

PROJECT ABSTRACT

Project for Bachelor Degree in Information Technology

Emphasis in Networks and communication systems

Adventist University of Central Africa

Title: MEDICAL DATA SHARING SYSTEM

A CASE STUDY: MASAKA DISTRICT HOSPITAL,

RWANDA MILITARY HOSPITAL

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Date completed : July ,2017

The main purpose of the entitled as " Medical data sharing system " is to computerize the communication sharing of data or electronic submission of patient data to Rwanda Military Hospital servers in order to speed up the current process and avoid paper bill based work from hospitals, deals with the transferring data between two medical systems that which are Masaka District Hospital and Rwanda Military Hospital. Traditionally, it was done manually by using paper bill. the main function of the system is to able show reality that it is possible to let one medical system currently working only for managing patient records, to be able to share needle patients data to another medical system and even when transfers become expired they send notification to resend it again without coming to hospital in personal as done before. The software developed has interface where the user can enter and retrieve data. It uses Xampp server for database management system,Java Server Faces as language,css and html for design. For the development of this project two methodologies have been used: the research methodology to collect the data and software engineering methodology.i use web services especially Restful which is a method helps in communication between two medical systems,based on interfaces they can communicate even if they are running on different operating system and written in different languages.

DEDICATION

With great pressure I dedicate this work:

To my almighty God,

To my Beloved parents

To my family

To my friends

To my colleague

To my Beloved brother and sisters

DECLARATION

I, Didier IYAMUREMYE, student at Adventist University of Central Africa in faculty of Information Technology, department of networks and communication systems on registration No 16913.I do hereby declare that this research project report is entirely the real reflection on my own original work and experience to the best of my knowledge. It has never been either partially or wholly presented in any university or any higher learning institution.

Student

Didier IYAMUREMYE

Supervisor

Pierre Celestin NIZEYIMANA

Signature.....

AKNOWLEDGEMENT

This research project has come into existence because of several people involved in to develop functionality in pharmaceuticals industry. They all deserve my thanks!

Mr. MUKWENDE Placide is appreciated for his ideas that he shared with me while he conducted me in my project proposal AUCA.

Our gratitude and unreserved recognition are addressed to Mr. NIZEYIMANA Pierre Celestin for his generosity for grant me upon his private activities and providing a lot of ideas that played a big role in this my research. The research policies that he suggested acted as the foundation to generate the full logic of this research project.

Finally I end by thanking the AUCA Information Technology faculty in which I belong and Staff for their commitment in each kind of service I desired from them. They are also appreciated for their expressed desires to see this research project completed and for them to thereafter use it as valuable resource while consulting and guiding other following promotions in their research projects and thesis.

No one is truly self-made; hence I pass on a cordial thanks to my colleagues at AUCA, especially MUNEZERO Josue, MUSIRIKARI Pacifique

May the Almighty God bless you abundantly.

Didier IYAMUREMYE

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LIST OF ABBREVIATIONS

API	-Application Programming Interface
AUCA	-Adventist University of Central Africa
CSS	-Cascading Style Sheet
DB	-DataBase
DBMS	- Database Management System
FK	-Foreign Key
GB	-Giga Byte
GoR	- Government of Rwanda
GUI	-Graphical User Interface
HTML	- Hyper Text Markup Language
ICT	-Information Communication Technology
IDE	- Integrated Development Environment
IT	-Information Technology
JSF	-Java Server Faces
JSON	-Java Script Object Notation
JSP	- Java Server Page
MB	- Mega Byte
MDH	- Masaka District Hospital
MDSS	-Medical Data Sharing System
MDSSWS	-Medical Data Sharing System using Web Services
MySQL	- My Structured Query Language
OO	- Object Oriented
OOM	- Object Oriented Methodology
PF	-Prime Faces
PK	-Primary Key
Restful	-Representation state transfer
RMH	-Rwanda Military Hospital
SDLC	- System Development Life Cycle

SQL -Structured Query Language

UML - Unified Modeling Language

UP - Unified Process

WS -Web Services

XAMPP -closed-platform Apache MySQL Php Perl

XHTML - Extensible Hypertext Markup Language

XML - Extensible Markup Language

CHAPTER 1

GENERAL INTRODUCTION

Medical services in Rwanda referred to necessary treatment for a short period of time for brief but serious illness ,injury or other health condition such as a hospital emergency, the district hospitals offer basic services and all have minimum of 15 doctors, most patients seek care at district hospitals that offer lack operative capacity creating a need for referral hospitals which is health care from specialists in a large hospital by providing complex clinical care to referred from lower levels, generally Rwandan hospitals are classified into 3 categories which are referral ,provincial and district hospitals whereby their objective is centered on the reduction of burden of disease of the most important health problems.

As district hospitals give quick support for patients, when a patient have a big problem that they cannot be operate there are occasions when they must be transported to another hospital either provincial or referral to provide a continuation of their care, this transport is referred to as a patient transfer since the patient along with their records are transferred from one facility to another.

“A Medical Data Sharing System Using Web Services” is powerful, flexible and easy to use and is designed and developed to deliver real conceivable benefits to hospitals by speed up the process of transferring patient data from Masaka hospital to Rwanda military hospital, my system is designed for multispecialty hospitals, to cover a wide range of the provided transfers from district hospital to referral hospital which actually done manually I only choice Masaka Districted Hospital as district hospital and Rwanda Military Hospital as referral hospital by testing purposes(Christophe,2010)

Background of the study

Health is a serious development issue. Issues of health service provision are central to any discussion of development. In Africa a disease such as malaria is estimated to cost African countries more than 1% of population has been classified as one of the biggest impediments to poverty alleviation.

Lack of effective means of accessing health facilities is largely expressed by short life expectancy in developing countries. For example in Rwanda average life expectancy is 55 years old. Rwanda is the most densely populated country in Africa with a population density of 417 inhabitants per km². Based on an annual population growth rate around 2.6%, it is estimated that the population will reach 16 million by 2020 but much as it has achieved impressive health insurance coverage of 98% of its population. The number of patients greatly outweighs doctors and health facilities. According to the 2002-2008 national census report as carried out by the ministry of health in Rwanda there were 45 main hospitals distributed in all provinces of Rwanda and among them only 4 were and are only referral hospitals. Most of the rest are remote district hospitals having limited medical equipments and few medical specialists. In other words the ratio of health facilities to mass population or on a specific note, doctor to Patient ratio is terribly small. As a result patients travel long distances, spend huge money and risk their lives to access health services(Jean Claude,2001) Some travel all the way from villages to Kigali only to ask for medical appointments. They make long queues at hospital, these sick, weak, vulnerable patients often times go back home unattended to only told to come back to find the same situation. The long hours they lie in wait for medical appointments while hungry, thirsty, coughing at each other creates conducive environment for infectious diseases like TB and Cholera.Advancements in communication technology, especially in computers, have caused a major impact on today's healthcare. In developed countries, almost every instrument in the medical field has become computerized. Everything from thermometers to computer assisted tomography (CAT) scans is either a type of computer itself or is monitored by a computer. They calculate and factor all the data leaving rarely any information to be determined. Thus, allowing for more efficient results because it reduces the risk of human error. Additionally, since other healthcare professionals are busy caring for the patients new jobs are created to operate the

computerized instruments. Rwanda like many other developing countries has not yet embraced the potential of information era, according to Minister of youth and ICT (MYICT), a large number of people is not ICT literate (Less than 4% of citizens of 6 years and above are computer Literate) . When it comes to mobile subscribers there is much hope for a better future, Rwanda has a total of 6,039,615 mobile subscribers. MTN Rwanda cell has the lion's share, with 3,452,182; followed by Tigo with 1,806,271 and Airtel with 781,162 which is totals to more than 57% of the country population and this is according to Rwanda Utilities Regulatory Agency's (RURA) May 2013 report(Chrisostome,2009)

Problem statement

The information generated by various transactions takes time and efforts to be stored as it is paper bill, when transfer spend a month without coming they oblige patient to go back to take another transfer paper bill which is very inconveniencing, loss of money to buy those transfer paper bill ,no security transfer paper bill have at all as done manually

Manually keeping patients record details is error prone and takes a lot of time this may result in incorrect information as done by human hands.

Choice and motivation in the study

A couple of interests prompted me to undertake this project. Briefly my project interests are categorized as follows:

To AUCA ,this work will increase the literature of the institution which will be used for the students as reference for work especially it will serve as a basis to ones who will deal with related topics. Academically it will serve in knowledge evaluative practices so as to scrutinize if the knowledge offered to AUCA students was well understood and practiced.

To MDH ,this work will serve Masaka Districted Hospital to interact with other collaborated system which is Rwanda Military Hospital by sharing patients' records among them, the way of communication between the two medical systems will be easy compared to how was it before.

To me ,this project is deemed to improve my practical skills in software development and I was motivated manly by the fact that I was eager to provide real world solution that may allow medical systems to be able to share useful patient records that they want to transfer from one medical system to another in our country Rwanda, . This project is the practical result of my acquired knowledge and is one of the academic requirements to award the bachelor degree.

To my country, As Rwanda uses medical systems in most medical hospitals for the purpose of recording patients data, our government generally will benefit from this system in collaboration between these medical systems that focus on transferring patient records among them.

The objectives of the study are presented into general objectives and specific objectives:

Objectives of the study

General objective

Aim for this research is to remedy to the problem that currently occurs in a Medical Data Sharing System

Specific objectives

- To develop a system that will surely satisfy the transfers service among hospitals.
- To save information about the Patients records that comes from another hospital.
- To review existing medical data that have been transferred to a collaborated hospital.

- Keeping information about the data for collaborated medical system available to cure them.
- To propose ICT medical data sharing system using web services that can help patient who transferred to be recorded through his/her records details without coming to hospital in personal.
- To improve the communication between hospitals and minimize the time of transferring patient data.
- To make a design of implementation process for proposed systems.

Scope of the project

- ✓ To define Medical Data Sharing System using web services by recording all information of the patient to be transferred
- ✓ Only Masaka system can be able to send transfers for patient data, kanombe military hospital can not send any patient to masaka districted hospital, reason is that no reference hospital can send transfers to districted hospital.
- ✓ Kanombe military hospital system generates a notification message to request that if possible send again patient records just in case patient transferred data is expired as it is only valid for a month after being reached to kanombe hospital.
- ✓ As current system is masaka districted hospital, must be integrated to kanombe military hospital using RESTful Web Services and plaintext or original data format to send data, display them to receptionist pannel side.
- ✓ After all patients records have reached their destination at receptionist in Kanombe hospital I don't have task to send again to the particular and available doctors according to their department because in actual way Kanombe hospital management system(open clinic system) have been already generated a way receptionist send new patients to available and particular doctors accordingly.

Methodology and techniques used in the study

In order to accomplish a scientific study, it is advisable to refer to data modeling methodologies and data collection techniques. For that the following are the modeling language and techniques that I used in order to meet the objectives that I undertook.

System Development Life Cycle (SDLC)

The method of building the system in question will refer to the System Development Life Cycle (SDLC). The SDLC is an application systems approach to develop any information systems. Specifically, through the system development, waterfall model will be referred to as it is a sequential development process in which is seen as flowing steadily downwards (like a waterfall) through the phases of requirement, analysis, design, implementation, testing, integration and maintenance. (Tutorials point, 2015)

Software design methodologies

Object oriented methodology

Generally there are many methodologies to use in order to develop Information systems. My project is specifically going to be developed by using Object Oriented Methodology (OOM) as this is a system development approach that encourages and facilitates the re-use of software components. With this methodology, a computer system can be developed on components basis which enables the effective re-use of existing components and facilitates the sharing of its components by other systems.

Unified Modeling Language (UML)

As the Object Oriented Methodology (OOM) will be followed as system development approach as well the Unified Modeling Language (UML) shall come into play as this is the standard language which is used to design object-oriented systems, it is used to specify, visualize, modify, construct and document the artifacts of an object-oriented under development. It is a standard notation for modeling the Object-oriented systems. A language used to specify, visualize and document the artifacts of an object-oriented system. One of the purposes of UML was to provide the development community with a stable and common design language that could be used to develop and build computer applications. (Adegboyega Oyo, 2005)

Challenges

Through the realization of this project I actually encountered some difficulties in terms of insufficient time to complete such a project, advanced java programming concepts like web

services by using Restful web services and how to use data formats in general, how to use API Gateway where necessary.

Expected results

The new system is expected to allow the following tasks:

- ✓ allow medical systems to share data for patients and process to avoid paper bill based work.
- ✓ Reduce the timeframe and work needed to transfer data between Rwanda Military Hospital and Masaka Districted Hospital.
- ✓ Manage to provide secured and neat record keeping patient data to be transferred.
- ✓ To review existing medical data that have transferred to a collaborated hospital.
- ✓ Keeping information about the data for collaborated medical system available to cure them.
- ✓ To propose ICT medical data sharing system using web services that can help patient who transferred to be recorded through his/her records details without coming to hospital in personal.

Organisation of the report

This Study consists of five chapters. There are the descriptions on every chapter in this study:

Chapter 1: General Introduction

This chapter is the introduction about the project to be developed. It consists of Background of the study, Statement of the problem, Project objective, Project interest, Project scope, Project methodology, Project scheduler, Expected Results, and Organization of the report.

Chapter 2: Analysis of the existing system.

This chapter explained the case study of the project. It will put much emphasis on the analysis of the existing system by describing the operation of the existing Car rental system and deeply discover the problems and illustrate suggested solutions on those problems. This chapter will describe the organizational environment in which the new system will be implemented.

Chapter 3: Requirement analysis and Design of the new system

This chapter discussed more close on the overall work flow in the development of the project. It shall justify the technique along with the equipment and the software. It is normally the logical conception of the new system. It will represent and describe the conceptual process of the solutions proposed to solve the problems of the existing system.

Chapter 4: System Implementation.

This chapter discuss on how the new System has been developed in development environment structurally and logically. The technical realization of the application and the interpretation of the results are elicited as well.

Chapter 5: Conclusions and Recommendations.

This chapter concludes about the entire system as well as recommendations for future development.

CHAPTER 2

ANALYSIS OF THE EXISTING SYSTEM

INTRODUCTION

A profound review of the existing system is the key for the conception of the new system. In order to completely depict the existing medical data sharing system, different aspects are to be taken into account such as the organizational environment of the existing system, functional procedures of the existing system, identifications of the existing medical data sharing system problems, and the requirements of the new system.

Similarly, this chapter provides literature review that is related to the critical work, references used to develop, the driving causes, and purpose of the necessity of the design of the new system entitled Medical Data sharing system using web services for replacing an existing manual medical system in MASAKA.

Specific terminologies

Before analysis of the existing system, it is better to have the same understanding of terms which will be used. So let explain some of those terms.

- ✓ **Medical:** a medicine or other substance which has a physiological effect when ingested or otherwise introduced into the body.
- ✓ **Data:** is a piece of information that has been translated into a form that is efficient for movement or processing.
- ✓ **Sharing:** describes as the exchange of data in public or private way between various system,organisation,people or in network with various levels of access privileges .
- ✓ **System:** is an organized set of communicating parts.
- ✓ **Web Services:**is a method of communication between two electronic devices over a network,based on interfaces they can communicate even if they are running on different operating system and written in different languages.

MDH background

Masaka Districted hospital is one of the district hospitals in city of Kigali situated in Kicukiro district Masaka sector. It has a catchment area of 355,195. There are ten health centers and four

secondary posts in the same area. The hospital also receives clients from outside of the Kicukiro district, such as Gasabo, Nyarugenge, Rwamagana and others. The hospital was founded on 19th September 2011. The hospital has a capacity of 135 beds. The use of telecommunications technologies in medical hospitals and connectivity promises to cause impact on real-world patients, particularly for those in remote communities of developing countries and it can translate into observable outcomes such as; improved access to specialists, increased patient satisfaction with care, improved clinical outcomes, reduction in emergency room utilization and cost savings. Although there are quite many ICT system in health sector around the world, very few can serve Rwandan rural community in facilitating patients to book their medical appointments, recording all needed patients details and patients follow-up just because they use technologies that are not compatible to current peoples' economic and literacy status. As statistics revealed it, only 5% of the citizens are able to use computers and more than 57% of them own and use dump mobile phones, therefore dump (non smart) phone based applications are highly recommended.

Vision

The vision of the Masaka District Hospital is to promote the Health of the population by the offer of services of health quality.

Mission

The Masaka District Hospital's main mission is to offer the services of the preventive, promotional and curative of high quality, in order to contribute to the well-being of the population and development social and economic population.

Delivered services

- ▶ Emergency, OPD, Laboratory, Dental,
- ▶ Ophthalmology, Dermatology, Mental Health& psychiatry, GBV, NCDs, Physiotherapy, Theatre, Maternity, Neonatology, Internal Medicine, Pediatrics, Surgery, Anesthesiology, TB, HIV, Social, Pharmacy, Accounting, Supervision, Maintenance, Ambulance ,Laundry, Imaging , Mortuary, Administration.

Description of the activities of the current system

Ministry of health in Rwanda is emphasizing to have a heavy distribution of health facilities and services in rural areas since majority of the population live in rural areas. This is because high population growth rate is in rural areas and lack of health services will affect the lives of the population. Government of Rwanda is establishing health centers in sectors and districted hospitals in the country, and this will help people living in rural areas to benefit from such established health Centre but lack of proper management and patient follow- up systems will inevitably impede positive results of the efforts invested in the sector. However, the integration of ICT in heath sector has been and is being approached differently in different countries and many applications have been implemented. Masaka Districted Hospital currently All their work is done manually by their operational staff and lot of papers are needed to be handled and taken care of. Doctors have to remember various medicines available for diagnosis and sometimes miss better alternatives as they can't remember them at that time. They have manual system that workers of the hospital must be care on patients by giving medicines and then after record all their details in the appropriate books, in case there is a disease that cannot be able to fix must give them transfer to Rwanda Military Hospital which is referral hospital with five stars in Rwanda patients first seek care from a health center that delivers primary health care,including only very minor operative interventiosn such as wound repair.patients can be referred from health centers to the district hospital ,where most minor and a few major operative procedures, such as cesarean sections are available orthopedic or neurosurgical procedures are not available at district hospitals although fracture stabilization can be provided before transfer to referral hospitals to definitive treatment

RWANDAN HOSPITALS CATEGORY DESIGN

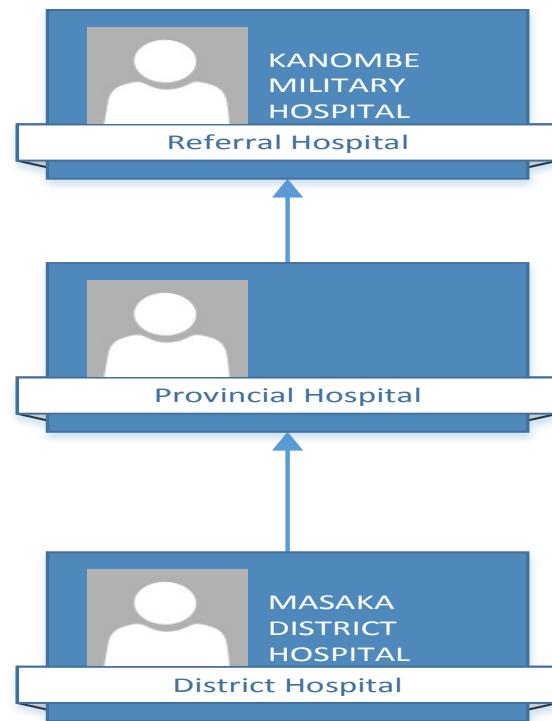


Figure 1:Hospitals category design

Techniques of data collection

There are several techniques that should be involved during this phase in order to collect data and at most time some of them sometimes are ignored and this normally could lead to acquire poor information concerning to the information that you really need. At least the following techniques should be involved as well as possible.

Written documents

During analysis, we collected the information/data from written documents available from manual-files of the institution.

Interview

The interview is the most commonly used requirements elicitation technique. After all, it is natural—usually, if you need to know something, you ask someone. In general, interviews are conducted one on one (one interviewer and one interviewee), but sometimes, due to time constraints, several people are interviewed at the same time.

Observation

Observation, the act of watching processes being performed, is a powerful tool to gain insight into the as-is system. Observation enables the analyst to see the reality of a situation, rather than listening to others describe it in interviews or document analysis.

Analysis of the existing system

In the existing MDH system is not efficiently done among data transferred from Masaka Districted Hospital to Kanombe Military Hospital because there is no direct platform that can facilitate data transferred submission and push collected or read data to be transferred directly to integrated medical systems. As well MDH system do not get data transferred conservations tips for adequate data to be shared usage management. Therefore the current system has actually a couple of weaknesses to address through adequate solutions.

Problems of the existing system

After analyzing the MDH existing system, I figured out the following weaknesses:

- ✓ Diagnosis information to patients is generally recorded on the document, which contains Patient information. It is destroyed after some time period to decrease the paper load in the office.
- ✓ MDH System have a gap of getting a way to transfer their patient to RMH
- ✓ No space in stock is available to store patient papers.
- ✓ Loss of money to buy papers bill to sign on for patient to be transferred.
- ✓ Patient should lost his/her transfer patient paper during home time before going to transferred hospital.

- ✓ If patient spend a month without coming to referral hospital transferred from his/her transfer becomes expired and require him/her to go back to Masaka District Hospital to take another transfer which is very inconvenience by wasting time.(appendix 4)

Proposed solutions to the problem found

The proposed system have the following modules:

I. The Front End:

A client-side application Mainly, it shall present:

Patient treatment tasked by Doctor side:

The doctor shall do the following:

1. Easily check available patient to be treated
2. Easily Submit patient data who have been treated to MDH servers.
- 3.able to view patients to be transferred before being shared in order to edit or delete where necessary
- 4.get alerts notification which is pushed from RMH application
- 5.easily read notification from RMH application

Orientation of patient tasked by Receptionist side:

- 1.able to orient patient to available and particular doctor
- 2.able to view all patient who get orientation to specific doctors
- 3.easily identifier patients who come to hospital

A web application that will be used by administrator and transfer applicator

- ✓ Send transfer s tasked by Transfer Applicator side:

The transfer applicator shall do the following:

1. Control and send data for patient to be transferred . The transfer applicator shall be able to process and share usage patient data just in case get data to be transferred
2. Access Reports on data of patient have been transferred.
3. View patient data reported problems, provide suggestions and solutions .

System administrator side:

The system Administrator shall do the following:

1. Control users of the system in terms of authentication to system by limiting user access.
2. Generally control the system

II. The Back-end server, which will be running at the Masaka Hospital side (MDH). It will be tasked with: Recording usage information generated to be transferred by doctor side at the transferpatientdata site in a databaseServing usage information to be transferred to the the Rwanda Military Hospital `s application

- Sending patient data transfer to the Rwanda Military Hospital`s application

CHAPTER 3

REQUIREMENT ANALYSIS AND DESIGN OF THE NEW SYSTEM

INTRODUCTION

This chapter introduces the system design techniques and overall depictions of the system as well as after through cross check of the requirements specification worked out during analysis phase. The main objective is to provide explanations on the organizing principles used to meet objectives of this research, which will elicit the significance of data collection and the analysis performed on the data in order to both achieve the research objectives produce reliable knowledge using one of the approaches known to provide efficient results scientifically and technically.

All diagrams and models of the new system will be UML based. As the Object Oriented Methodology (OOM) will be followed as system development approach as well the Unified Modeling Language (UML) shall be involved into play as this is the standard language which is used to specify, visualize and document the artifacts of an object-oriented under development. It is a standard notation for modeling the Object-Oriented system. One of the purpose of UML is to provide the development community with a stable and common design language that could be used to develop and build computer applications. (OMG TM UML, 2015).

Design concepts definition

System Design: is the process of defining the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. System design is done from the study of the existing system in order to determine what changes will be needed to incorporate the user needs that were not really met by the existing one. The output of this phase will consist of the specifications, which must describe both what the proposed system will accomplish and how it will work. The new system specifications serve to evaluate design as well as their implantation. They also facilitate quality assurance via verification (MITRE, 2015).

Concepts of object oriented methodology

Data encapsulation: this is the wrapping of data and function into a single unit. The data is not accessible to the outside world, only those functions which are wrapped in the class can access it. (Mayr, 2015)

Inheritance: The inheritance relationship, also known as the generation relationship, is used to indicate that one class is a specialization of another. With the use of inheritance the information is made manageable in a hierarchical order where the sub-classes inherit all features of their super classes. (Mayr, 2015)

Polymorphism: means the ability to take more than one form, it is also applicable on hierarchical relationship as Inheritance do. A polymorphic operation is one that has many implementations, it means the abstract operations become concrete in sub-class where they have to respond according to the specific object. (Mayr, 2015)

Unified Modeling Language (UML)

The Unified Modeling Language (UML) is the standard language which is used to design object-oriented systems, it is used to specify, construct and document the artifacts of an object-oriented under development. It is a standard notation for modeling the object-oriented systems.

(Adegboyega O., 2005)

UML Notations

- **A class** is an abstraction in object-oriented modeling and in object-oriented programming languages. Like abstract data types, a class encapsulates both structure and behavior. Unlike abstract data types, classes can be defined in terms of other classes by using inheritance. (Adegboyega O., 2005)

Class Name
-Attribute 1
-Attribute 2
-Attribute n

+operation 1()
+operation 2()
+operation n()

- A table is a set of data elements that is organized using a model of vertical columns and horizontal rows. A table has a specified number of columns, but not for rows.
(Abumarasa, 2011)

Table Name

Relationships

are connections between modeling elements, they are the UML way of connecting things together so that they can perform useful work of benefit to the users of the system. In OO modeling, there are three kinds of relationships that are most important: dependencies, generalizations and associations.

1. Dependency

A dependency is a using relationship between two elements where a change to one element may affect information needed by the other element but not necessarily the reverse. Graphically, a dependency is rendered as a dashes directed line, directed to the thing being depended on.



2. Generalization

Generalization is a relationship between more general element (Super-class) and more specific element (sub-class), where the more specific element is entirely consistent with the more general element, but contains more information. Graphically, generalization is rendered as a solid directed line with a large open arrowhead, pointing to the super-class.



3. Association

An association is a relationship between two classes/objects represented by a solid line. Associations are bi-directional by default, so both classes know about each other and about the relationship between them. Graphically, an association is rendered as a solid line connecting classes.



4. Multiplicity (Cardinality)

Kinds of multiplicity are the symbols which indicate the number of instances of one class linked to one instance of the other class and are placed at the end of relationships. It is written as an expression with a minimum and maximum value, two dots are used to separate the minimum and maximum values. (Briefly is the number of objects that participate in the relationship)

5. Navigability:

Aggregation Kinds of multiplicity is a plan association between two classes represents a structural relationship between peers, meaning that both classes are conceptually at the same level, no one more important than the other .It expresses a relationship among instances of related classes. It is a specific kind of container-Containee relationship. Expresses a more informal relationship than composition expresses .

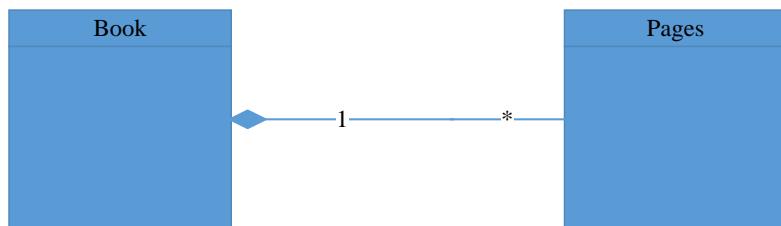
Aggregation is appropriate when Container and Containees have no special access privileges to each other. May form “part of” the association, but may not be essential to it. They may also exist independent of the aggregate.

6. Aggregation: "is part of" – symbolized by a clear white diamond



Composition: "is entirely made of"

- Stronger version of aggregation
- The parts live and die with the whole
- symbolized by a black diamond
- symbolized by dotted line
- Often is an implementation detail, not an intrinsic part of that object's state



Software development methodology

Waterfall model

The waterfall model is a sequential development process in which is seen as flowing steadily downwards (like a waterfall) through the phases of requirement, analysis, design, implementation, testing, integration and maintenance Drugs Ordering Integration Gateway between Pharmacy and Pharmaceutical Warehouse followed Water model phases. (Tutorials point, 2015)

The two key advantages of waterfall development-based methodologies are:

- The system requirements are identified long before programming begins
- Changes to the requirements are minimized as the project proceeds.

The two key disadvantages of waterfall development-based methodologies are:

- The design must be completely specified before programming begins
- A long time elapses between the completion of the system proposal in the analysis phase and then delivery of the system. (Tutorials point, 2015) The waterfall model can be shown in the following figure:

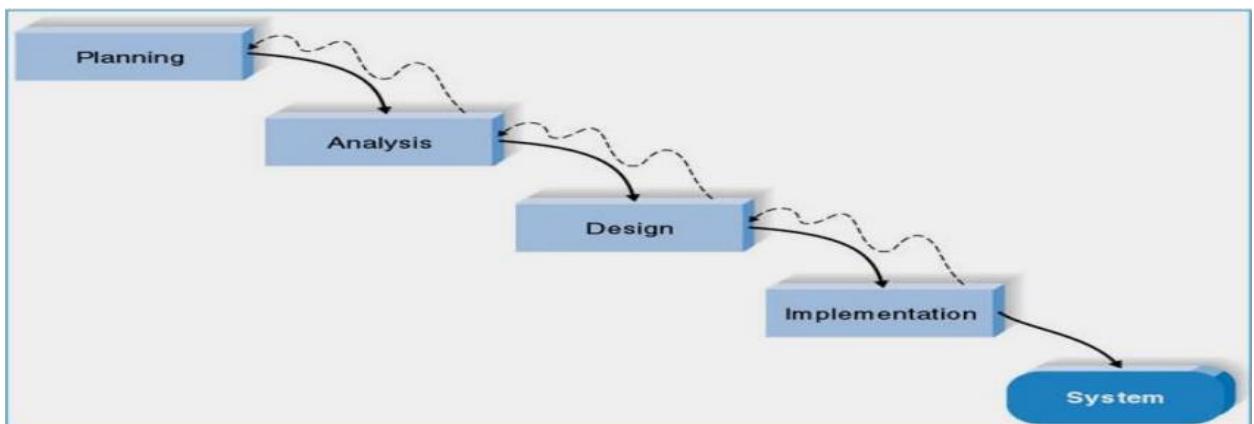


Figure 2. Waterfall model

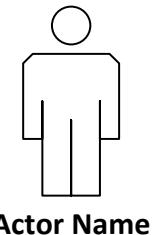
Waterfall model time spent on making requirements and design are absolutely correct and saved to the researcher much time and effort. A further argument for the waterfall model is that it places emphasis on documentation (such as requirements, documents and design documents) as well as procedures. Despite to the above, the researcher prefers the waterfall model for its simple approach and argues that is more declined.

Design of the new system

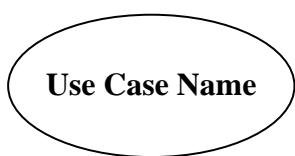
Usecase diagram

After getting all customer needs or requirements we have to analyze them, doing so different models or diagrams are used. At this particular point we will focus on use case diagram. Use case diagram describes the functionality provided by a system in terms of actors, and relationships between actors and use cases. The followings are components of a use case model:

An actor: a person or any device that interacts with a system (Visio professional, 2013) and is represented as follows:

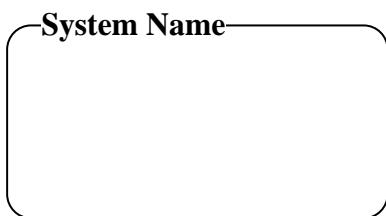


A use case is a specification of sequences of actions that a system can perform by interacting with outside actors, and is represented as follows:



Relationships are meaningful associations between actors and use cases, which is a UML association symbol.

System boundary: It is a box drawn around the use case to denote the edge or boundary of the system being modeled



MDH Administrator Use Case Diagram

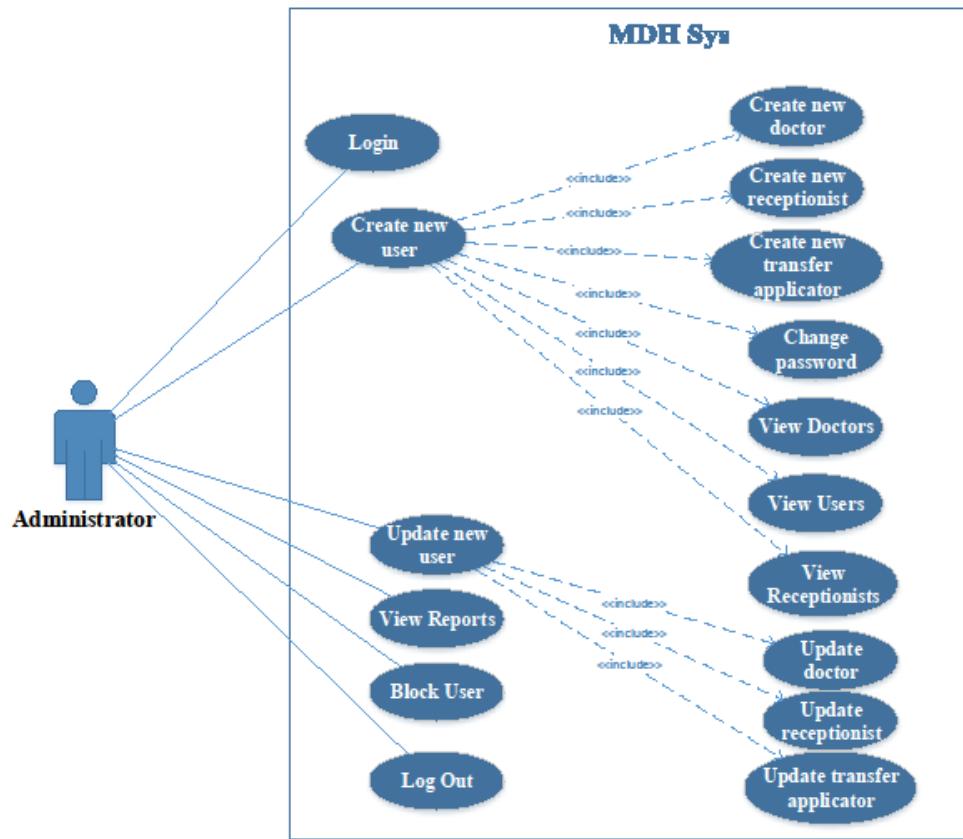


Figure 3:Use Case Diagram MDH Administrator

MDH Receptionist Use Case Diagram

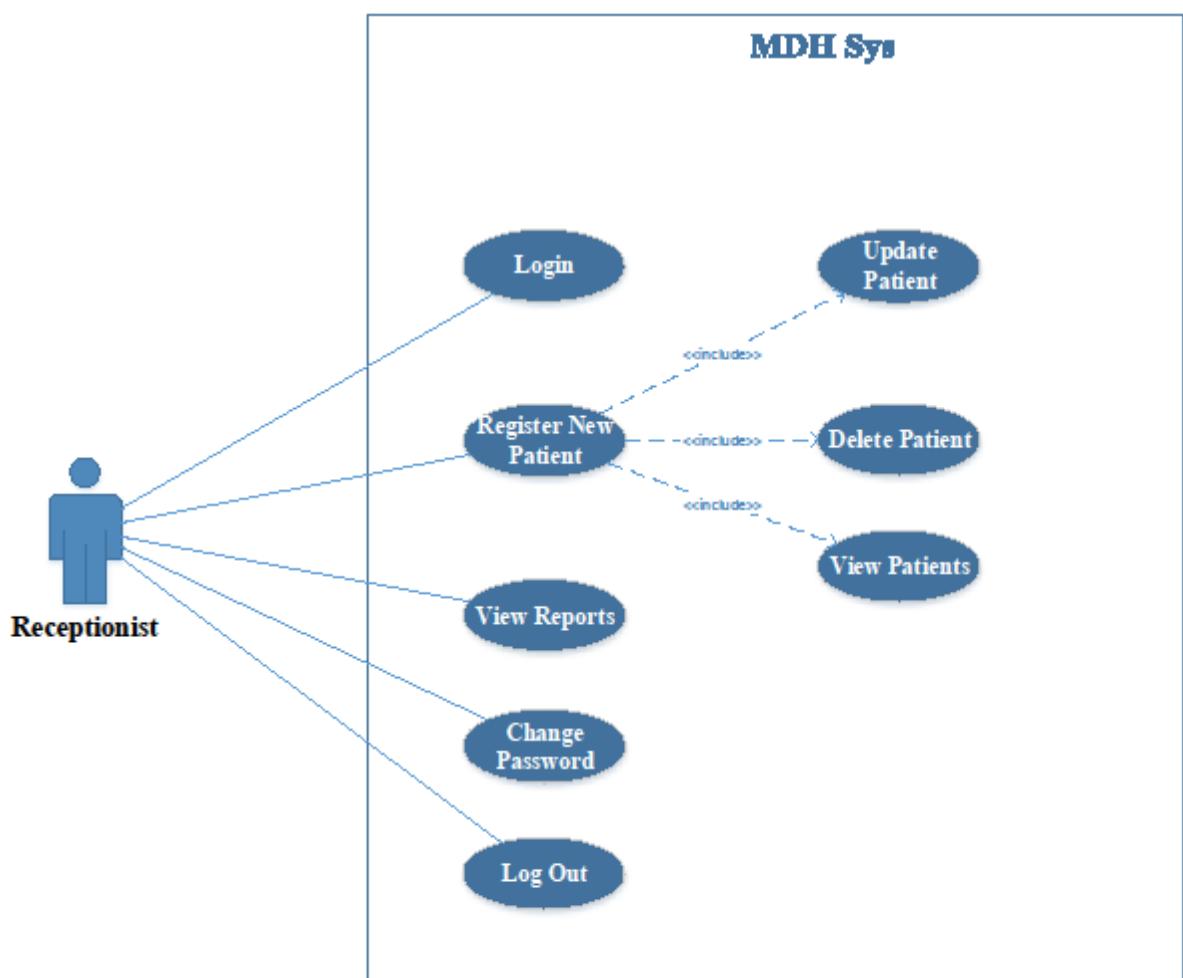


Figure 4: Use Case Diagram MDH Receptionist

MDH Doctor Use Case Diagram

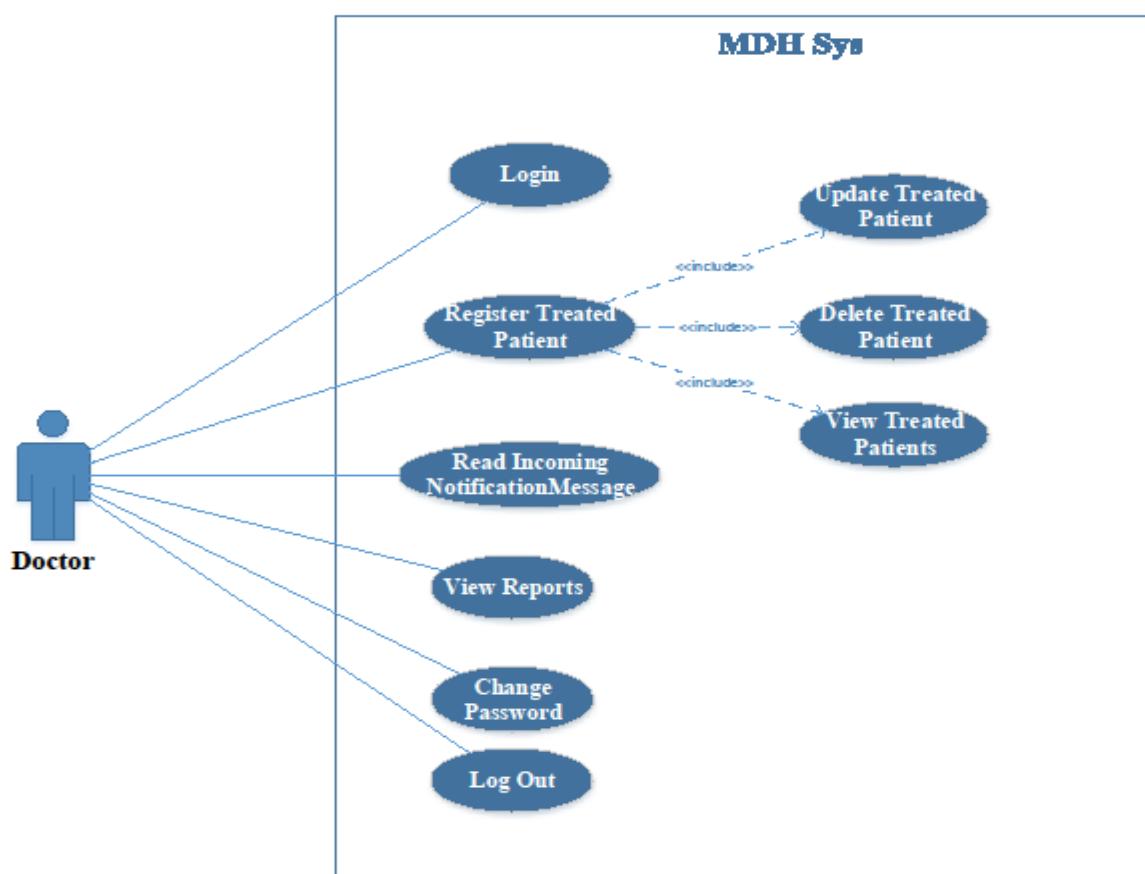


Figure 5: Use Case Diagram MDH Doctor

MDH Transfer Applicator Use Case Diagram

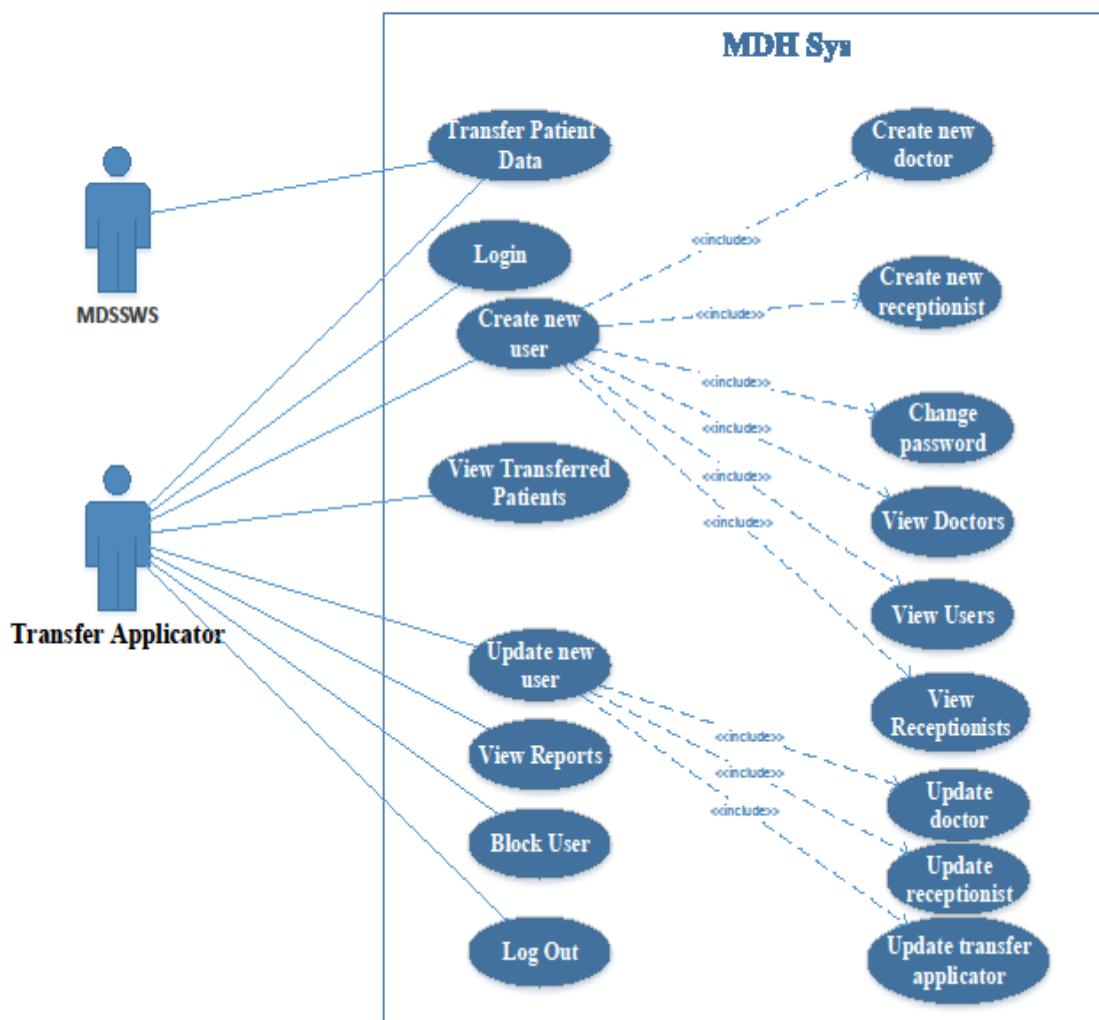


Figure 6: Use Case Diagram MDH Transfer Applicator

RMH Administrator Use Case Diagram

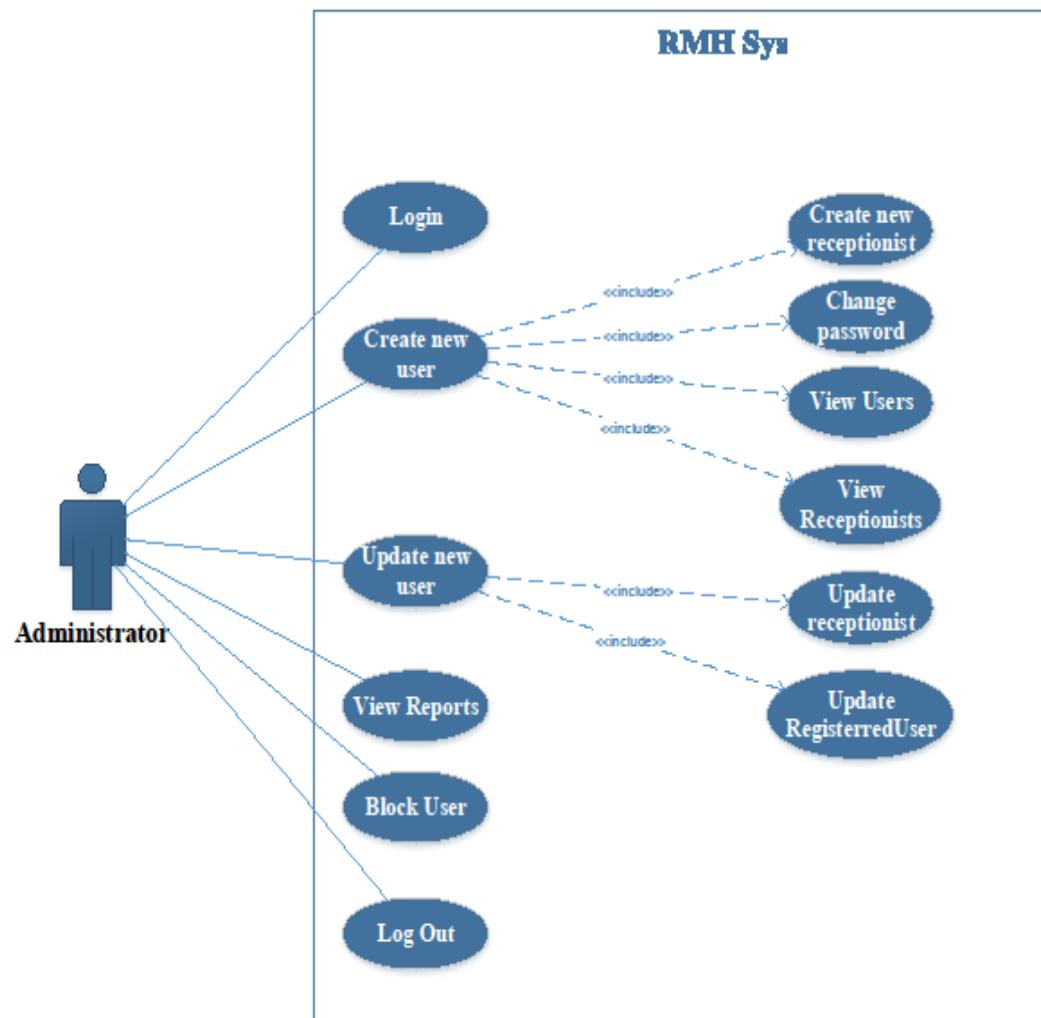


Figure 7: Use Case Diagram RMH Administrator

RMH Receptionist Use Case Diagram

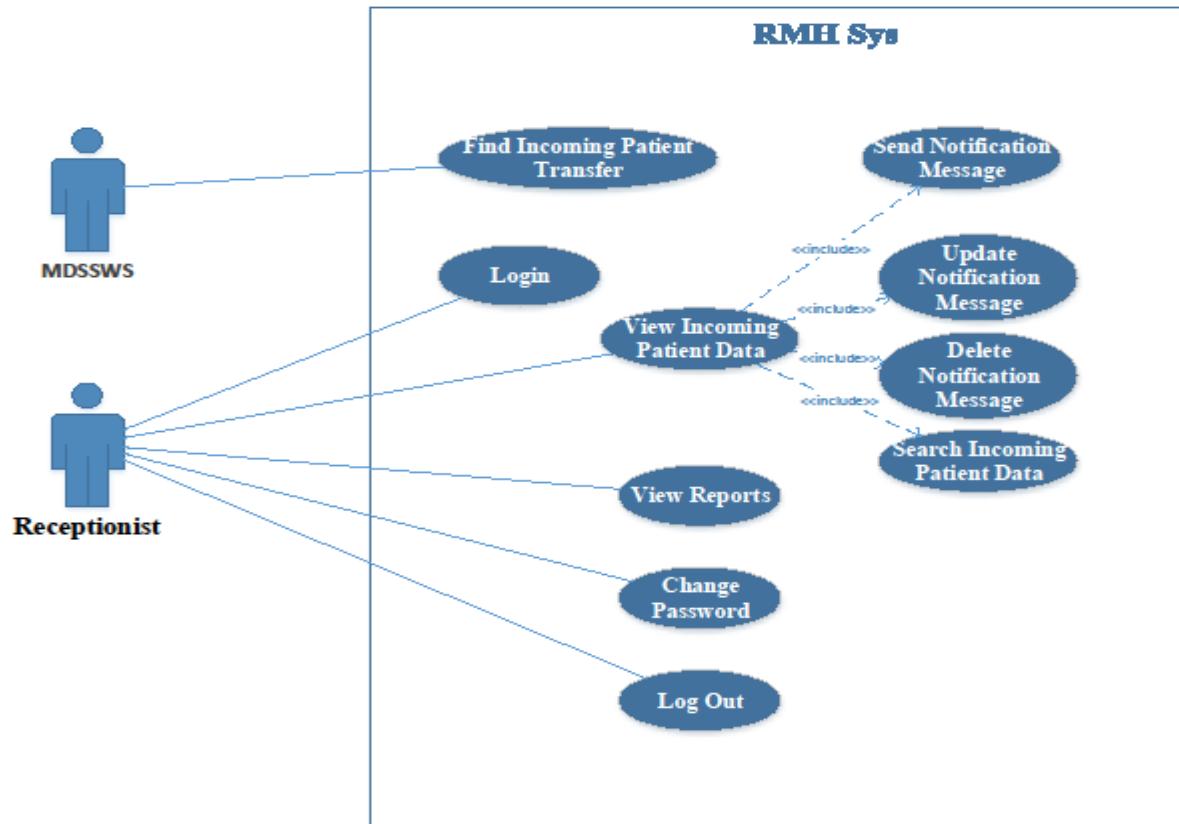


Figure 8: Use Case Diagram RMH Receptionist

Usecase description

Use Case description details what a use case do, and what it requests in order to be well executed. Each use case looks like this:

Title: a name of a use case.

Goal: what a system intends to do.

Actor: the actor involved in the use case.

Precondition(s): the system state before the use case can begin.

Post condition(s): the system state when the use case is over.

Main normal flow: the actual steps of the use case.

Alternative flow: steps which may happen in case a normal flow fails.

Use Case Description: Login

Use case Description for kanombe Hospital Integrated System: Login

Use Case Name:	Login:
Actor:	Admin ,Receptionist ,Doctor
Description:	This case allows user to check authentication
Pre-condition:	User must prompt the system to login
Normal Flow	
Actor	System
3.The User will fill in the information and continue /login as necessary	1.The system will display login page 2.The system will bring up login menu.(user ID and password)
Alternative Flow	3.a. in step 3 of normal flow, if the user does not log in successfully 1.system displays unknown user message 2.system resumes on step 3
Exceptions	3.a. in step 3 of normal flow, if the credentials are invalidated 1.The system displays invalidation Error message 2.The system resumes on step 3
Post-conditions	The system gives access to the user

Table 1.Usecase Description RMH System Login

Use case Description for Kanombe Hospital Integrated Systems: Create Users

Use Case Name:	Create users
Actor:	Admin
Description:	This case allows user create user
Pre-condition:	User should be logged in
Normal Flow	
Actor	System
2.The administrator will log in 4.The administrator selects create user 6.The administrator fills in all required data	1.The system will prompt for login 3.The System prompts the administrator to the main menus/option 5.system will the use page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown user message 2.system resumes on step 2
Exceptions	2.a. in step 2 of normal flow, if the credentials are invalidated 1.The system displays invalidation Error message

Table2.Usecase Description RMH System create Users

Use case Description for Masaka Hospital Integrated Systems: Create Users

Use Case Name:	Create users
Actor:	Admin, TransferApplicator
Description:	This case allows user create user
Pre-condition:	User should be logged in
Normal Flow	
Actor	System
2.The administrator, transferApplicator will log in 4.The administrator selects create user 6.The administrator, transferApplicator fills in all required data	1.The system will prompt for login 3.The System prompts the administrator, transferApplicator to the main menus/option 5.system will the use page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown user message 2.system resumes on step 2
Exceptions	2.a. in step 2 of normal flow, if the credentials are invalidated 1.The system displays invalidation Error message

Table3.Usecase Description MDH System create Users

Use case Description for Masaka Hospital Integrated System: Block user account

Use Case Name	Block user account
Actor:	Administrator,transferapplicator
Description:	This case allows admin,transferapplicator to block user account
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The admin,transferapplicator will log in 4.The admin,transferapplicator select block user account 6.The admin,transferapplicator fills in all required data	1.The system will prompt for login 3.The System prompts the admin,transferapplicator to the main menus/option 5.system will bring up user page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table4.Usecase Description MDH System block user account

Use case Description for Masaka Hospital Integrated System: create new Doctor,Receptionist,TransferApplicator

Use Case Name	Create doctor,receptionist,transferapplicator
Actor:	Admin
Description:	This case allows admin to create doctor,receptionist,transferapplicator
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The administrator will log in 4.The administrator select create doctor,receptionist,transferapplicator option 6.The administrator, transferApplicator fills in all required data	1.The system will prompt for login 3.The System prompts the administrator to the main menus/option 5.system will bring up the doctor,receptionist,transferapplicator page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully

Table5.Usecase Description MDH System block user account

Use case Description for Kanombe Hospital Integrated System: create new Doctor, Receptionist

Use Case Name	Create doctor, receptionist
Actor:	Admin
Description:	This case allows admin to create doctor, receptionist
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The administrator will log in 4.The administrator select create doctor, receptionist option 6.The administrator, transferApplicator fills in all required data	1.The system will prompt for login 3.The System prompts the administrator to the main menus/option 5.system will bring up the doctor,receptionist page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table6 :Usecase Description MDH System create new doctor,receptionist,transferapplicator

Use case Description for Masaka Hospital Integrated System: save new patient

Use Case Name	Save new patient
Actor:	Receptionist
Description:	This case allows receptionist to save new patient
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The receptionist will log in 4.The receptionist select save new patient option 6.The receptionist fills in all required data	1.The system will prompt for login 3.The System prompts the receptionist to the main menus/option 5.system will bring up the patient page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table7 :Usecase Description MDH System create new patient account

Use case Description for Masaka Hospital Integrated System: register treated patient

Use Case Name	Register treated patient
Actor:	Doctor
Description:	This case allows doctor to register treated patient
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The doctor will log in 4.The doctor select register treated patient option 6.The doctor fills in all required data	1.The system will prompt for login 3.The System prompts the doctor to the main menus/option 5.system will bring up the treated patient page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table8 :Usecase Description MDH System register treated patient account

Use case Description for Masaka Hospital Integrated System: send patient transfer

Use Case Name	Send patient transfer
Actor:	TransferApplicator
Description:	This case allows transferapplicator to send patient transfer
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The transferapplicator will log in 4.The transferapplicator select send patient transfer option 6.The transferapplicator fills in all required data	1.The system will prompt for login 3.The System prompts the transferapplicator to the main menus/option 5.system will bring up the send patient transfer page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table9:Usecase Description MDH System send patient transfer account

Use case Description for Masaka Hospital Integrated System: read notification

Use Case Name	Read notification
Actor:	doctor
Description:	This case allows doctor to read incoming notification message
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The doctor will log in 4.The doctor select read notification option 6.The doctor read all incoming notification message	1.The system will prompt for login 3.The System prompts the doctor to the main menus/option 5.system will bring up the incoming notification page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown user message

Table10 :Usecase Description MDH System read notification

Use case Description for Kanombe Hospital Integrated System: Send notification

Use Case Name	Read notification	
Actor:	receptionist	
Description:	This case allows receptionist to send notification	
Pre-condition:	User should be logged in first	
Normal Flow		
Actor	System	
2.The receptionist will log in 4.The receptionist select send notification option 6.The receptionist fills in all required data	1.The system will prompt for login 3.The System prompts the receptionist to the main menus/option 5.system will bring up the send notification page 7.The system processes the input data	
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown	

Table 11:Usecase Description MDH System send notification

Use case Description for Kanombe Hospital Integrated System: read incoming patient data

Use Case Name	Read incoming patient data
Actor:	receptionist
Description:	This case allows receptionist to read incoming patient data
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The receptionist will log in 4.The receptionist select read incoming patient data option 6.The receptionist read all incoming patient data	1.The system will prompt for login 3.The System prompts the receptionist to the main menus/option 5.system will bring up the incoming patient data page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown

Table12 :Usecase Description MDH System read incoming patient data

Use case Description for Masaka Hospital Integrated System: update doctor, receptionist, transferapplicator account

Use Case Name	Update doctor,receptionist,transferapplicator account
Actor:	Administrator
Description:	This case allows administrator to update doctor,receptionist,transferapplicator
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The admin will log in 4.The admin select update doctor, receptionist and transferapplicator account 6.The admin fills in all required data	1.The system will prompt for login 3.The System prompts the admin to the main menus/option 5.system will bring up user page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown user

Table 13:Usecase Description MDH System Update doctor,receptionist,transferapplicator

Use case Description for Masaka Hospital Integrated System: update transfer patient data

Use Case Name	Update transfer patient data
Actor:	doctor
Description:	This case allows doctor to update transfer patient data
Pre-condition:	User should be logged in first
Normal Flow	
Actor	System
2.The doctor will log in 4.The doctor select update transfer patient data and transfer applicator account 6.The doctor fills in all required data	1.The system will prompt for login 3.The System prompts the doctor to the main menus/option 5.system will bring up doctor page 7.The system processes the input data
Alternative Flow	2.a. in step 2 of normal flow, if the user does not log in successfully 1.system displays unknown user message

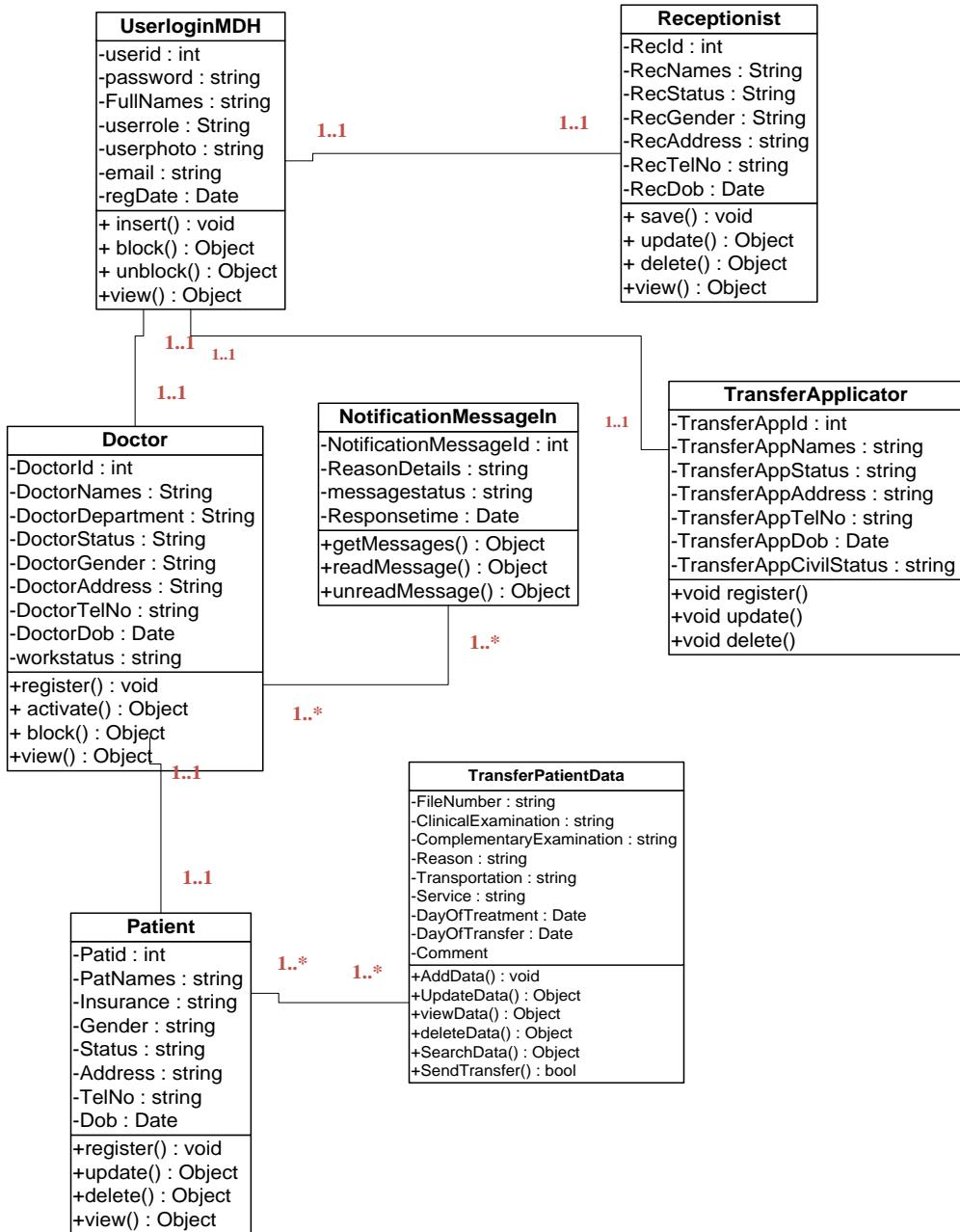
Table14 :Usecase Description MDH System update transfer patient data account

Use case Description for Masaka Hospital Integrated System: Login

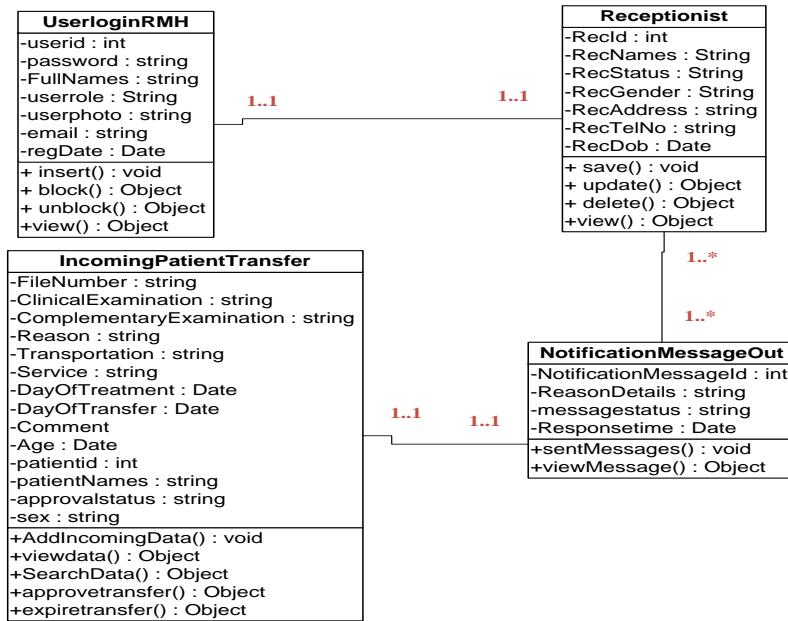
Use Case Name:	Login:
Actor:	Admin ,Receptionist ,Doctor, Transfer Applicator
Description:	This case allows user to check authentication
Pre-condition:	User must prompt the system to login
Normal Flow	
Actor	System
3.The User will fill in the information and continue /login as necessary	1.The system will display login page 2.The system will bring up login menu.(user ID and password)
Alternative Flow	3.a. in step 3 of normal flow, if the user does not log in successfully 1.system displays unknown user message 2.system resumes on step 3
Exceptions	3.a. in step 3 of normal flow, if the credentials are invalidated 1.The system displays invalidation Error message 2.The system resumes on step 3
Post-conditions	The system gives access to the user

Table15 :Usecase Description MDH System Login account

Class diagram : MDH



Class diagram :RMH



Domain analysis

In Software engineering, Domain analysis is the process of analyzing related software to determine the operations, properties appropriate for designing solutions to problems in a given Domain. The output of this process is a class diagram. Class diagram in the Unified Modeling Language (UML) is a structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes.

Architecture design System architecture is a representation of a system in which there is a mapping of functionalities into hardware and software components, a mapping of the software

architecture into the hardware architecture, and human interaction with these components. The following figure displays sample system architecture of an application server. The important step of design is the creation of the physical architecture layer design, the plan for how the system will be distributed across the computers and what hardware and software will be used for each computer. Most systems are built to use the existing hardware and software in the organization, so often the current architecture and hardware and software infrastructure restricts the choice. Other factors, such as corporate standards, existing site -licensing agreements, and product vendor relationships also can mandate what architecture, hardware, and software the project team must design. However, many organizations now have a variety of infra-structures available or are openly looking for pilot projects to test new architectures, hardware, and software, which enable a project team to select architecture on the basis of other important factors.

The system design architecture has following parts:

1. The user interface, which runs on the user's computer (the client) this part is a set of Hardware (mainly computers) and software with a user interface (usually a web browser) for presentation purposes. It presents the user interface from an application server side.
2. The functional modules that actually process data. This middle tier runs on server and is often called the application server.
3. A database management system (DBMS) that stores the data required by middle tier. This tier runs on a second server called the database server.

System design architecture

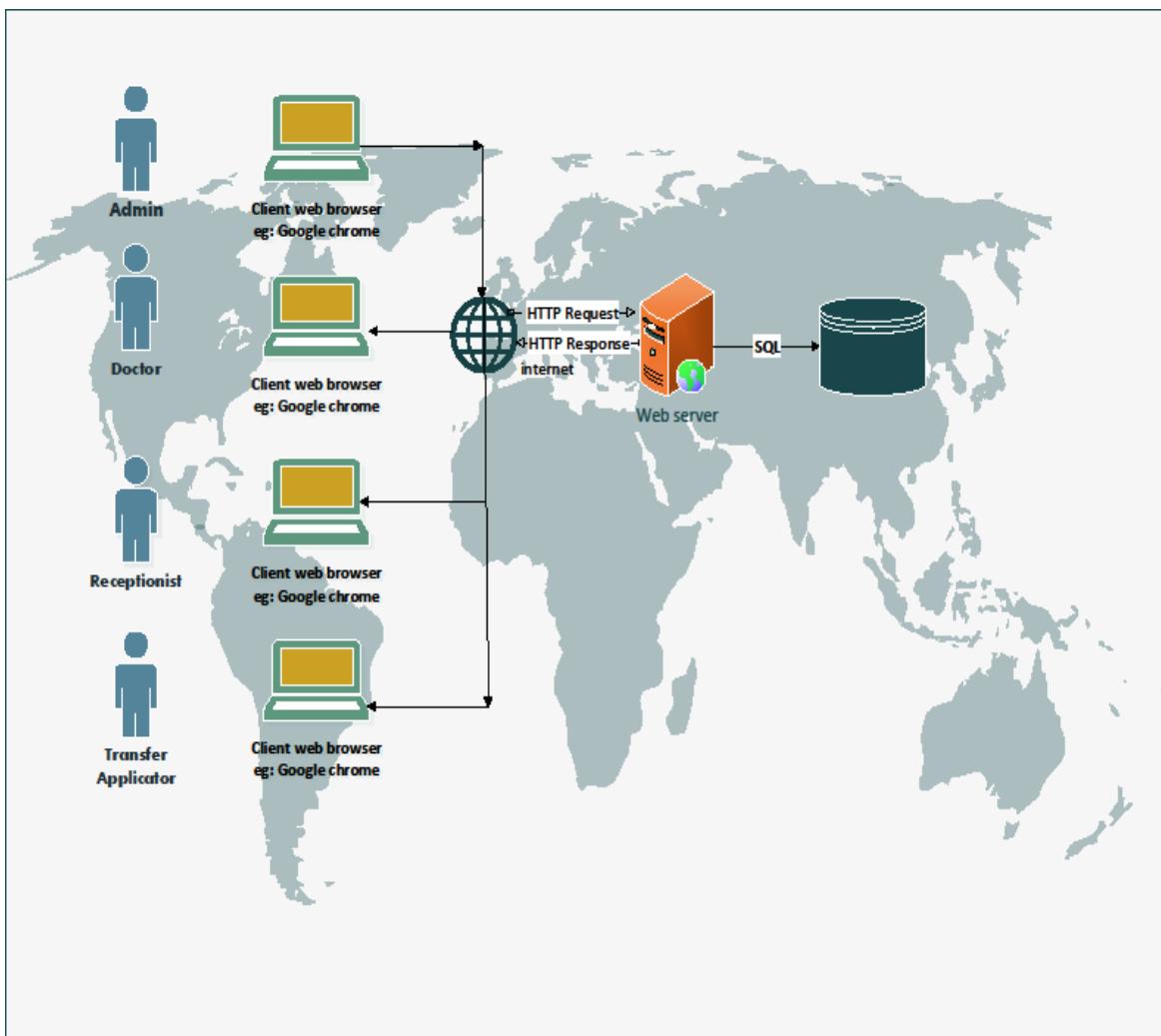


Figure 9. System design architecture

Sequence diagram

A sequence diagram shows object interactions arranged in time sequence, in a Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another in a given order. Sequence diagrams typically are associated with use case Realizations in the logical view o f the system under development. (Concept Draw Solution Park, 2015)

The symbols below are used in sequence diagram:

- Object



- Activation



- Messages



Sequence diagram of the new system

Login Process sequence diagram

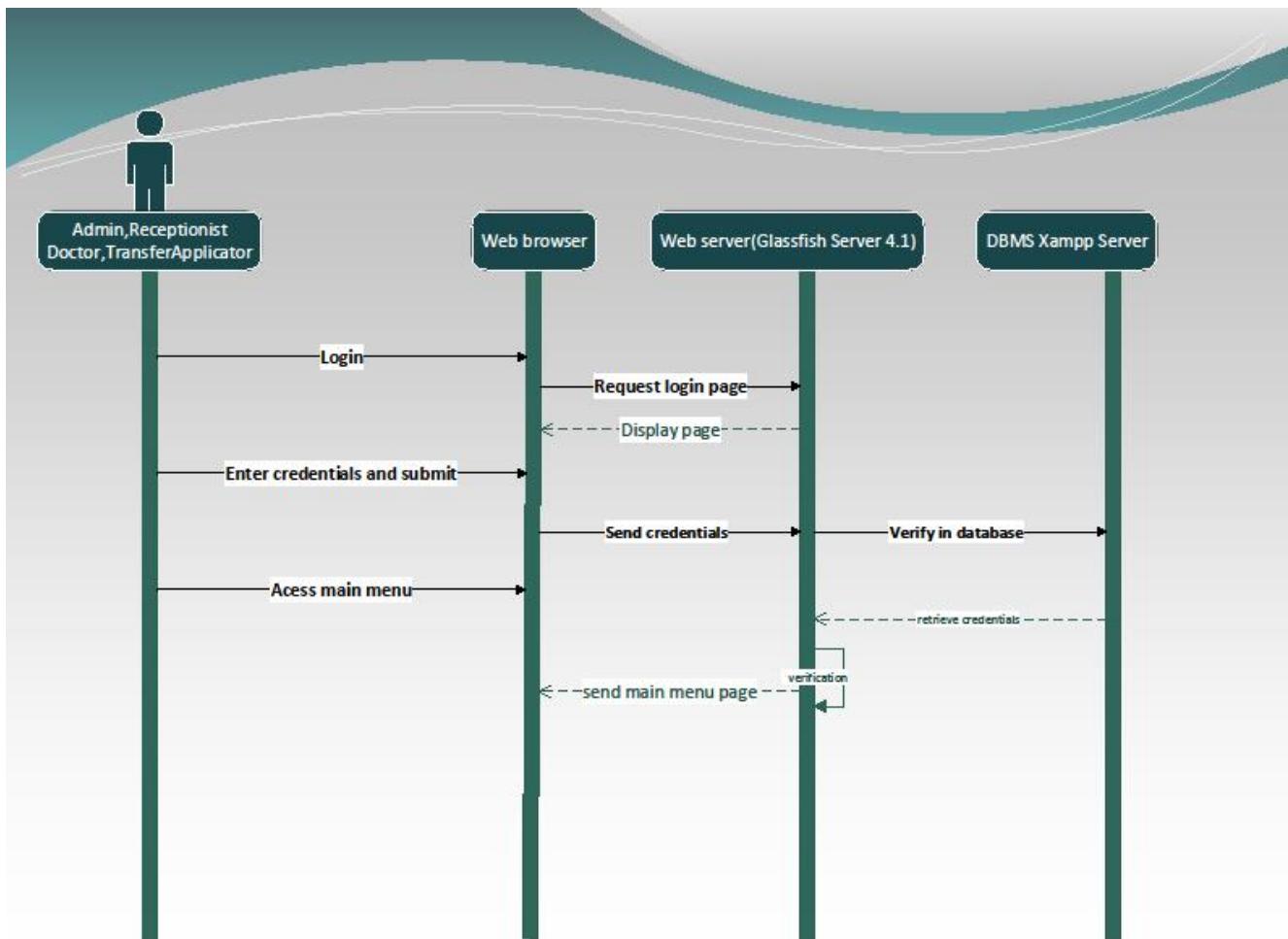


Figure10. Sequence diagram: Login process

Create user account sequence diagram

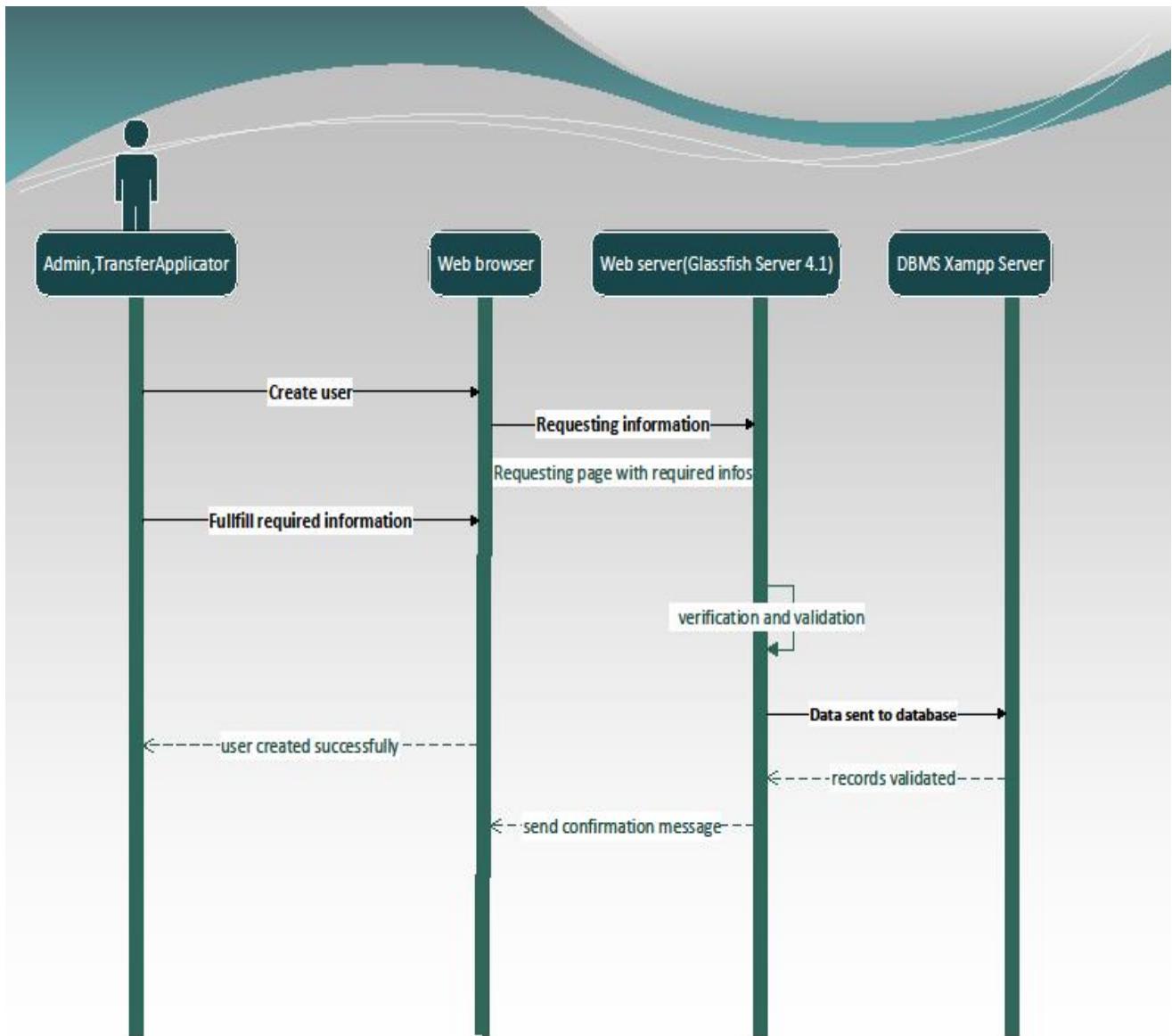


Figure11. Sequence diagram: create user account

Block user account sequence diagram

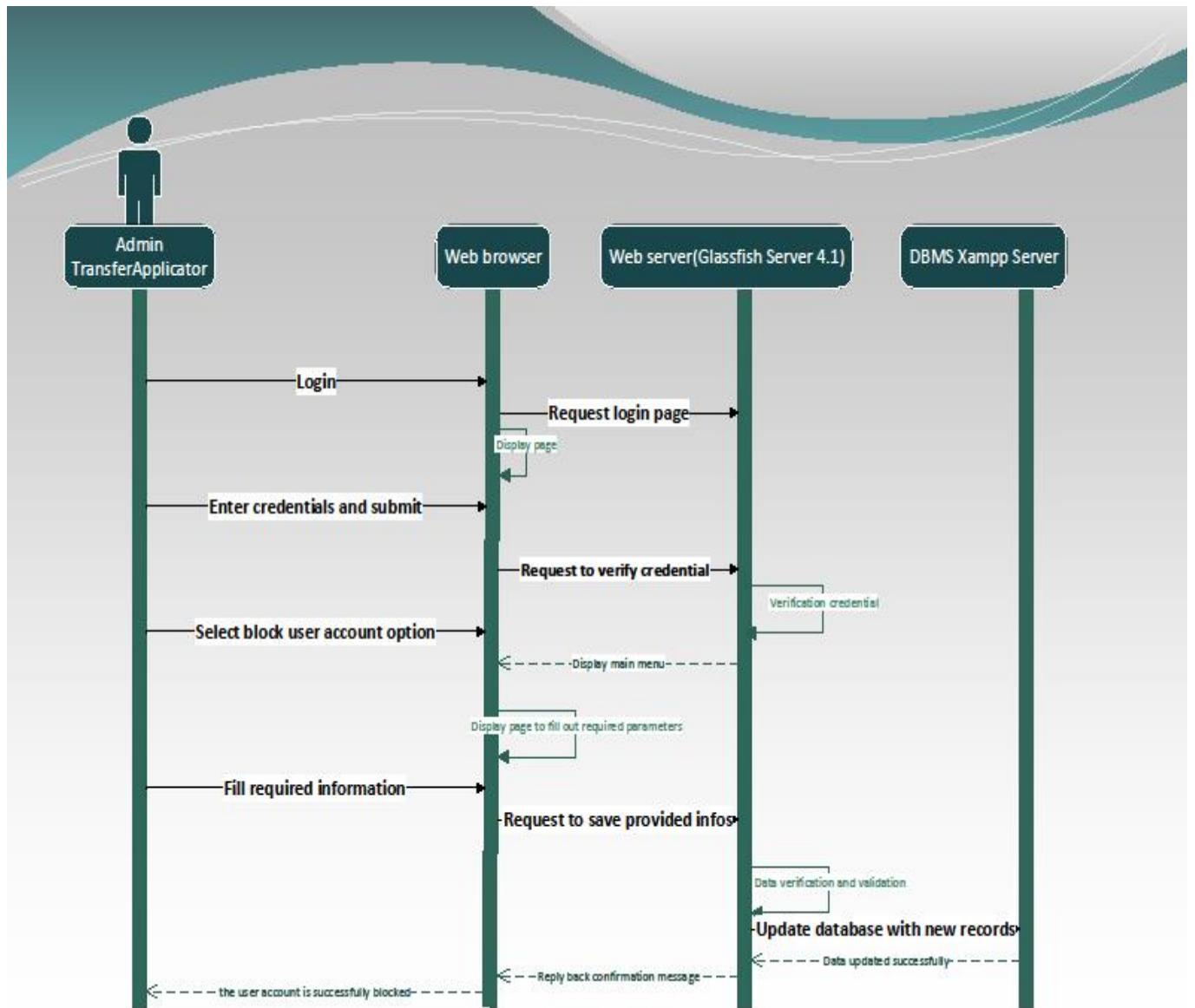


Figure 12. Sequence diagram: block user account

Transfer patient data account sequence diagram

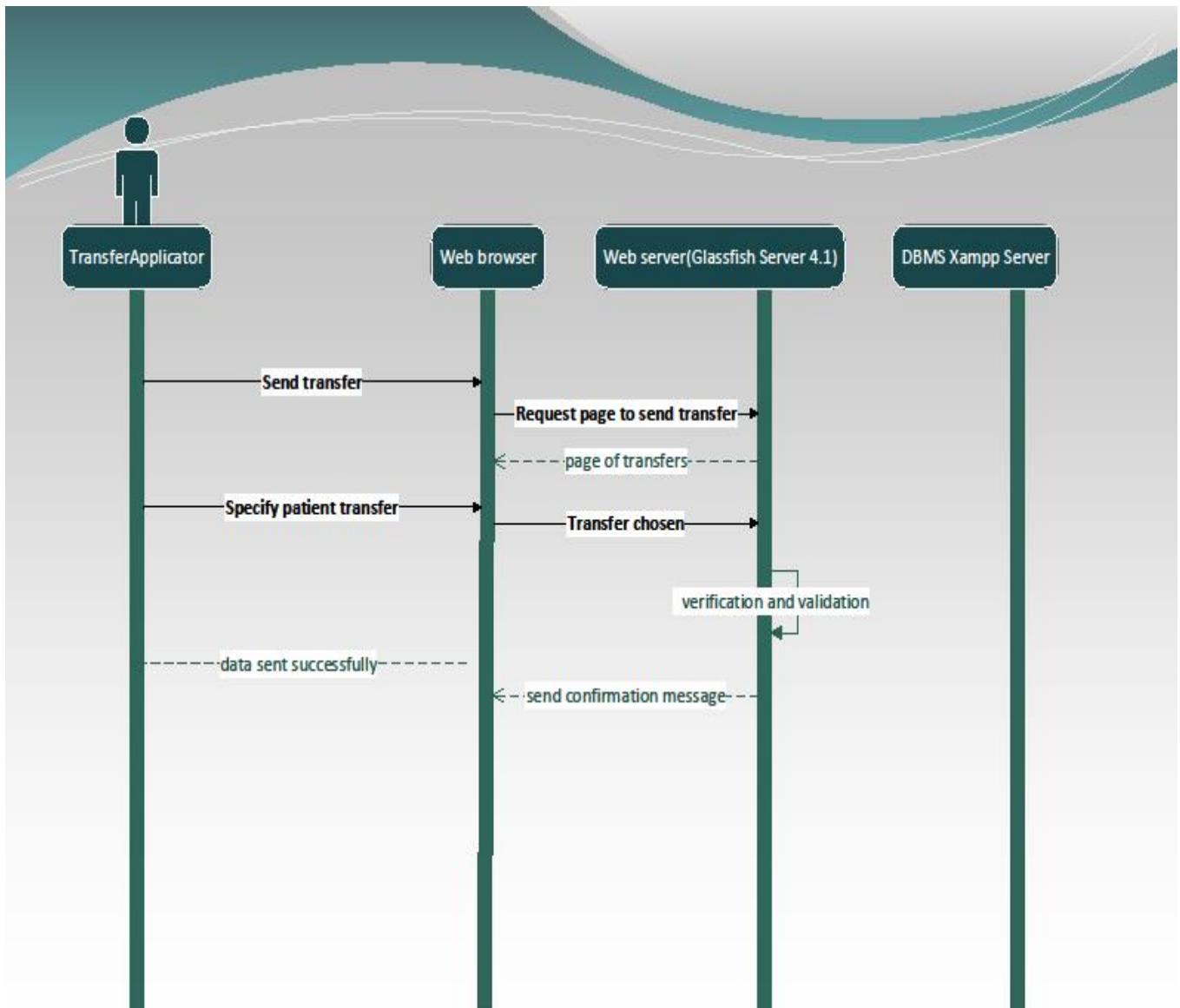


Figure 13. Sequence diagram: block user account

Database design

Database design illustrates a detailed data model of a database. It shows how the database is structured and used. Database designs also include Entity-Relationship(ER).A database is a collection of related data. By data, we mean known facts that can be recorded and That has implicit meaning. This logical data model contains all the needed logical and physical Design choices and physical storage parameters needed to generate a design in a Data Definition Language, which can then be used to create a database. A fully attributed data model contains detailed attributes for each entity. In an object database the entities and relationships map directly to object classes and named relationships. However, the term database design could also be used to apply to the overall process of designing, not just the base data structures, but also the forms and queries used as part of the overall database application within the database management system (DBMS). (Cinegreix Pty .Ltd, 2015)

Database terms

A. Record

A record or tuple is a complete set of related fields. Usually, in a table containing fields, a row of related fields of data is also a record.

B. Field

A field is a property or a characteristic that holds some piece of information about an entity. Also, it is a category of information within a set of records.

C. Entity

Entity is an existing or real thing, in relation to database; an entity is a single person, place or thing about which that can be stored.

D. Relation

In the relational data model, the data in a database is organized in relations. A relation is synonymous with a table. A table consists of columns and rows, which are referred as field and records in DBMS terms, and attributes and tuples in Relational DBMS terms.

E. Relationship

Relationship is an association among several entities. Relationship between more than two entities set is rare. A relationship shows connections among the system's entities. There are four major types of relationships used in ERD- Entity Relationship Diagrams (Which are specialized graphics that illustrate the inter- relationships between entities in a database):

- One to one;
- One to many;
- Many to one;
- Many to many;

F. Attributes

Attributes describe the entity of which they are associated. A particular instance of an attribute is a value. A 'patient' for example, has attributes such as a First name, a nd a district. The domain of First name is a character string. Attributes are classified as identifiers commonly called keys, which uniquely identify an instance of an entity. They are also classified as descriptors which show a non-unique characteristic of an entity instance.

G. Data

Data is a collection of facts, such as values or measurements. It can be numbers, words, Measurements, observations or even just descriptions of things.

H. Keys

The key is defined as the column or attribute of the database table. For example if a table has id, name and address as the column names then each one is known as the key for that table.

We can also say that the table has 3 keys as id, name and address. The keys are also used to identify each record in the database table.

The following are the various types of keys available in the DBMS system.

- A simple key contains a single attribute.
- A composite key is a key that contains more than one attribute.
- A candidate key is an attribute (or set of attributes) that uniquely identifies a row.
- A primary key is the candidate key which is selected as the principal unique identifier. Every relation must contain a primary key. The primary key is usually the key selected to identify a row when the database is physically implemented. For example, a part number is selected instead of a part description.
- A foreign key is an attribute (or set of attributes) that appears (usually) as a non key attribute in one relation and as a primary key attribute in another relation. I say usually because it is possible for a foreign key to also be the whole or part of a primary key.

Database schema diagram

A database schema of a database system is its structure described in a formal language supported by the database management system (DBMS) and refers to the organization of data as a blueprint of how a database is constructed (divided into database tables in case of Relational Databases). The formal definition of database schema is a set of formulas (sentences) called integrity constraints imposed on a database. These integrity constraints ensure compatibility between parts of the schema.

Figure 14. RMH Database Schema

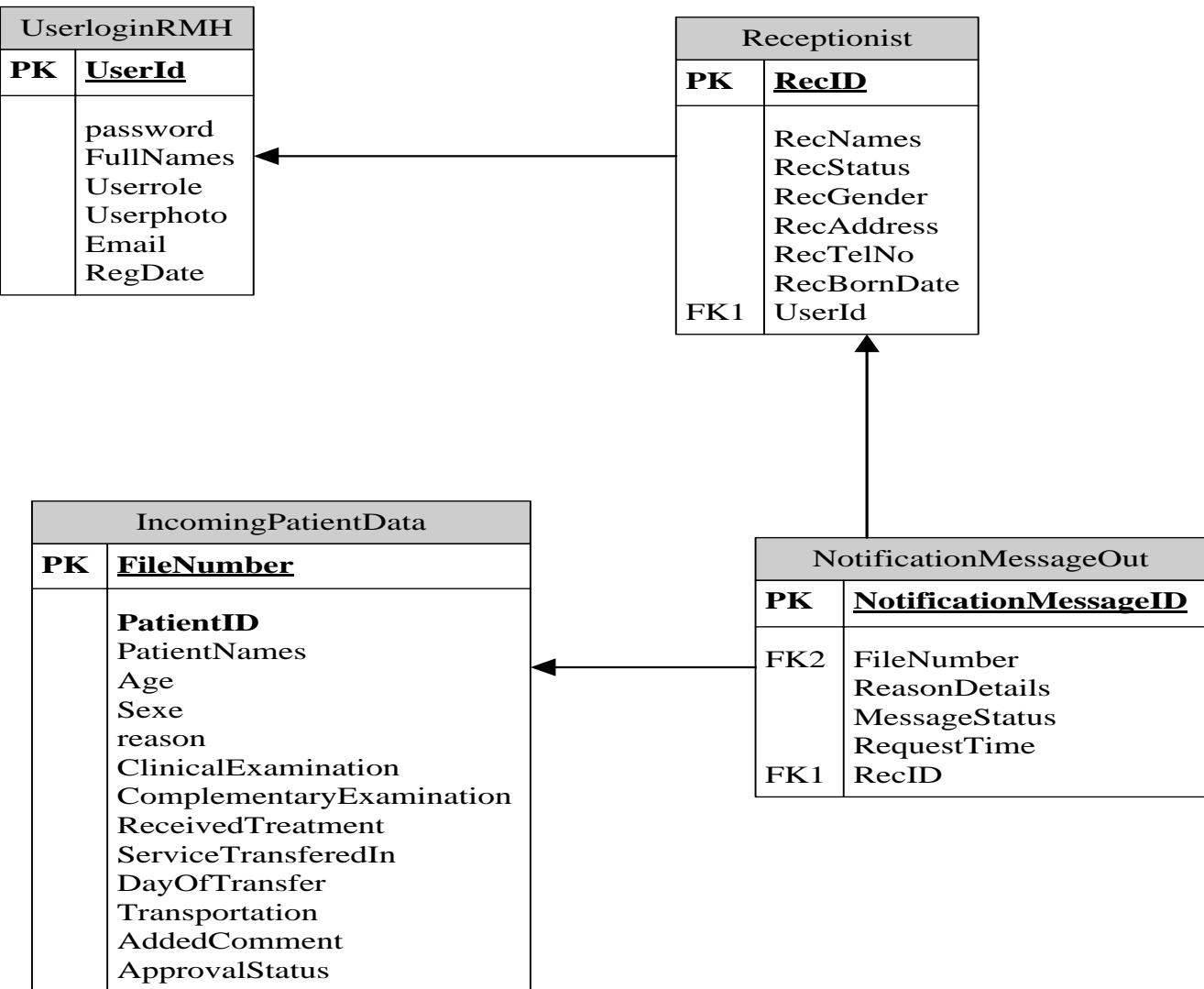
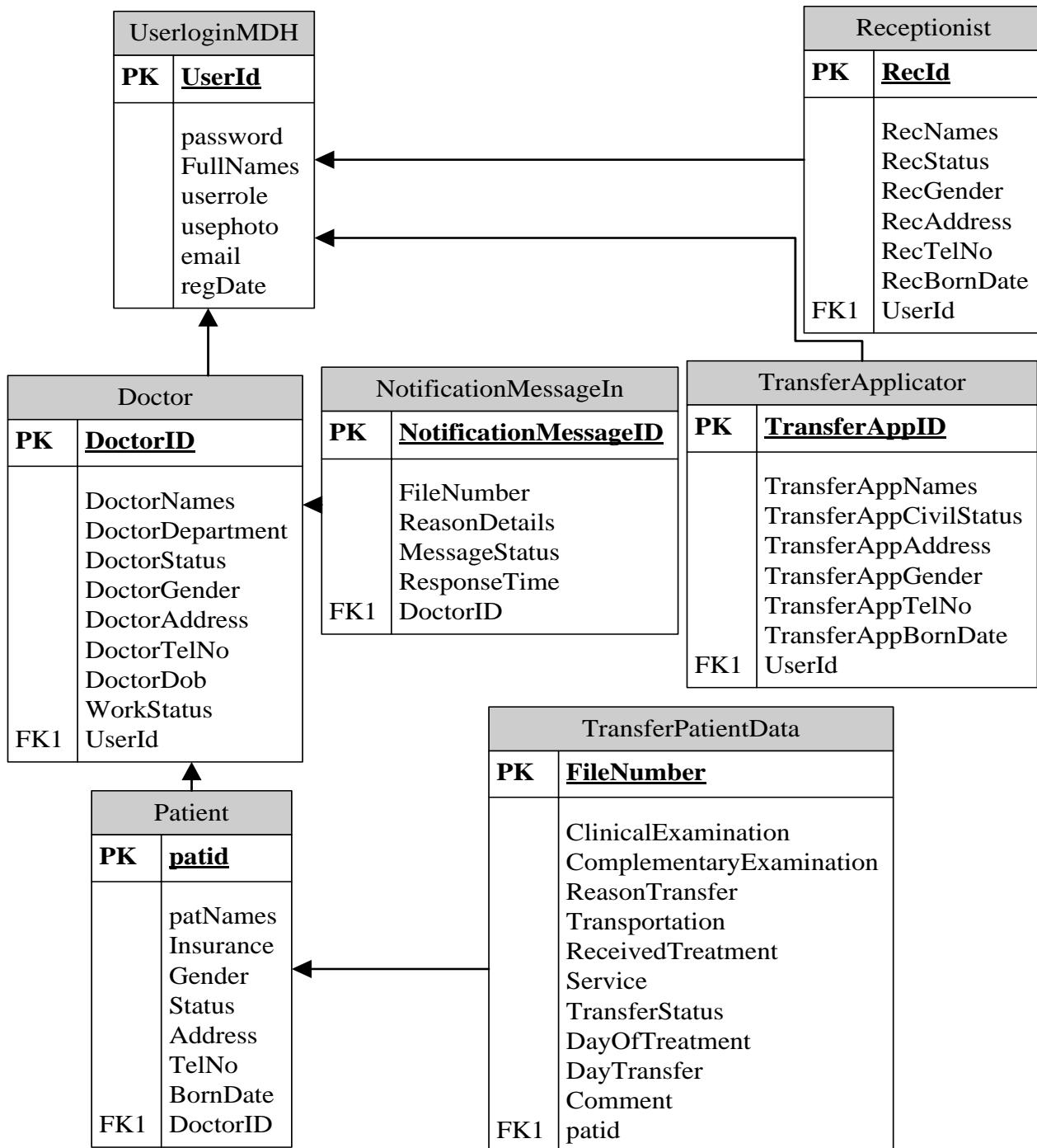


Figure 15:MDH Database schema



CHAPTER 4

IMPLEMENTATION AND TESTING OF THE NEW SYSTEM

INTRODUCTION

In this chapter, the requirement analysis and design performed in the third chapter will be referred to for developing the Medical Data Sharing System Using Web Services. Mainly this chapter consists of couple of parts such us technologies and tools used, the new system interfaces, and software testing.

Technologies and Tools used to implement the new System

Referring to the system implementation. I have planned, to interpret or translate the system application design into programming language that can be understood by a computer system so the application can run and be used. The following are the tools and technologies used:

- Microsoft Office Visio Professional 2013 will be used to create Use cases, ERD and sequence diagrams
- Microsoft Office Visio 2007 will be used for creating the data Model (Database Schema) for the system.
- HTML, CSS will be used to develop structure and styles of the centralized web application.
- NetBeans IDE 8.0.1 for code writing for web application side.
- Xampp server and MySQL 5.5 Command Line Client used for database development of the system.
- iReport for the reports design and generation.
- Glass Fish is going to serve as a server of the system.
- JSF is serving as Java Server Faces Framework.
- Jersey is a library that holds import used in Restful web services

NetBeans is a complete set of development tools for building the Web applications and all use the same integrated development environment (IDE), which allows them to share tools and facilitates in the creation of mixed-language solutions. In addition, these languages leverage the functionality of the Java Framework, which provides access to key technologies that simplify the development of Java Web applications. (Patrick K., 2006)

CSS

It stands for Cascading Style Sheet. Style sheet refers to the document itself. Style sheets have been used for document design for years. They are the technical specifications for a layout, whether print or online. The style sheets were used to insure that the design is printed exactly to specifications. (Graham, 1995)

Development platform

Java Serves Faces (JSF)

Web application framework. Java Server Faces (JSF) is a Java specification for building component-based user interfaces for web applications,. It was formalized as a standard through the Java Community Process and is part of the Java Platform, is a Java-based web application framework intended to simplify development integration of web-based user interfaces. JavaServer Faces is a standardized display technology which was formalized in a specification through the Java Community Process.

Features of JSF

✓ Portability:

Java Server Faces files can be run on any web server or web-enabled application server that provides support for them. Dubbed the JSF engine, this support involves recognition, translation, and management of the Java Server Faces lifecycle and its interaction components.

✓ Components

It was mentioned earlier that the Java Server Faces architecture can include reusable Java components. The architecture also allows for the embedding of a scripting language directly into the Java Server Faces file. The components currently supported include Java Beans, and Servlets.

✓ **Processing:**

A Java Server Faces file is essentially an HTML document with JSF scripting or tags. The Java Server Faces file has a JSF extension to the server as a Java Server Faces file. Before the page is served, the Java Server Faces syntax is parsed and processed into a Servlet on the server side. The Servlet that is generated outputs real content in straight HTML for responding to the client.

✓ **Access Models:**

A Java Server Pages file may be accessed in at least two different ways. A client's request comes directly into a Java Server Faces. In this scenario, suppose the page accesses reusable Java Bean components that perform particular well-defined computations like accessing a database. The result of the Beans computations, called result sets is stored within the Bean as properties. The page uses such Beans to generate dynamic content and present it back to the client. In both of the above cases, the page could also contain any valid Java code. Java Server Faces architecture encourages separation of content from presentation.

Database

XAMPP Server

It is a software product whose primary function is to store and retrieve data as requested by other software applications, on the same computer or those running on another computer across a network.

MySQL Server is a Relational Database Management System server (**RDBMS**), means it is a DBMS in which data is stored in tables and the relationships among the data are also stored in tables, which favors data to be accessed or reassembled in many different ways without having to change the table forms.

MySQL Server uses SQL (Structured Query Language) which is a standard language of the American National Standards Institute (ANSI) since 1986. SQL is a special-purpose

programming language designed for managing data in relational database management systems (RDBMS). It makes queries onto databases and information system. SQL server management studio is used for configuring, managing, and administering all components within MySQL Server. (Jay G., 2001)

The followings are the subsets of SQL:

- The Data Definition Language (DDL): DDL manages table and table structure. The most basic items of DDL are the Create which creates an object (a table, for example) in the database, Alter modifies the structure of an existing object in various ways (for example, adding a column to an existing table), Rename, Drop (deletes an object in the database) and Truncate deletes all data from a table in a very fast way (deleting the data inside the table and not the table itself).
- The Data Manipulation Language (DML) is the subset of SQL used to add, update and delete data.
- The Data Control Language (DCL) authorizes users and groups of users to access and manipulate data. Its two main commands are: Grant, it authorizes one or more users to perform an operation or a set of operations on an object, Revoke eliminates a permission, which may be the default grant.

Data integrity: it ensures quality of data. It helps to keep the data unchanged and unique. Data types ensure that the data accepted by the column is restricted to the type specified. For e.g. an integer data type cannot accept strings.

Software testing

Software Testing is the process used to help identify the correctness, completeness, security, and quality of developed computer software. Testing is a process of technical investigation, performed on behalf of stakeholders, that is intended to reveal quality-related information about the product with respect to the context in which it is intended to operate. This includes, but is not limited to, the process of executing a program or application with the intent of finding errors. Quality is not an absolute; it is value to some person. With that in mind, testing can never

completely establish the correctness of arbitrary computer software; testing furnishes a criticism or comparison that compares the state and behavior of the product against a specification. An important point is that software testing should be distinguished from the separate discipline of Software Quality Assurance (SQA), which encompasses all business process areas, not just testing.

There are many approaches to software testing, but effective testing of complex products is essentially a process of investigation, not merely a matter of creating and following routine procedure. One definition of testing is "the process of questioning a product in order to evaluate it", where the "questions" are operations the tester attempts to execute with the product, and the product answers with its behavior in reaction to the probing of the tester[citation needed]. Although most of the intellectual processes of testing are nearly identical to that of review or inspection, the word testing is connoted to mean the dynamic analysis of the product—putting the product through its paces. Some of the common quality attributes include capability, reliability, efficiency, portability, maintainability, compatibility and usability. A good test is sometimes described as one which reveals an error; however, more recent thinking suggests that a good test is one which reveals information of interest to someone who matters within the project community.

Software testing objectives

- To demonstrate to the developer and the system owner that the software meets its requirements.
- A successful test shows that the system operates as intended.
- To discover faults or defects in the software where its behavior is incorrect or not in conformance with its specification.
- A successful test is a test that makes the system perform incorrectly and so exposes a defect in the system.
- Tests show the presence not the absence of defects.

Software Testing Methodology

White box and black box testing are terms used to describe the point of view a test engineer takes when designing test cases. Black box being an external view of the test object and white box

being an internal view. Software testing is partly intuitive, but largely systematic. Good testing involves much more than just running the program a few times to see whether it works. Through analysis of the program under test, backed by a broad knowledge of testing techniques and tools are prerequisites to systematic testing. Software Testing is the process of executing software in a controlled manner; in order to answer the question “Does this software behave as specified?” Software testing is used in association with Verification and Validation. Verification is the checking of or testing of items, including software, for conformance and consistency with an associated specification. Software testing is just one kind of verification, which also uses techniques as reviews, inspections, walk-through. Validation is the process of checking what has been specified is what the user actually wanted.

- Validation: Are we doing the right job?
- Verification: Are we doing the job right?

In order to achieve consistency in the Testing style, it is imperative to have and follow a set of testing principles. This enhances the efficiency of testing within SQA team members and thus contributes to increased productivity. The purpose of this document is At SDLC, 3 levels of software testing is done at various SDLC phases

- Unit Testing: in which each unit (basic component) of the software is tested to verify that the detailed design for the unit has been correctly implemented
- Integration testing: in which progressively larger groups of tested software components corresponding to elements of the architectural design are integrated and tested until the software works as a whole.
- System testing: in which the software is integrated to the overall product and tested to show that all requirements are met

A further level of testing is also done, in accordance with requirements:

- Acceptance testing: upon which the acceptance of the complete software is based. The clients often do this.
- Regression testing: is used to refer the repetition of the earlier successful tests to ensure that changes made in the software have not introduced new bugs/side effects

Software results presentation

Graphical User Interface ScreenShots

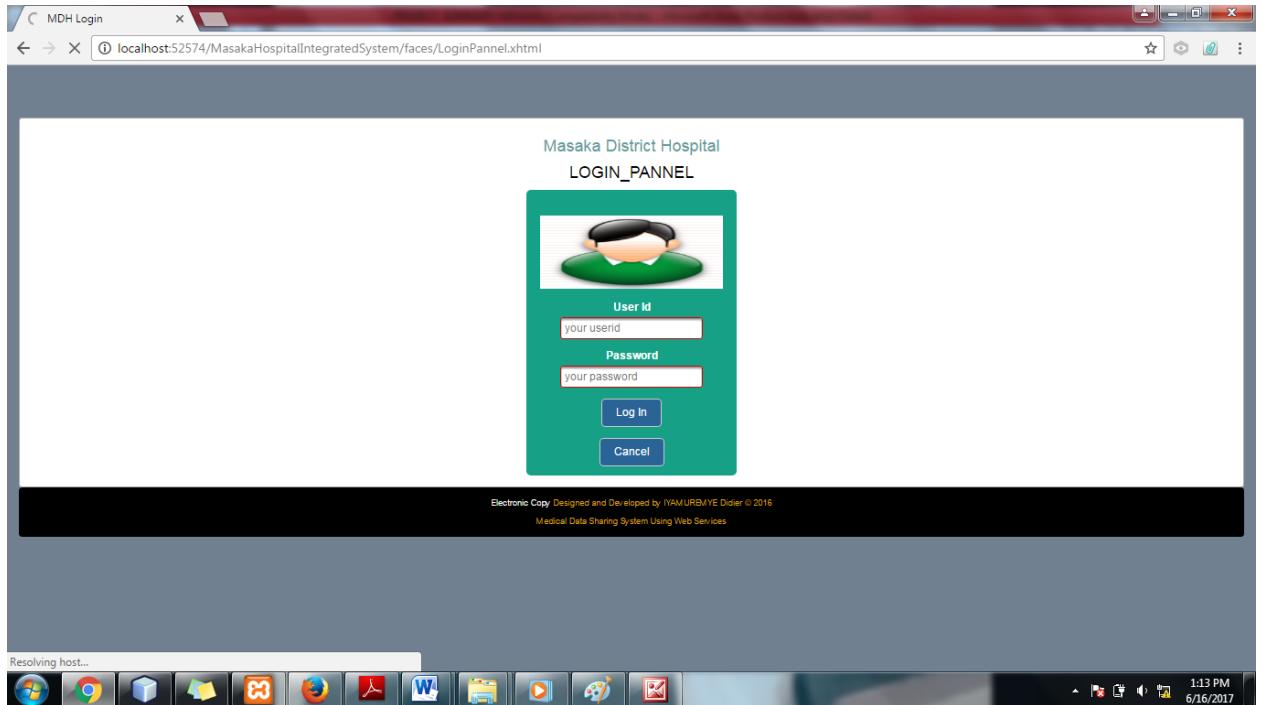


Figure 15. MDH LoginPage

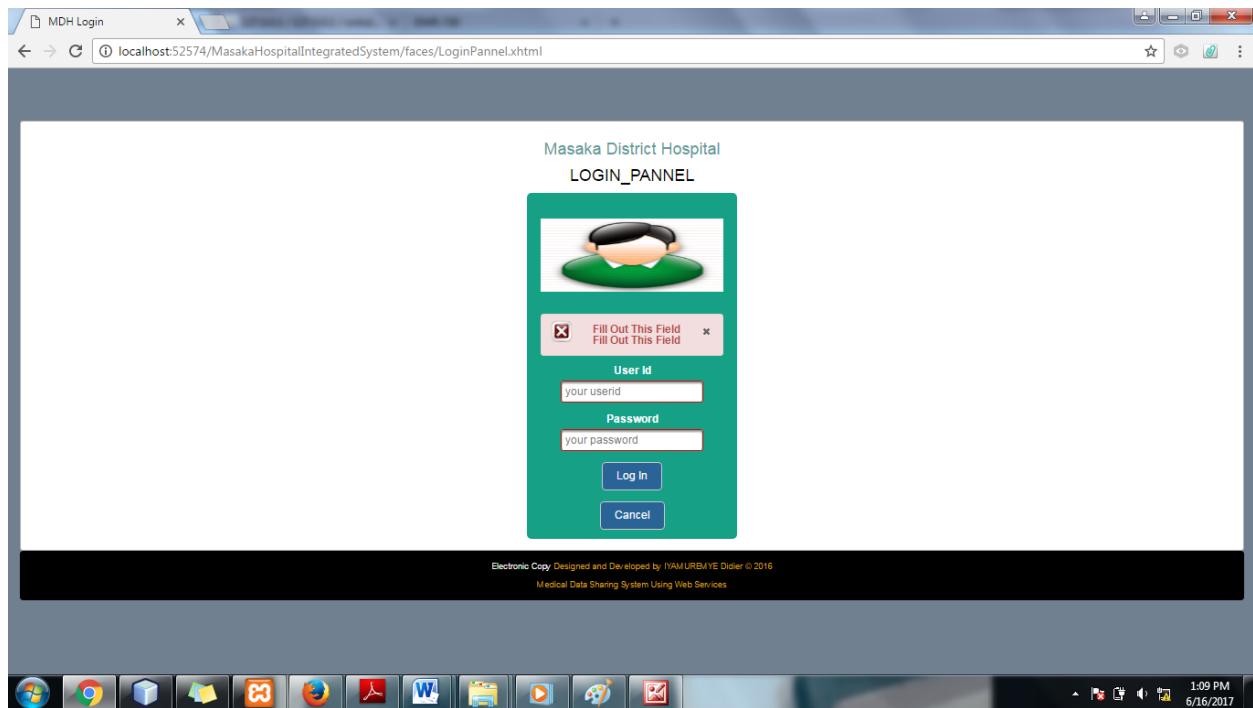


Figure 16.MDH Login Page with validation

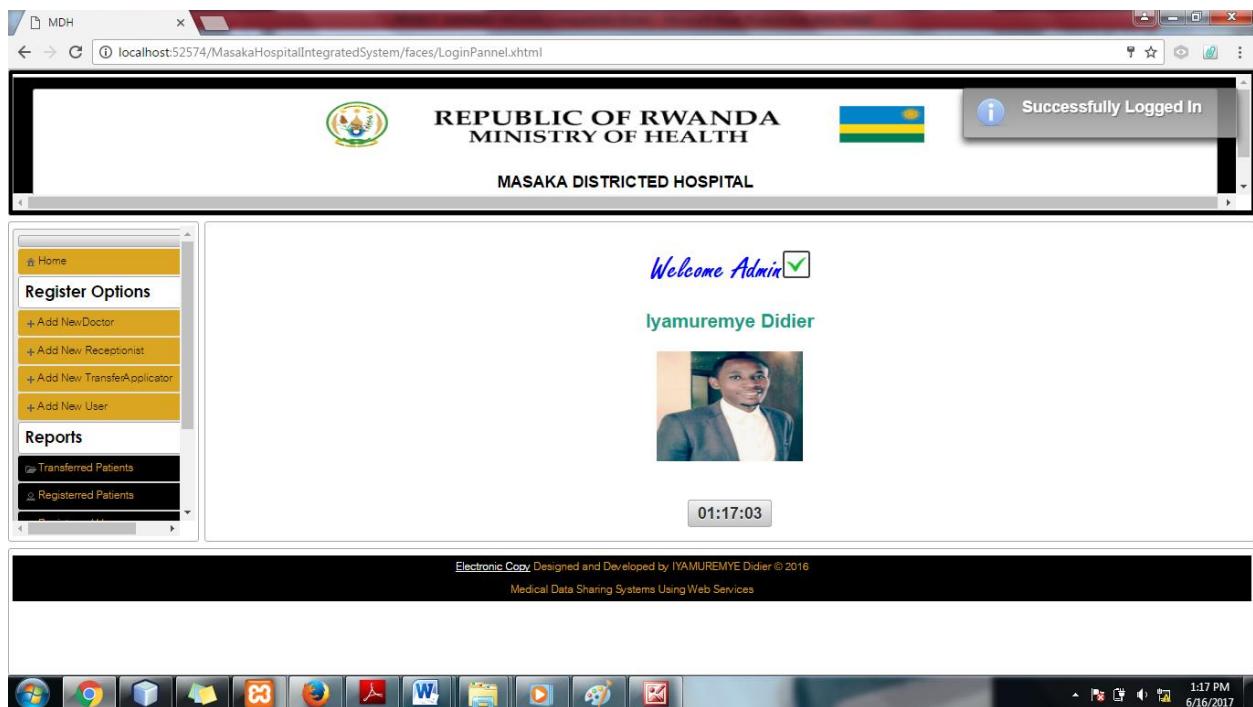


Figure 17.MDH Admin Page

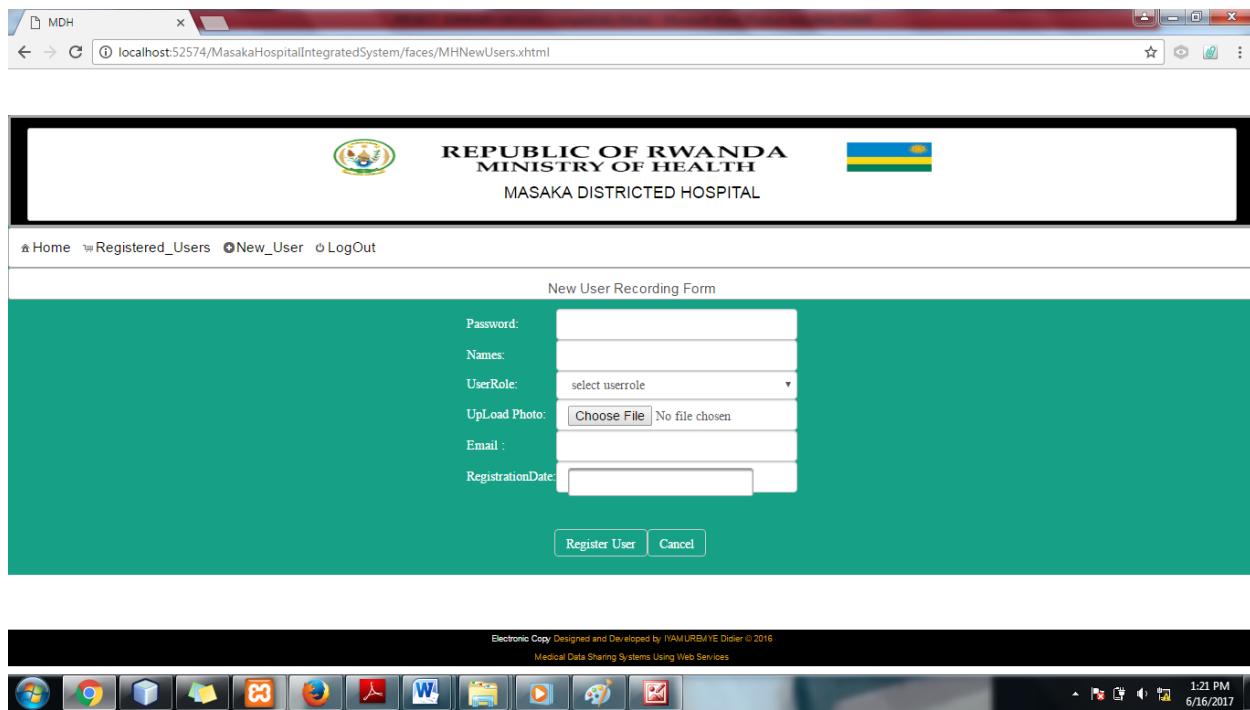


Figure 18.MDH create new user page

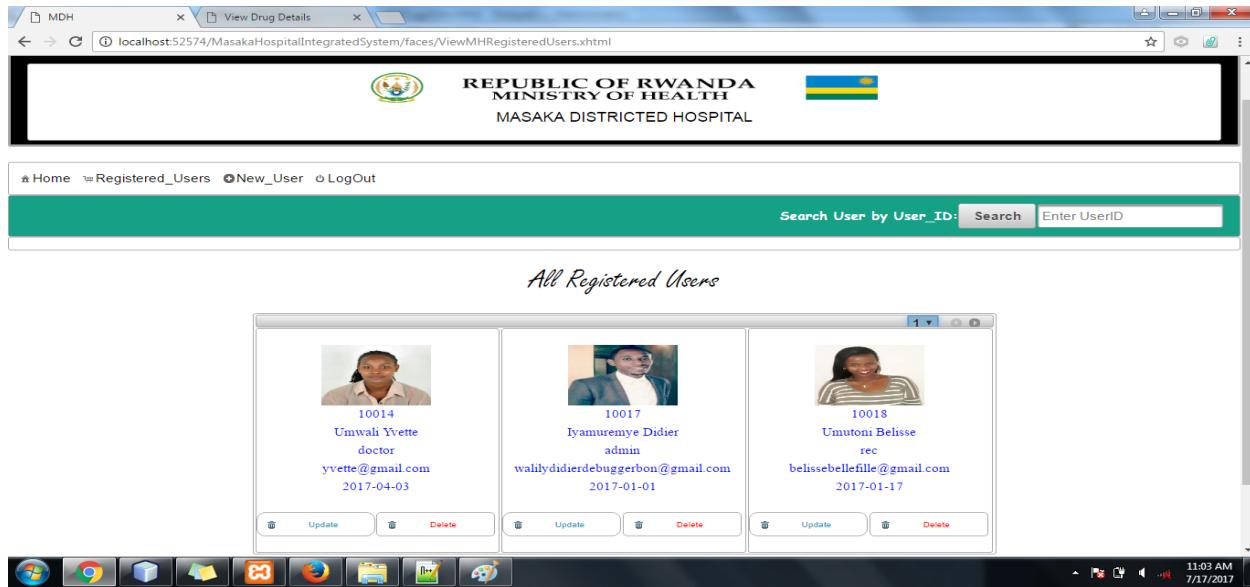


Figure 19. MDH Registered users page

New Patient Recording Form

Names:

Insurance: select Insurance

Gender: select Gender

Civil Status: select Status

Address :

TelNo:

DateOfBirth:

Available Doctors: Umwali Yvette

Figure 20.MDH save new patient page

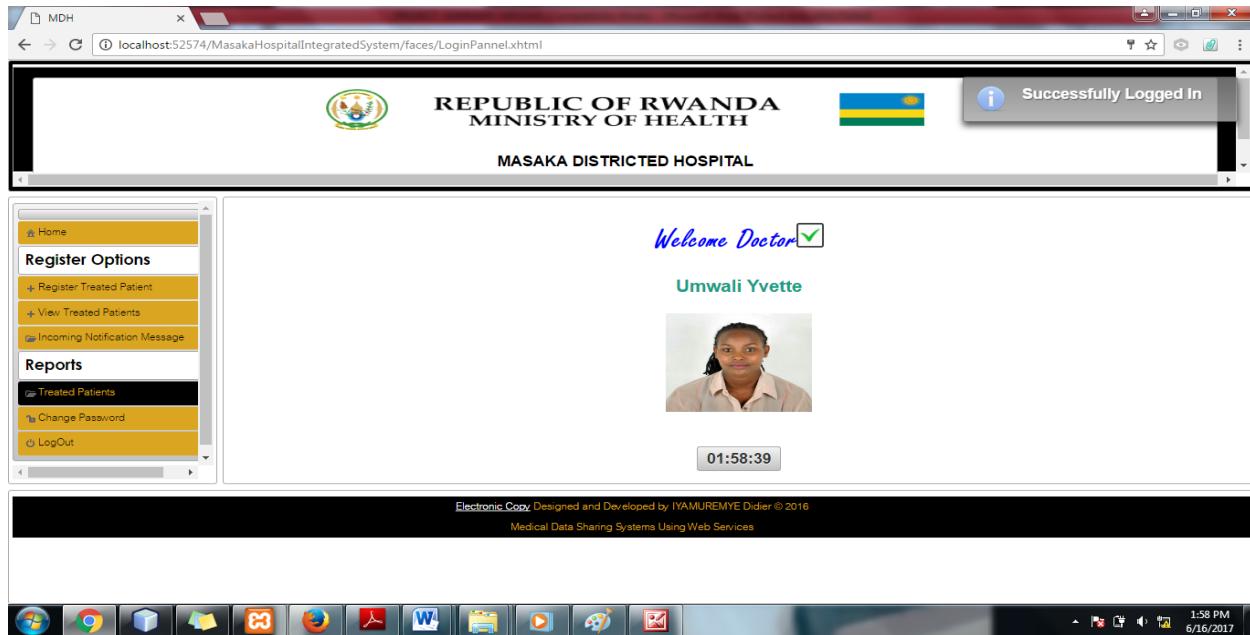


Figure 21.MDH Doctor Homepage

Disease Identification Form

Available Patients: Kuramba Honore

File Number:

Anamnesis/Clinical examination :

Complementary/additional examination :

Reason of transfer :

Received Treatment :

Service transferred in

Transportation

DayTreated:

Add Comment* :

Figure 22.MDH New treated patient page

Transfer patient data panel

File Number	Patient Names	Clinical Examination	Complementary Examination	ReasonOf Transfer	Received Treatment	Transport	Service Transferred In	DayTreated	Added Comment	Transfer Status	OPERATIONS
10000/10	Nishimwe Claudine	heart attack testing and quick support about eyes	microscope testing about his eyes	further support about heart attack	simple microscope tests	Medical Ambulance	Emergency	2017-07-02	okay	waiting...	Update Delete

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Figure 23.MDH view treated patient page

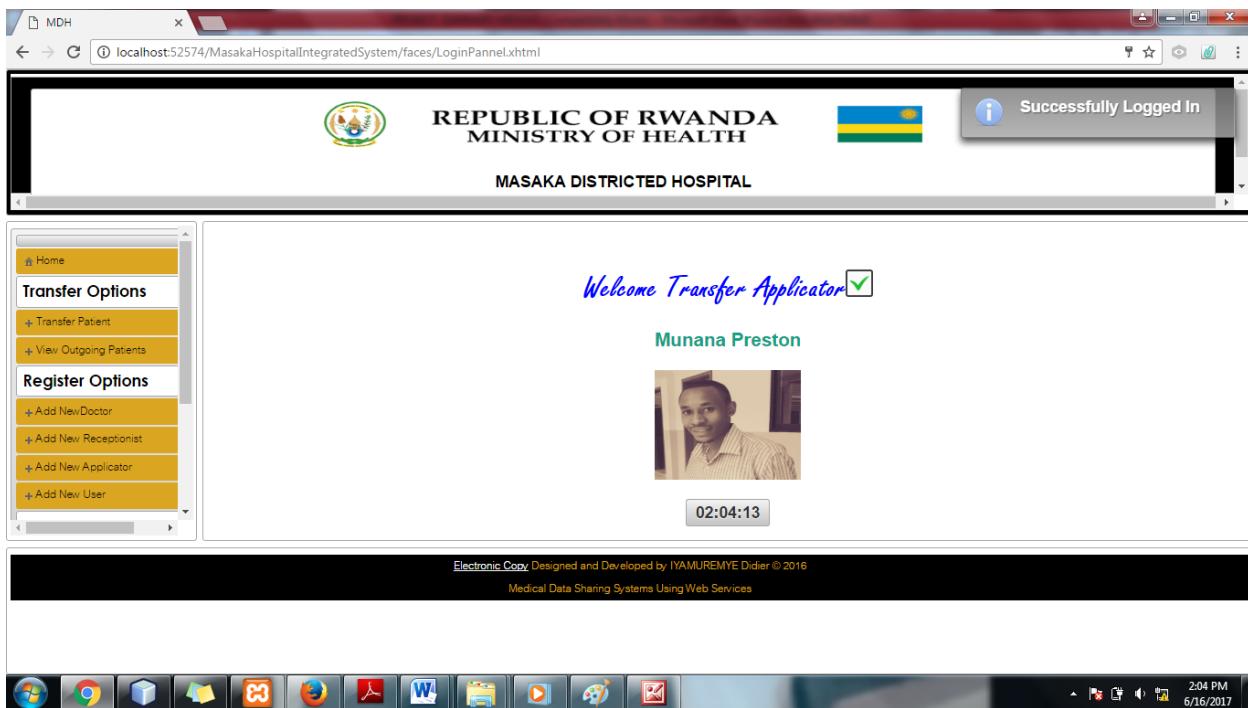


Figure 24.MDH transfer applicator homepage

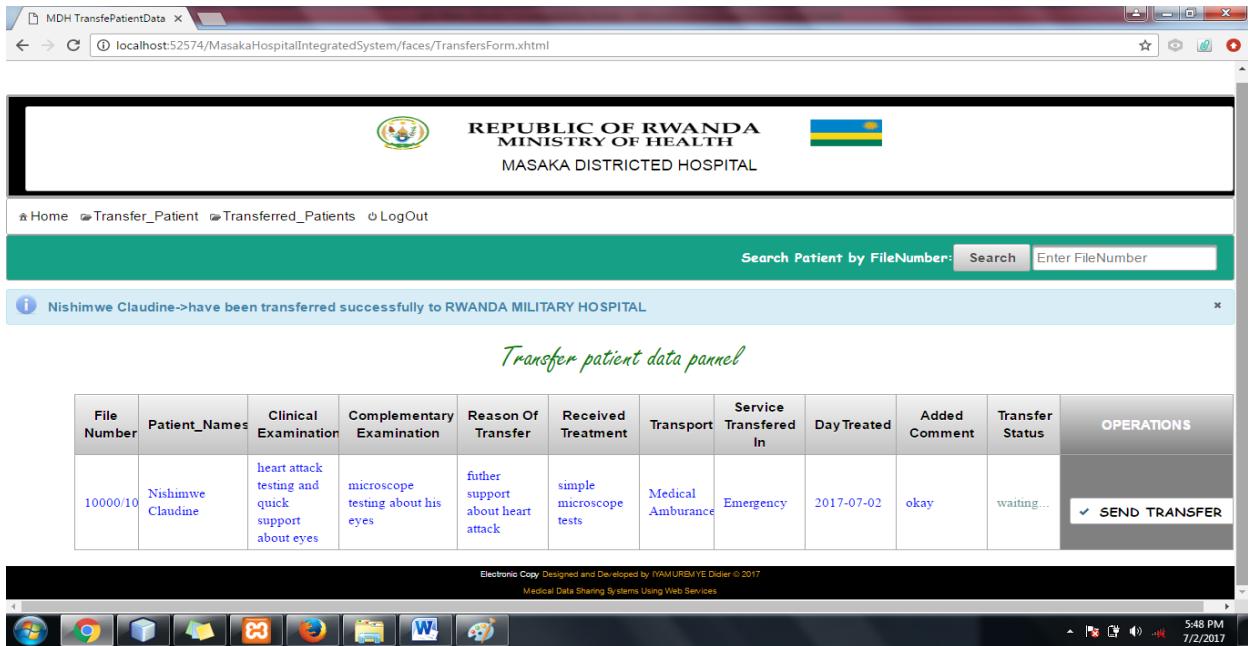


Figure 25.MDH send patient transfer page

Incoming Notification Message panel

FileNumber	MessageID	Reason Details	RequestMessageTime	MessageStatus	ACTION
11000/02	1102	transfer is expired before patient come to be treated then send transfer again	2017-07-16	unread...	<input checked="" type="checkbox"/> Read Message
10000/04	1105	transfer has expired due to personal issue of this patient please send transfer again	2017-07-02	unread...	<input checked="" type="checkbox"/> Read Message

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Figure 26:MDH Incoming Notification Message Page

FileNumber	MessageID	Reason Details	RequestMessageTime	Message Status	ACTION
10000/05	1100	transfer has expired due to personal issue of patient so better you can send it again	2017-07-01	read	Cancel_Message
11000/02	1102	transfer is expired before patient come to be treated then send transfer again	2017-07-16	read	Cancel_Message
11000/04	1104	transfer again transfer file of this patient cauz the first one has been expired	2017-07-30	read	Cancel_Message

Figure 27:MDH read Notification Message Page

Figure 28.RMH Login Page

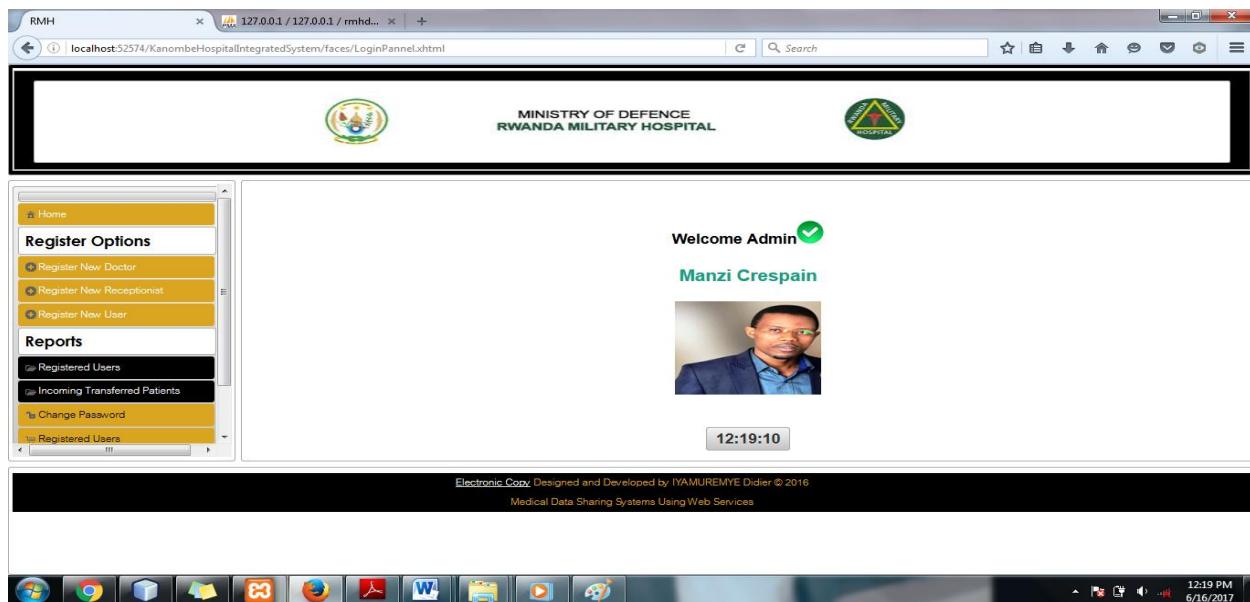


Figure 29.RMH Admin Page

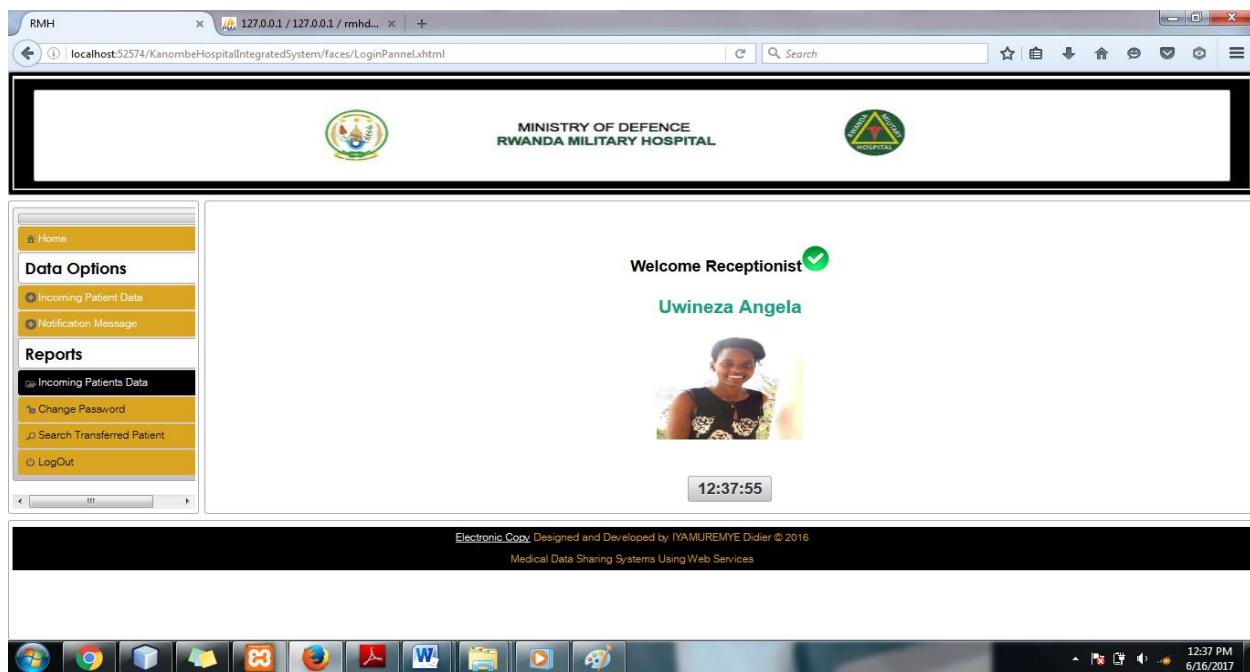


Figure 30.RMH receptionist homepage

RMH 127.0.0.1 / 127.0.0.1 × +

localhost:52574/KanombeHospitalIntegratedSystem/faces/IncomingDataRecept.xhtml

Search | Search

MINISTRY OF DEFENCE
RWANDA MILITARY HOSPITAL

Home Incoming Patients LogOut

Search Patient by PatientId: Search Enter PatientId

Incoming Patients Data Panel

File Number	PatientId	Patient Names	Sexe	Clinical Exams	Complement Exams	Reason Of Transfer	Received Treatment	Age	Transport	Service	Day Transferred	Added Comment	Approval Status	OPERATIONS
10000/09	11014	Iranzi Kevin	male	heart attack testing and quick support about eyes	microscope testing about his eyes	further support about heart attack	simple microscope tests	1997-06-17	Medical Ambulance	Emergency	2017-07-02	okay	waiting...	<input checked="" type="checkbox"/> Approve
10000/10	11013	Nishimwe Claudine	female	heart attack testing and quick support	microscope testing about his eyes	further support about heart attack	simple microscope tests	2010-02-22	Medical Ambulance	Emergency	2017-07-02	okay	waiting...	<input checked="" type="checkbox"/> Approve

Figure 31.RMH Imcoming patient data page

Approved Transferred Patients Pannel

File Number	PatientId	Patient Names	Sexe	Clinical Exams	Complement Exams	Reason Of Transfer	Received Treatment	Age	Transport	Service	Day Transferred	Added Comment	Approval Status
10000/04	11004	Umurerwa Queen	female	disorder of sex development	examination of penocratal and spasadias bacteria	examine futher help about her body hybrids	labo testing and give her some medecine 100gr of penecelynies	1982-01-17	private	General Medecine	2017-07-02	okay	Approved
						further support by doing							

Figure 32:RMH Approved Incoming transfers

New Notification Message Form

Available FileNumber: 10000/04

Reason Details:

Save Message Cancel

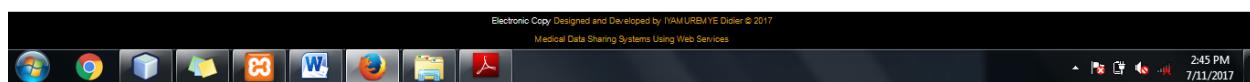


Figure 33:RMH save notification message pannel

The screenshot shows a web browser window titled "RMH Request Message" with the URL "127.0.0.1 / 127.0.0.1 / rmhd...". The page header includes the Ministry of Defence Rwanda Military Hospital logo and navigation links for Home, View Notifications, New Notification Message, Change Notification Message, Sent Notification Message, and LogOut. A search bar at the top right allows searching by MessageId. The main content area is titled "Send Notification Message Panel" and displays a table with one row of data. The table columns are: MessageID, FileIndex, Reason Details, Request Message Time, Message Status, and Operations. The data row shows: MessageID 1106, FileIndex 10000/09, Reason Details "file has expired due to delaying of patient reason is personal issue about life status", Request Message Time 2017-07-02, Message Status "waiting...", and Operations button labeled "SEND MESSAGE". The footer contains copyright information: "Electronic Copy Designed and Developed by IYAMURIBIYE Didier © 2017 Medical Data Sharing Systems Using Web Services".

MessageID	FileIndex	Reason Details	Request Message Time	Message Status	OPERATIONS
1106	10000/09	file has expired due to delaying of patient reason is personal issue about life status	2017-07-02	waiting...	<input checked="" type="checkbox"/> SEND MESSAGE

Figure 34.RMH Send notification message page

MASAKA DISTRICT HOSP X MASAKA DISTRICT HOSP X MASAKA DISTRICT HOSP X MDH Notification Messa X

localhost:52574/MasakaHospitalIntegratedSystem/faces/OutgoingTransferPatientDataReport.jsp

**REPUBLIC OF RWANDA
MINISTRY OF HEALTH**

TRANSFERRED PATIENT DATA LIST'S REPORT

PATIENT NUMBER	CLINICAL EXAMINATION	COMPLEMENT EXAMINATION	REASON OF TRANSFER	TRANSPORT	RECEIVED TREATMENT	SERVICE	TRANSFER STATUS	DAY OF TREATMENT	PATIENT ID	DAY OF TRANSFER	COMMENT
10000/35	examine radiology scanning	labo testing and due to head broken we test it using simple materials for quick support	examine further help	Medical Ambulance	labo testing and give her 100gr of paracetamol	Radiology	transferred	2017-07-10	11025	2017-07-10 11:40:30.0	it is okay
10000/36	blood pressure due to accident we give him simple support for help	labo testing and radiography scanner	examine further help we can not handling	private	labo testing give him 100gr of hydralazine	General Medicine	transferred	2017-07-09	11034	2017-07-10 16:04:50.0	it is okay
10000/37	fdgtrggsgf gsdff gsdff gdfgdsfds gdsfdgfdstdfgfd sfgsgfdsg	rerfgeerfrfr	freferferr	Medical Ambulance	frwerfr	Radiology	transferred	2017-07-10	11034	2017-07-10 16:19:32.0	it is okay
10000/38	fdgtrggsgf gsdff gsdff gdfgdsfds gdsfdgfdstdfgfd sfgsgfdsg	rerfgeerfrfr	freferferr	Medical Ambulance	frwerfr	Radiology	transferred	2017-07-10	11034	2017-07-10 16:27:58.0	10000/35 changed to 10000/37

6:53 PM
7/12/2017

Figure 35 :MDH Transferred Patient Data Report

The screenshot shows a web browser window with four tabs open, all titled "MASAKA DISTRICT HOSPITAL". The active tab displays the URL localhost:52574/MasakaHospitalIntegratedSystem/faces/IncomingNotificationReportDMH.jsp. The page content is titled "MASAKA DISTRICT HOSPITAL" and "1 / 1". It features the logo of the Republic of Rwanda Ministry of Health, which includes a green circular emblem on the left and the national flag of Rwanda on the right. The main heading is "REPUBLIC OF RWANDA MINISTRY OF HEALTH". Below this, a section titled "INCOMING NOTIFICATION MESSAGE LISTS REPORT" contains a table with the following data:

NOTIFICATION MESSAGE ID	FILE NUMBER	REASON DETAILS	MESSAGE STATUS	INCOMING MESSAGE TIME
100	10000/06	transfer is expired	unread...	2017-07-06 09:39:41.0
101	10000/08	transfer is expired due to delaying of patient resend it again	unread...	2017-07-06 09:41:31.0
102	10000/15	transfer is expired due to delay of personal issue of patient resend transfer	read	2017-07-06 10:27:25.0
103	10000/16	transfer is expired due to personal issue of patient resend it again	unread...	2017-07-06 13:35:49.0
125	10000/24	transfer is expired due to delaying of personal issue of this patient please resend it again	unread...	2017-07-09 15:29:23.0
126	10000/28	transfer is expired resend it again patient got personal problems	unread...	2017-07-09 16:54:29.0
127	10000/32	transfer is expired due to personal issues then resend it	unread...	2017-07-09 17:35:03.0
128	10000/32	transfer is expired due to delaying of personal issue of this patient resend his data	unread...	2017-07-09 23:46:02.0

The browser interface includes standard navigation buttons (back, forward, search) and a status bar at the bottom showing "6:54 PM" and "7/12/2017".

Figure 36 :MDH Incoming Notificationmessage Report

ApprovedIncomingPatientData... X NotificationReport.jsp X +

localhost:52574/KanombeHospitalIntegratedSystem/faces/NotificationReport.jsp

Page: 1 of 1

MINISTRY OF DEFENCE
RWANDA MILITARY HOSPITAL

SENT NOTIFICATION MESSAGE LIST'S REPORT

NOTIFICATION MESSAGE ID	FILE NUMBER	REASON DETAILS	MESSAGE STATUS	NOTIFICATION MESSAGE TIME
100	10000	transfer is expired	sent	2017-07-06 10:01:18.0
101	10000	transfer is expired due to delaying of patient resend it again	sent	2017-07-06 10:07:54.0
102	10000	transfer is expired due to delay of personal issue of patient resend transfer	sent	2017-07-06 10:27:41.0
103	10000	transfer is expired due to personal issue of patient resend it again	sent	2017-07-06 13:37:30.0
125	10000	transfer is expired due to delaying of personal issue of this patient please resend it again	sent	2017-07-09 15:32:31.0
126	10000	transfer is expired resend it again patient got personal problems	sent	2017-07-09 17:27:09.0
127	10000	transfer is expired due to personal issues then resend it	sent	2017-07-09 17:35:10.0

7:19 PM 7/12/2017

Figure 44:RMH Incoming Patient Data transfers Report

Hardware and software requirements

The following are software and hardware requirements needed for better performance of Medical data sharing system using web services for Masaka district hospital and Rwanda military hospital

For the Client Machine the minimum specification requirements are:

- ✓ Any operating System
- ✓ A Web browser (either Microsoft Internet Explorer, Mozilla Firefox, Safari etc...)
- ✓ internet
- ✓ Microprocessor: Pentium II or higher;
- ✓ RAM: 512 MB (1 GB recommended);
- ✓ 5 GB or more hard disk free space.

For the Server Machine the minimum specification requirements are:

- ✓ Operating System: Windows 2008 Server or later;
- ✓ Java SE Development Kit;
- ✓ A Web server (Glassfish 2.0 or later);
- ✓ Xampp server ;
- ✓ Network card: 1 GB/second;
- ✓ RAM: 1GB minimum;
- ✓ 5 GB or more free hard disk space.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Conclusion

the aim of this project was to develop a medical system that really show how it is possible to let Masaka Districted Hospital be able to send patient data to collaborated Kanombe Military Hospital when necessary, therefore the medical data sharing system using web services was developed with various features such as:

- Electronic submission of patient data to RMH servers in order to speed up the current process and avoid paper bill based work.
- Manage to provide secured and neat record keeping of patient data.
- Patient must only have one patientID that will be holding all records both in MDH and RMH
- Stock management that actually kept patient transfer paper bill will be free to be used in other necessarily affairs of hospital as well
- As after a month transfer becomes expired and require a patient to go back again to MDH to get another transfer paper bill , would no longer happen

Different methods such as observation, interview and documentation were used in order to get the problems with the existing system. The planning, analysis, design, implementation of the system were done according to water fall model as on software development methodologies. On server side: Jsf, Prime Faces, Web Services were used. On client side : Java and plain text data format were used. In terms of modeling language, I used UML in various notations and diagrams. Regarding system testing, I carried out different tests to ensure if the developed system solves the problems encountered in MDH existing system as far as data to be shared is concerned, I found that the results were positive.

Recommendations

Once the following recommendations are completely accomplished, the developed system will provide expected output and services will be provided in quick and adequate manner:

the new system can resolve some of the problems faced by Masaka Hospital, Rwanda Military Hospital and help the public to get a better and an adequate service as far as useful medical data sharing is concerned:

To the Masaka Hospital and Rwanda Military Hospital, it will be better to whoever use the new system be first of all trained how the system works and what it does.

- ✓ We recommend regular backups of data from the system once installed and used, it will be extremely important to avoid potential data loss.
- ✓ As the proposed application helps to raise the public awareness of the problem to induce positive cultural changes, Masaka hospital and Rwanda Military Hospital can be developed further to include a lot of features because the proposed system is developed on the view of future, Therefore I wind up this work by welcoming and encouraging whoever wants to contribute to the improvement of this work.
- ✓ It provides security so that data is not accessed by unauthorized people.

Training should be provided to the users (every user is really involved) in order to know what is really expected within a new system.

I recommend regular backups of data from the system once installed and used, it will be extremely important to avoid potential data loss.

Users should be sure with information fulfilled in respective boxes so that it cannot lead to the mistakes.

I finish my work by expecting the opinions and advices form every participant who would like just to contribute for any enhancement of this work of mine.

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APPENDIX

1. Approval letter by Nizeyimana Pierre Celestin
2. Data letters
3. Curriculum Vitae
4. transfer paper