

## Online Health Management System for University Teaching Hospital (UTH) – Women and Newborn Hospital

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### Abstract:

*The use of information and communication technology (ICT) is rapidly increasing in Zambia. In the health sector ICT has been recognized internationally and by the Government to be of strategic importance as it facilitates the sharing of health data, information and resources between different stakeholders and the delivery of appropriate services.*

*The objective of this project is to provide online health services to users. Users can connect through their home internet or approach any nearby internet café or use smartphones to access these services. The motivation to build this system is that a patient can make an appointment with the hospital and set the date to see a doctor or the patient can book for an ambulance to the hospital from the point where she/he is. The system also helps the user to reduce the time spent at the hospital in the sense that by the time one reaches the hospital, they would have done the registration and brief history about the problem that has caused them to be taken to the hospital.*

*The system also allows the user to chat with any available doctor. For simple illnesses the user advance what medicine to take and may not even visit the hospital. The online health management system is a web-based application*

*which is available every time. The system provides details of medical services and allows users to interact with doctors and other medical personnel online. Patients and doctors can interact and chat through the use of short message service (SMS), e-mails or phone calls. Doctors get their patients' details from the database of the system.*

**Keywords:** Patient Card, Database, Centralization, storage, Records, Wampserver, HTML5, Java, JAVASCRIPT, PHP, and MySQL

### 1.0 INTRODUCTION

A hospital is an organization that mobilizes the skills and efforts of a widely divergent group of professionals, semi-professionals and professional personnel, to provide highly personalized personnel services to patients. (WHO, 2018). World Health Organization (WHO) has defined a hospital as an integral part of social and medical organization that provides the complete curative and preventive health care and treatment to people. Hospitals are the focal points of education for health professionals and clinical research necessary for advancement of medicine.

Thus, a hospital is one of the most complexes of all administrative organizations. The main purpose of a hospital is to provide adequate care and treatment to people. Various operational works that are done in a hospital include: recording information about patients, generating bills, recording information related to diagnosis given to patients, keeping records of the immunization provided to patients, keeping information about various diseases and medicines available to cure them, etcetera. Our hospitals in Zambia do their works on papers (Peter Mwaba, and Kasonde, 2013). The need for proper management of the health sector leads to the creation of an electronic means of keeping records, administering discharge, querying of data, prescription helper and good accountability. Information technology in general enables intra-

organizational networking that facilitates effective information flow within the various units of a firm.

The application of information technology in health care is unceasingly evolving, as the quality of patient care in contemporary times seems to depend on the timely acquisition and processing of clinical information related to a patient. The Online Health Management System (OHMS) comprises a computerized web-based application for record keeping, tracking and prescriptions with monitoring. OHMS can manage multiple users of the system and can have the track of the right assigned to them. It makes sure that all the users function with the system as per the rights assigned to them and they can get their work done in an efficient manner.

A good management system should allow for input and output by providing an objective for recording and aggregation information. It should be able to quickly collect and edit data, summarize results, and adjust as well as correct errors promptly.

## 1.1 Background of the study

The country faces a rising burden of non-communicable diseases, including mental health, diabetes, cardiovascular diseases and violence. Emerging from a severely constrained health system are opportunities for eHealth in Zambia. The Government of the Republic of Zambia, through its ongoing health sector reforms aims, to improve health outcomes.

As a part of these reforms, the Ministry of Health had developed, among other strategies, the National Health Strategic Plan (2011-2015) and the eHealth strategy (2014-2016) to guide priority setting and deployment of resources in the health sector. Although implementation of the strategies promised to produce many positive results, realising the best outcomes in the face of increasing pressures on the healthcare system requires a fundamental transformation in the way we deliver

and manage health care. The Ministry of Health recognizes the potential of information and communications technology (ICT) in transforming healthcare delivery by enabling information access and supporting healthcare operations, management, and decision-making (Edgar Lungu, and Lucky Mulusa, 2017).

However, a fragmented landscape of ICT pilot projects characterizes the Zambian health sector and numerous data and health information system (HIS) silos with significant barriers to the effective sharing of information between healthcare participants. Information and communication technologies have over the past few years, significantly influenced many aspects of society and have the potential to impact positively on the delivery of healthcare services. Their strategic plan heralds the use of ICTs to leverage service delivery for successful implementation of eHealth systems and coincides with the Government of Zambia adopting a different paradigm through the implementation of a “SMART Zambia Now” (Chitalu Chilufya, and Jabbin Mulwanda, 2017).

## 1.2 Motivation of the study

The author designed and developed an Online Health Management System with a view of creating an efficient health management system for the University Teaching Hospital (UTH), which will allow doctors, nurses, pharmacists and general members of staff to go about their daily duties, with quickly capturing data and retrieving information. The main motivation was from the need to implement particular viewpoints on issues concerning the management of medical records at the hospital and to manage the billing of the patients

The inspirations came from the concepts being implemented at national level through the Smart-Care project, from which most of the modules implemented on the system were obtained. The Cancer Diseases Hospital at University Teaching

Hospital (UTH) is already using this type of system

This project is an investigation into the possibility of such an implementation in other clinics at UTH.

### ***1.3 Significance of the study***

The project will help in a number of ways, including easing the queuing system in the hospital premises as the online hospital system can help patients to achieve whatever they want to without really queuing up unnecessarily in the quest for treatment. Clear advantages of internet information processing over traditional manual systems are higher yields. Online hospital management system allows the users to book for hospital check-ups, give payment details, buy medicines, describe/show symptoms, and save/print prescription.

### ***1.4 Scope of the study***

This project was limited to the design and development of an online hospital management system for the University Teaching Hospital in Lusaka, Zambia. The classes of individuals likely to benefit from this project are patients, hospital staff and administration members, administrators and other stakeholders at UTH. This system supports the easy and timely access to needed information between patients, staff and administration, and proper tracking and enhanced security of patient records and information.

The scope provides for the boundary of the research in terms of content and methodology, geographical and theoretical coverage. The online Health Management System was designed and developed for the University Teaching Hospital. The Registry Department is responsible for keeping medical records for patients and keeping track of this information. An online health management system was designed in a way that makes it easy to access it through any web browser.

The system has user interface, which is supported by any web browser because as it is designed in a

dynamic manner and is backed by a database system that enables users to have the privilege to input, access, manipulate and delete data from the database.

HTML (Hyper Text Markup Language) and CSS (Cascading Style Sheets) were used as the languages for the design of user interfaces, and Java script was used as the client-side validation tool. PHP was used as a scripting language for linking the interfaces to the SQL database(s). PHP is a server-side scripting language that enables one the ability to insert into a web interface instruction that web server software would execute before sending a response to the web browser.

SQL Structured Query Language (SQL) is a standard computer language for relational database management and data manipulation. Structured Query Language (SQL) was used as the programming language for developing the database.

### ***1.5 Limitations***

This project covers some of the aspects of a computer software-based online hospital management system using the University Teaching Hospital as a case study. However, the following were the constraints:

- Time constraints: Due to time constraints, the system only deals with the main modules for the online hospital management system, only leaving out other minute but necessary system details.
- Financial constraints: Due to financial constraints, other individual hospital personnel cannot afford this kind of process online, especially towards the cost of accessing internet. Therefore, it would cost a lot to develop a full online hospital management system. Some administrators considered other documents confidential and we could not access them.

## **1.6 Statement of the Problem**

Hospital is a health care institution providing patient treatment with specialized medical doctors, nursing staff, and medical equipment. Since hospital is associated with lives of common people and their day-to-day lives, the researcher decided to design an online health management system for University Teaching Hospital (UTH) – Women and Newborn Hospital. The purpose of this project is to make an online system that will be used for activities like admission of new patients, discharge of patients, assigning a doctor and finally computing bills.

The design and development of an online health management system for UTH Women and Newborn Hospital was undertaken in order to minimize the problem of redundancy, errors and incomplete data inefficiencies in retrieval of data.

The problem was mainly caused by the fact that data, under the manual recording system, was entered into books and paper files and was later stored in the storeroom full of files and folders, making it very time-consuming to retrieve the file from the archival records.

## **1.7 Aims and objectives of the study**

The main aim of this project was to design an online health management system that provides easy access to patient database. The application will obtain more efficient support for clinical work, better possibilities for integration with future systems, and lower cost of operation.

## **1.8 General objective**

To design and develop an online Health Management System for the University Teaching Hospital (UTH) – Women and Newborn Hospital that will enable faster and more efficient storage, retrieval and updating of clinical information.

## **1.9 Specific objectives**

The projects specific objectives where:

- To carry out a feasibility study for the possibility of design and developing an online health management system for the University Teaching Hospital (UTH) – Women and Newborn Hospital
- To test and validate the online health management system for the University Teaching Hospital (UTH) – Women and Newborn Hospital

## **1.10 Research Questions**

1. Do you have an Online Health Management System?
2. Is the system effective in the day-to-day operations?
3. Would you like an online registration user form rather than the printed form?
4. What improvement would you want to the system?
5. Is the current system effective when capturing data?
6. What would you want to be or included in the system?

## **1.11 Organization of the thesis**

The thesis is organized in a way that is easy to read through: Chapter One introduces the idea under research, going through Chapter Two, which is the literature review with particular interest in software systems development that shares certain implementable similarities to the OHMS.

Chapter Three, on the other hand, gives an insight into methodologies used to implement the online Health Management System for the University Teaching Hospital (UTH). Chapter Four gives the baseline study results, survey results and discussion, system implementation results and summary. Chapter Five gives an analysis of the

findings of the previous chapters and concludes the discussion.

## **1.12 Summary**

This chapter was an introductory note to the design and development of an online Health Management System for University Teaching hospital (UTH). It highlighted the aim and objectives of this project, and gave the significance on the scope and problem statement under discussion. In conclusion in Zambia, as in other countries, healthcare services occupy an important and significant position amongst the decisions made by the Government. Technological advances and the flow of information are encouraging the healthcare authorities in the Ministry of Health to look for facilities and systems for improving the management of information in the healthcare delivery system. The MoH planners are attempting to provide high quality care by providing healthcare professionals with the information they need. Paper patient records, SMARTCARE and hospital libraries are examples of clinical information sources available in the healthcare delivery system in Zambia.

Indeed, all these clinical information sources and other sources are discussed in the literature review in the next chapter and some are investigated in this research since they play an important role in supporting the decision-making and medical practice of doctors. Thus, understanding information users' needs and identifying the way information flows through the healthcare organization are essential issues in developing a successful system and improving the quality of services in any organization or society.

## **METHODOLOGY**

### **3.1 Introduction**

The current the study was conducted to justify the development of an online health management system solution to problems that are encountered by the health workers at the University Teaching Hospital (UTH) – Women and Newborn Hospital. A survey was conducted to establish the current status of the information management system and to the levels of utilization of ICTs among workers at the hospital.

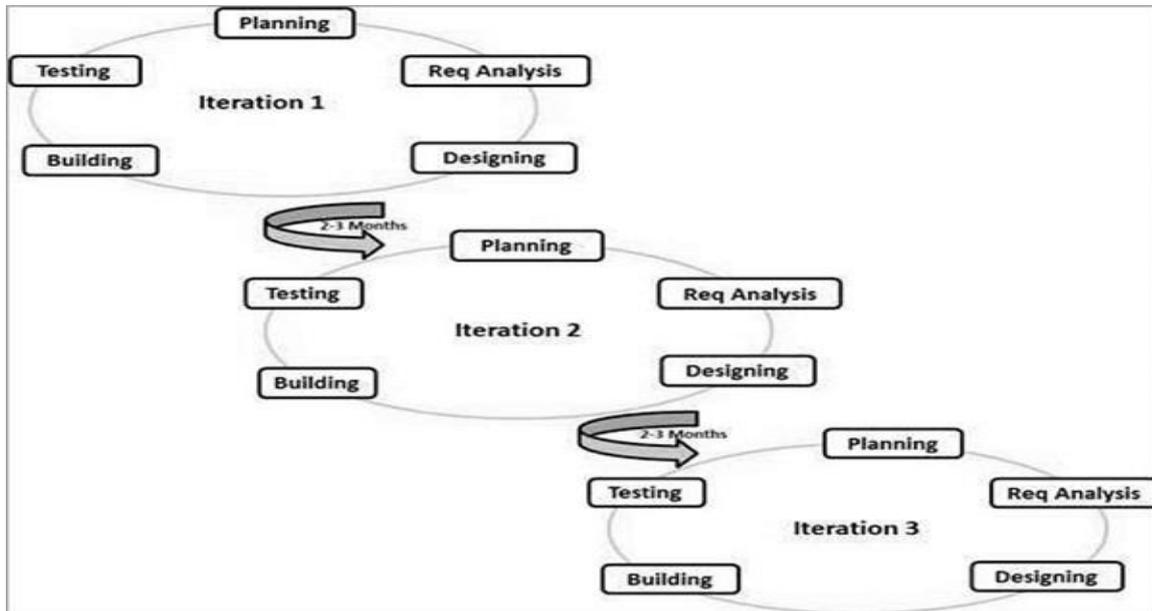
Questionnaires were designed to establish the sources of the problem of the current system being used at the institution

Later, the design and development of the system, which is the proposed solution to reduce the cost of paper-related materials, was looked at. It also looked at the methodology that was used for the software development process, function and non-functional requirements, process maps, implementation of languages and the configuration of equipment.

An Online Health Management System was developed using the agile method. All the modules of the Online Health Management were developed separately and linked together during presentation and testing, then changes were made.

Agile SDLC model is a combination of iterative and incremental process models with focus on process adaptability and customer satisfaction by rapid delivery of working software product. Agile methods break the product into small incremental parts.

Fig 1. Showing the interaction of the process



The agile method is a particular approach to project management that is utilized in software development. This method assists teams in responding to the unpredictability of constructing software. It uses incremental, iterative work sequences that are commonly known as sprints.

### ***Companies that use agile method***

Although there is no official list of companies that use the agile method for their projects, IBM is one of the companies that openly use this method to develop software. Many companies will adopt the use of this method within their development structure, but they are not always open about their choice to use it.

According to IBM, the use of this method means that significant organizational changes will take place. They believe that many agile software development teams will increase their chances of success by partnering with a trusted guide. They help clients implement their own agile software development strategies for their projects. They provide critical guidance that will help agile software development teams to avoid common adoption, expansion, and implementation pitfalls.

### ***Benefits of using the agile method***

The agile method grew out of the experience with the real-life projects of leading software professionals from the past. Because of this, the challenges and limitations of traditional development have been discarded. Subsequently, the method has been accepted by the industry as a better solution to project development. Nearly every software developer has used the agile method in some form.

This method offers a light framework for assisting teams. It helps them function and maintain focus on rapid delivery. This focus assists capable organizations in reducing the overall risks associated with software development.

It ensures that value is optimized throughout the development process. The use of iterative planning and feedback results in teams that can continuously align a delivered product that reflects the desired needs of a client. It easily adapts to changing requirements throughout the process by measuring and evaluating the status of a project.

The measuring and evaluating allows accurate and early visibility into the progress of each project.

It could be stated that the agile method helps companies build the right product. Instead of trying to market software before it is written, the agile method empowers teams to optimize the release during its development. This allows the product to be as competitive as possible within the marketplace. It preserves the relevance of the critical market, and it ensures that a team's work doesn't wind up collecting dust on a shelf. This is

why this method is an attractive developmental option for stakeholders and developers alike. This is according to **tutorials point simple easy learning** website accessed on 27/05/19

### 3.2 Baseline Study

The baseline study was conducted in Lusaka at the University Teaching Hospital (UTH) - Women and Newborn Hospital was chosen because it is the biggest teaching hospital which has patients from all the towns of Zambia, as well as from the neighbouring countries.

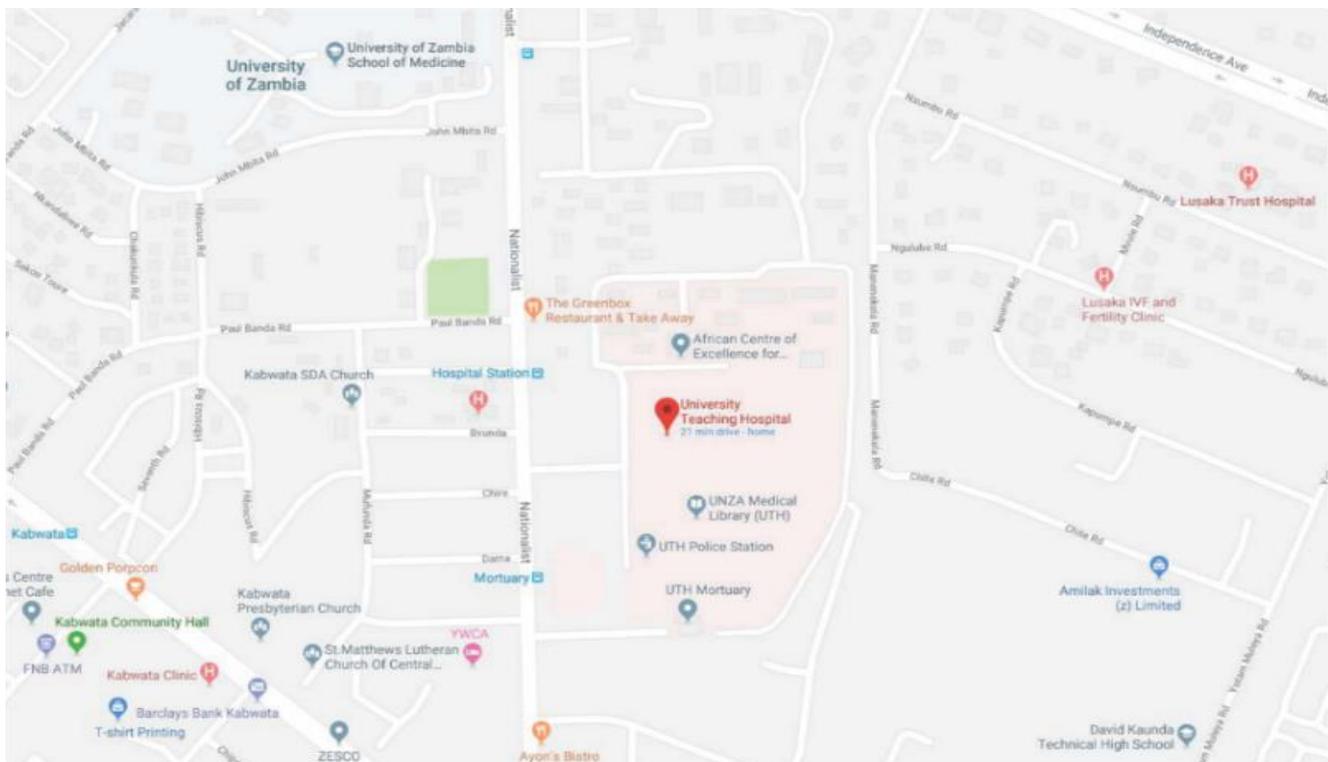


Fig 2. University Teaching Hospital (UHT) - Google Maps

### 3.3 Data Collection

The researcher gathered data necessary for the project from various sources during this project research. The researcher used two major fact-finding techniques in gathering and collecting necessary data and information needed from the system analyses. These are:

#### 3.3.1 Primary Source

This refers to the source of collecting original data in which the researcher made use of empirical approaches such as personal interviews and questionnaires. The questionnaire used is included in the appendix.

#### 3.3.2 Secondary Source

The researcher obtained secondary data from magazines, journals, newspapers, library sources, and internet downloads. Data collected using these sources is presented in the literature review in chapter two.

### **3.3.3 Oral interview**

The researcher orally quizzed the hospital administrators, staff members, patients, and some stakeholders of University Teaching Hospital (UTH) – Women and Newborn Hospital in order to have a clear view of the expected system requirements.

### **3.4 Research Approach**

The researcher chose the University Teaching Hospital (UTH) – Women and Newborn Hospital in Lusaka, Zambia as a case study due to easy access to the medical information and the consultant. The researcher visited the hospital to collect appropriate information. The purpose of the study was to find out the current state of the information management system in use to help find means of enhancing it further. The researcher interviewed various medical personnel in order to know their duties and challenges they face while discharging their duties. The researcher learnt that the hospital had written vouchers, bills of payment, receipts and other test results. This was to have an idea on how the system operates for referencing and saving for future works and the platform of how to turn the manual printed reports into an electronic one.

The current system used by UTH – Women and Newborn Hospital is both a manual and an online system called Smart Care. The manual system makes the operations tedious and time consuming. The processes take much time to be completed and causes a lot of stress to both staff and the patients involved. In the manual system, the file cabinet contains the documented patient documents. The hospital initializes a search operation in the file

cabinet each time they need the documents to locate a particular patient's medical form.

SmartCare is an online information management system. The SmartCare electronic health record system (EHR) has been developed and deployed by Zambia's Ministry of Health (MoH) in collaboration with the Centres for Disease Control and Prevention (CDC) and many other implementing partners.

### **3.5 Evaluation of Forum**

The researcher accessed necessary and available documents. These included medical forms, receipts, and registration forms etc. The researcher also reviewed how the SmartCare System is used and the challenges faced by the users. These forms helped in the design of the new system.

#### **3.5.1 Problem of the Current System – Manual System**

The manual means used by the University Teaching Hospital – Women and Newborn Hospital in hospital operations dispensation and other such operations is characterized by many problems, which include:

- Delay in processing medical forms;
- Unavailability of some key staff while processing some medical forms, which leads the patients or their guardians to repeatedly visit a particular office in order to sign their medical form(s);
- Loss of some vital documents as the filing system is manual;
- Damage of document as a result of fire or rain;
- Illegal removal of forms by fraudulent staff leading to insecurity; and
- It takes a lot of time to retrieve a particular medical form(s).

### 3.5.2 Problem of the Current System – SmartCare System

The SmartCare System used by the University Teaching Hospital – Women and Newborn Hospital in hospital operations dispensation and other such operations is characterized by many problems, which includes

- Delay in processing medical forms due to internet connectivity;
- Unavailability of some key staff while processing some medical forms, which leads the patients or their guardians to repeatedly visit a particular office in order to sign their medical form(s); and
- Lack of knowledge by some personnel in handling the system.

### 3.5.3 Development of the Application

The researcher designed the new system to solve the problems affecting the manual system and improved the functionality of the system in use. It was designed to be used online, thereby relieving administrators, staff and patients from much stress such as that experienced in the manual system. This does the analysing and storing of information either automatically or interactively. It makes use of online access to the internet. The system also has some other features like:

- Accuracy in handling of data;
- Fast rate of operation and excellent response time;
- Flexibility (i.e.) it can be accessed at any time;
- Easy way of back up or duplicating data in varied storage media in case of data loss;
- Better storage and faster retrieval system; and
- Accessibility from any part of the world.

After studying the requirements for development of the system, hardware requirement, fusibility study, and the economical fusibility, the researcher started developing the system. The Gantt chart also shows

the dependency relationship between activities. Gantt charts can be used to show current schedule status. The Gantt chart is constructed with a horizontal axis representing the total time span of the project, broken down into increments (days, weeks, or months). It is constructed with a vertical axis representing the tasks that make up the project. The Gantt chart shows the process of the design and development of the Online Health Management System for University Teaching Hospital (UTH) – Women and Newborn Hospital:

Fig 3 Gantt Chart for the design and development of an Online Health Management System

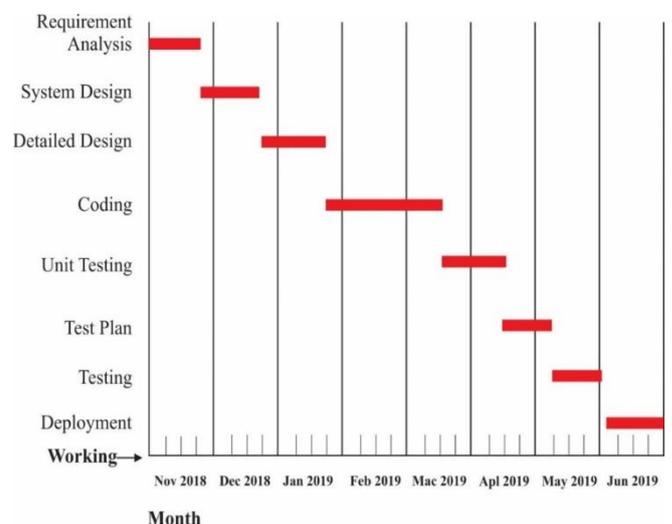


Fig.4 Agile life cycle



Source:

<https://www.capterra.com/p/130500/SoftClinic/>

In the development of the Online Health Management System for the University Teaching Hospital (UTH) – Women and Newborn Hospital, this research methodology was mainly used in the analysis and design phases of the system development process. This is because it allowed the researcher to analyze changes in technology.

### **3.6 System Design**

This is the process of determining user expectations for a new or modified product.

The requirements for the system were identified during this stage as follows:

#### ***Identify customers' needs***

The needs of the users or stakeholders were taken into consideration. These were what the users or stakeholders wanted the system to do and its appearance. The researcher achieved this by using data that was collected during research conducted at UTH Women and Newborn Hospital.

#### **3.6.1 Evaluating system for feasibility.**

The main purpose conducting the feasibility study was to establish the reasons to develop the software that would be accepted by all the users and could be modified easily as per the requirements (KENTON, 2018). The researcher did evaluate system for feasibility to determine whether the software was able to fulfil the requirements of the hospital or a user.

#### **3.6.2 Perform economic and technical analysis**

Economic feasibility: helped in determining whether the required system had the potential to generate financial gains for the University Teaching Hospital (UTH) – Women and Newborn Hospital. This type of study involves the cost incurred on the researcher for the system development, cost of study involved in conducting a feasibility study, estimated cost of software and hardware. Software can be considered to be

feasible only if it focuses on the issues that are discussed below:

- The cost associated with the training, development team, software and hardware.
- Cost required for conducting system investigation such as requirements analysis and requirements elicitation.
- The cost incurred on the development of the system for producing long-term gains for UTH - Women and Newborn Hospital.

#### **3.6.3 Allocate functions to system elements**

Function allocations determine the correct means of control for the functions and allowed transitions between functions identified in the system. This includes: Performance demands, Human and machines capabilities/limitations, Existence practice, Regulatory requirements, Technical requirement, Cost, Operating experience and Redundancy.

#### **3.6.4 Establish schedule and constraints.**

A schedule constraint is a limitation placed on a project schedule that affects the start or end date of an activity. The researcher established the schedule and constraints to the design and development of an online health management system for University Teaching Hospital (UTH) – Women and Newborn Hospital. The schedule and constraints can restrict the start of a project. The researcher decided to use constraints as they may restrict the work item to be completed on or before a specified date. When one applies this constraint to a task, one must specify the constraint date by which the task must be completed. To apply this constraint, there is need to select the constraint type such as 'Finish no later than', and specify the constraint date as the time at which the work item must be completed. This is according to IBM Knowledge Centre on schedule and constraints.

### **3.6.5 Create system definitions.**

System definition activities are conducted to create and describe in detail a system-of-interest (SoI) to satisfy an identified need. The activities are grouped and described as generic processes. These consist of system requirements definition, system architecture definition, system design definition and system analysis. This helped the researcher in the design and development of an online health management system for UTH – Women and Newborn Hospital.

### **3.6.6 System requirements**

The system requires a client-server architecture where a server is necessary to host the application and the database. The users will access the server to retrieve information from their desktops, laptops, tablets or smartphone through their web-based interfaces. For this system to work properly the following will be required:

Users must log in, order to access the system resources.

The system was designed and developed in such a way that the user must log in using their user name and password to access the system resources. The researcher developed the system with the login module for security reasons to prevent just anyone from accessing information on the system. It only allows a registered user to access to access it.

### **3.6.7 Internet must be always available**

This is an online web-based system that will work with internet connectivity. The internet must be available at all time for the system to work effectively.

All users should undergo training.

A user must be trained on how the system works and what should be done in order to achieve the goal of designing and development of the online

health management for the University Teaching Hospital UTH – Women and Newborn Hospital.

### **3.6.8 Non-functional requirements**

Non-functional requirements are described as the constraints on the services the system provides.

After analyzing the requirements, the researcher developed a plan as explained in the planning phase

#### ***Planning***

A plan for designing and development of an online health management for University Teaching Hospital (UTH) – Women and Newborn Hospital project was formulated as well as other supporting documents. The plan provided the necessary information vital for the project needed in achieving the solution of developing the system. The planning phase of the project also had a project timeline and work plan developed.

#### ***Design***

In systems design the functions and operations were described in detail, including screen layouts, process diagrams and other documentation. The output of this stage described the new system as a collection of modules or subsystems. For each requirement, a set of one or more design elements was produced as a result of interviews and/or prototype efforts.

Design elements described the desired system features in detail, and generally included functional hierarchy diagrams, screen layout diagrams, tables of business process diagrams, pseudo code, and a complete entity-relationship diagram with a full data dictionary.

#### ***Development***

This is the process of coding and testing of the system. The researcher ensured that this was done. An online health management system for the University Teaching Hospital was developed. Testing was done by using the web server WampServer. The program was tested on localhost

first. The aim of testing was to find out if there were any faults in the system and if these could be repaired.

### Implementation phase / release

Here all the iterations were brought together and integrated to make one working system. Modular and subsystem programming code was

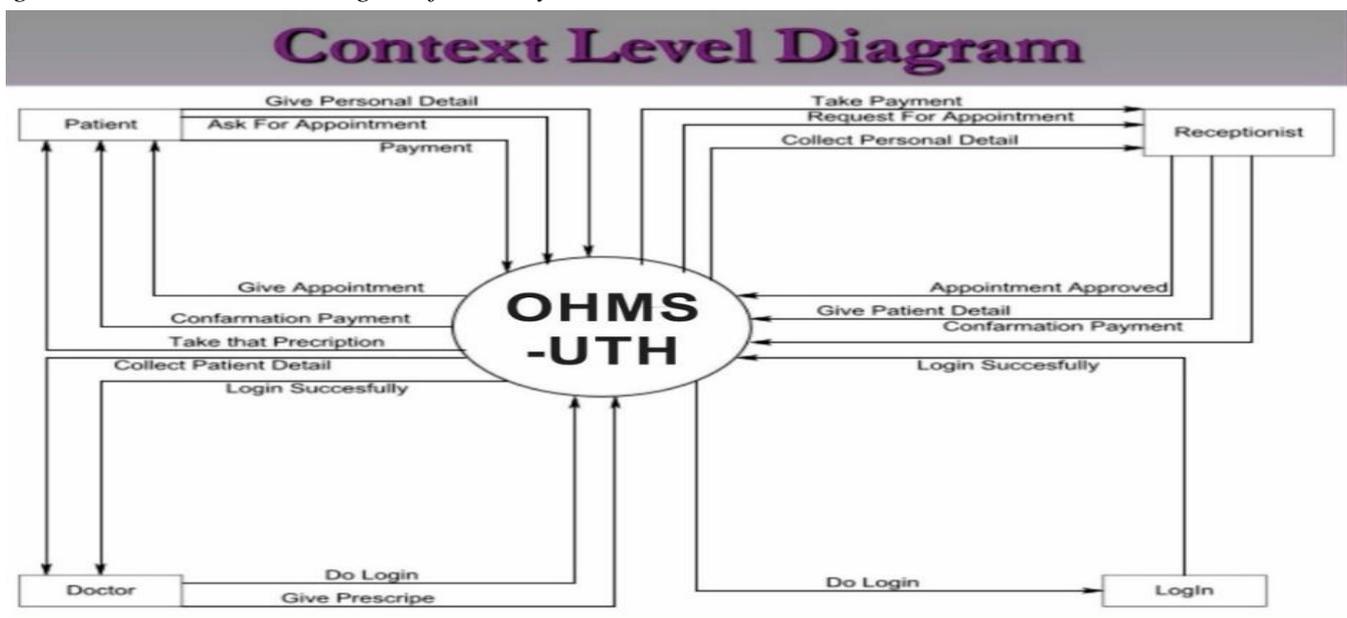
accomplished during this stage. Unit testing and module testing were done at this stage.

**Track and monitor** This is the process of tracking and monitoring the performance of the system designed and developed. The researcher monitored an online health management system for UTH – Women and Newborn hospital.

### 3.7 System Design

Fig. 5: shows the context diagram for the system

Source: Author, 2019



The context diagram gives the following benefits stated below:

- Shows the scope and boundaries of a system at a glance, including the other systems that interface with it.
- No technical knowledge is assumed or required to understand the diagram.
- Easy to draw and amend due to its limited notation.
- Easy to expand by adding different levels of DFDs.
- Can benefit a wide audience, including stakeholders, business analysts, data analysts, and developers.

### 3.7.2 System software level architectural design

Architectural design is the first stage in the software design process. It is the critical link between design and requirements engineering, as it identifies the main structural components in a system and the relationships between them. The output of the architectural design process is an architectural model that describes how the system is organized as a set of communicating components.

### 3.7.3 Logical architecture

Designing the logical architecture is possibly the stage of the software development life cycle (SDLC) which mostly leans on patterns. It is uncommon to build a system that is not based on some well-known architectural styles. Famous

examples of such patterns include the client-server pattern, broker pattern, layered architecture. Since the current application is intended to be a web application there is need to combine layered architecture with MVC where the need data management layer, a business logic layer and a presentation layer are required.

The data management layer will contain those parts of the application that need to be used. Entity management framework is vital.

Software architectures can be designed at two levels of abstraction, which Sommerville calls architecture ‘in the small’ and architecture ‘in the large’:

Architecture in the small is concerned with the architecture of individual programs. At this level, users are concerned with the way that an individual program is decomposed into components.

Architecture ‘in the large’ is concerned with the architecture of complex enterprise systems that include other systems, programs, and program components. These enterprise systems are distributed over different computers, which may be owned and managed by different companies.

The three main advantages of explicitly designing and documenting a software architecture are:

- Stakeholder communication - The architecture is a high-level presentation of the system that may be used as a focus for discussion by a range of different stakeholders.
- System analysis - Making the system architecture explicit at an early stage in the system development requires some analysis. Architectural design decisions have a profound effect on whether or not the system can meet critical requirements such as performance, reliability, and maintainability.
- Large-scale reuse - A model of a system architecture is a compact, manageable description of how a system is organized and how the components interoperate. The system architecture is often the same for systems with similar requirements and so can support large-scale software reuse.

Regarding implementation platform and technology no decision was made. An MVC-style layered architecture can be implemented in various platforms. For example, NET offers the Entity Framework for persistence management and ASPs can be used to implement the web frontend.

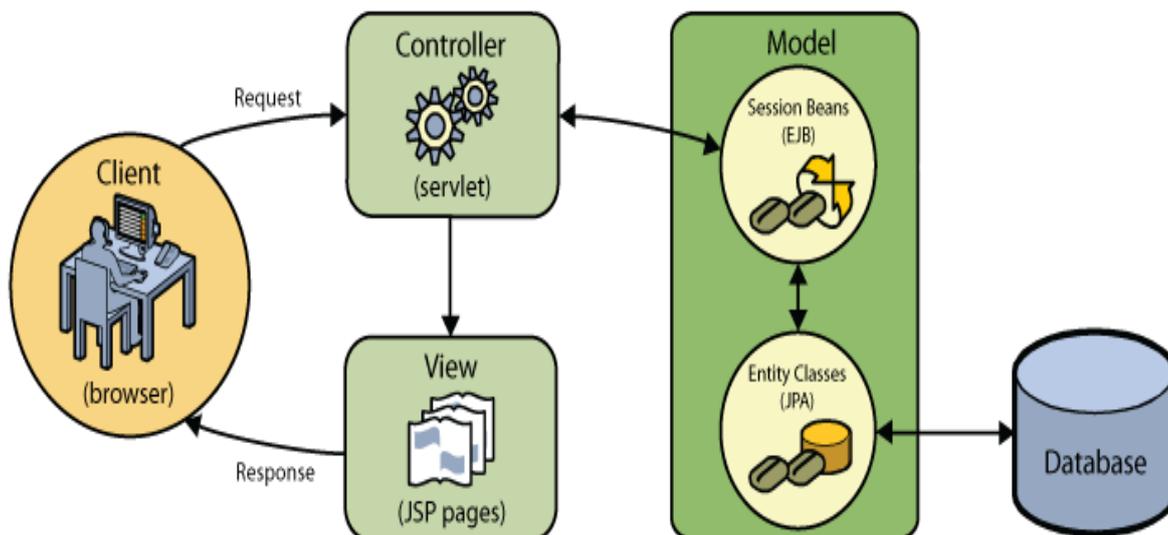


Fig 6:  
Overall MV-  
based  
architecture

(<https://netbeans.org/kb/docs/javaee/ecommerce/design.html>)

### 3.7.4 Physical architecture

The physical layout of our applications can be depicted by deployment diagrams.

### 3.7.5 UML 2 Deployment diagram

A deployment diagram models the run-time architecture of a system. It shows the configuration of the hardware elements (nodes) and shows how software elements and artifacts are mapped onto those nodes.

**Node:** A Node is either a hardware or software element. It is shown as a three-dimensional box shape. As a deployment target, it represents computational resource upon which artifacts may be deployed for execution. A node can contain other elements, such as components or artifacts, or other nodes.

**Device:** A device is a node which represents a physical computational resource with processing capability upon which artifacts may be deployed for execution. Examples are: application server, database server, client workstation, mobile device, embedded device, etc.

**Execution environment:** An execution environment is a (software) node that offers an execution environment for specific types of components that are deployed on it in the form of executable artifacts. Components of the appropriate type are deployed to specific execution environments. Examples of execution environments are: OS (operating system), workflow engine, database system, Java EE Container, web server, web browser, etc.

**Node instance:** A node instance can be shown on a diagram. An instance can be distinguished from a node by the fact that its name is underlined and has a colon before its base node type. An instance may or may not have a name before the colon. This is useful when describing a real physical architecture with existing device names (machine names).

**Artifact:** An artifact is a product of the software development process. That may include process models (e.g., use case models, design models, etc.), source files, executables, design documents, test reports, prototypes, user manuals, etc. An artifact is denoted by a rectangle showing the artifact name, the «artifact» keyword and a document icon. Artifact is a source of a deployment to a node. Examples of artifacts are: text documents, source files, binary executables, archives, etc.

**Communication path:** A communication path is an association between two deployment targets, through which they are able to exchange signals and messages. Communication path is notated as association, and it has no additional notation compared to association.

### 3.7.6 Modular design of the system function

In a modular design, it is necessary to solve the “problem (difficulty) of optimization of the functional performance, the cost, size, etc. of a system due to considering of the module” and “difficulty of the development of the system variation due to the guarantee of the module interface”. It is important to make the design environment where a designer can feel free to think about the trade-off of the modularization.

### 3.7.7 System class diagram

Class diagram is a diagram that describes the structure and description of classes, packages and objects as well as relationships with one another. Class diagrams also explain the relationship between classes in a system and how they collaborate with each other in order to achieve a goal, According to A.B. Mutiara, A. Muslim, T. Oswari, R.A. Miharja (2019).

The patient has a doctor’s examination, including observation, evaluation, and instruction. Observations have four parts: observation, history, examination and investigation. Observations that generate data that can be measured by numbers.

### 3.7.8 System data model design

Many data models are designed using a process where the modeller creates a Logical and a Physical model. Typically, logical models describe entities and attributes and the relationships that bind them, providing a clear representation of the business purpose of the data. Physical models then implement the Logical model as tables, columns, datatypes, and indexes along with concise data integrity rules. These rules define primary and foreign keys and default values. Additionally, views, triggers, and stored procedures can be defined to support the implementation as required. The physical model also defines the storage allocation on a disk based upon specific configuration options provided by most host systems (like Oracle, MS SQL Server, MySQL). UML Information Architecture was used to design the database of the online Health Management System of University Teaching Hospital (UTH) - Women and Newborn Hospital because each Home page, Admin Login, *Fig. 7: Doctor's Login page of UTH Online Health Management System*

element object encapsulates a particular part of a data silo and connecting lines (also called links) which define specific relationships between two elements (and, again, only two). Particular element items (called characteristics) are defined to further assist in the understanding and purpose of the object. These are either:

Protected (where values are pre-determined)

Public (where values are mutable)

Private (where values have restricted use)

### 3.7.9 User interface design

User interface (UI) design is the process of making interfaces in software or computerized devices with a focus on looks or style. The user interface was designed in the manner that is easy to use. The design is user-friendly for all the users of the online health management system, below is the screenshot of the following –

Online Health Management System

<http://localhost/uthohms/doctorlogin.php>

UNIVERSITY TEACHING HOSPITAL

Home About US Online Appointment Login Registration Contact US

ACCOUNT PROFILE PATIENT APPOINTMENT TREATMENT DOCTOR SETTINGS LOG OUT

Doctor Login Panel

Kindly Enter Login ID and Password..

Login ID impetemoya

Password .....

Submit

Copyright © 2019 - | Admin Login Panel | Doctor Login Panel All Rights Reserved. Designed and Maintained By Ignatius Mpetemoya. SIN: 150620390

Online Health Management System

http://localhost/uthohms/index.php

Fig. 8: Home page of UTH Online Health Management System

Source:  
Author, 2019



1 of 1

7/18/2019, 3:56 PM

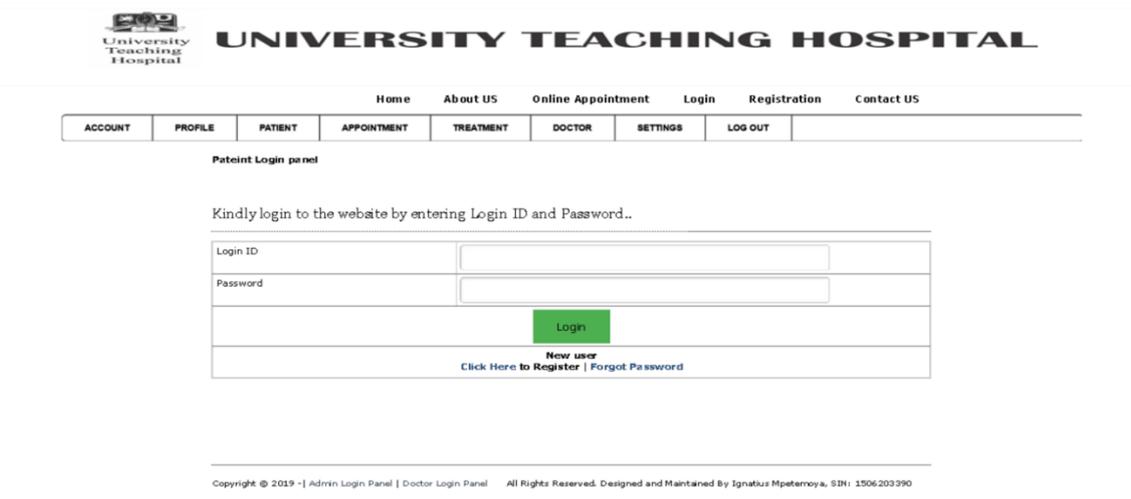
Fig. 9: Patient's Login page of UTH Online Health Management System

Online Health Management System

http://localhost/uthohms/patientlogin.php

Source,  
Author  
2019

Agile



1 of 1

7/18/2019, 5:09 PM

### 3.8 Summary

This chapter gave detail of the methodology used for design and development the online Health Management System for the University Teaching Hospital (UTH) - Women and Newborn Hospital.

methodology was adopted in the design of the system.

The agile methodology was mainly used in the analysis and design phases of the system development process. This is because it allowed the researcher to analyze changes in technology.

## RESULTS

### 4.1 Introduction

In this chapter, the focus is on the results of the research, which was conducted at the University Teaching Hospital (UTH) - Women and Newborn Hospital in Lusaka with regard to the design and development of an online Health Management System for the institution.

The survey revealed that the respondents (doctors, nurses, pharmacists, lab technicians, registry clerks, and all medical personnel) were exposed to risks of losing patients' data in the process. The results also showed the appreciation in the use of ICT, such as computer and the use of technological innovations such as an online health management system and cashless transactions, among the respondents.

The results of the survey enabled the researcher to determine the development of an online Health Management System. A cloud-based system is developed using PHP, Java Scrip, HTML IDE, Java programming language and MySQL database.

### 4.2 Baseline Study Results

The survey was conducted as part of this research, on which the justification for development of an online Health Management System for University Teaching Hospital (UTH) - Women and Newborn Hospital is based. The next section deals with the results of the implementation of the system.

### 4.3 Survey Results and Discussion

In this section, the results of the survey that was done in this study are discussed. The Statistical Package for Social Sciences (SPSS) application software was used to analyze the data, which was gathered from the survey by the researcher.

The respondents at the University Teaching Hospital (UTH) - Women and Newborn Hospital were as shown in tables.

The results show the gender distribution for the study that was conducted as 50 % and 50 % for male and female respondents respectively. It is clear, therefore that there was no gender imbalance. Maybe the result would have shown otherwise due to the sample size that was used in this survey as shown in table 1.

|       |        | SEX       |         |               |                    |
|-------|--------|-----------|---------|---------------|--------------------|
|       |        | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | MALE   | 15        | 50.0    | 50.0          | 50.0               |
|       | FEMALE | 15        | 50.0    | 50.0          | 100.0              |
| Total |        | 30        | 100.0   | 100.0         |                    |

*Table 1 shows gender distribution*

The results show the age distribution for the study that was conducted at University Teaching Hospital UTH Women and Newborn Hospital. The majority of the respondents were between the ages of 26 to 35 years, representing a 50% and other as shown on table 2.

|       |                | AGE       |         |               |                    |
|-------|----------------|-----------|---------|---------------|--------------------|
|       |                | Frequency | Percent | Valid Percent | Cumulative Percent |
| Valid | 18 TO 25 YEARS | 8         | 26.7    | 26.7          | 26.7               |
|       | 26 TO 35 YEARS | 15        | 50.0    | 50.0          | 76.7               |
|       | 36 TO 45 YEARS | 4         | 13.3    | 13.3          | 90.0               |
|       | 46 TO 55 YEARS | 3         | 10.0    | 10.0          | 100.0              |
| Total |                | 30        | 100.0   | 100.0         |                    |

*Table 2 shows age distribution*

The results show the marital status distribution for the study that was conducted at University Teaching Hospital (UTH) Women and Newborn Hospital. The majority of the respondents were single, representing a 50% while 30% were married.

**MARITAL STATUS**

|              | Frequency | Percent | Valid Percent | Cumulative Percent |
|--------------|-----------|---------|---------------|--------------------|
| Valid SINGLE | 15        | 50.0    | 50.0          | 50.0               |
| MARRIED      | 9         | 30.0    | 30.0          | 80.0               |
| DIVORCED     | 5         | 16.7    | 16.7          | 96.7               |
| WIDOWED      | 1         | 3.3     | 3.3           | 100.0              |
| Total        | 30        | 100.0   | 100.0         |                    |

*Table 3 shows marital status distribution*

The results show the education level distribution for the study that was conducted at University Teaching Hospital (UTH) - Women and Newborn Hospital. The majority of the respondents were degree holders 63.3%, 26.7% were diploma holders, 6.7% were master's degree holders and 3.3% were primary certificate holders as shown on tables

**EDUCATION STATUS**

|                     | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------------------|-----------|---------|---------------|--------------------|
| Valid PRIMARY LEVEL | 1         | 3.3     | 3.3           | 3.3                |
| COLLEGE LEVEL       | 8         | 26.7    | 26.7          | 30.0               |
| DEGREE LEVEL        | 19        | 63.3    | 63.3          | 93.3               |
| MASTER'S LEVEL      | 2         | 6.7     | 6.7           | 100.0              |
| Total               | 30        | 100.0   | 100.0         |                    |

*Table 4 shows education level distribution*

The results show the position distribution for the study that was conducted at University Teaching Hospital (UTH) - Women and Newborn Hospital. The majority of the respondents were doctors at 33.3%, 26.7% were student doctors, 23.7% were nurses and 6.7% were pharmacists and 3.3% were registry clerk as shown on table 5.

**WHAT IS YOUR POSITION?**

|                | Frequency | Percent | Valid Percent | Cumulative Percent |
|----------------|-----------|---------|---------------|--------------------|
| Valid DOCTOR   | 10        | 33.3    | 33.3          | 33.3               |
| STUDENT DOCTOR | 8         | 26.7    | 26.7          | 60.0               |
| NURSE          | 7         | 23.3    | 23.3          | 83.3               |
| PHARMACIST     | 2         | 6.7     | 6.7           | 90.0               |
| REGISTRY CLERK | 3         | 10.0    | 10.0          | 100.0              |
| Total          | 30        | 100.0   | 100.0         |                    |

*Table 5 shows position distribution*

The results show the period distribution for the study that was conducted at University Teaching Hospital (UTH) - Women and Newborn Hospital. The majority of the respondents were doctors at 33.3%, 26.7% were student doctors, 23.7% were nurses and 6.7% were pharmacists and 3.3% were registry clerks as shown on table 6.

The researcher observed that the University Teaching Hospital (UTH) - Women and Newborn Hospital has an online health management system. 43.3% of the respondents said the institution has a system in place. Although the majority (56.7%) said the hospital does not have an online health management system, the researcher proved that it actually has an online health management system. Below is the table showing responses from the respondents.

**DO YOU HAVE AN ONLINE HEALTH MANAGEMENT SYSTEM?**

|           | Frequency | Percent | Valid Percent | Cumulative Percent |
|-----------|-----------|---------|---------------|--------------------|
| Valid YES | 13        | 43.3    | 43.3          | 43.3               |
| NO        | 17        | 56.7    | 56.7          | 100.0              |
| Total     | 30        | 100.0   | 100.0         |                    |

*Table 6 shows do you have an online Health Management System distribution*

According to the survey, the researcher observed that 30.8%, people that had worked at the hospital for less than 3 years said the system was in place while 38.5% of people that had worked for this institution for 4 to 5 years said the hospital had an online health management system. Six to 7 years shows 30.8% said the institution has an online health management system. On the next page is the table 7 indicating distribution on how the responses were according to the period the respondents have worked at the hospital in regard to an online health management system. According to the survey, researcher observed that online health management system is good in the delivery of health care services.

## 4.4 System Implementation Results

In this section, the study's results on the online Health Management System, which is an online-based system, are covered. Initially, the interaction of the user with the system is explained. Then later, the interaction of the administrator is also explained. The testing of the online health management system was done. The administrator is able to add the users to the database of the system: patients, doctors, pharmacists and registry clerks. The patient was able to make an online appointment, the appointment was successfully approved. The doctor was also able to view the patients' data on the system.

## 4.5 Summary

This chapter has presented the results of the baseline study and the design and development of an online Health Management System. It covered the successful implementation of an online health management system that is able to successfully register a patient and then perform successful registering with remote users (patients). The administrator was able to add a doctor, and also the doctor was able to view the patients' data using all the authentication factors on the System on which it was implemented. The chapter concludes with the testing of an online Health Management System.

## DISCUSSION AND CONCLUSION

### 5.1 Introduction

This chapter discusses the research design and methodology for creating the OHMS for University Teaching Hospital (UTH) - Women and Newborn Hospital. The research methods include interviews and surveys creating the prototypes. For designing the OHMS, we use Hypertext Preprocessor (PHP) for designing the web-based interface; MySQL for system database and the Unified modeling

language (UML) is designed specially to represent object-oriented systems. The project was started by first clarifying what kind of prototype was envisaged to solve the problems at the University Teaching Hospital (UTH) - Women and Newborn Hospital by means of gathering concepts from a focus group among whom interviews and surveys were conducted. The analysis of this data led to the first prototype. The OHMS the researcher came up with manages data systematically in order to ease the burden of accessing and manipulating the health records of patients. This chapter discusses and analyzes the technical aspects of the OHMS web-based application. It covers the kind of technologies used and why they were chosen, and in what way the considered solutions could contribute to the project.

### 5.2 Discussion

The experiment showed that the system was able to create and handle users, submit and retrieve information, which was the main purpose of creating an online health management system. However, this is just a black-box test on the application showing that it does what it needs to do without considering the program code and database interaction behind the functionality. This is why a quantitative performance test was essential for each of the requests to the server associated to the entire qualitative black box in order to have an indirect white box test. This is basically a load test. Load-testing a web application involves making concurrent requests for resources, typically by simulating multiple users, and then examining the servers' behaviour. The same test plan was used with adjustments made to the number of users and other settings to determine how the server behaves under a given workload.

### 5.3 Baseline study

The Health Management Information System at the University Teaching Hospital (UTH) - Women and

Newborn Hospital has been paper-based since its inception before the introduction of a SmartCare. The Institution has been running its patient admission system using a clumsy and error-prone manual system that has led to many frustrations, such as missing or duplicated patient records and time has been wasted searching for documents that have not been read correctly, until when the SmartCare system was introduced. After intensive interviews with the University Teaching Hospital personnel and administering a written questionnaire the researcher determined the greatest needs to produce an online Health Management System following the first round of interviews and questionnaires regarding the requirements of users at UTH.

Medical personnel and medical personnel could try out the system and familiarize themselves with computers. In this process they also gained invaluable experience in the use of computers to ease their clerical burden of keeping track of patients' records in the hospital. After engaging with the first prototype for a few weeks, the administrative and medical personnel gained some experience and familiarity with our prototype computing system that assisted them in their daily duties. These users could now respond with more authority and confidence to questions of how they saw the future growth of the system.

The administrative staff and the medical personnel using the system were subsequently interviewed and a survey was done using a second questionnaire to determine requirements and improvements to the system. Users could now identify problems because they had a better understanding and much more familiarity with the capabilities of a computerized administrative system.

## 5.4 Use of Technology

JavaScript is a script-based programming language which was developed by Netscape Communication Corporation. It was originally called Live Script and renamed as JavaScript to indicate its relationship with Java.

JavaScript supports the development of both client and server components of web-based applications. On the client side, it can be used to write programs that are executed by a web browser within the context of a web page. On the server side, it can be used to write web server programs that can process information submitted by a web browser and then updates the browser's information accordingly.

Even though JavaScript supports both client and server web programming, we prefer JavaScript at client-side programming since most of the browsers support it.

HTML Hypertext Markup Language refers to the languages of the World Wide Web (www) allows users to produce Web pages that include text, graphics and pointers to other Web pages (hyperlinks).

HTML is not a programming language but it is an application of ISO Standard 8879, SGML (Standard Generalized Markup Language), but specialized to hypertext and is adapted to the Web. The idea behind Hypertext is that instead of reading text in rigid linear structure, we can easily jump from one point to another. We can navigate through the information based on our interest and preferences.

SQL structured query language is a tool of communication between a user and DBMS. SQL is a simple and powerful language in the sense that most of the operations in DBMS can be done using SQL

PHP Hypertext Pre-processor is a widely-used open source general-purpose scripting language

that is especially suited for web development and can be embedded into HTML

Cascading Style Sheets describes how documents are presented on screens, in print, or perhaps how they are pronounced. W3C has actively promoted the use of style sheets on the Web since the consortium was founded in 1994. Provides easy and effective alternatives to specify various attributes for the HTML tags. Using CSS, one can specify a number of style properties for a given HTML element, according to **tutorialspoint**.

WampServer is a Web development platform on Windows that allows you to create dynamic Web applications with Apache2, PHP, MySQL. WampServer automatically installs everything one needs in order to develop web applications.

## **5.6 Development of system as a solution**

An online health management system will help doctors to devote more time to patients, not documentation. All the necessary information about the patient is collected and stored in the database of the system. The doctor will be able to see the history of the disease and quickly obtain the test results. The more information the doctor has, the more accurately he can make a diagnosis and prescribe the right treatment.

The database will help a doctor or nurse to give a medical protocol to their patient, and add information to the patient's card. It is useful for doctors as well as for the administration. Duration of an appointment can be shortened without compromising quality. This will increase the hospital's revenue. Doctors can look at the appointment at any time and make changes if necessary.

The system will help the hospital authority to analyze doctors' work and evaluate how many hours each one of them worked. It will optimize hospital peak hours and reduce medical equipment

downtime. Find out which medical directions generate revenue and which ones should be closed or modified.

It will also help patients to make online appointments with the hospital, and they will have an interaction with the doctors via SMS. The online Health Management System will store all laboratory results in database of the system and these can be used by doctors for reference or research.

The system will help registry clerks to retrieve patients' information within a short time hence reducing the time spent at hospital's reception. A patient will be seen by a doctor as quickly as possible and the doctor will spend less time on the patient because he or she will have the necessary information about the patient.

## **5.7 Comparison with other similar works**

**SmartCare.** The SmartCare electronic health record system (EHR) was developed and deployed by Zambia's Ministry of Health (MoH), in collaboration with the Centres for Disease Control and Prevention (CDC) and many other implementing partners.

The system is being simplified making it more hospital-friendly starting with the OPD module, supported by CDC through BroadReach HealthCare Corporation.

**SoftClinic** is world's best EHR & HMS (Hospital Management System) with all required features to run a practice or hospital smoothly and is hassle-free. It has become preferred a choice for physicians, clinics, hospitals and nursing homes. Currently there are more than a million patients registered on SoftClinic in over 30 countries. Having various integrated modules like pharmacy, laboratory, human resources and financial accounting, it has everything a physician needs, according to JVS Group

## 5.8 Possible application

The researcher found out that designing and developing of a mobile application for the health management system will help in so many ways. Statistics show that around 64.5 percent of the households in the country have access to a mobile phone, determined by at least one member of the household owning the gadget. Further, about 51 percent of people aged above 10 years in Zambia are active users of mobile phones. Only 13.5 percent of the individuals that own mobile phones have smartphones. About 71 percent of individuals that own smartphones use the devices to access over the top (OTT) applications like WhatsApp, Viber, Facebook, Skype and Twitter for communication using instant messaging or voice calling. While probably only a handful of applications make up the bulk of this total usage, it doesn't change the fact that each user has to unlock, scroll, and scan their device for the apps. This is according to ICT Survey Report-Households and Individuals of 2015.

## 5.9 Summary

The goal and aim of the project were to create an online Health Management System that provides quick and easy access to patients' records at the University Teaching Hospital (UTH) – Women and Newborn Hospital. The researcher can confidently say that this has been met because the system can do the functionality. Furthermore, the resources listed in this report suffice for this project to be implemented and the qualitative results performed have shown that the application can withstand great deal of loads. This project was a success; the system meets all the user requirements and it is usable.

## 5.10 Conclusion

The thesis started with a software problem that is an online health management information system for UTH - Women and Newborn Hospital. Following interviews and questionnaires, the researcher determined the requirements to implement an OHMS to manage patients' information. Important elements are data storing, data collection, and data entry. The main concepts of the system were formulated by applying a Use Case diagram to describe its main elements. The UML Use Case diagram not only assisted the developer to create the prototype but was also used to communicate the functionality of the system to the end users. The agile method was used for developing the OHMS, since it is accountable for the needs of end user, as well as for rapid deployment of the system.

## 5.11 Future Works

Certain elements in this project leave scope for further development. With almost any project which includes a software component, a list of future enhancements could be endless. In this case, it is important to highlight the general areas where extra work would benefit the projects such as this one. Since the OHMS is a first version which is an ongoing project, the researcher intends to distribute the system to more hospitals and the Ministry of Health. The system will be expanded to provide for the storage of patients' records, a digital imagery, for example X-rays. A plan to improve an appointment system whereby a patient can be reminded by SMS of an appointment sent to their phone whose number is in the system.

## DEFINITION OF TERMS

**Clinic:** It is a healthcare facility primarily focused on the care of outpatients.

**Database:** An electronic filing system; a collection of information organized in such a way that a program can select pieces of data.

**Diagnosis:** The identification of the nature of an illness or other problem by examination of the symptoms.

**Doctor:** A person who is qualified to treat people who are ill.

**Finance:** The management of money that includes activities like investing, borrowing, lending, budgeting, saving, and forecasting.

**Health:** This is "a state of complete physical, mental, and social well-being and not merely the absence of disease", according to the World Health Organization (WHO).

**Hospital:** A health care institution providing patient treatment with specialized medical and nursing staff and medical equipment.

**ICT:** Information and communications technology

**Information system:** software that helps one organize and analyze data.

**Java:** This is a simple object-oriented high-performance language.

**Java Scrip:** An object-oriented computer programming language commonly used to create interactive effects within web browsers.

**Online:** Connected via computer attached to or available via a central computer network.

**Patient:** A person who is receiving medical care, or who is cared for by a particular doctor, nurse, or dentist when necessary.

**Pharmacist:** A person who is professionally qualified to prepare and dispense medicinal drugs.

**Software:** A general term for programs used to operate computers and related devices.

**System:** A set of computer components, that is, an assembling of hardware, software, and peripherals functioning together.

**Treatment:** Medical care given to a patient for an illness or injury.

**Web-based software:** Software one uses over the internet with a web browser.

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