

# Design and Development of Online Patient Record Management System: Automated Patient record

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## Abstract

*Patient Record Management Systems (manual) in hospitals today necessitate a competent administration when handling patients, generating reports from cashier, patient details which serves as a key factor for the flow of business transactions in hospitals. Unfortunately, the current Record Management system leads to misplacement of drug details, payment details, and late release of reports and insecurity to records. This research project is aimed at computerising all the records about patients, staff and drug suppliers. In order to achieve this goal, a thorough system study and investigation was carried out and data was collected and analysed about the current system using document and data flow diagrams. The concept of report production has been computerised hence, no more delay in report generation to the hospital management. Errors made on hand held calculators are dealt out completely. The method used to develop the system includes iterative waterfall model approach, dataflow, logical and entity relationship diagram were used to design the system and finally the software used implement the system is MySQL, PHP, HTML5 and CSS, and JavaScript. Information and communication technologies (ICTs) have great potential to improve health in both developed and developing countries by enhancing access to health information and making health services more efficient; they can also contribute to improving the quality of services and reducing their cost. Patient information system, for example, have the ability to track individual health problems and treatment over time, giving insight into optimal diagnosis and*

*treatment of the individual as well as improving the delivery of services. This is particularly useful for chronic diseases, such as diabetes and cardiovascular diseases, and for maternal and child health services where a record of health and treatment over a period of time is required. Analysis of data in patient information systems can lead to new insight and understand of health and diseases, both chronic and acute. Generally, automation plays an important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organisational tools to create complex system for a rapidly expanding range of applications. The patient record management system (PRMS) is an automated system that is used to manage patient information and its administration. It is meant to provide the administration and staff, with information in real-time to make their work more interesting and less stressing. PRMS is a system that 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 efficient manner.*

**Keywords** – Automated Patient Information; Computerised record keeping; Electronic patient Record; Automated Patient Record; Computerised Record Management. Electronic Health record.

## Introduction

Information and communication technologies (ICTs) have great potential to improve health in both developed and developing countries by enhancing access to health information and making health services more efficient; they can also contribute to improving the quality of services and reducing their cost. Patient information systems, for example, have the ability to track individual health problems and treatment over time, giving insight into optimal diagnosis and treatment of the individual as well as improving the delivery of services. This is particularly useful for chronic diseases, such as diabetes and cardiovascular diseases, and for maternal and child health services where a record of health and treatment over a period of time is required. Analysis of data in patient information systems can lead to new insight and understanding of health and diseases, both chronic and acute.

Generally, automation plays an important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organisational tools to create complex systems for a rapidly expanding range of applications.

The patient record management system (PRMS) is an automated system that is used to manage patient information and its administration. It is meant to provide the administration and staff, with information in real-time to make their work more interesting and less stressing.

## Background of the study

The scope of the service in Zambia (mostly Government) hospitals, particularly Mwinilunga hospital is basically curative and preventative and offers clinic unit x-ray/ultrasound, laboratory and dental unit. Other services include admission (ward) inpatient (where drugs are issued) and many other general clinical services.

The hospital offers 24 hours' service to its staff and the entire population being the district hospital. The records of patients in Mwinilunga hospital have over time been run down due to large numbers of patients, this led to poor record keeping since it's a paper based system. The reason why the current system used is manual has led to a variety of problems and these include; unnecessary duplication of data especially for inpatients and outpatients, inconsistency may occur since data is held more than once and hard to analyse the data hence difficult to trace the flow of patient past medication data.

According to Patricia T. Vigil (2010) paper records lose reliability as their quality deteriorates over time to fading, copying, and other factors. She also added that the timeliness of receiving patient's data is critical for physicians to offer the highest quality of care for patients. Due to these factors few hospitals in Zambia in the private sector have endorsed the use of information technology in the health care to improve quality and efficiency of care.

Patient record and disease pattern documentation is concerned with documentation of information obtained from patients and their particular health system in order to function properly. If this information is not documented perfectly causing some data to get misplaced, the health system will not be effective.

According to Tang (2011) In examining the document system that exists at the hospital that is mostly manual much importance has been placed on creating a system that documents the inpatient record using a computerised database system with a secure procedure for accessing it.

Patient information past and present is extremely vital in the provision of patient's care which guides the physicians in making the right decision about the diagnosis.

## Methodology

### Introduction

This is a description of methods chosen to achieve the objectives of the proposed system. It will go on to describe the techniques of data collection that will be employed in the research study of the proposed systems. The methods that will be applied to achieve the specific objectives are namely: Literature review, Oral interviews, system analysis, system design, Data modelling and Black box testing. The tools that were used to implement the system are MySQL, HTML5, JAVASCRIPT, and PHP.

### Approach for the development of PRMS

The system development life cycle (SDLC) we chose to use the iterative waterfall model. In this model, the system follows a series of events from the requirement definition, system and software design, implementation and unit testing, integration and system testing and operational maintenance. We also used different aspects from other models like prototyping which helped us come up with system definition and analysis, data flow diagrams (DFD) and entity relationship diagram (ERD). The ERD was used to show the relationship between entities while the Data Flow Diagrams were used to show the flow of data in the system.

Iterative waterfall model divides the system development lifecycle into phases. During each phase of the lifecycle, a set of well-defined activities are carried out for instance at the Analysis stage (structured analysis of requirement) was specifically carried out in focus of the functionality of dataflow at Mwinilunga Hospital. The system and structured analysis was then transformed into software design (software architecture to decompose the system into modules and representation of relationships among the modules, data structures and algorithms for the modules to be designed).

### Data Collection Methods

The following methods were used during data collection: Observation, Interviewing and Questionnaires as our research methods. Through this we were able to collect raw data on PMS at Mwinilunga Hospital where existing reports on the current system were obtained. Verbal interview techniques were used to interview employees from the hospital.

### Baseline Study

The baseline study was conducted in Mwinilunga District of north-western. Mwinilunga district hospital was chosen because it is a big hospital and all the people in the district come to seek medical attention when their medical conditions have gone beyond what clinics in their respective areas can handle. It was also chosen because this is where people come to see doctors and also for lab related situations.

### Observation

The researcher went to the hospital and observed their daily as regards their current system and they were manually recording the patients' records as specified by the receptionists, doctors, pharmacist and cashier. A follow up was made to determine the time it took to carry out the patient record management. We observed the system's weaknesses like it was vulnerable to errors.

### Interviewing

In this method, there was interaction between the researcher and the Staff. Interviews was conducted with the medical superintendent and some potential employees to find out what difficulties they encountered with the existing system. These interviews were held to verify the information collected using the questionnaires since there was room to search for further information during the interview.

### Questionnaires

The efficiencies and inefficiencies of the current system were reviewed by issuing questionnaires to

the users of the system. This helped the researcher to establish the requirements of the proposed system.

## Development of the system

A software process is a set of related activities that leads to the production of the software product. These activities may involve the development of software from scratch in a standard programming language. There are many different software processes but all must include four activities that are fundamental to software development:

1. *Software specification.* The functionality of the software and constraints on its operation must be defined.
2. *Software design and implementation.* The software to meet the specification must be produced.
3. *Software validation.* The software must be validated to ensure that it does what the customer wants.
4. *Software evolution.* The software must evolve to meet changing customer needs.

Software processes are complex and, like all intellectual and creative processes, rely on people making decisions and judgments. Sometimes, software processes are categorized as either plan-driven or agile processes. Plan-driven processes are processes where all of the process activities are planned in advance and progress is measured against this plan. In agile processes, planning is incremental and it is easier to change the process to reflect changing customer requirements.

## Software process models

A software process model is a simplified representation of a software process. Each process model represents a process from a particular perspective, and thus provides only partial information about that process. For example, a process activity model shows the activities and their sequence but may not show the roles of the people involved in these activities.

A systems development life cycle (SDLC) is an outline that is used to describe the stages of developing an information system. These software development systems models include the waterfall model, rapid application development model, the spiral model, the incremental model and the prototype model. These life cycle models are also known as predictive life cycles because the latitude of the projects can be clearly expressed and the schedule and the cost can precisely be predicted. A lot of time is used by the project team, to clarify the requirements of the entire system and then producing a design. For an extended period, users are often unable to see any real results in terms of the working software.

On the other hand, the Adaptive Software development (ASD) life cycle models, which are the opposite of the Predictive life cycle models, assume that software development follows an adaptive approach because the requirements cannot be clearly expressed early in the life cycle. Unlike the predictive approaches, the adaptive approach offers more freedom to create components that provide functionality that is specified by the business group, using a freer form approach.

## Agile methods

Businesses now operate in a global, rapidly changing environment. They have to respond to new opportunities and markets, changing economic conditions, and the emergence of competing products and services. Software is part of almost all business operations so new software is developed quickly to take advantage of new opportunities and to respond to competitive pressure. Rapid development and delivery is therefore now often the most critical requirement for software systems. In fact, many businesses are willing to trade off software quality and compromise on requirements to achieve faster deployment of the software that they need. Because these businesses are operating in a

changing environment, it is often practically impossible to derive a complete set of stable software requirements. The initial requirements inevitably change because customers find it impossible to predict how a system will affect working practices, how it will interact with other systems, and what user operations should be automated. It may only be after a system has been delivered and users gain experience with it that the real requirements become clear. Even then, the requirements are likely to change quickly and unpredictably due to external factors. The software may then be out of date when it is delivered.

Software development processes that plan on completely specifying the requirements and then designing, building, and testing the system are not geared to rapid software development. As the requirements change or as requirements problems are discovered, the system design or implementation has to be reworked and retested. As a consequence, a conventional waterfall or specification-based process is usually prolonged and the final software is delivered to the customer long after it was originally specified.

The need for rapid system development and processes that can handle changing requirements has been recognized for some time. Agile methods are incremental development methods in which the increments are small and, typically, new releases of the system are created and made available to customers every two or three weeks. They involve customers in the development process to get rapid feedback on changing requirements. They minimize documentation by using informal communications rather than formal meetings with written documents.

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The thought process of the Agile method started early in the software development and became popular with time due to its flexibility and adaptability. The Agile Manifesto principles include the following benefits:

1. **Individuals and interactions** – agile development fosters self-organization and motivation and these are as important, as are interactions that come due to co-location and pair programming.
2. **Working software** – Agile methods involves showing a Demo working software to the client. This is considered to be the best means of communicating with the customer, in order to make sure that their requirement have been understood. This is more effective than just presenting documentation.
3. **Customer collaboration** – It is usually difficult for the client to clearly present their requirements to the programmer due to various factors. It important that there is continuous interaction with the customer in order to get proper product requirements.
4. **Responding to change** – One of the important features of the agile development is getting quick responses to change and continuous development.

Agile is centred on the adaptive software development methods as opposed to the traditional SDLC models which are based on the predictive approach such as like waterfall model. In the traditional SDLC models, Predictive teams usually work with exhaustive planning and have a

complete forecast of the exact tasks and features to be delivered during the product life cycle. Predictive methods completely rely on the requirement analysis and planning done at the start of the cycle. Adjustments that are to be made have to be scrutinised through a stringent change control management and prioritization process.

Adaptive approach is used in agile method, where detailed planning is not critical, but for clarity in future tasks in regard to what features need to be developed, is required. Feature driven development is required and the team adapts to the changing product requirements dynamically. The product is tested repeatedly, through the release iterations, thus, reducing the risk of any catastrophe in future. Customer interaction is the pillar of agile methodology. Open communication with minimum

documentation is an important feature of an agile development environment. The agile teams collaborate closely with each other and are usually located in the same geographical location. In this study the agile method was used to develop the application and the system analysis was conducted as described in the next sections.

## System Implementation

This describes the tools used to implement the graphical user interface and the database whose concept is based on cloud storage (computing). Cloud storage is discussed above.

According to Sommerville I. (2011), system implementation is the process of realising the design as a program, where the executable software is developed.

System implementation is the process of:

1. Defining how the information system should be built (e.g. physical system design)

2. Ensuring that the information system operational and used,
3. Ensuring that the information system meets quality standard (e.g. quality assurance).

MySQL was used to create and connect relational tables to the database. HTML was used to develop the GUI. PHP was used to process queries and request data and to integrate interfaces to help meets all the requirements of this system.

## Requirements Specifications

After analysing the data collected, we formulated a number of requirements namely user requirement, system hardware software attribute. These were grouped as user, functional, non-functional and systems requirements.

## System Requirement

This section describes the hardware components and software requirements needed for effective and efficient running of the system.

**Table 1:** Hardware Requirements

Hardware	Minimum System requirement
Processor	2.4 GHz
Memory	128 MB RAM (256 MB Recommended)
Disk space	80 GB (including 20 GB for database management system)
Display	800 x 600 colours (1024 x 768 colour – 16 bit recommended)

The table above shows hardware components of the machine that allows the system to function as required for using PMS.

**Table 2:** Software Requirements

Software	Minimum System requirement
Operating system	Windows 2000 or later, any device that can access web based systems e.g. tablets, smart phones etc.
Database management system	MySQL
Run-time Environment	Apache server

The table above shows software requirements recommended to enable the system to run as required for using PMS.

## System Design

After interpretation of the data, tables were drawn and process of data determined to guide the researcher of the implementation stage of the project. The tools, which were employed during this stage, were mainly tables, Data Flow Diagrams (DFDs) and Entity Relationship Diagrams (ERDs). The design ensures that only authorized users to access the system's information.

The Online patient record management system is an automated version of the manual system. The main purpose of this system is to provide a paper-less hospital up to 90%. It also aims at providing low-cost reliable automation of the existing systems. The system has seven main actors and these are the system administrator, accountant, Doctor, Laboratory's, Nurse, Patient, and Pharmacist. The Hospital owns and manages the system through its system Administrator.

## User Requirement

For effective use of the system, it is important that users are fully involved and are given opportunities to participate as much as possible.

This rectifies numerous problems associated with change management, users getting accustomed to using new way of doing things as opposed to traditional system of patient management system. During data collection, the researcher investigated and found out how the current system operates, not only that but also tried out which problems are faced and how best they can be settled. The users described some of the basic requirements of the system as;

- i. Search for patients
- ii. Register patients
- iii. Update patient's details
- iv. Generation of all types of patient related reports
- v. Assign access rights and privileges to the system users

## Functional Requirement

According to Sommerville I. (2011), functional requirements are statement of services the system should provide, how the system should react to particular inputs, and how the system should behave in particular situations. In some cases, the functional requirements may also explicitly state what the system should not do.

Functional Requirements defines a function of a software system and how the system must behave when presented with specific inputs or conditions. For example, logging into the system, registration of users, various requests and their handling, showing results to users, recovering passwords, etc.

The following is the desired functionality of the system.

### • Administrator

1. **Add users/administrator:** the administrator must be able to add users of the system, including other administrator(s).

2. **Edit user:** The administrator must be able to edit the details of the system users
  3. **View users:** The administrator must be able to view system users
  4. **Delete users:** The administrator must be able to delete a user (deactivate account).
  5. **Manage system settings:** The administrator must be able to manage system settings, which include backup and restore, managing the notice board, and so on.
  6. **Add department:** The administrator must be able to add department(s).
  7. **Edit profile:** The administrator must be able to edit his/her profile.
- **Accountant**
1. **Take payment:** The accountant must be able to take payments from customers (patients), and manage invoice.
  2. **View payments:** The accountant must be able to view payment history of the patient.
  3. **Search payment:** The accountant must be able to search for payment history of the patient.
  4. **Edit profile:** The accountant must be able to edit his/her profile.
- **Doctor**
1. **Add patients:** The Doctor must be able to add patient to the system.
  2. **View patient:** The Doctor must be able to view the patients
  3. **Search patient:** The Doctor must be able to search for a patient
  4. **Delete patient:** The Doctor must be able to delete a patient from the system
  5. **Edit patient:** The Doctor must be able to edit patient details.
  6. **View appointment:** The Doctor must be able to view appointment.
  7. **Add appointment:** The Doctor must be able to add appointment.
  8. **Search appointment:** The Doctor must be able to search for appointment
  9. **Delete appointment:** The Doctor must be able to delete appointment.
  10. **Add prescription:** The Doctor must be able to add prescription
  11. **Search prescription:** The Doctor must be able to search for prescription of the patient
  12. **View prescription:** The Doctor must be able to view prescription
  13. **Edit prescription:** The Doctor must be able to edit prescription
  14. **Delete prescription:** The Doctor must be able to delete prescription
  15. **View bed allocation:** The Doctor must be able to view bed allocation
  16. **Search bed allocation:** The Doctor must be able to search for bed allocation
  17. **Add bed allocation:** The Doctor must be able to add bed allocation
  18. **Edit bed allocation:** The Doctor be able to edit bed allocation
  19. **Delete bed allocation:** The Doctor must be able to delete bed allocation
  20. **View blood bank:** The Doctor must be able to view blood bank
  21. **View blood donor:** The Doctor must be able to view blood donor
  22. **Search blood donor:** The Doctor must be able to search for blood donor
  23. **Search blood group:** The Doctor must be able to search for blood group
  24. **Manage report generation:** The Doctor must be able to manage report generation such as adding reports. This includes birth reports, death reports, operation reports (surgery), and any others related reports.
  25. **Edit profile:** The Doctor must be able to edit his/her profile
- **Laboratory's**
1. **Add diagnostic report:** The laboratory's must be able to add diagnostic report

2. **View diagnostic report:** The laboratory's must be able to view diagnostic report
3. **Search diagnostic report:** The laboratory's must be able to search for diagnostic report
4. **Edit blood bank:** The laboratorist must be able to edit blood bank
5. **View blood donor:** The laboratorist must be able to view blood donor list
6. **Add blood donor:** The laboratorist must be able to add blood donor
7. **Edit blood donor:** The laboratorist must be able to edit blood donor
8. **Delete blood donor:** The laboratorist must be able to delete blood donor
9. **Edit profile:** The laboratorist must be able to edit his/her profile
  - **Nurse**
    1. **Add patient:** The nurse must be able to add a patient
    2. **Edit patient:** The nurse must be able to edit patient details
    3. **View patient:** The nurse must be able to view patient
    4. **Search patient:** The nurse must be able to search for a patient
    5. **Delete patient:** The nurse must be able to delete a patient form the system
    6. **Add bed:** The nurse must be able to add bed details
    7. **View bed list:** The nurse must be able to view bed list
    8. **Edit bed details:** The nurse must be able to edit bed details
    9. **Search bed:** The nurse must be able to search for bed
    10. **Delete bed:** The nurse must be able to delete a bed details
    11. **Manage bed allocation:** The nurse must be able to manage bed allocation (allocating beds to patients when admitted)
    12. **View blood bank:** The nurse must be able to view blood bank
  - **Patient**
    1. **View appointment:** The patient must be able to view appointment
    2. **Search appointment:** The patient must be able to search for appointment
    3. **View Prescription:** The patient must be able to view his/her prescription
    4. **View admit history:** The patient must be able to view his/her admit history
    5. **View invoice:** The patient must be able to view invoice
    6. **View payment history:** The patient must be able to view payment history
  - **Pharmacist**
    1. **Add medicine:** The pharmacist must be able to add medicine details
    2. **Edit medicine:** The pharmacist must be able to edit medicine details
    3. **View medicine:** The pharmacist must be able to view medicine category
    4. **Delete medicine:** The pharmacist must be able to delete medicine
13. **Edit blood details:** The nurse must be able to edit blood details
14. **Add blood donor:** The nurse must be able to add blood donor
15. **Edit blood donor:** The nurse must be able to edit blood donor details
16. **View blood donor:** The nurse must be able to view blood donor details
17. **Search blood donor:** The nurse must be able to search for a blood donor
18. **Delete blood donor:** The nurse must be able to delete a blood donor from the system
19. **Manage report generation:** The nurse must be able to manage report generation such as add, edit, delete, and so on. These includes birth reports, death report, operation (surgery) reports, and any other reports.
20. **Edit profile:** The nurse must be able to edit his/her profile

5. **Search medicine:** The pharmacist must be able to search for medicine
6. **Search medication history:** The pharmacist must be able to search for medication history of the patient
7. **View prescription:** The pharmacist must be able to view prescription for medication of the patient
8. **Edit prescription:** The pharmacist must be able to edit prescription
9. **Search prescription:** The pharmacist must be able to search for prescription of the patient for medication
10. **Edit profile:** The pharmacist must be able to edit his/her profile
- v. The system allow room for expansion
- vi. The system has a high performance and reliability level
- vii. The system must be user friendly
- viii. The system must be accurate
- ix. The system must allow more than one user at any time
- x. The system must comply to the laws of Zambia concerning ICT

## Non-functional Requirement

Sommerville I. (2011), defines non-functional requirements as the constraints on the services or functions offered by the system. They include timing constraints, constraints on the development process, and constraints imposed by standards. Non-functional requirements often apply to the system as a whole, rather than individual system features or services.

Non-functional requirements are those requirements are not directly concerned with the specific function delivered by the system. They may relate to emergent system properties such as reliability response time and store occupancy. Alternatively, they may define constraints on the system such as the capability of the input/output devices and the data representation used in the system interface. The key non-functional requirements are:

- i. The system should verify and validate all user input and users must be notified in case of errors detected.
- ii. The system should have pleasant look and feel
- iii. Easy way navigation through interfaces
- iv. Attractive user interface (UI)

## Use case diagrams

Use case diagrams are requirements discovery techniques that identifies the actors involved in an interaction and names the type of interaction. This is then supplemented by additional information describing the interaction with the system. The additional information may be a textual description or one or more graphical models such as Unified Modelling language (UML) sequence or state charts.

Use cases identify the individual interactions between the system and its users or other systems. Each use case should be documented with a textual description. These can then be linked to other models in the UML that will develop the scenario in more details. Scenarios and use cases are effective techniques for eliciting requirements from stakeholders who interact directly with the system. Each type of interaction can be represented as a use case. The use case diagrams shown below illustrates how the users interacts with the system.

## Results

This section looks at the results of the research that was conducted at Mwinilunga District Hospital in Mwinilunga District with regard to the establishment of a web based patient record system in Zambia, in as much as the patients are involvement was concerned. The result also showed the appreciation in the use of ICT in as much as patients' medical record is concerned. This chapter also looks at validation steps that

were used to make sure that interfaces and the application as a whole meets the requirements. For it's important for the finished product to answer every question or meet customer's needs.

## System Validation

Software validation or, more generally, verification and validation is intended to show that a system both conforms to its specification and that it meets the expectations of the system customers. Program testing, where the system is executed using simulated data, is the principal validation technique. Validation may also involve checking processes, such as inspections and review at each stage of the software process from user requirements definition to program development.

As one of the specific objective of this study, validation of the system was very important. Validation of the system was done by comparing it to the questions asked by the users at Mwinilunga Hospital. Most of their answers matched with what the system can do. JavaScript was used to validate user input and the respective input. For example, the system does not accept blank fields; the system also discriminates between numerical and non-numerical characters.

## System Testing

Sommerville I. (2011), suggest that testing is intended to show that a program does what is intended to do to discover program defects before it is put into use. When you test software, you execute a program using artificial data. You check the results of the test run for errors, anomalies, or information about the programs non-functional attributes.

Testing is vital to the success of any system. Testing is done at different stages within the development phase. System testing makes a logical assumption that all parts of the system are correct and the goals will be achieved successfully. Inadequate testing or no testing leads

to errors that may come up after a long time when correction would be extremely difficult. Another objective of testing is its utility as a user-oriented vehicle before implementation.

Software testing is a critical element of software quality assurance and represent the ultimate review of specification, design and coding. In fact, testing is the one step in the software engineering process that could be viewed as destructive rather than constructive.

A strategy for software testing integrates software test case design methods into a well-planned series of steps that result in the successful construction of software. Testing is the set of activities that can be planned in advance and conducted systematically. The underlying motivation of program testing is to affirm software quality with methods that can economically and effectively apply to both strategic to both large and small—scale systems.

Testing was done after the system was put in place. This was in two ways namely Unit Testing and integration testing.

## Strategic approach to software testing

The software engineering process can be viewed as a spiral. Initially system engineering defines the role of software and leads to software requirement analysis where the information domain, functions, performance, constraints and validation criteria for software are established. Moving inward along the spiral, we come to design and finally to coding. To develop computer software, we spiral in along streamlines that decrease the level of abstraction on each turn.

A strategy for software testing may also be viewed in the context of the spiral. Unit testing begins at the vertex of the spiral and concentrates on each unit of the software as implemented in source code. Testing progress by moving outward along the spiral to integrate testing, where the focus is on

the design and the construction of the software architecture. Talking another turn on outward on the spiral we encounter validation testing where requirements established as part of software requirements analysis are validated against the software that has been constructed. Finally, we arrive at system testing, where the software and other system elements are tested as a whole.

## Test plan

The software test Plan (STP) is designed to prescribe the scope, approach, resource, and schedule of all testing activities. The plan will identify items to be tested, the features to be tested, the types of testing to be performed, and the personnel responsible for testing, the resources and schedule required to complete testing. The purpose of the software test is such as;

- i. To achieve the correct software and ensure all functional and design requirements are implemented as specific in the documentation.
- ii. To provide a procedure for unit and System testing
- iii. To identify the test methods for unit and system testing.

## Process of Test Plan

- i. Identify the requirements to be tested. All test cases shall be derived using the current design specification.
- ii. Identify particular test to use to test each module.
- iii. Identify the expected results for each test.
- iv. Perform the test
- v. Document the test data, test cases used during the testing process.

The following explain the ways in which testing is done.

## Unit testing

Unit testing is the process of testing program component, such as methods or object classes.

Individual functions or methods are the simplest type of component. The test should be calls to these routine with different input parameters.

In unit testing, the focus is on the verification of the smallest unit of the project that is a module or a function. In unit testing we work according to white box testing that is providing the input set and checking the output in accordance with the expected output or not.

Unit testing was carried out on individual modules of the system to ensure that they are full functional units. The researcher did this by examining each unit for example, the “add patient page” by the doctor or the nurse. It was checked to ensure that it functions as required and that it adds patient’s data and other details and also ensure that this data is sent to the database. The success of each individual unit gave the go ahead to carryout integration testing. All identified errors were dealt with.

## Integration Testing

Integration or system testing is the process of integrating components to create a version of the system and then testing the integrated system. System testing checks that components are compatible, interact correctly and transfer the right data at the right time across their interface. When you integrate components to create a system, you get emergent behaviour. This means that some elements of the system functionality only become obvious when you put the component together. This may be a planned emergent behaviour, which has to be tested. Therefore, system testing focuses on testing the integration between the components and objects that make up a system.

The researcher carried out integration testing after different modules had been put together to make a complete system. Integration was aimed at ensuring that modules are compatible and they can be integrated to form a complete working system. For example, it was tested to ensure that when a

user is logged in, he/she is linked to the appropriate page, and also could access the database.

The test gives a brief idea of the correct expected output and the incorrect output. This test confirms proper behaviour of the GUI during system initialisation and start-up. The unit under test should initialise without any errors.

## Performance testing

Once a system has been completely integrated, it is possible to test for emergent properties, such as performance and reliability. Performance tests have to be designed to ensure that the system can process its intended load. This usually involves running a series of tests where you increase the load until the system performance becomes unacceptable.

Performance testing was carried out to demonstrate that the system meets its requirements and discovering problems and defects in the system.

## In user module

When the user logs in

- i. If click on update details – **Expected**-New data saved
- ii. If click on View Details **Expected** – Navigate to view page
- iii. If click on forgot password **Expected** – Navigate to related page

## System Security

Security means different things to different people depending upon their perspective. In the context of our product it means only valid users can login into the system and each user can only access the functionality authorised them. To prevent unauthenticated access, form based authentication implemented through front controller is used. To prevent unauthorised access, different roles are to be created by the administrator and access to features is to be controlled through these roles.

## System implementation Results

In this section, the results of the online patient record management system which is a web based system, are looked at. The interaction of the administrative roles and user roles are explained.

The system administrator logs into the system using an email as username and password. The administrator then adds the users on the system according to their category, accept the patient which can be added into the system by the nurse or the doctor.

Only authorised users with the right username (email) and password has the right to access the services to particular department he or she intend to view. When wrong username and or password is used, the system rejects access to the services.

## Patient

A computer, smart phone or a tablet can be used by the patient to perform tasks such as view appointments, view prescription, view admit history, view payment history, and so on.

## Administrative roles

The accountant, doctor, nurse, laboratorist, and the pharmacist takes up the administrative roles in as much as the patient is concerned. They can access patient's data according to their specialisation.

The screenshots below show how the system's graphical user interface looks.

## Discussion

As discussed in the previous chapters, the main problem that was addressed was dealing with patient's medical documents. It is the above situation that drove the researcher in developing this Online Patient Record Management System to enable them to handle details on policies efficiently and effectively. The project has implemented most of the objectives stipulated in earlier chapters. The Online Patient Record Management System offers a number of benefits

to the user and can capture data, store, view, add, and delete the records entered, the data can also be posted into the database. Problem encountered during data collection: sensitive information released, few projects and books written about patient record management system.

Problems encountered during system design: limited time to finish up the work, inadequate financial support to facilitate the project. As a way to justify the development of web based patient record system that will simplify the work that is involved in patient's record keeping, questions were asked and the corresponding responses from the respondents were as showed in the table below. The table below shows the main findings of the research with respect to the objectives of the research.

## **Baseline study**

Despite many innovations in information technology, many hospitals still rely on paper-based medical records. Critics, however, claim that they are hard to read, because of illegible handwriting, and uncomfortable to use. Moreover, a chronological overview is not always easily possible, content can be destroyed or get lost. There is an overall opinion that electronic medical records (EMRs) should solve these problems and improve physicians' efficiency, patients' safety and reduce the overall costs in practice. However, to date, the evidence supporting this view is sparse.

The survey reviewed that in Mwinilunga and the whole North-western province, hospitals still use the manual way of medical record system. This may include the whole nation at large. Hospitals and medical providers often have warehouses literally filled with paper records. Besides taking up space, paper records are not eco-friendly. Paper records also naturally deteriorate over time in storage, regardless of how well their environment

is controlled, and they tend to decay upon excessive handling.

The manual record system does not provide an instantaneous way of sharing medical records with other professionals. For paper records to reach other interested parties, they must either be mailed or converted to electronic format. Paper record system can also be susceptible to natural disasters such as fire or flood, and a facility will typically have only one copy of paper record.

## **Use of technology**

This section describes the level utilisation of ICTs in Mwinilunga district. This was based on the assessing the usage and appreciation of ICTs as a way to reduce paper work by 90% in as much as patients' medical documents are concerned.

The survey that was carried out in Mwinilunga showed that about 70% of the respondents use smart phones, and of the 70%, 45% have access to computers and the internet. They use smart phones and computers to access the internet as they conduct their businesses.

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

The main objective was to develop an operational web based system to manage patients' medical record that would reduce the cost of doing work.

The research showed that there was a considerable appreciation in the use of smart ICTs in the hospital and among the patients. Smart phones and computers are tools with which the medical practitioners can access medical documents of patients without the need of searching among thousands of hard copy medical documents which is time consuming. This saves time for example, if a patient is already in the system his/her name will be just searched for and the medical document for that patient will be retrieved within a second, because time can be critical in medical treatment.

One of the benefit of electronic medical records is that the type face is more or less standardised and

clear across all the records. This clarity saves time for the reader. Electronic medical records also allow medical professionals to share medical records with other medical professional almost instantaneously via electronic transmission or direct access to the storage systems.

Another benefit of electronic medical record is that it can be stored on a computer drive that require less space and resources to produce. In addition, electronic records can be stored and accessed forever without the deterioration of record quality.

The discussion above motivated the development of an online patient record management system that would be used by medical professional to store and access patient's medical records as well by patients to access their medical history wherever they are without the need to carry a batch of paper. The application was built using the agile software development method, using HTML 5 and CSS, PHP, JavaScript, and MySQL as explained in previous chapters.

### **Comparison with other works**

Significant work has been made in the area of innovative use of ICTs that covers various fields such as health, agriculture, education, commerce, banking etc. This study acknowledges the work do by ministry of health at University Teaching Hospital (UTH), where a patients' electronic record system is used to capture and store patients' medical data. This system is only implemented in selected hospitals and covers only few departments in as much as clinical care is concerned. The online patient record management system has been built to cover all the patients regardless of the age, condition, etc.

### **Possible application**

This work is an attempt to reduce paper work where patients' medical record is concerned. This online patient record management system may help the government (Ministry of health) to keep

patients' medical records so that he/she can access his/her medical history wherever they are when need arises. This application can be used any institution that is involved in treatment of patients.

### **Recommendations**

Training of all the members of the staff in the hospital to get accustomed to the system will be a priority. This being a new system, some members of the staff's management will get threatened that the computerized patient record management system will replace their jobs. I would recommend that management of the hospital educates the staff of how this system will operate and how it will supplement their efforts. For the efficiency of the hospital, users of the system need to be thoroughly educated about the use of the passwords and usernames, not only that but also not to be careless of them. They should be kept confidential. Access to the server room should be physically guarded against unauthorized person; the server room should be dust free and should be fully protected and should have an air conditioner of 1100BTU to prevent the server from overheating. Backup media like CDs, external hard drives and Flush disks can be used for backups and storage of data.

### **Future works**

The system does not auto generate reports and alarm ton alert for example, alerting the pharmacist of the expiring date of the drugs at a given period of time. Reason being that the database was developed using MySQL program which cannot support the triggers which can only be found in Oracle program.

### **Conclusion**

The core reason for the establishment of computerizing patient record management system is to enable the hospital administrators in a convenient, fair and timely manner. Therefore, the IT used should support the core objective of the system if it is to remain relevant to the hospital. A lot still needs to be done in the IT department in

order to make available technology effective. This may involve training of the staffs on how to enter data in the right and relevant data in the system and the management to keep updating the hardware and software requirements of the system. IT and computer systems need to be kept being upgraded as more and more IT facilities software are introduced in today's IT market. The researcher acknowledges the fact that this system does not handle all staffs in the hospital such as the security and other sections of the hospital. The researcher therefore suggests that for further research, the following can be researched on.

### **Opportunity and lesson learned**

During the course of this project, the researcher was able to understand better what goes on in the patient record management system in the hospital. This was effectively done through reading of literature and research. The whole process of developing the system was an opportunistic challenge. Seeing the system into a tangible system was a rewarding exercise.

### **Acknowledgement**

First and foremost, I would like to express my sincere thanks to the almighty God for the gift of life, wisdom and understanding He has given to me, a reason for my existence. And to my family

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Special thanks goes to Miss Yvonne Manjomba for the support, love, and everything she provided during my study; she shall always be remembered.

Dr. John Mupala whom I regard as my mentor and supervisor, I thank him for the expertise and intelligence he has displayed while supervising this project. I believe this good work is a result of his good guidance and cooperation.

I cannot forget my friends in the school of engineering and ICT for the academic interactions and company they accorded to me especially Mr. Nkhoma Tobias and Mr. Ignatius Mpetamoyo among others; they shall always be remembered as having been good friends in a life time.

Last but not the least, I would like to convey my gratitude to the lecturers for the good job done during the 4 years period of my course.

May the good Lord bless them all and keep them safe. I love you all.

Tables and figures

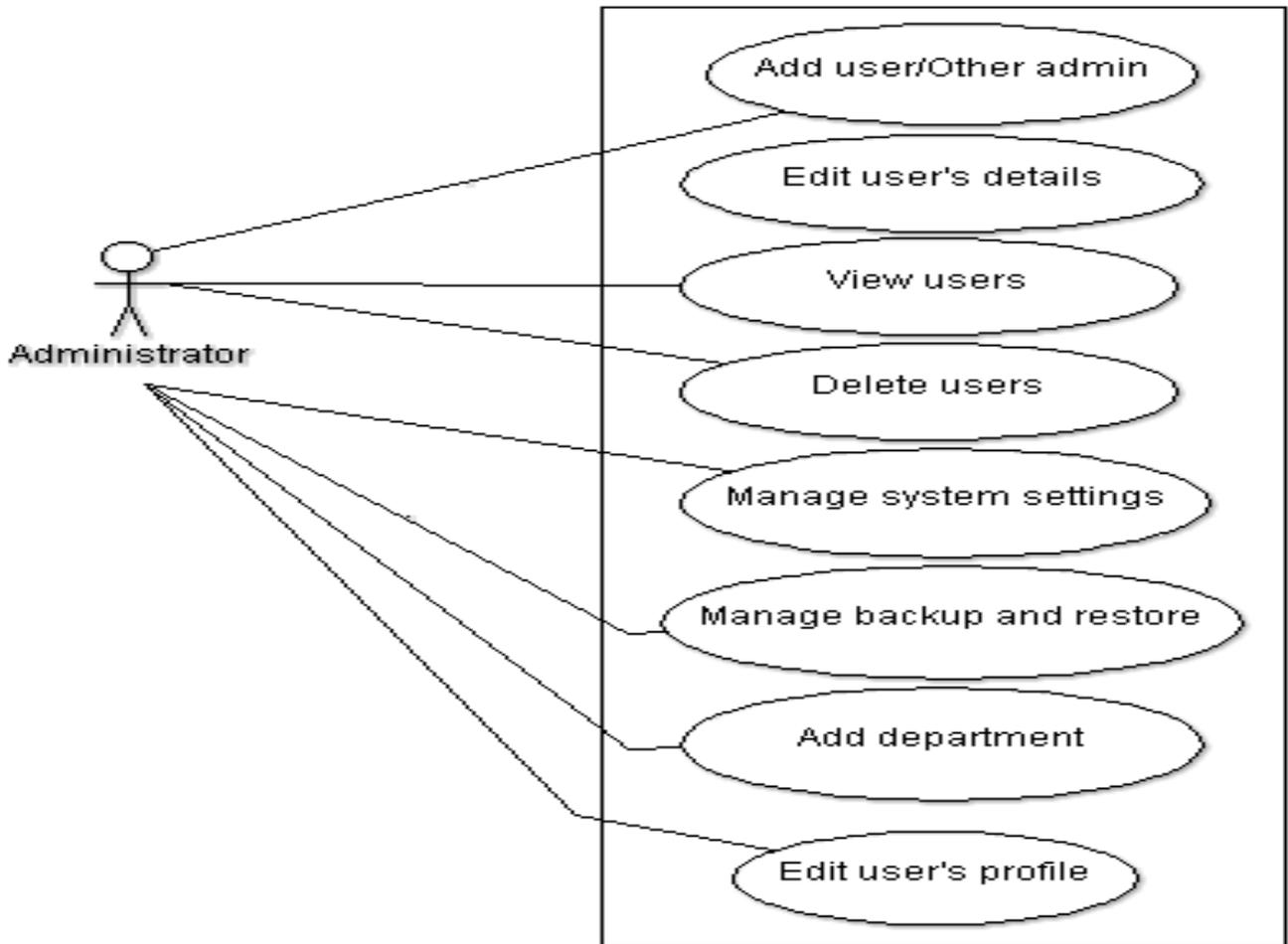


Figure 1: Use case diagram for the administrator

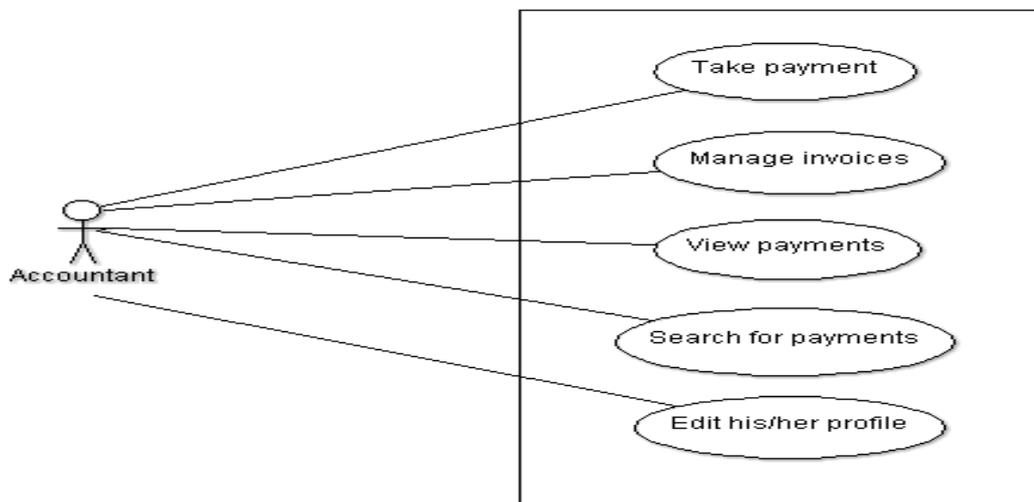
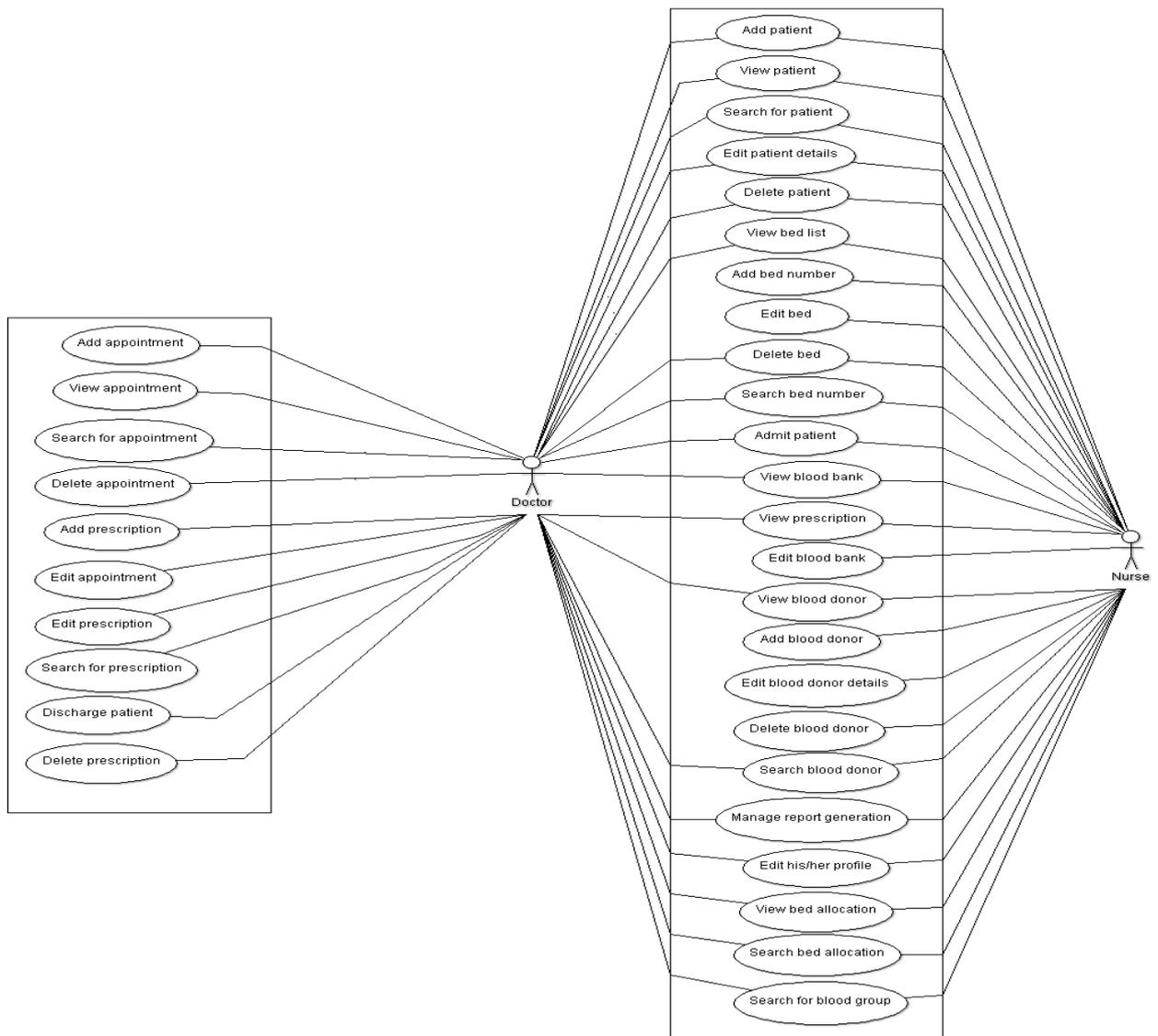
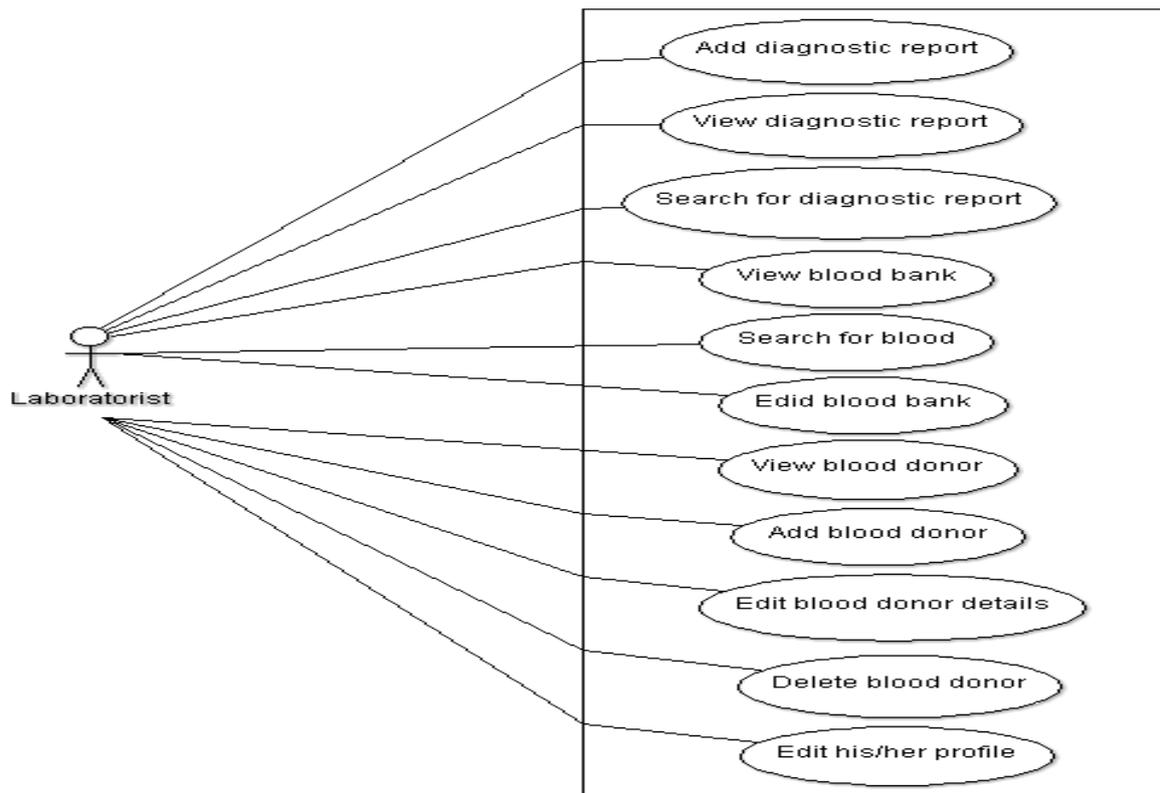


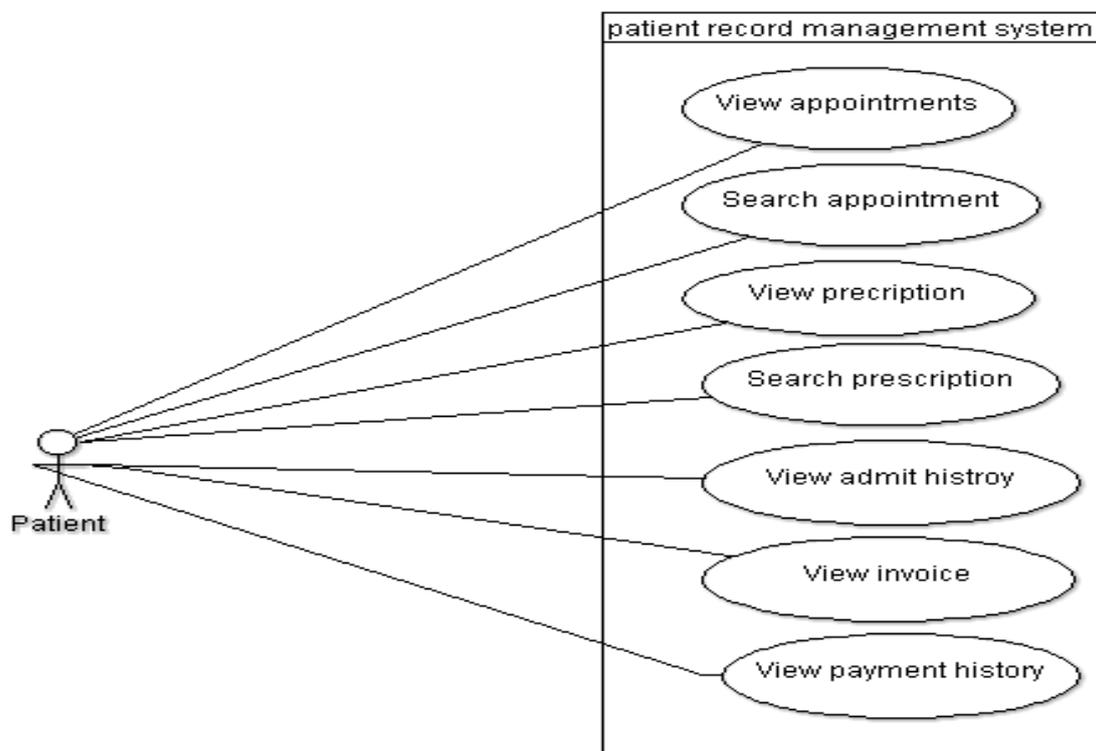
Figure 2: Use case diagram for accountant



**Figure 3:** Use case diagram for the Doctor and the nurse



**Figure 4:** use case diagram for the laboratorist



**Figure 5:** Use case diagram for the patient

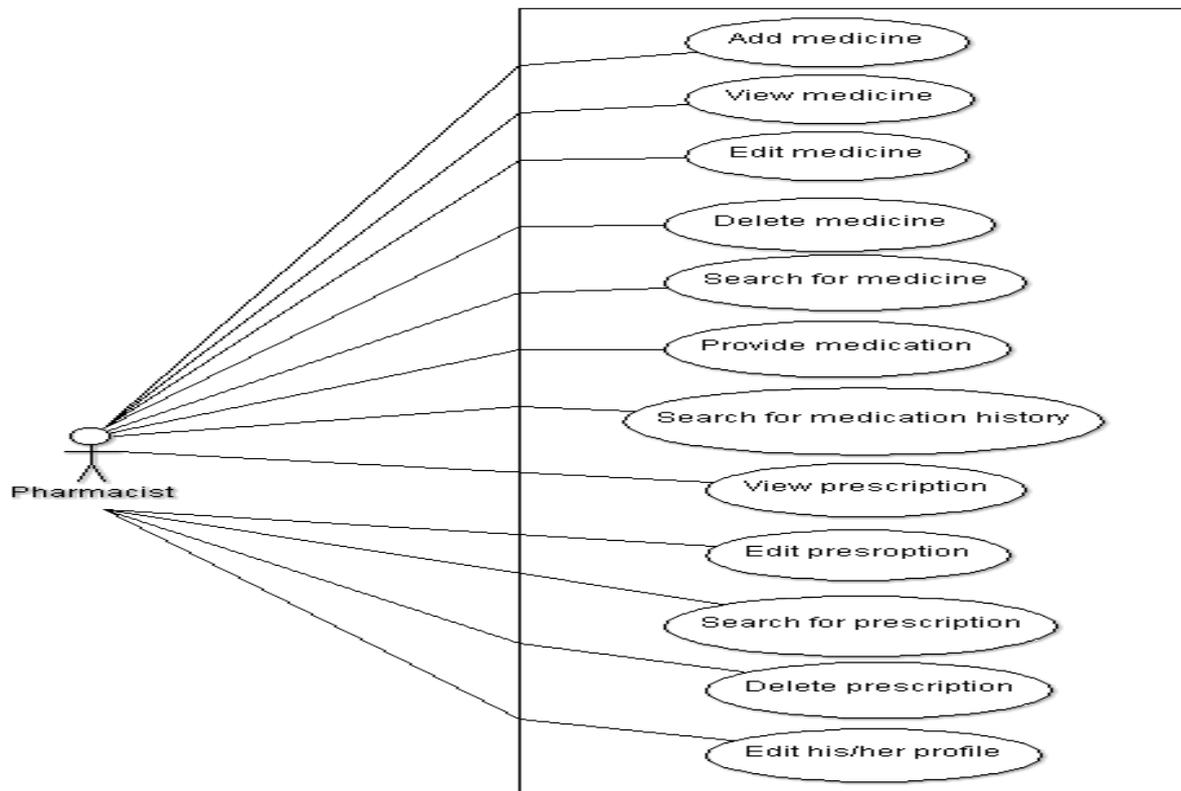


Figure 6: Use case diagram pharmacist

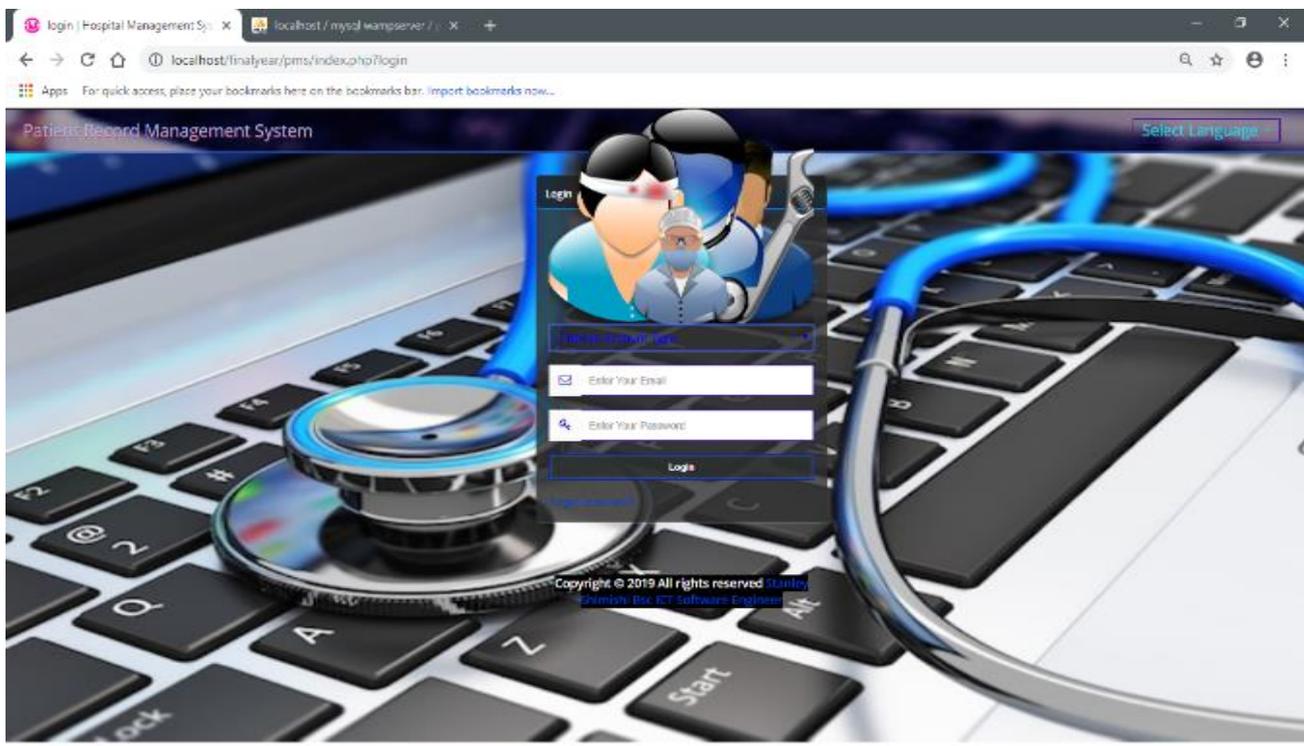


Figure 7: The login page for the Administrator and the users

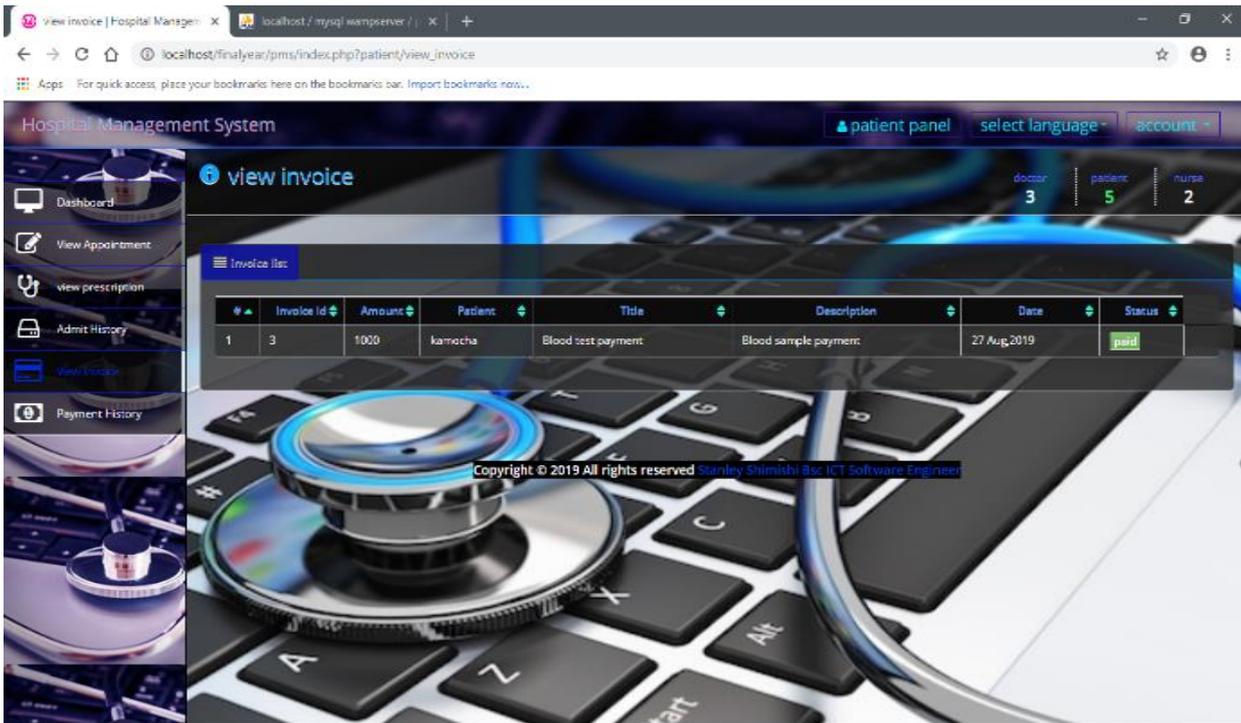


Figure 8: Patient page viewing invoice

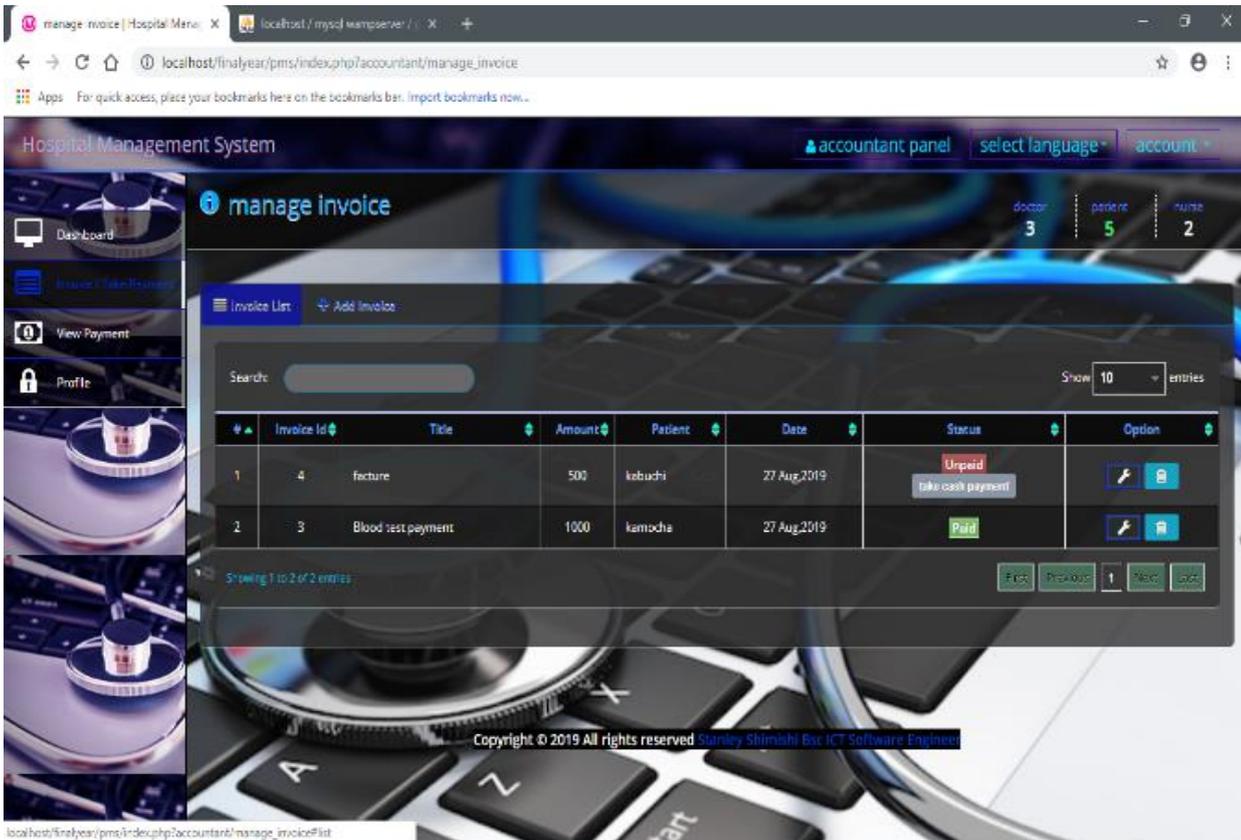


Figure 9: Accountant viewing patient payment

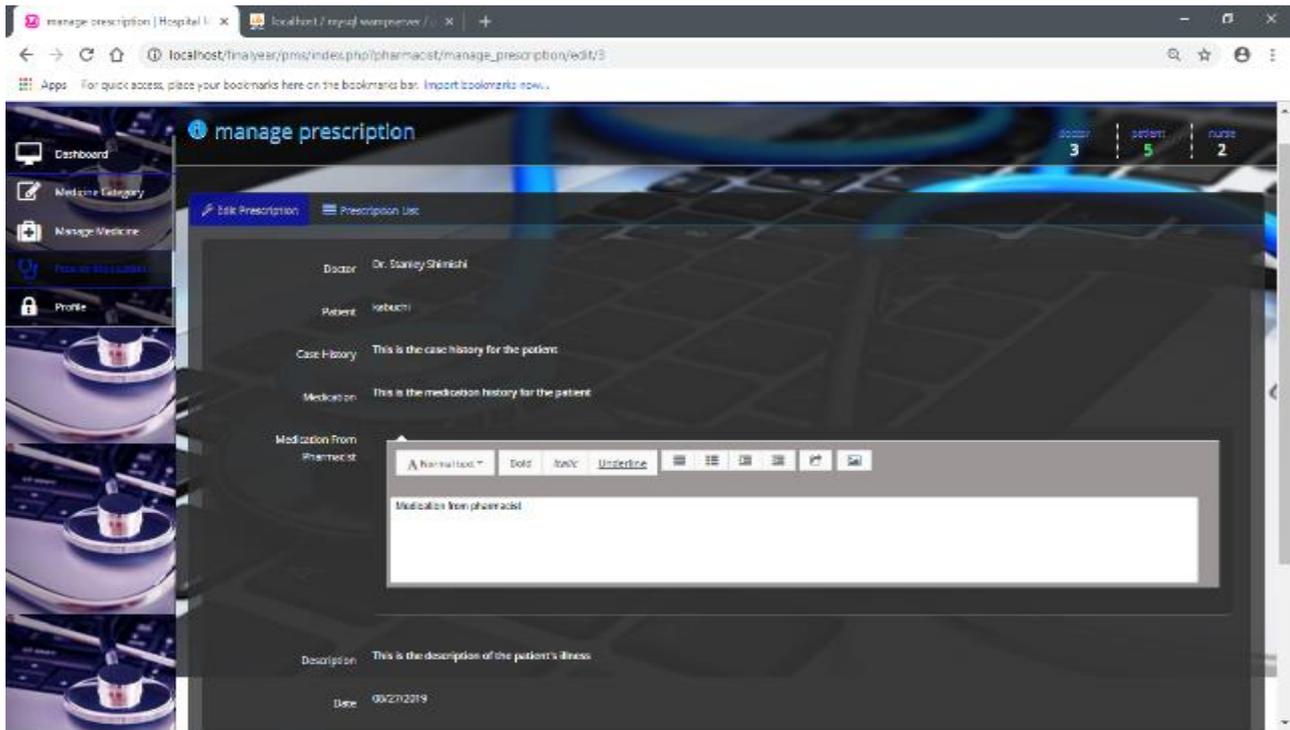


Figure 10: Pharmacist adding medication details for the patient

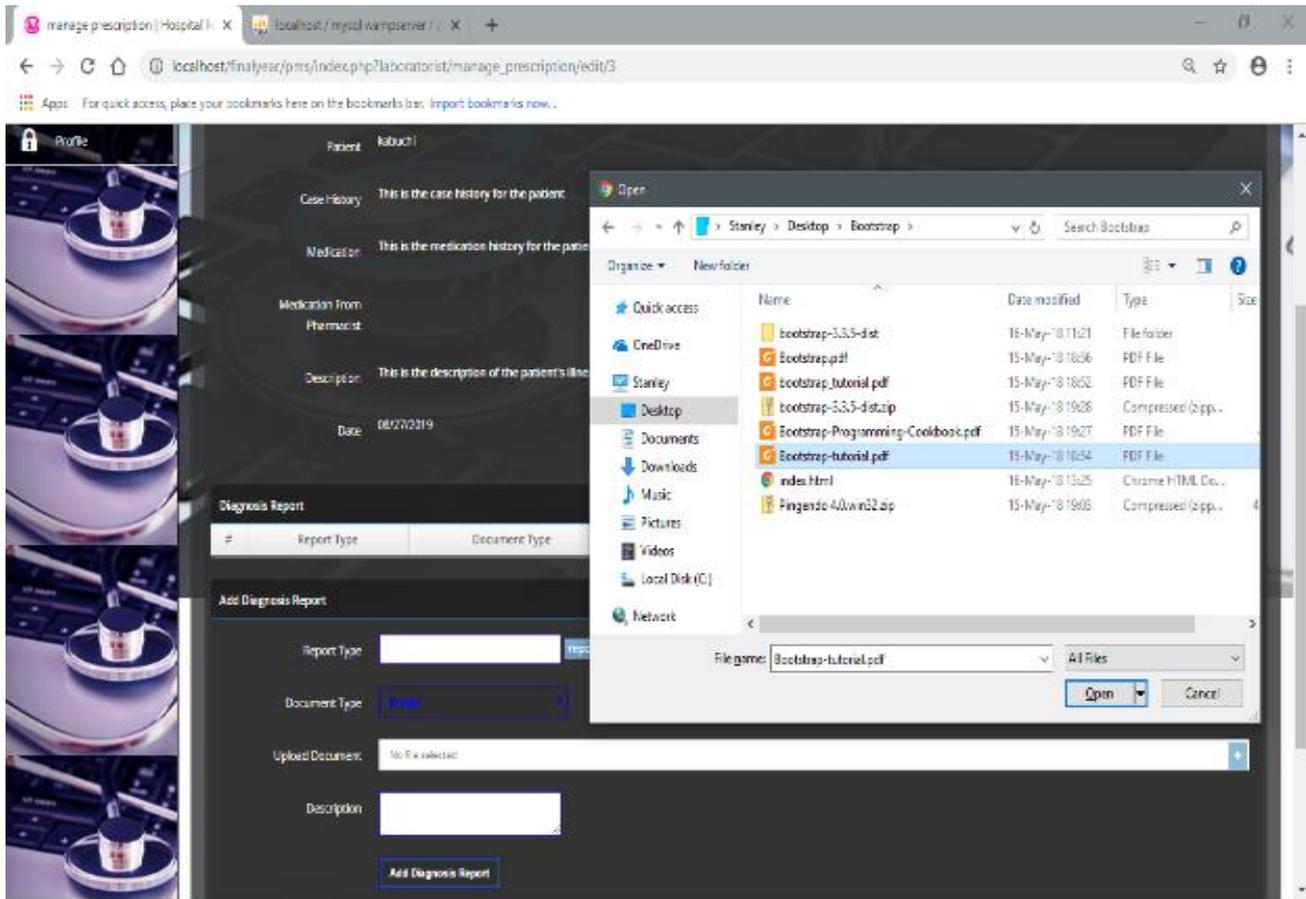


Figure 11: Laboratorist adding diagnostic report

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- [15] [www.tutor2u.net](http://www.tutor2u.net) (accessed at 14:35:08, 02/03/2019) types of information systems