction of paper in use specifically at Kacyiru Police Hospital where OpenMRS is called paperless. The administrators at both sites have said that the control is easy and fast. Privacy of record and authentication is strong: every user has owner password to login in the system. These were confirmed by users, ICT staffs and Administrators at both sites.

The weakness of the system is related on network problem which delay work and which discourage the use of the system there is significant difference between OpenMRS users OpenClinic user responses p value is <0.05, OpenClinic users seem not appreciating the system while those of OpenMRS few only reproach the system. Even relating to work those of OpenClinic many (63.1%) have said that the system delay works. In general what we realise is that according to results and p value which is <0.05, OpenClinic is weak compared to OpenMRS. Suprising is that At Nyamata the users (100%) have said that there is no network problem. Probably explanation could be that If we try to analyse the problem, based on interview with the administrators and ICT technician from Nyamata Hospital, they have said that there is a problem of resistence to change among Clinicians, also the system should be complicated or difficult to be initiated. Another weakness related to these eHealth system is that some data are missing which cause the use of paper in addition, this issue delay works, the proof is that on cashier stage (billing) patients delay, the users of either OpenClinic or OpenMRS pointed the same, p value is >0.05 meaning that patients spend more time in payment. Analysing this is due to the fact that
some users don’t enter information needed in the system. According to the ICT staff these is due to lack of willingness to the part of users and the lack of severity of administration because some use the system other do not, only they target to the billing (cashiers) these give more works to the cashiers so that delaying of billing service. Also the fact that the system has some module which are not yet used give more work.

Relating to interoperability, both ends, the user have said that the eHealth system allow them to communicate between them, 100% agree on that, but to the side of administrators during interview, one from Nyamata has said that for external report they use other system, the one from Kacyiru has said that the system help them in reporting either internal report or external report. This confirm what Erik Gaju the coordinator of national eHealth who has said that OpenMRS deliver an automated HMIS report to to MoH (Erick, 2014)
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSION

This study compared OpenMRS and OpenClinic e-health systems in the provision of healthcare service, the two ehealth systems; OpenMRS and OpenClinic are used as HMIS at Kacyiru Police Hospital and Nyamata District Hospital respectively, the comparative study was based on functionality, effectiveness and efficiency.

Overall, both systems are closely the same they work as HMIS and have similar functionalities, but the degree of usability is different. OpenMRS appear more effective and efficient because of 100% users uptake, and interoperable with external system, it has a link with MoH however this not the case with OpenClinic. OpenClinic according to results is not effective and efficient at Nyamata District Hospital because it is not appreciated by the users, also the fact that it not allow the external report makes it less efficient than OpenMRS! Probably is due to the fact that OpenMRS is deployed in a police facility where its use is mandatory. OpenClinic as HMIS is acceptable however users have an option to use or not to use.

The study also observed that at both sides, weakness are related to delay in work this is related to network problem, missing data which cause the mixing with the paper based, complication of term.
6.2. RECOMMENDATION

Based on this study the following is recommended:

- To hospital administration: must encourage users specifically clinicians to use eHealth to attain full potential benefits from the eHealth system, it is better every concern new staff must be initiated and facilitated to the system as he/she do on other duties. Administrative conditions determine usage and effectiveness of the system.
- The IT team must continually assist users to help them urgently to overcome the difficulties so the system keep running and served as expected.
- To the concern, network problem must be resolved if not users will be discouraged to use the system.
- The MoH should keep deploying the OpenMRS which is free and managed by Government in other Hospitals as Hospital management system as it show success at Kacyiru Police Hospital.
- Further research should be done on best administration practice and cause of weakness.
REFERENCES


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CONSENT FORM FOR PARTICIPATION IN A RESEARCH STUDY

Title of Study “A COMPARATIVE STUDY OF OpenMRS AND OpenClinic E-HEALTH SYSTEMS IN THE PROVISION OF HEALTHCARE SERVICE.”

Case study Kacyiru Police Hospital and Nyamata District Hospitals.

Description of the research and your participation

You are invited to participate in a research study conducted by UWAMARIYA Josée. This research is one of the requirement I have to fulfill in order to obtain the Master of Science degree in HEALTH INFORMATICS at UNIVERSITY OF RWANDA COLLEGE OF MEDICINE AND HEALTH SCIENCE. Your participation will involve fulfillment of Questionnaire by answering the question asked to you.

Risks and discomforts

There are no known risks associated with this research.

Potential benefits

There are no known benefits to you that would result from your participation in this research. This research may help us to understand the functionality of eHealth system you are using in this Hospital.

Protection of confidentiality

We will do everything we can to protect your privacy: Your identity will not be revealed in any publication resulting from this study.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

Contact information
If you have any questions or concerns about this study or if any problems arise, please contact UWAMARIYA Josee at The University of Rwanda, College of medicine and Health science. Or Mobile phone 0788672937/0727112764.

If you have any questions or concerns about your rights as a research participant, please contact The University of Rwanda, College of medicine and Health science; Kigali Campus.

Consent

I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant’s signature_______________________________ Date:_________________

A copy of this consent form should be given to you.
QUESTIONNAIRE

Question I: Users

1. Gender: Male: □
   Female: □

2. Working place: Nyamata Hospital □
   Kacyiru Police Hospital □

3. EHealth system in use: OpenClinic □
   OpenMRS □

4. Profession: Nurse □
   Clinician □
   Doctor (Physician) □
   Cashier □
   Other (specify) □

Q 1: Do you often use eHealth system:
1. Yes/Yego □
2. No/Oya □

Q 2: Is the e-Health System easy to use?/Eseububuryoburoshyekubukoresha?
1. Yes/Yego □
2. No/Oya □

Q 3: Which is the best for you between paper based and the eHealth system?
1. Paper based /ubw’impapuro □
2. e-health system/Ubw’ikoranabuhanga □

Q 4: is all information needed in your work automated in this eHealth system?1)
1. Yes/Yego □
2. No/Oya □

Q 5: How often is the eHealth system is not functioning?
1. Often /Kenshi □
2. Rarely /rimwenarimwe □
3. Never/Ntanarimwe □
Q 6: Where the patients wait longer?
1. Cash payment □
2. Anywhere □
3. almost everywhere □

Q 7: Do you have enough knowledge to use eHealth system?
1. Yes □
2. No □

Q 8: According to how you see the system and your difficulties, what do you purpose to be familiar with the system?
1. Training □
2. Simple demonstration □

Q 9: What are you reproaching the eHealth system
1. Delay service(much work) □
2. Network problem □
3. Nothing □
4. Missing data/incomplete □
5. Complicated □

Q 10. EHealth system produces more accurate results than paper based:
1. Agree □
2. Not agree □
3. They are the same □

Q 11. Is eHealth system allow you to communicate with other services
1. Yes/Yego □
2. No/Oya □
Questionnaire II: Administrator

1. For how long the eHealth System has been used here in Hospital? Where do you get Support?

2) What do you benefit mostly to the EHealth system?

3) What are the challenges on using this system?

4) Compared to the paper based which is efficient? How?
Questionnaire III: ICT Technician

1. Does the eHealth system have the modules which are not used?
   Why?

2. Does every staff hospital have been trained to use the system?
   Is the system interoperable (communicate between them) within the department of the hospital and other system

   Does the eHealth system ever have interruption?
   Why?

   Is the system easy to maintain or to configure?

   What are the Challenge do you meet in using the system?

   How about the security of record?