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Project Title	Web based patient management system for surgical clinic of OPD at National Hospital of Sri Lanka
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Web Based Patient Management System for Surgical Clinic of OPD at National Hospital of Sri Lanka

A dissertation submitted for the Degree of Master of Information Technology

D.U.S Thanthrige

University of Colombo School of Computing

2018

UCSC

DECLARATION

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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Signature: Date: 01/09/2018

This is to certify that this thesis is based on the work of

Mr. /~~Ms.~~ D.U.S Thanthrige under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Dr. K L Jayaratne

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Signature: Date: 01/09/2018

ABSTRACT

Information systems for patient management in hospitals are in high demand to cope up with the increasing patient population day by day. Tasks managed through a patient management system range from patient registration, to the point of receiving medication from a doctor.

Thereby tasks such as patient registration, patient medical record administration, queue number generation etc... have been considered crucial tasks in providing and managing of an effective service to patients that visit the Out Patients Department of National Hospital of Sri Lanka.

Unfortunately the current file based manual system in the hospital would lead to a numerous number of issues such as misplacement of patient medical history records, surgery details etc. It also have many other drawbacks such as time consummates for patient record searching, manual queue number generation and confusion of patient records.

This project is aimed at computerizing the processes involved with the patient management tasks of the surgical clinic at the OPD of NHSL, in order to carry them out efficiently and effectively.

In order to achieve this goal, a thorough system study and investigation was carried out and tasks were analyzed about the current system. The major issues encountered by the hospital staff whilst carrying out the daily operations within the clinic was studied in detail.

A new system is developed to overcome the identified drawbacks of the current system. The structures and the new functions of the system are analyzed and designed using UML diagrams and ERD's.

Many benefits are catered with the new system such as easiness of patient record saving, retrieval, automatic queue number generation, prescription generation for doctors and medical information history storage.

The methods used to develop the system include iterative waterfall model approach, UML and an entity relationship diagram was used to design the system. The languages used were MySQL, Php, HTML, Css and JavaScript.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

Terminology	Meaning
NHSL	National Hospital of Sri Lanka
OPD	Out Patient Department
ERD	Entity Relation Diagram
UML	Unified Modeling Language
HTTP	Hyper-Text Transfer Protocol
MySQL	My Structured Query Language
PMS	Patient Management System
PACT Analysis	People, Activity, Context, Technology Analysis

CHAPTER1: INTRODUCTION

1.1 Project Overview

This work studies about how the implementation of a web based application can be used to overcome some major and crucial problems identified, which affect the smooth functioning of day to day operations at the surgical clinic in the Out Patients Department of the National Hospital of Sri Lanka (NHSL).

Established in 1864, NHSL is being rated as the best and the largest public hospital in Sri Lanka with all the state of the art medical facilities. Consisting of 75 wards, 35 operating theatres and 12 intensive care units, it is also the largest training center for under graduates and post graduate trainees of the Faculty of medicine. The nurse's training school and schools of Radiology, Pharmacy, Cardiograph, Physiotherapy and Occupational therapy are also affiliated to the NHSL.

1.2 The Problem

Among the departments of the hospital the Out-Patient-Department (OPD) plays an important role in which more than 500 to 600 patients visit the OPD to receive treatment daily. Within the OPD there are several clinics out of which the surgical clinic being the clinic where the most patients visit to consult the doctor before or after their prescribed types of surgeries. Currently their medical history and other medical records are being manually stored in files for each patient. These are stored in large file cabinets. With the ever-increasing patient count, the hospital staff finds it very difficult to manage these medical records. Also it takes a considerable amount of time to search for a file relevant to a patient; once the patient visits the clinic and present their clinic registration number to the staff. The other major problem that currently exists is that some files are being misplaced by the minor staff of the hospital during handling. This would result in the loss of all the previous sensitive and important medical records of a patient which are crucial for the prescription of their future medications.

Another major problem that is encountered with the ever increasing population of patients that visit the surgical clinic for consultation and medication is the hospital support staff should put in a tremendous amount of effort to issue the patient queue numbers without mixing up as at when they arrive. Since this process is handled manually at present, there are also instances where the same queue number is given to many patients. This causes some sort

of confusion and hassle among patients who stay up in the queue until their respective numbers are called out. This indirectly increases the patient waiting times within the OPD which may ultimately lead to patient dissatisfaction.

In addition, if a patient prefers to consult the same doctor of the surgical clinic outside NHSL, for their convenience, which can be referred to as another district government hospital or other nearby medical center, the doctor would have no access to the previously prescribed medical information. This is because the patient medical record files are only available and accessible within NHSL. Therefore patients will always have to visit NHSL at all times to consult the doctor, even if the same doctor is available in a nearby hospital or medical center which is much easier and nearer for the patients to visit, rather than NHSL.

1.3 Motivation

The motivation factors for the implementation of a patient management system at the surgical clinic of the OPD include:

- Easiness of hospital staff to manage medical records electronically rather than manual (paper-based) – with the implementation of the system the handling procedures and housekeeping of medical records will be bought to the ease of the fingertips. Manual handling of medical record files from clinic to storage cabinets and henceforth will be eliminated, thereby making it very easy and effective in the retrieval of any medical record within a few seconds.
- Time management- most of the time consuming operations will be reduced and eliminated, enabling more time for the staff to look on more critical operations and tasks within the hospital. This enables more time to attend to patient needs within the surgical clinic which indirectly can increase patient satisfaction on the service provided.
- Increased efficiency and effectiveness of doctor prescription- with the readily availability of medical history records who visit the surgical clinic, doctors will find it more easy to prescribe the most appropriate medicine in relation to the patients' current state.
- Increased staff satisfaction- with a considerable lowering of efforts need to put in to carry out the same processes said and done within the clinic in a much more effective and disciplined way, the staff will have a very high satisfaction rate.
- Decreased patient waiting times and increased patient satisfaction- the smooth functioning of operations within the clinic may lead in the decrease of time to get

things done and receive the necessary medication. This decreases the waiting time a patient needs to spend within the OPD to receive medication. This indirectly leads to an increased patient satisfaction and creates a good image on the hospital service provided.

- Increased hospital ranking –with the operations made more disciplined and effective, the overall ranking of the service provided by the hospital results in an increase. This can increase the world rankings' of the hospital which is being measured every year by the World Health Organization (WHO) based on the effectiveness and efficiency of processes and patient satisfaction on the service provided by the hospital.

1.4 Objective of Project

The major objective of the project would be to address the problem of handling the current manual processes by means of an IT based management system:

The manual processes include:

- Logging medical records in paper based files
- Storing the patient medical record files in large cabinets.
- Manually searching of files when a patient presents a clinic registration number.

The main objective of the project will be to automate these manually handled processes.

In addition the system to be developed would be able to handle the queuing of patients for the clinic by issuing a queue number as at when they arrive at the OPD making it easier for the hospital staff to manage the patient load.

Some other planned achievements of implementing the system include:

- Increased accuracy of patient records that are recorded in the system.
- Increased efficiency and smooth functioning of related operations.
- On-Demand availability of patient medical history records through the web-based system irrespective of the government hospital the patient arrives or is admitted for treatment, if required by the hospital or doctor.
- Usability and accessibility of patient medical history by other departments of NHSL as at when required.

1.5 Scope of Project

The system developed will mainly focus on the following tasks.

- Patient Registration for Surgical Clinic at NHSL
- Medical history logging for individual patient.

- Storage of medical records against a patient registration number.
- Mark attendance of patient to prescribed clinic sessions.
- Generate medical history log of a patient as at a particular time.
- Online queuing of patients for the surgical clinic to receive medication as they arrive.
  - View number of patients remaining to be served in a particular clinic session.
  - SMS facility to notify patients when they register and make appointments for the clinic.
  - Authorization, visibility and editing of patient medical history information and other sensitive medical records available only for a doctors login account.

Note: The medical history of a patient will automatically be recorded from the day of implementation of the web-based system. Entering of useful previous medical data that would be crucial for a patient's future medication is decided upon the doctor's decision who examines the patient on their first visit after the implementation of the system is done.

1.6 Out of Scope

Apart from the requirements gathered and considered to develop the system some requirements and functionalities were not considered in order to narrow done the large scope of the project.

- Tracking/storage of medical inventory item records within the system since the system will be integrated with the current hospital management system of the hospital to retrieve that information.
- Storage of hospital staff information (personal details of doctors and nurses.)

CHAPTER 2: LITERATURE REVIEW

2.1 Related projects and information on similar studies done

This section explains on the similar systems which were found and implemented as a result of different types of research done, that are already in use in the real world. These similar systems are developed and designed to cater similar type of requirements to different health organizations throughout the world. It will also discuss on the types of technologies that are used to develop the current system that is being discussed in this thesis.

Hospitals, both public and private can be considered as healthcare organizations based on technology which rely and generate on information intensive processes. A famous survey that had been carried out with the base of 2752 European hospital managers clearly indicates that the use of information technology can substantially influence hospital activities and services [1].

The main objective of this implementation carried out is also to influence the efficiency and effectiveness of the current activities carried out within the surgical clinic of NHSL. The help of information technology based systems are taken into use to handle time and effort consuming activities. The smooth functioning and operation of activities with less hassle will indirectly result in the improved service of the hospital.

A research done by [2] states that the construction of meaningful and organized data that are generated through technology based hospital information systems are crucial and important to improve the hospital medical care capability, the management decision making process and the hospital operational efficiency.

This was bought to concern at the time of requirement analysis with the NHSL management and staff. Their views complied in relation to this particular point discussed. They agreed on the ways that an implemented system within the hospital can bring about in management and operational efficiency.

Computerized Hospital Management Systems (HMS) developed to cater specific requirements for different hospitals are increasingly becoming an emerging must-have tool in hospitals to efficiently and effectively enable the delivery of high quality healthcare service to patients. These systems have the capability to store large bases of medical information intended primarily for communication and administrative purposes of hospitals. HMS has different components integrated together ranging from sub systems limited to specific clinical or financial domain to knowledge based systems that provide diagnostic information required

for patient care. The project further elaborates on a point where the implementation of any type of HMS is an organizational process and includes the collaboration of the whole line of user community within the healthcare arena ranging from physicians, nurses, administrators to hospital managers and directors.Neglegation of any of these parties may cause in missing of related information of expertise, skills, requirements, knowledge and expectations. Studies indicate that the identification of clear user expectations are very much required to design effective Hospital Management Systems to cater all of the requirements effectively [3].

A study states that many different user groups (Doctors, Nurses, Administrators, Pharmacists, and Managers Etc.) exist in the context of hospitals with a variety of backgrounds and conflicting interests [4]. Implementation of a hospital information system or a patient management system could not happen without a clear analysis of the feelings and perceptions of the individual users who are intended to use the system that is planned to be developed.

A very recent success story on the implementation of a web based patient management and hospital management system can be referred to as the E-Dompe system implementation for the Dompe hospital in Sri Lanka [11].The system has been able to ease the daily operations of the hospital for patient management and hospital management. It includes some strong management areas in patient management but lacks in the functionality of queue management of patients.

As shown in Figure 2.0 the user interface of the E-dompe web based patient management system was developed with the collaboration of Information and Communication Technology Agency in Sri Lanka (ICTA).

Figure 2.0: Main Administrator Panel of E-dompe system.

Figure 2.0 represents the main menu of the E-dompe patient management system. The main menu is developed in a menu based layout to make it to the highest usability standards.

Figure 2.1: Patient Consultancy record of E-dompe system

Figure 2.1 shows one of the main screens in the E-dompe PMS which is the patient medical history and registration details form. Each form in the system consists of the main functionalities such as save cancel find and close activities

As a result, requirements that the system should cater were finalized after a thorough analysis and discussion of the requirements with the full stack of user community that plans to use the system within NHSL. Their views were noted down individually and then prioritized to fit into the scope that is being planned for implementation.

2.2 Background of the technologies and principles used.

2.2.1 SMS Gateway

The SMS that is being generated in the developed patient management system is currently being sent via a broadband dongle which is connected to a service provider. The SMS requests that are generated from the application are then sent into the SMS gateway of the particular service provider which is then redirected to the relevant recipient.

The technology that is taken in use in this application can be considered as a direct-to-mobile SMS gateway.

A direct-to-mobile SMS gateway is a wireless device connected which has a wireless GSM connectivity. The device contains an inbuilt Subscriber Identity Module (known as the SIM card) which is identified by a unique identifier of the respective service providers' network. The connection to the mobile network is made by acquiring a SIM card number from the mobile operator and installing it in the gateway. The more capable devices are designed with SIM management to regulate the number of SMS messages per SIM, ODBC to connect to a database such as MySQL, and HTTP interfaces to interact with third party applications. [5], [8], [9]

2.2.2 Queue management

Queue management can be considered as an effective method used to reduce waiting times of subjects in relation to any real world scenario which is used to provide a service or get something done. Queues can be seen in almost many places ranging from supermarkets, parking spaces, service centers, hospitals etc...

When considering the healthcare sector (especially in government hospitals where services are provided free of charge), the growing population base will continue having a pressure to the existing hospital facilities. With the cycle of limited facilities, it leads to the coupled

staffing shortages which will guarantee that long queues to remain synonymous anytime visiting a hospital and other public service facilities. The people must take a queue as long as they need the services. Whether the problem is caused by staff shortages, equipment shortages, or the hospital capacity is not sufficient for the population area they serve. Long queues are an unwanted and unnecessary burden to the public as well as the hospital staffs. Long queues are then associated with a negative image of the hospital experience and service provided. [6], [7], [10]

To avoid the problems discussed an effective queue management scenario is implemented in the system which delivers the patients with an effective numbering system of the queue. Patients can go anywhere without physically staying in the queue until there specific number is reached in order to get the medication required. The queue management is handled in the web application through PHP.

CHAPTER 3: SYSTEM ANALYSIS AND SYSTEM DESIGN

3.1 Introduction

The chapter describes the system study, analysis, design, strengths and weaknesses of the current system, UML modeling diagrams, Entity Relationship Diagrams, Architectural design.

3.2 System Study

The study is carried out at the National Hospital of Sri Lanka (NHSL) and the main purpose of the study is to find out how the processes related with patient management and patient medical history is managed. The system that is currently being used at NHSL is entirely manual. From inception, where a patient visits the surgical clinic to the point where the medical history is updated, processes are carried out manually. All the data of a particular patient are recorded in paper based files. These lead to a number of practical issues during the management of patient records as discussed in the introduction chapter.

3.3 System Analysis

During the system study phase, requirements of the patient management system were categorized into user requirements, system and hardware requirements. A PACT analysis was also carried out in order to identify the various aspects in relation to people, activity, context and technology.

3.3.1 Existing Patient Record Management System

The current system was manual where data is written on different papers and maintained in cardboard files. The probability and vulnerability of human errors were high since it was paper based. The retrieval of specific files as at when required was time consuming as they had to manually locate files. Some of these files which contained sensitive and highly important medical history data were found to be lost. Many of the mid-tier users such as nurses and executive staff were not contented with the system due to the reason that the currently followed methodology was not secure in terms of security and storage as it was prone to damages like loss of important information, worn out papers, outbreak of fire etc... For patients with lost medical history files doctors found it a very hectic task to prescribe them with the most appropriate medicine. The users and the hospital management recommended that the proposed system should be user friendly, multipurpose enough to handle a number of users at a go, could generate feedback when request is submitted and use of passwords which could deny access to unauthorized users of system which ensured

security. Access levels of viewing were also a crucial part of the system as it would need to show the highly sensitive medical data of patients to doctors only.

3.3.2 PACT Analysis

1. People

The people would be the stakeholders of the patient management system. There are three types of stakeholders that can be identified in the patient management system that is proposed for the National Hospital of Sri Lanka.

Primary Stakeholders (Directly involves in using the system)

- Doctors
- Nurses
- System Administrator

Secondary Stakeholders (Uses occasionally or through an intermediary)

- Director Board of Hospital
- Patients

Tertiary Stakeholders (Affected of use)

- Patients

1.1 Physical Aspects:

- **Age:** All the primary stakeholders who directly use the system is between 20 and 60 years of age
- **Gender:** Both male and female are included among stakeholders
- **Physical Ability:** Stakeholders are physically fit. There could be exceptions where patients can be physically unfit but they will not directly involve with the system.

1.2 Psychological Aspects:

The stakeholders who primarily use the system are well educated. They do have high proficiency levels. They could understand things better and able to adapt to changes. IT literacy level is also in an average level among these stakeholders

1.3 Social Differences:

Primary stakeholders are IT literate and have some sort of IT background. English and Sinhala would be the common communication language among the stakeholders and other languages such as Tamil may be used in special contexts.

2. **Activity**

   The overall purpose of the system will be to handle the basic functions of the OPD in relation to patient medical records management. Following activities are carried out from the system.

   2.1 **Patient registration:** the system is used to register patients visiting the OPD of the hospital. Basic information of the patient is recorded and a registration number is issued to the patient.

   2.2 **Medical history logging:** medical history is entered in the system by the doctor when the patient is examined. Any medicine prescribed is also entered at time of prescribing. This medical information is only visible to a doctor's account as it is treated as sensitive information.

   2.3 **Patient Queue management:** Queue numbers are generated through the system to patients as at when they arrive at the OPD.This function is carried out by a nurse who is responsible for the particular clinic session at the OPD at that particular point in time.

   2.4 **Patient Attendance marking for clinic session:** Attendance is automatically being marked through the system as at when a doctor saves any medical record specific to a patient.

3. **Context**

   3.1 **Physical Context:** All the activities in relation with the system are carried out within the surgical clinic of the OPD of the hospital. The functions carried out should not interfere or influence the operations or activities of the OPD. Since the data records highly sensitive data such as patient medical data the system should have means of high data security.

   3.2 **Social Context:** Only doctors should be enabled to view patient medical history data. All the other users of the system will be enabled to view only the patient basic information.

   The queue management process should effectively and accurately manage the numbering of patients which should not lead to confusion between patients by

issuing same number to several patients. This may lead to longer waiting times than expected and longer queues.

3.3 **Organizational Context**: Any issues or misbehavior of system should not disturb the normal operation of OPD activities. System administrators are responsible for the smooth functioning of the system without any major impact on the normal operations.

4. **Technology**

Since the patient management system is implemented in a government hospital, the cost is one prime factor that decides on the overall implementation success of the system. The technologies used in the implementation of the system include PHP for the overall designing of the system and MySQL being used as the database technology. These are two cost effective technologies that can be used in the development. MySQL is also a very powerful data base technology with a wide variety of features being enabled.

3.3.3 Functional Requirements

- Patient Registration for Surgical Clinic at NHSL-the system should be able to record patient registration information and automatically generate a clinic registration number for each new patient.
- Store medical records against a patient registration number-the medical records should be automatically saved with respect to the generated patient registration number which is also known as the clinic registration number. This allows easy retrieval of patient medical information with respect to the registration number.
- Mark attendance of patient to prescribed clinic sessions-the system should have the capability to automatically mark the patient attendance as an when the patient record is opened up during the current clinic session.
- Generate medical history log of a patient as at a particular time-a detailed medical history record log should be generated for each patient on demand.
- Online queuing of patients for the surgical clinic to receive medication as they arrive.
- View number of patients remaining in queue to be served in a particular clinic session.
- Generate prescription through system.

3.3.4 Non Functional Requirements

- The system must verify and validate all user input and users must be notified in case of errors detected in the course of using the system.

- The system only allows the system administrator to delete records in the database.

- The system should allow room for expansion where other clinics may be integrated into the system as well in the future.

- System should be available in a 24/7 with high performance in order for smooth operation and anytime availability.

3.3.5 System Requirements

This section describes the hardware components and software requirements needed for effective and efficient running of the system. This may need to be altered as more and more data is handled in years to come.

Table 3.0: Hardware Requirements

Hardware	Minimum System Requirement
Processor	2.4 GHZ processor speed
Memory	2GB RAM (4GB Recommended)
Disk Space	500GB(726 GB Recommended)
Display	800 x 600 colors (1024 x 768 High color- 16 bit Recommended)

Table 3.0 shows the minimum system requirements needed for smooth operation of the system to overcome any performance related issues with daily increase in system load. However these requirements may vary with time to enhance system performance with increase in system load.

Table 3.1: Software Requirements

Software	Minimum System Requirement
Operating System	Windows 7 or later
Database Management System	MYSQL
Run-time Environment	Apache/tomcat5 server

As shown in Table 3.1 the minimum software requirements should also be met in order for the developed system to function smoothly and as expected.

3.4 System Design

After interpretation of the data, tables were drawn and process of data determined to guide the in the implementation stage of the project. The tools, which were employed during this methodology stage, were mainly tables, UML diagrams and Entity Relationship Diagrams (ERDs).
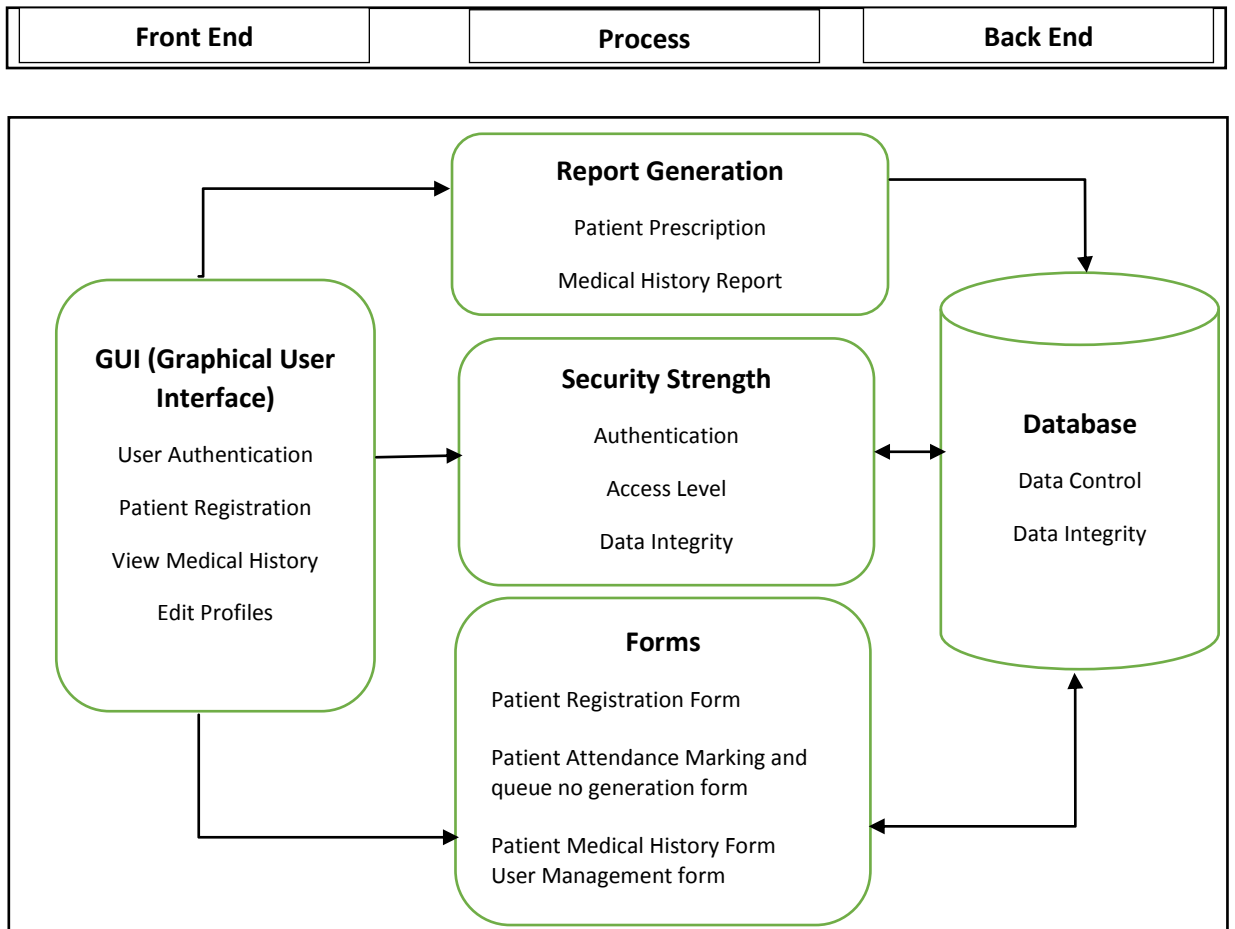
Figure 3.0: System Architecture

Figure 3.0 shows the system architecture and it represents how the individual components of the proposed system are integrated to work together. The GUI component of the system directly communicates with the report generation and form components. Data is flown from the GUI component into these components in order to generate the reports and process the data. Thereafter data is flown from these components into the database component in order for data retrieval and data storage. Apart from this another special component is set up in place to handle the security of the system. This component is responsible for handling the security of the data and system authorization according to the setup access levels.

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3.4.1 System Use Case Diagram

The use case below depicts the list of actions that each type of identified user would be involved during its operation.

Figure 3.1: Use Case Diagram of Patient Management System
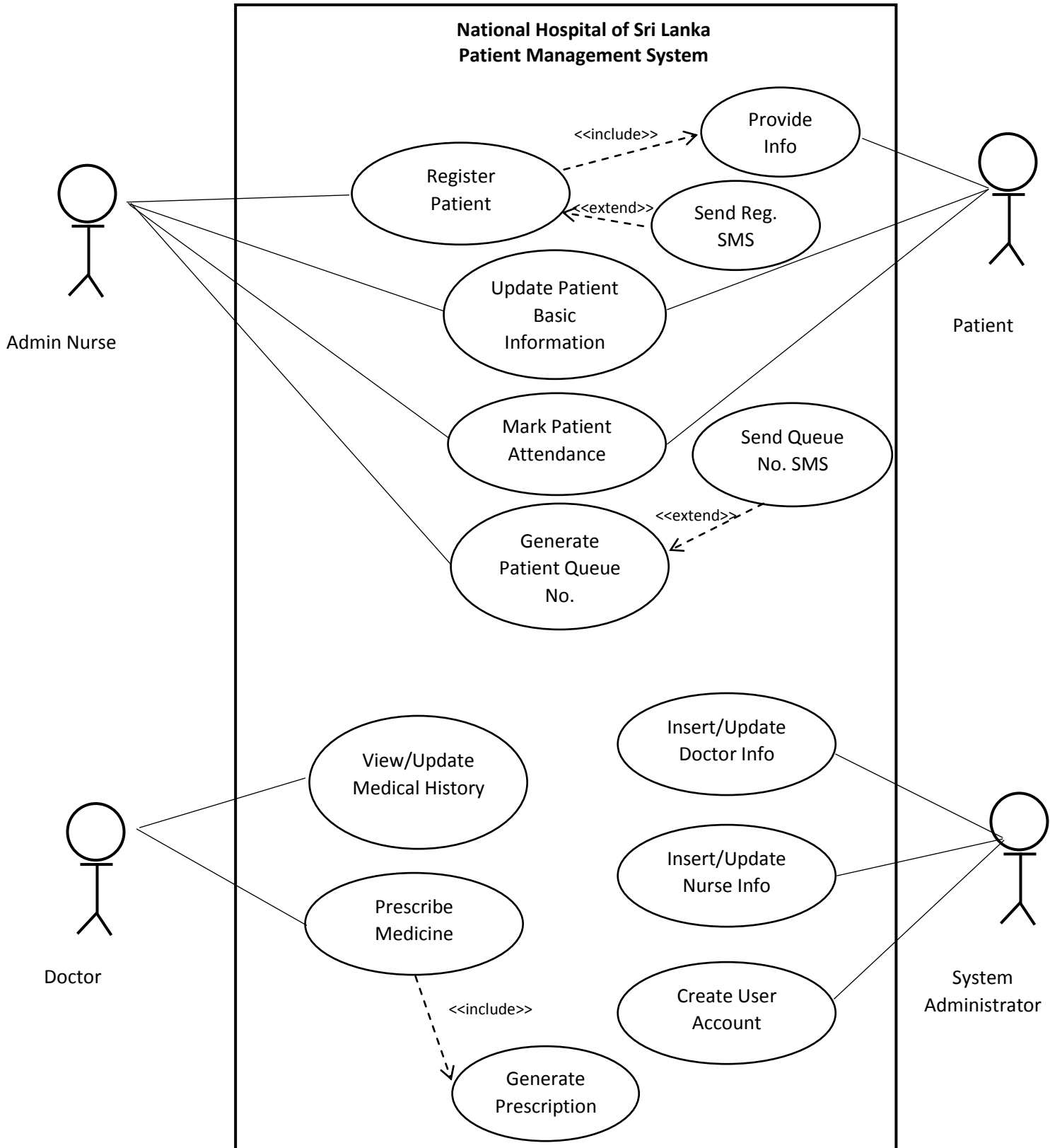
3.4.2 Class Diagram

The class diagram shows the application structure of the patient management system by showing the systems classes. It also clearly shows the relationships among these classes, their attributes, and also the class methods.

Figure 3.2: Class Diagram for Patient Management System

```
┌─────────────────────────────────┐          ┌─────────────────────────────────┐
│            DOCTOR               │          │            PATIENT              │
├─────────────────────────────────┤          ├─────────────────────────────────┤
│ DOC_ID        :      Int        │          │ Patient_ID     :      Int       │
│ Name          :      String     │          │ Patient Name   :      String    │
│ Department    :      String     │ attends  │ Phone N        :      Int       │
│ Specialization :     String     │   1...*  │ Address        :      String    │
│ Phone No      :      String     │          │ Age            :      Int       │
│ Location      :      String     │          │ Sex            :      String     │
├─────────────────────────────────┤          ├─────────────────────────────────┤
│ prescribeMedicine()             │          │ addPatient()                    │
│ updateMedicalhistory()          │          │ updatePatient()                 │
│ generatePresciption()           │          └─────────────────────────────────┘
│ enterNextQueuePatient()         │
└─────────────────────────────────┘
```

has

prescribe

```
┌─────────────────────────────────┐          ┌─────────────────────────────────┐
│           MEDICINE              │          │       MEDICAL HISTORY           │
├─────────────────────────────────┤          ├─────────────────────────────────┤
│ Medicine_ID   :      Int        │          │ History_ID      :      Int      │
│ Drug Name     :      String     │          │ Surgery Status  :      String   │
│ Manufacturer  :      String     │          │ Surgery Date    :      Date     │
├─────────────────────────────────┤          │ Comments        :      String   │
│ addMedicine ()                  │          ├─────────────────────────────────┤
│ deleteMedicine ()               │          │ generateHistoryReport()         │
│ updateMedicine ()               │          └─────────────────────────────────┘
└─────────────────────────────────┘
```
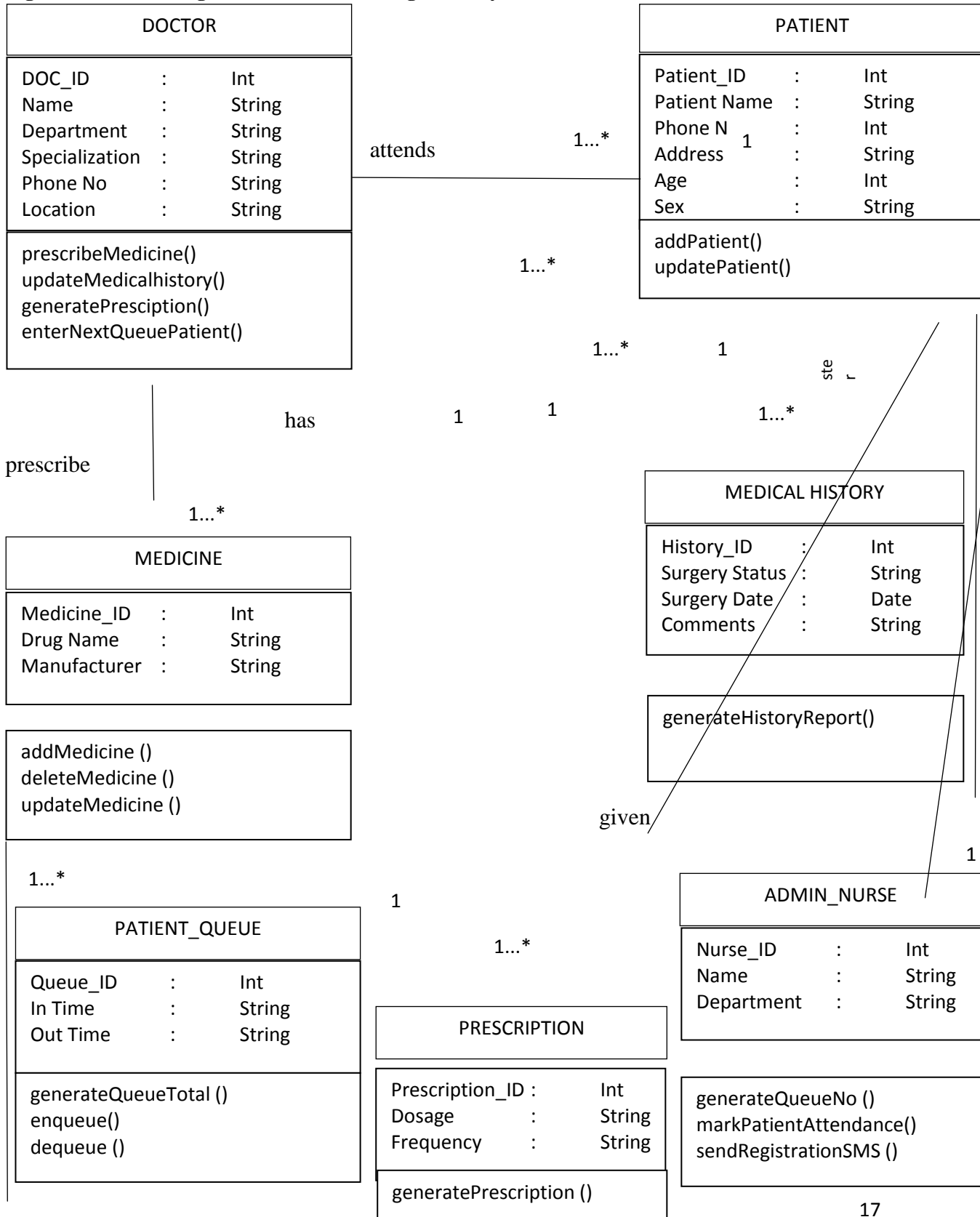
given

```
┌─────────────────────────────────┐          ┌─────────────────────────────────┐
│         PATIENT_QUEUE           │          │          ADMIN_NURSE            │
├─────────────────────────────────┤          ├─────────────────────────────────┤
│ Queue_ID      :      Int        │          │ Nurse_ID       :      Int       │
│ In Time       :      String     │          │ Name           :      String    │
│ Out Time      :      String     │          │ Department      :      String   │
├─────────────────────────────────┤          ├─────────────────────────────────┤
│ generateQueueTotal ()           │          │ generateQueueNo ()              │
│ enqueue()                       │          │ markPatientAttendance()         │
│ dequeue ()                      │          │ sendRegistrationSMS ()          │
└─────────────────────────────────┘          └─────────────────────────────────┘

┌─────────────────────────────────┐
│          PRESCRIPTION           │
├─────────────────────────────────┤
│ Prescription_ID :     Int       │
│ Dosage          :     String    │
│ Frequency       :     String    │
├─────────────────────────────────┤
│ generatePrescription ()         │
└─────────────────────────────────┘
```

3.4.3 Activity Diagrams

The activity diagrams shown below are representations of the workflows of stepwise activities and actions that happen within the system by users. Some of these activities do happen offline to the information system but are directly involved with completing the tasks within the system

Figure 3.3: Patient Registration Activity Diagram
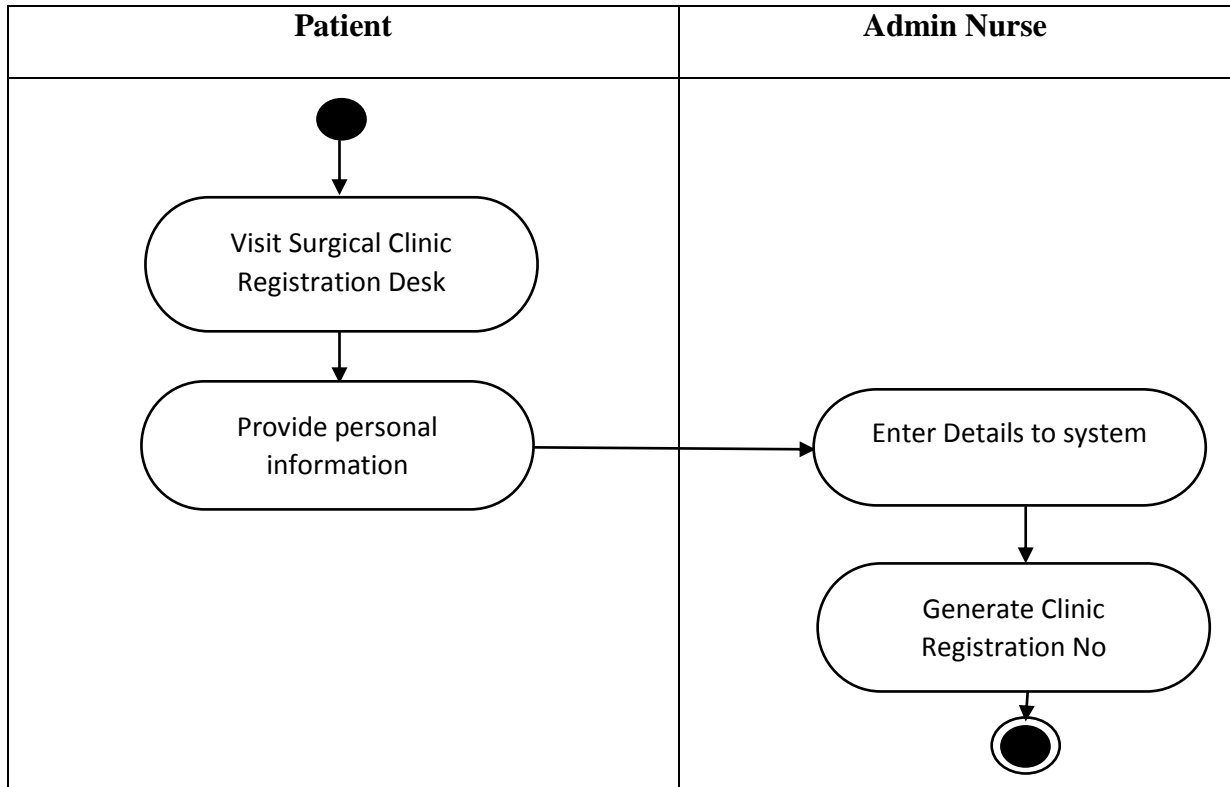
A patient visiting the surgical clinic of the OPD of NHSL should register himself/herself at the registration admin desk in the clinic. After basic information of patient is provided to the admin nurse at the desk, the information is entered into the system and saved. An unique clinic number is generated for each new patient. This number can be used in future for the clinic sessions. If the patient has provided a mobile phone number this registration number would be automatically sent to the phone via a SMS. If a phone number is not provided the admin nurse who registers the patient will have to print or write down the registration number and hand it over to the patient for future reference purposes.

Note: Patients who have already been visiting the clinic before the system implementation will have to re-register with the system. Data would be recorded from the day of implementation of the system.

Figure 3.4: Mark Patient Attendance and generate queue number Activity Diagram
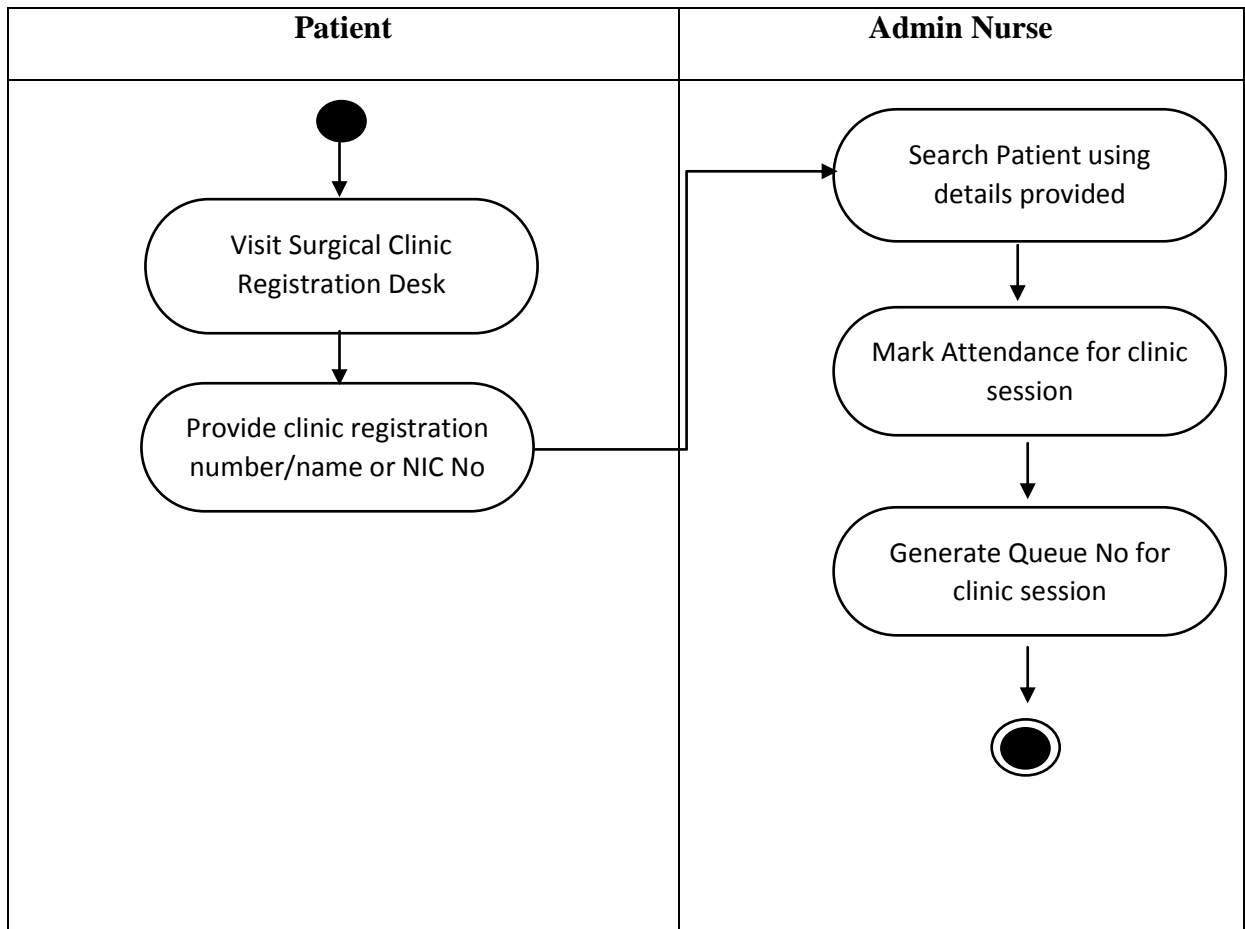
When an already registered patient visits the admin desk of the clinic for the clinic session the patient will have to hand over the clinic registration number to the admin nurse. The nurse will then search the system for the patient record and mark the attendance for the patient for that particular day. If the clinic number is not available the patient record can also be searched using the national identity card number or the patient name. A queue number is then generated through the system for the patient to meet the doctor. The queue number is given to the patient and asked to be seated on the clinic bench until their number is called out by the clinic room nurse.

Figure 3.5: Receive Medication and Checkup Activity Diagram
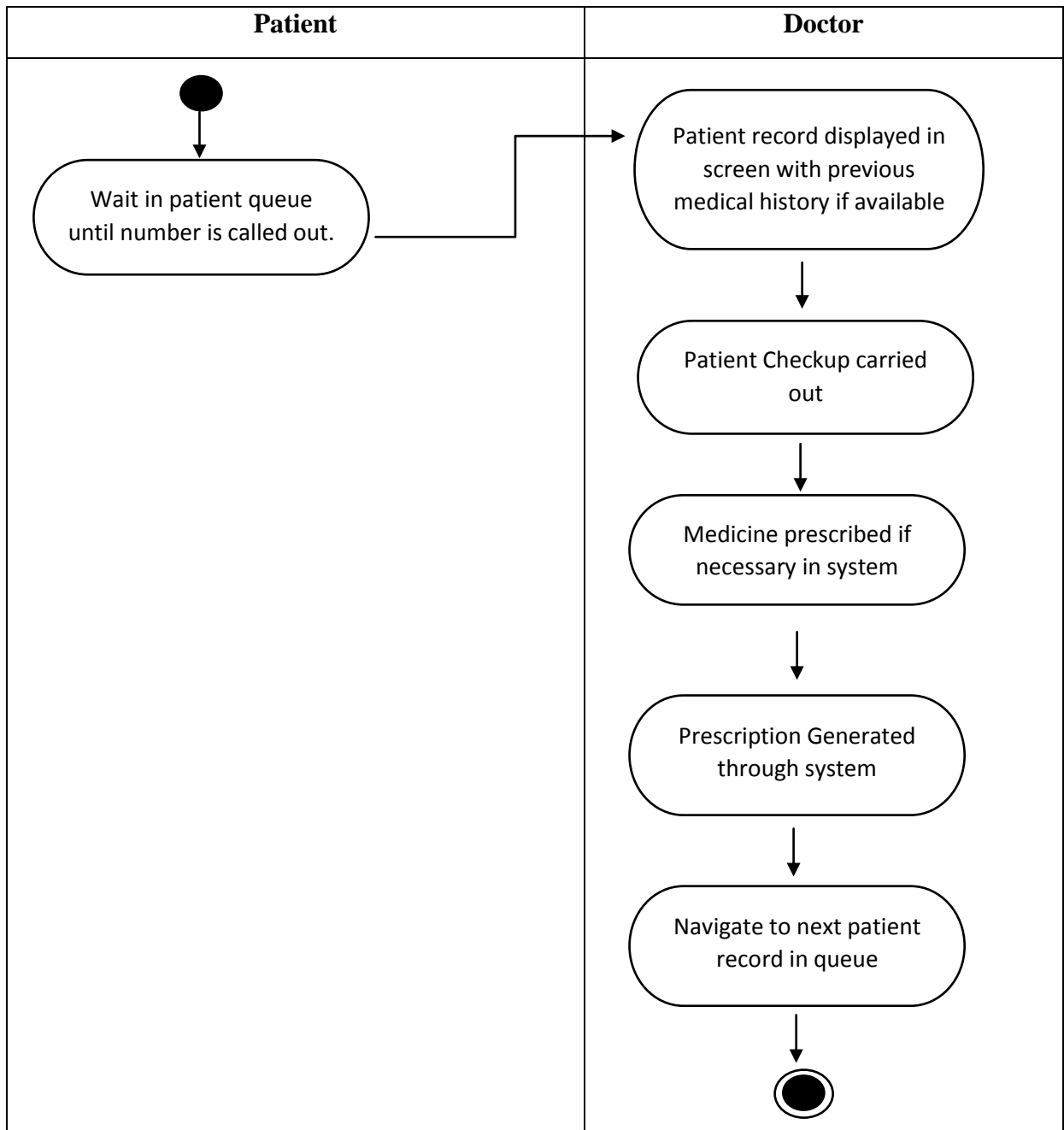
The doctor will log into the system from the computer available at the clinic room using his/her login credentials. He/she will be shown with the patients currently in the queue. The doctor can now navigate through each patient one at a time whilst the number is called out and the patient visits the room for the checkup. The doctor carries out the patient examination and if any medicine is to be prescribed he/she would enter it in the system and click on generate prescription button. This will print a prescription through the system. The doctor can save the patient record and navigate to the next available patient in the queue. The process is repeated until all the patients are served.

3.5 Database Design

The Entity Relation-ship diagram shows the entities and the relationships that will be mapped onto the database tables of the patient management system to be developed.

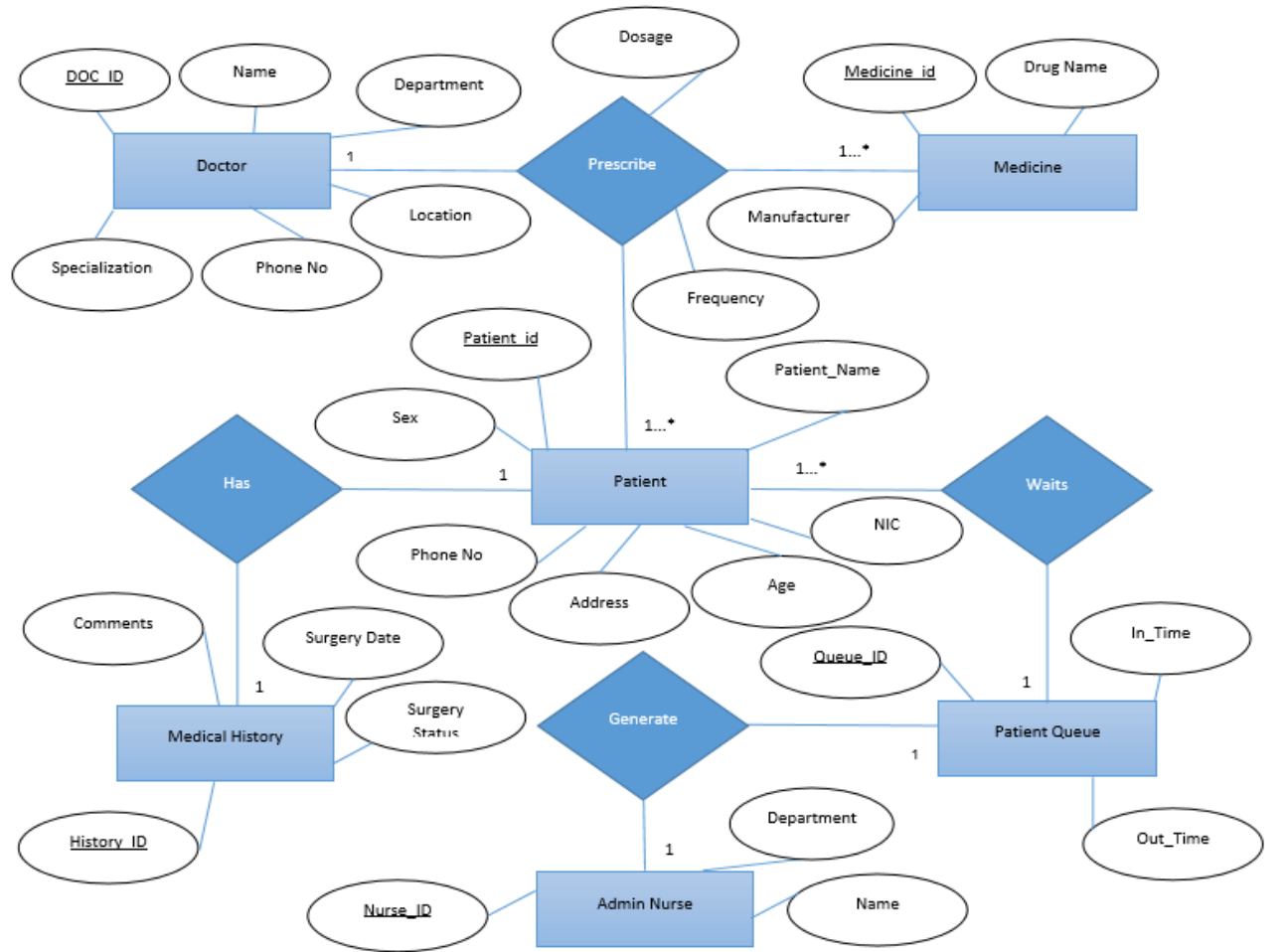**Figure 3.6: Entity-Relationship Diagram**

Figure 3.6 shows the ER diagram of the system to be developed. There are 6 major entities identified in order for data storage. The 6 major entities involve

- Patient
- Medical History
- Admin Nurse
- Patient Queue
- Doctor
- Medicine

During the implementation some temporary global tables were created to enhance performance of the system which is not included in the ER design.

The entities represented in the ER diagram would map onto database tables as shown below.

Doctor (Doc_ID, Name, Location, Phone_no, Specialization,Dept_id)

Patient (Patient_id, Patient_Name, Sex, Phone_no, Address, Age, NIC)

Medical_History(History_id, Surgery_status, Surgery_date, Comments, Patient_id)

Patient_queue (Queue_id, In_time, Out_time,Patient_id)

Admin_Nurse (Nurse_id, Name, Dept_id)

Prescribe (Doc_id, Medicine_id, Patient_id, Dosage, Frequency)

Note: The ER diagram does not depict a separate department table to be mapped onto a table. But a separate department table is being generated for the time being to stop the redundancy of department records within the other tables. Although this particular implementation would have only one department (surgery department) where both the doctors and the nurses belong to; there can be several other departments entered into the system in the future when the system is enhanced and implemented to other clinics within the OPD as well.

Department (Dept_id, Department_name, Enabled)

In addition a user table will be maintained to store the user login details and their access levels.

User(User_id,Username,Password,Access_level,Enabled,Doc_nurse_id)

3.5.1 Table Structures

Table 3.2: Doctor Table

Column Name	Data Type	Size	Constraint
Doc_id	Number	10	Primary Key
Name	Varchar	100	Not Null
Location	Varchar	50	-
Phone_No	Varchar	12	-
Specialization	Varchar	50	Not Null
Dept_id	Number	10	Foreign Key

The doctor table stores the basic information of doctor in the system.

Table 3.3: Patient Table

Column Name	Data Type	Size	Constraint
Patient_id	Varchar	15	Primary Key
Patient_Name	Varchar	100	Not Null
Sex	Varchar	2	Not Null
Phone_No	Varchar	12	-
Address	Varchar	250	Not Null
Age	Number	3	Not Null
NIC	Varchar	11	Unique Key

The patient table stores all basic information of a patient who registers at the surgical clinic. NIC is not considered as the patient ID because some infant patients are also brought into the clinic for treatment. These patients do not have an NIC. Therefore a separate Patient ID is generated for each patient to comply with consistency and easiness.

Table 3.4: Medical History Table

Column Name	Data Type	Size	Constraint
History_id	Number	10	Primary Key
Surgery_status	Varchar	20	-
Surgery_date	Date	11	-
Comments	Varchar	12	-
Patient_id	Varchar	15	Foreign Key

The medical history table stores medical history data of a patient such as the surgery status and surgery date. This table is joined with the prescribe table for generating data in the medical history form of the system.

Table 3.5: Prescribe Table

Column Name	Data Type	Size	Constraint
Doc_id	Number	10	Composite Key
Medicine_id	Varchar	20	
Patient_id	Varchar	15	
Dosage	Varchar	10	Not Null
Frequency	Number	2	-

The prescribe table stores the medicine prescribed to the patient by the doctor. This consists of both history information and current information of medicine prescribed to the patient.

Dosage field in this table represents the amount of drug in mg that is prescribed to the patient. The frequency field stores the number of times the patient needs to take the medicine as prescribed by the doctor.

Data in this table is used to generate the prescription.

Table 3.6: Patient Queue Table

Column Name	Data Type	Size	Constraint
Queue_id	Number	10	Primary Key
In_time	Date/Time	20	Not Null
Out_time	Date/Time	15	Not Null
Patient_id	Varchar	15	Foreign Key

The patient queue table is designed as a global temporary table. This holds data temporarily only during the active clinic session. Used to manage the patient queue during the issuing of patient queue numbers. The user responsible for entering data is the Admin nurse.

Table 3.7: Admin Nurse Table

Column Name	Data Type	Size	Constraint
Nurse_id	Number	10	Primary Key
Name	Varchar	100	Not Null
Dept_id	Number	10	Foreign Key

This table stores the details of the admin nurse responsible for carrying out the administration tasks such as patient registering, queue number issuing etc.…

Table 3.8: Department Table

Column Name	Data Type	Size	Constraint
Dept_id	Number	10	Primary Key
Name	Varchar	100	Not Null
Enabled	Yes/No	2	Not Null

Table 3.9: User Table

Column Name	Data Type	Size	Constraint
User_id	Number	10	Primary Key
Username	Varchar	100	Not Null
Password	Varchar	50	Not Null
Access_level	Number	1	Not Null
Enabled	Yes/No	2	Not Null
Doc_nurse_id	Number	10	Foreign Key

The user table is used to store the login details of the users of the system. It also controls the access level of the users. Access levels are categorized into three namely High (1), Medium (2), Low (3).

The high access level is given to system administrators with full functionality for administration purposes of the system. But they are unable to view medical history data of the patients.

The medium access level is given to doctors where they cannot change system settings and configurations but are enabled to edit and view patient medical history data.

The low access level is assigned to admin nurses who login to system for administering a particular clinic session. They are only allowed to view and edit patient basin information and generating queue numbers.

CHAPTER 4: SYSTEM IMPLEMENTATION

4.1 Solution Description

After careful analysis and design of a web based system to cater the functional and non-functional requirements the following system was developed. The developed system consists of four main modules. The modules can be identified as

- Patient Module
- Patient Queue management module
- User management module
- Reports Module

4.2 System Architecture

4.2.1 Backend of Application

Database of the web based patient management system is developed in MySQL. MySQL is widely used in internet applications since it's recognized as a very fast database and it is the most popular open source database. It is easy to install, maintain and work with.

4.2.2 Frontend of Application

The front end of the system is developed using the PHP language and HTML.PHP is a powerful server-side scripting language for creating interactive web pages. In web development PHP code can be easily embedded into HTML code.

4.2.3 System Overview Diagram

Figure 4.0: System Overview Diagram
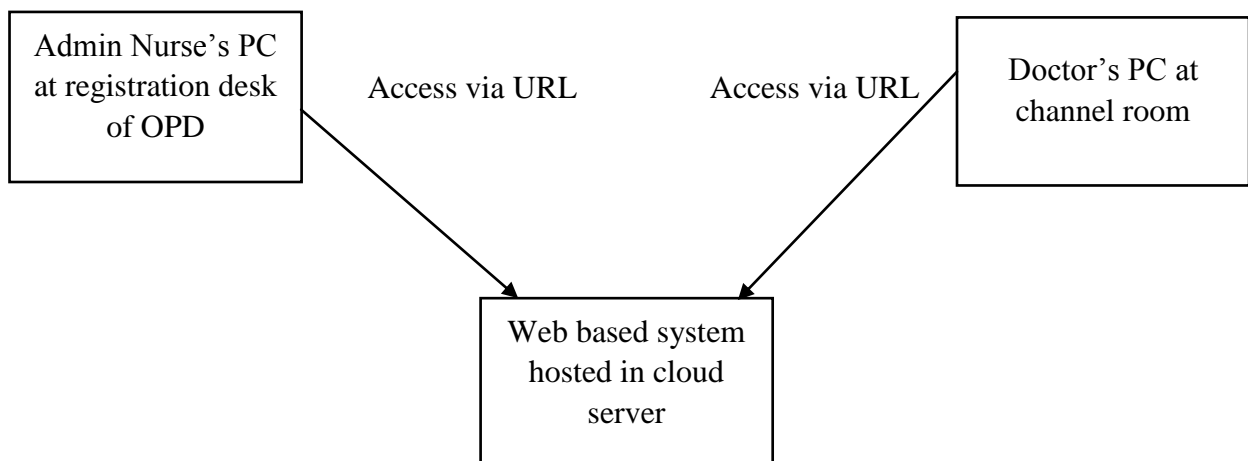
4.2.4 GUI Screen Overview

System Login

The login screen as shown in Figure 4.1 is used to provide first level security to different types of users and control their user access levels. One admin user login is created in the system enabling all functions to be performed using the particular login. In addition different credentials are provided to the respective doctors and nurses who intend to use the system.
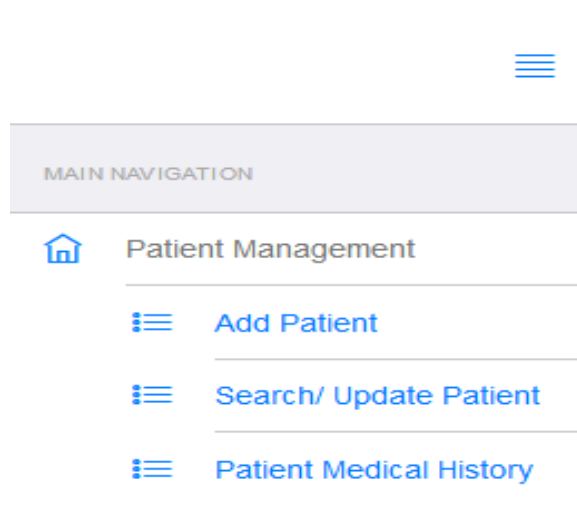
Figure 4.1: System Login
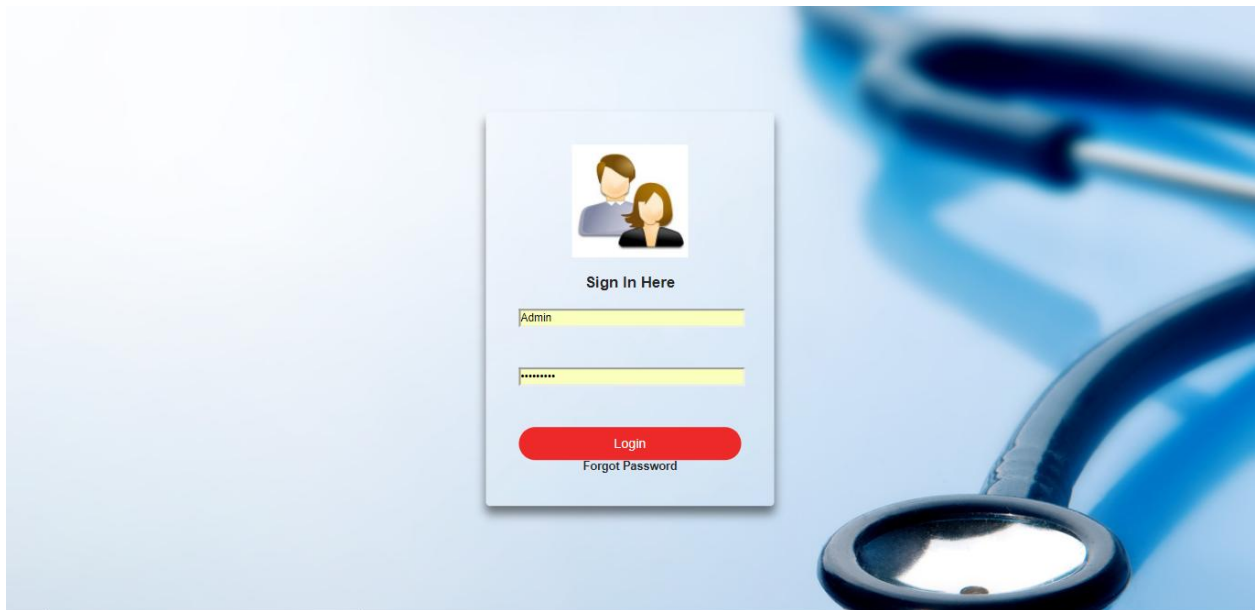
Administrator Dashboard

Figure 4.2: Admin Dashboard
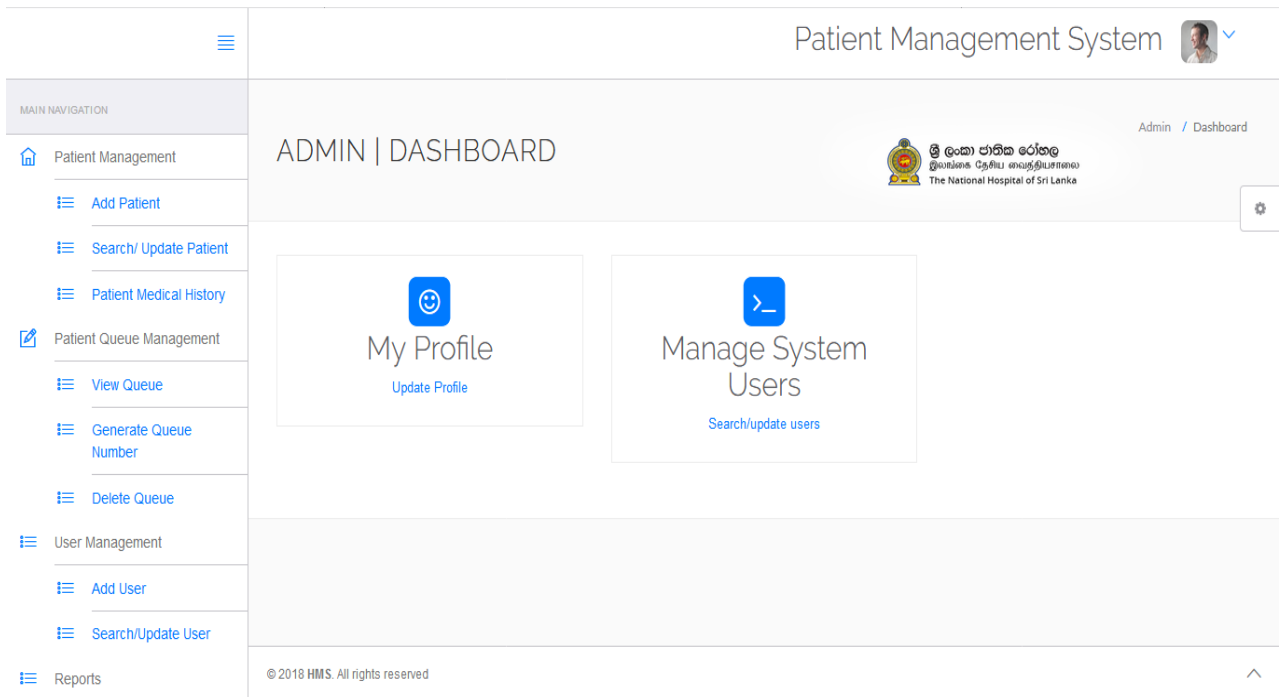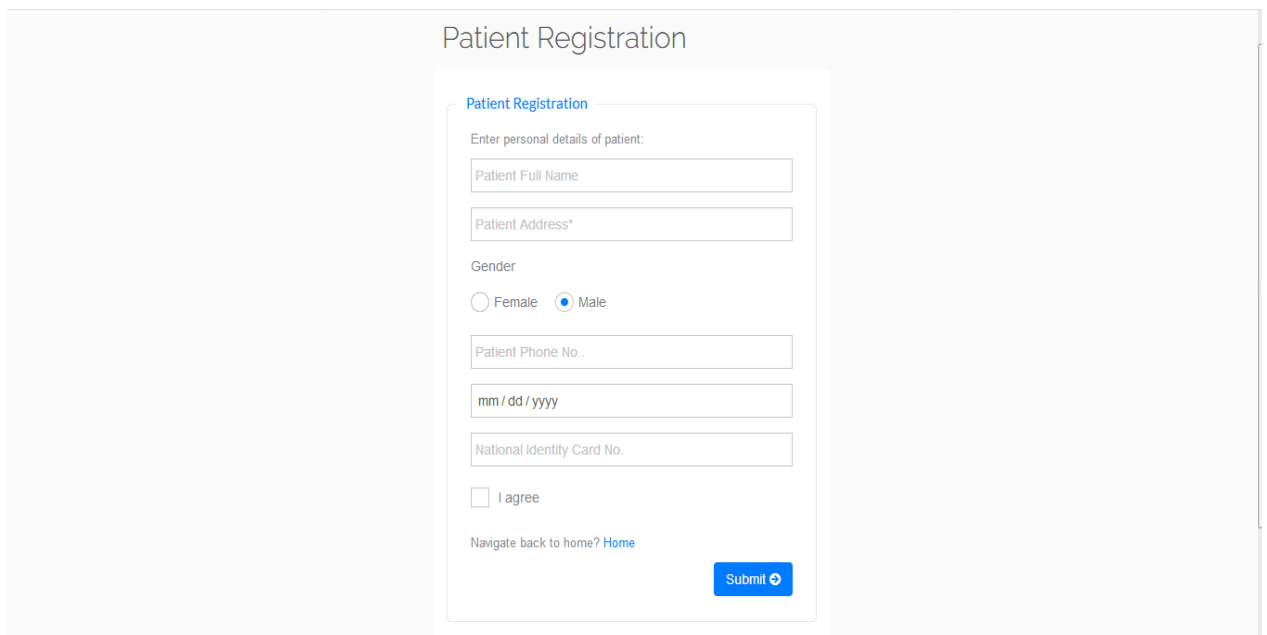
As shown in Figure 4.2 the main page of the system is the admin dashboard. This dashboard is used to navigate to every other module in the system. This dashboard varies from the type of user who uses the system.

Patient Management Module.

One major function of the patient management module is the patient registration. The patient registration function is carried out in the system using the 'ADD PATIENT' form.

Figure 4.3: Add Patient Form

A patient can be registered in the system by entering the patient basic details into the system and saving. A patient registration number is automatically generated from the system for every new patient entered into the system.

Search/Update Patient

This function enables a user to search or update existing patient records in the system.An existing patient record can be queried from the system using several search criteria. Patient records can be searched using clinic registration number, patient name, phone number or NIC number.

Figure 4.4: Search/Update Patient Form

Patient Medical History

The most important and major part of the system includes the management of patient medical history records.

This particular form is made visible only to a doctor login since this manages highly sensitive patient medical history information. The previous, next, first and last navigation buttons can be used navigate through the patient records currently available in the queue of the current clinic session.

Figure 4.5: Medical History View

Prescribe function available in the medical history is used to prescribe new medicine and medical tests to a patient during his/her current visit to the clinic session. The doctor is provided with the option of adding or deleting records during prescription of medicine.

Figure 4.6: Medicine and test prescription
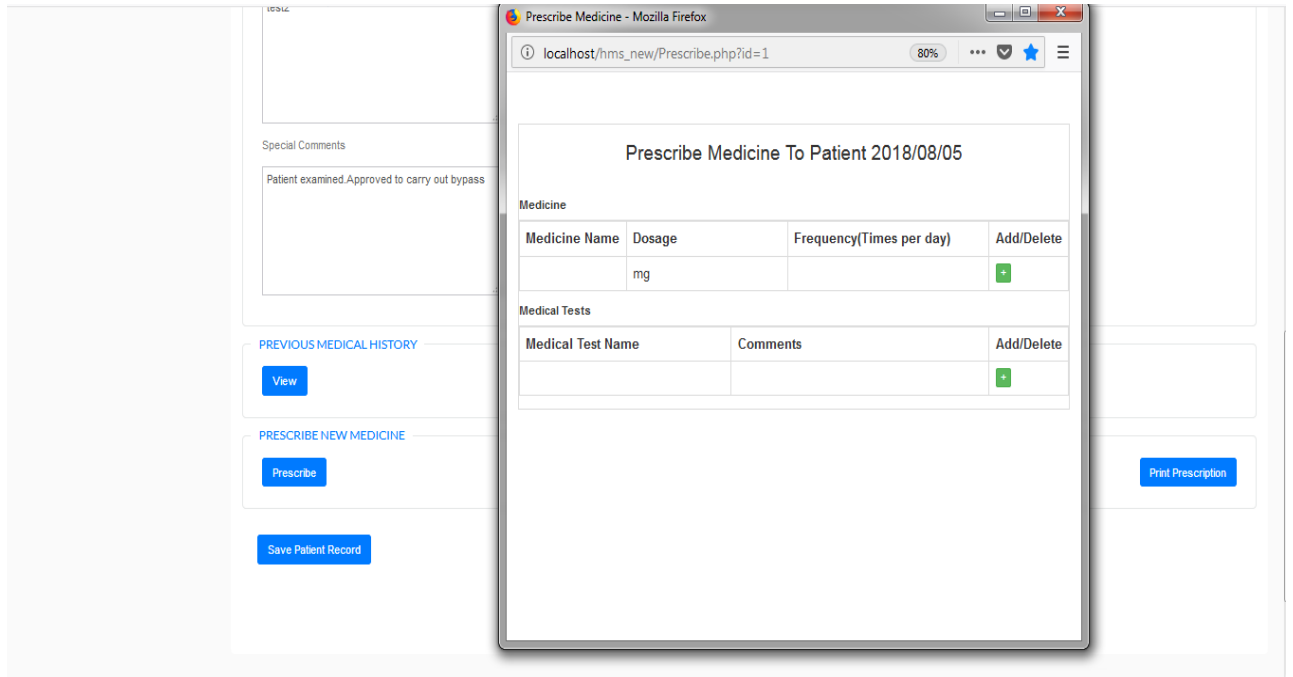
After medicine and medical tests are prescribed to the patient a prescription can be automatically generated from the system using the generate prescription function.

Figure 4.7: Print Prescription
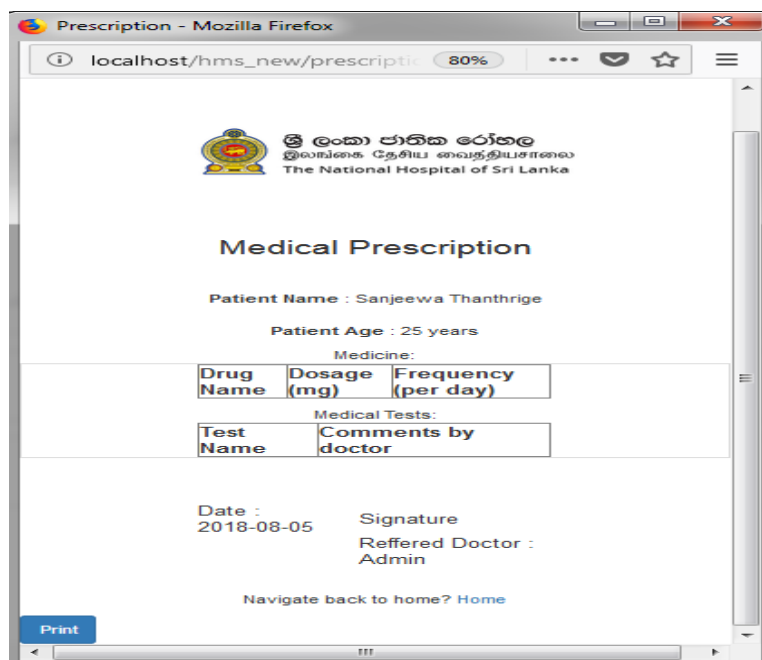
After successful prescription of medicine to a patient, the changes can be saved. Saving a patient record during a particular clinic session will automatically remove the patient from the current queue of the clinic session.

Patient Queue Management Module

View Queue

The patients currently available in the queue session can be viewed using the view queue menu. The now serving section displays the current patient number being served by the doctor.

Figure 4.8: View Queue Form

ශ්‍රී ලංකා ජාතික රෝහල
இலங்கை தேசிய வைத்தியசாலை
The National Hospital of Sri Lanka

NOW SERVING :   6
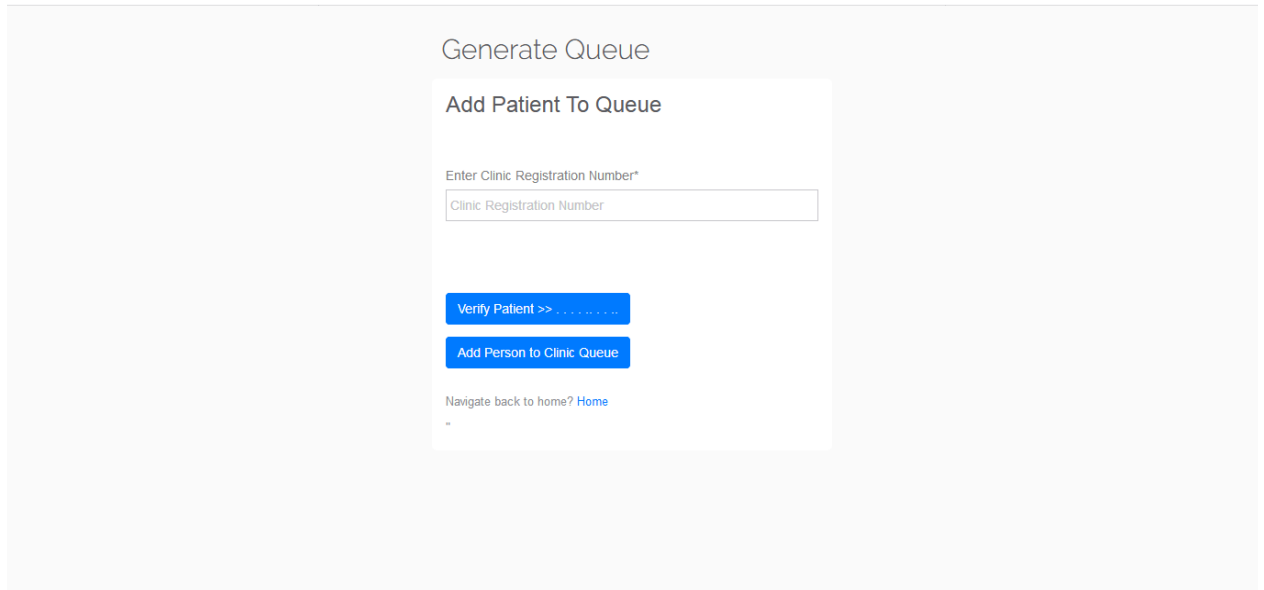
Queue Number	Patient Name	Clinic Reg. No.
6	Sanjeewa Thanthrige	1
7	K.A.D.S Perera	2
8	D.A.R Wimalarathna	3
9	D.S.L Thanthrige	5
10	D.L.A Siribaddana	7
13	D.S.L Perera	6

Generate Queue Number

The generate queue functionality is used to add a patient to a clinic session queue.

The patient clinic registration number can be verified to check if a patient actually exists in the system. After successful verification of patient the patient can be added into the clinic queue for medical prescription.

Figure 4.9: Generate Queue Form

Clean Queue

At any given point in time the queue can be cleaned up or deleted if required using the clean queue menu functionality.

Figure 4.10: Clean Queue Function

User Management Module

Add User
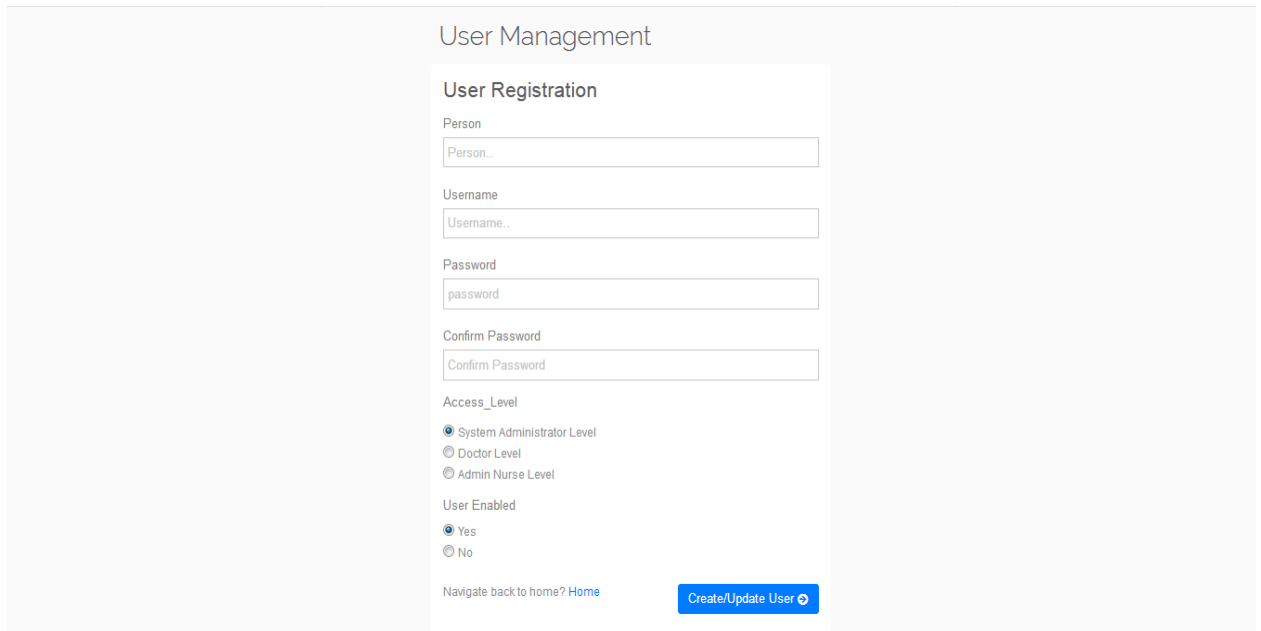
Figure 4.11: Add User Menu
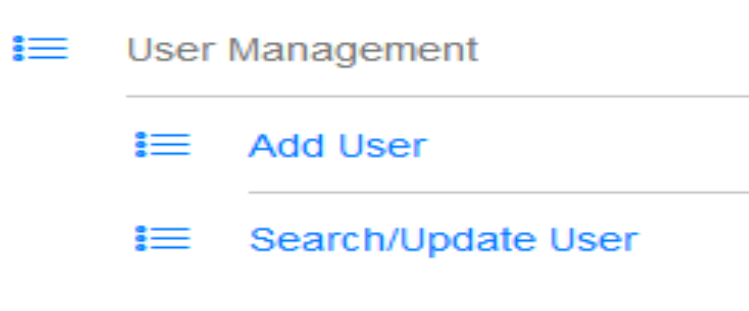
The 'Add User' functionality can be used in the system for adding a new user into the system.

A username and password can be set for a particular user defined in the system. An access level of either system administrator, doctor or admin nurse level can be set for the user according to the required user access level. Any user can be either enabled or disabled within the system.

Figure 4.12: Add User Form

Search/Update User

An existing user already available in the system can be searched and updated if required using the search/update user functionality of the system.

Figure 4.13: Search/Update User

The user can be searched in the system using the username.

CHAPTER 5: USER EVALUATION AND TESTING

5.1 Testing Approach

The testing phase was divided into different sub phases in order to test that the functionality of the developed system catered all the expected functional and non-functional requirements identified during the analysis phase.

In addition development was carried out taking into consideration an iteration model. Initial phases of unit testing and integration testing were carried out during each development iteration.

5.2 Testing Phases

Unit Testing- Testing on each and every single unit in the system such as the patient registration module, patient queuing module and reports module was carried out individually during the pre and post development phases of the system

Integration Testing- Every single menu developed separately was integrated together as a single module or whole system. A fully functional menu based web system was developed as the output of the integration task. Thereafter a thorough testing was carried out to check whether each and every function of the system performed as of expected.

Regression/Load Testing- A load test was carried out by a simulation of 50 users taken to access the system at one particular time. This was done to check on how the system performance was affected by the increase in the user load. This would not be beneficial for the current implementation since the maximum user amount per clinic session that would be accessing the system will be around five users at a given time. But in the future with the integration of the system, with the current hospital management system at NHSL this test would give an approximate metric on how the system would be ready to function with increasing load.

Performance Testing- This test was carried out on the system to ensure that all the desired functions were not time consuming to use. The system output times were calculated to check if the system was able to perform the required processing within a short period of time.

User Acceptance Testing- This phase of testing was the final part of the testing phase. A selected group of users ranging from a doctor from the surgical clinic, an admin nurse and the current systems administrator of the hospital was demonstrated on the functions of the system. They were then given access to the system in order to gain hands on experience of

the developed system. Feedback of each individual was then recorded and then analyzed to check on the areas that needs further enhancement on its functions.

5.3 Test Cases

The following shows a few of the test cases that were used in the different testing phases to test the ability of the system to perform its functionality as desired and handle any sorts of exceptions. If the actual result is different from the expected result that was noted down in the "Actual Result" column of the test case.

5.3.1 Login Module

Table 5.0: Test Case 1

Test Case Description	Steps	Expected Result	Status
Verify Successful Login	Enter wrong username and password	Err Msg: "Invalid Username or Password"	Pass
	Enter correct username and wrong password and vice versa	Err Msg: "Invalid Username or Password"	Pass
	Enter correct username and password	Login Successful	Pass

Log in to the system test case validates the authentication of the user into the web based system. Username created by the administrator of the system has to be entered. Password is accepted as a password field. This test case ensures that the system cannot be accessed without an authorized username and password.

Table 5.1: Test Case 2

Test Case Description	Steps	Expected Result	Status
Verify User Access Levels after successful login	Enter correct username and password of a user with the admin nurse access level given	Menu should display only 'Add patient' and Update/Search patient' options in the patient management tab. Patient Queue Management menu tab should be displayed	Pass
	Enter correct username and password of a user with the doctor access level given	Menu should display only 'Patient Medical History' and 'View Queue' menu tab	Pass
	Enter correct username and password of a user with the system admin access level given	Menu should display all the menu tabs	Pass

The test case in Table 5.1 depicts the results that were obtained as a result of testing the user access level of the system

5.3.2 Patient Management Module

Following test case covers the functions and validations that should fire at time of adding a new patient.

Table 5.2: Test Case 3

<table>
<tr><td colspan="4" align="center">ADD NEW PATIENT TO THE SYSTEM</td></tr>
<tr><td>Test Case Description</td><td>Steps</td><td>Expected Result</td><td>Status</td></tr>
<tr><td>Verify new patient can be added into the system</td><td>Click on Add Patient menu tab.</td><td>Patient Details Page should be opened</td><td>Pass</td></tr>
<tr><td></td><td>Enter Patient Details. Leave fields marked with an asterisk blank and click on Submit</td><td>An alert with message 'Please fill out this field 'should appear on top of respective field</td><td>Pass</td></tr>
<tr><td></td><td>Enter All Patient Details and click on Submit</td><td>Popup with the clinic registration number of new patient should be displayed.</td><td>Pass</td></tr>
</table>

Following test case covers the scenario where an existing patient record is searched from the system and updated if required.

Table 5.3: Test Case 4

SEARCH/UPDATE PATIENT DETAILS IN THE SYSTEM			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify existing patient can be searched using the searching criteria.	Click on 'Search/Update Patient' menu tab.	'Search Patient Details Page' should be opened	Pass
	Enter either 'Clinic Reg. No', 'PatientName', 'Phone No' or 'NIC' an click on Search button	Pop up should appear with the details of the patient if such a patient that satisfies the search criteria is available in the system.	Pass
	Click on 'Reg No' field of search results	Should navigate to patient details page. All fields should be populated with the existing data of patient	Pass
Verify Patient Details Can be updated	Change any column of the populated data of the patient. Click on 'Update Patient Details' button.	Confirmation message as 'Patient record successfully updated' should be displayed for the existing patient registration number	Pass

The following test case covers the functionalities that should be tested in the patient medical history page of the patient management module.

Table 5.4: Test Case 5

UPDATE/VIEW PATIENT MEDICAL HISTORY DETAILS			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify patient medical history details who are currently in the queue are being displayed.	Click on Next Button	Patient details of the next patient in the queue should be populated into the fields	Pass
	Click on Previous Button	Patient details of the previous patient who was in the queue should be populated into the fields	Pass
	Click on 'View' button in Previous medical history section	All previous medical history records of the patient should be displayed.	Pass
	Click on 'Prescribe' button in Prescribe New Medicine section	A pop up should be opened to enter the newly prescribed medicines and observations	Pass
	Click on 'Save' button.	All the details of the particular patient should be saved	Pass

5.3.3 Patient Queue Management Module

The following test case verifies whether the queue that will be displayed on the large screen of the clinic functions as of expected.

Table 5.5: Test Case 6

VIEW PATIENTS IN THE QUEUE			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify the number of patients currently in the queue, their details and currently serving patient detail	Click on 'View Queue' menu tab.	'View Queue Page' should be opened	Pass
	Verify the first number in the queue is displayed as the now serving number	System displays a running number as now serving with top most queue number	Pass
	Verify a new queue record is added to the queue when a patient is added to the queue	New record shown at end of the table	Pass
	Verify current queue record is deleted from queue after finishing being served.	Top most record should be removed from the queue automatically	Pass

Table 5.6: Test Case 7

The test case checks the functionality of adding a patient to the queue during a clinic session.

ADD PATIENT TO THE QUEUE			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify Patient is added to the current queue of the clinic session successfully	Click on 'Generate queue number'menu tab.	'Add patient to queue Page' should be opened	Pass
	Click on 'Verify' or 'Add person to clinic queue' button without entering clinic registration number	Popup should be displayed as 'Please fill out this field'	Pass
	Click on 'Verify' button after entering clinic registration number	Popup should be displayed with patient details	Pass
	Click on 'Add person to clinic queue' button after verifying the clinic registration number	Patient record should be added to queue. New page should open up with the queue number.	Pass

Table 5.7: Test Case 8

The test case verifies that all the data in the queue can be deleted as an when required.

CLEAN THE QUEUE			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify the session queue can be cleaned at any time.	Click on ' Clean Queue 'menu tab.	Popup should be displayed as 'QUEUE OF CURRENT SESSION DELETED!'	Pass

5.3.4 User Management Module

Table 5.8: Test Case 9

ADD NEW USER TO THE SYSTEM			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify a new user with the relevant access level given can be entered into the system	Click on ' Add User 'menu tab.	'User Management Page' should be opened	Pass
	Click on 'Create/Update' user without entering any field	Popup should be displayed as 'Please fill out this field'	Pass
	Click on 'Create/Update' user without entering any field	Popup should be displayed as a new user is added successfully.	Pass

This test case checks on whether a new user can be added into the system with the appropriate access levels defined.

Table 5.9: Test Case 10

SEARCH/UPDATE USER IN SYSTEM			
Test Case Description	**Steps**	**Expected Result**	**Status**
Verify an existing user can be searched and updated in the system.	Click on ' Search/Update User 'menu tab.	'User Details Page' should be opened	Pass
	Click on 'Search User' without entering the username field	Popup should be displayed as 'Please fill out this field'	Pass
	Click on 'Search User' after entering the username field	Popup should be displayed with user details. After clicking on username field new page should be opened with details of user populated in it.	Pass
	Change details of user and click on Update	Details of the existing user should be updated in the system. A confirmation popup should appear.	Pass

5.4 User Evaluation of System

The main aim of the user evaluation step was to identify the feedback of the users on the system being developed. Their ideas on the system was collected and critically evaluated to come up with an overall picture as to whether the developed system met their expectations of a system. A sample of users was selected and a carefully designed questionnaire was distributed among them to collect their feedback on the system. In addition some face to face discussions took place with a selected number of professionals engaged in hospital clinic duty such as a few doctors and senior nursing staff.

5.4.1 Determining the sampling size

The sample size was determined by taking into consideration the response rate and a certain amount of margin of error. A high response rate would aid in getting an accurate overall idea of the system from the different user perspectives. Over sampling method or a large sample size was taken into account in order to compensate for the non-responses an margin of error. The following questionnaire was distributed to 15 doctors arriving at the surgical clinic on different days and 18 nursing staff handling the operations of the clinic during a specific roster of the surgical clinic. Therefore the total sample size of the analysis summed up to a total of 33 participants.

5.4.2 Analysis of the Feedback

Feedback collected through the questionnaire (appendix 1) was put together and processed into a summarized format in order to gain a clear idea on the responses of the system. The data was represented pictorially by the use of a percentage pie chart.

Figure 5.0: Question 1 / Overall Feeling of System
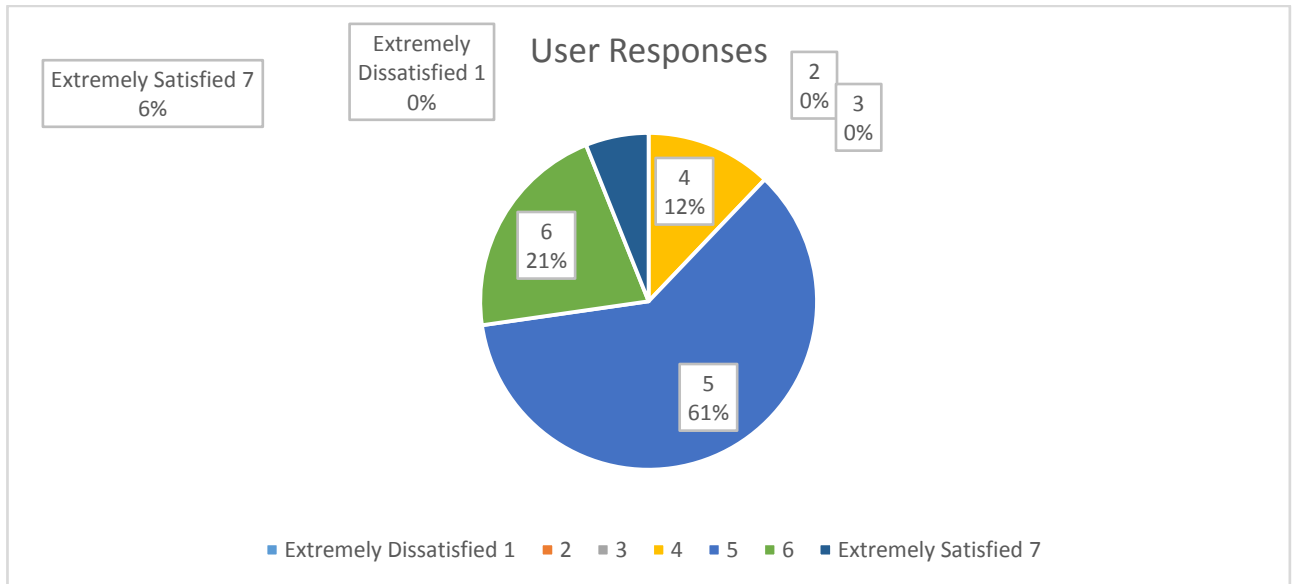
61% of the total respondents show a high overall satisfaction of the system being developed. They highlighted that this was due to the fact that the system covered up the most critical requirements needed in a simple manner without much complexity in operation.

Figure 5.1: Question 2 / Easiness of system navigation and menu locations
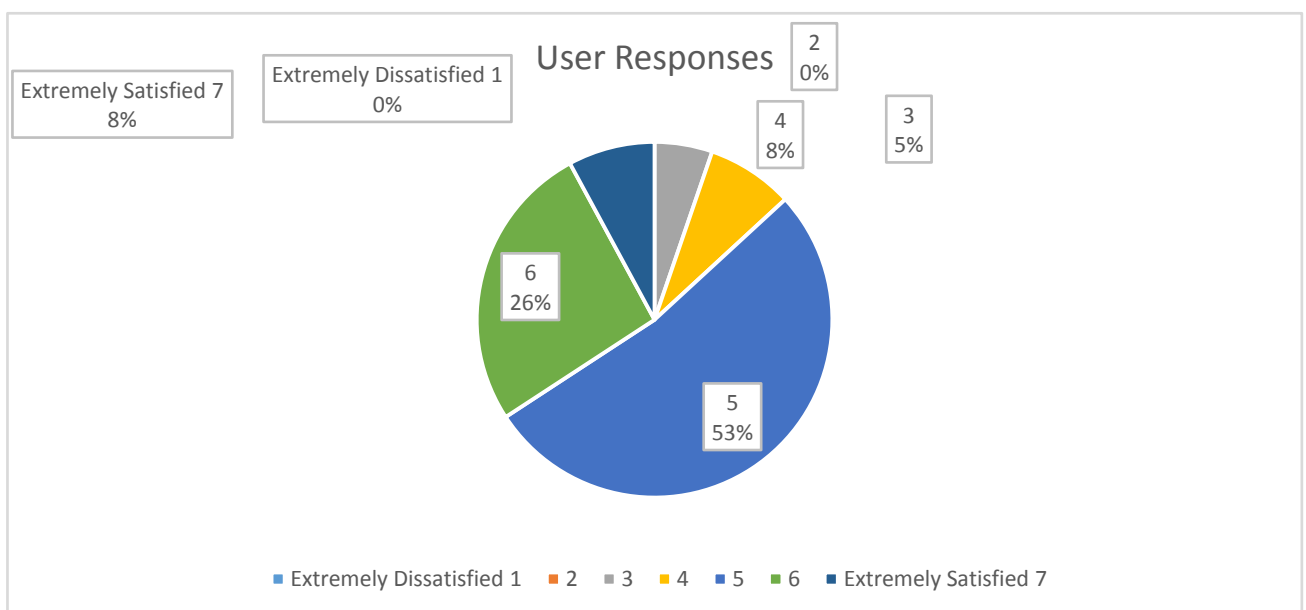
53% of the respondents were satisfied with the systems navigation structure and easiness to operate whereas 26% of the respondents were extremely satisfied on the navigations and easiness of the handling of the system. This can be the reason for the use of a very simple and easy to use menu based navigation structure along with the use of the already familiar web browser navigations

Figure 5.2: Question 3 / System performance and facilitation of day to day operations currently handled manually.
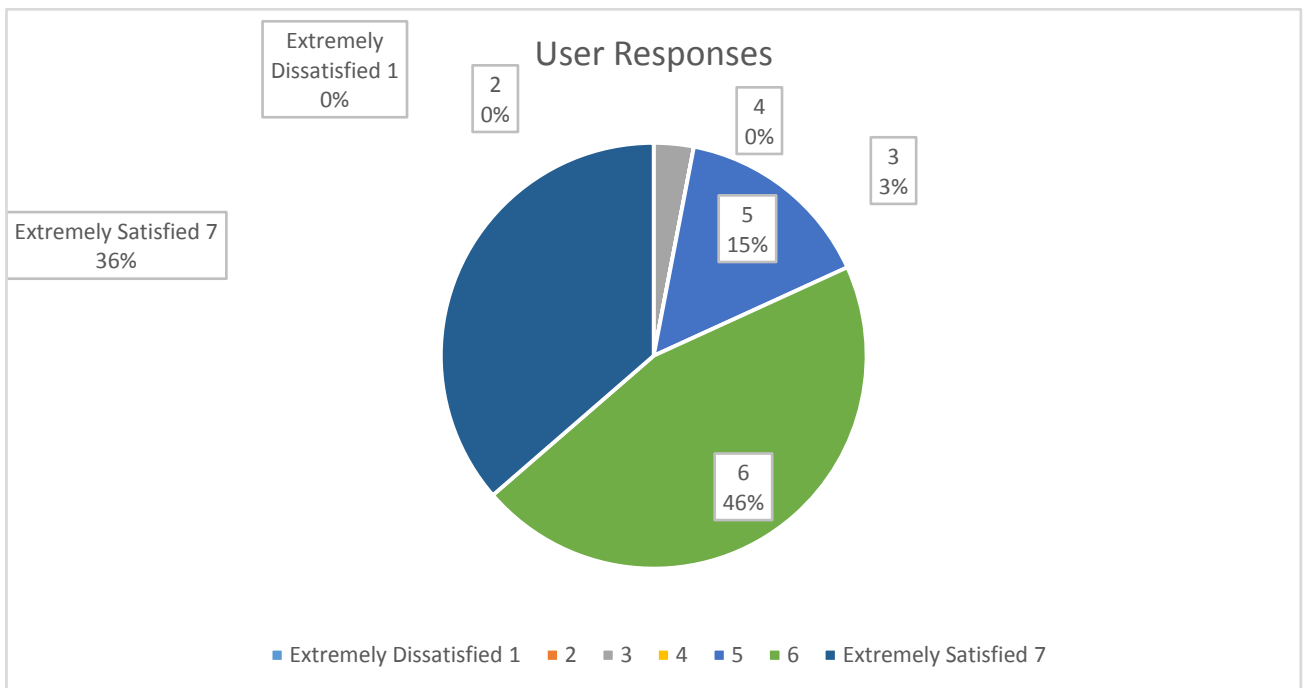
An overall of 82% have responded that the system performed well during the initial pre-live sessions to handle the operations through it. The intended functionality to cater the initially identified requirements worked well without any hassle.

Figure 5.3: Question 4 / Overall look and feel of system
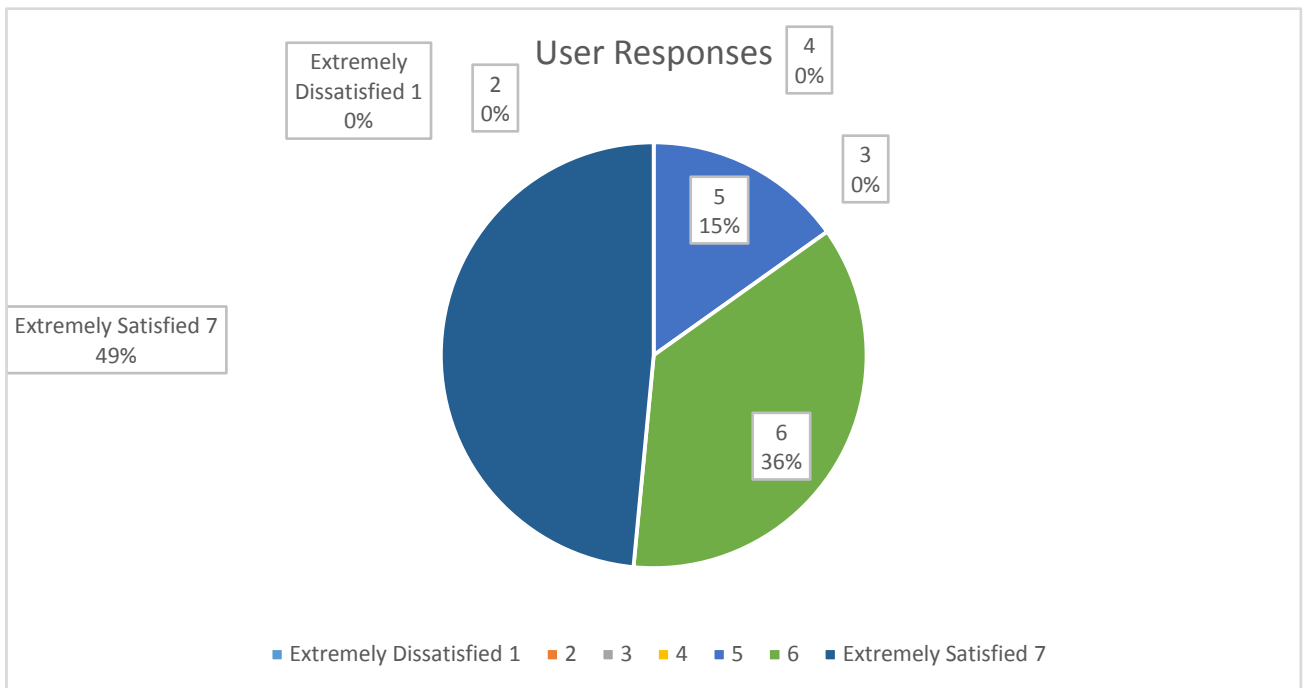
Almost all respondents liked the use of colors of the system which was not over contrasting. The colors used were kept to the simplest level as possible.

Figure 5.4: Question 5 / Difficulty in learning new system
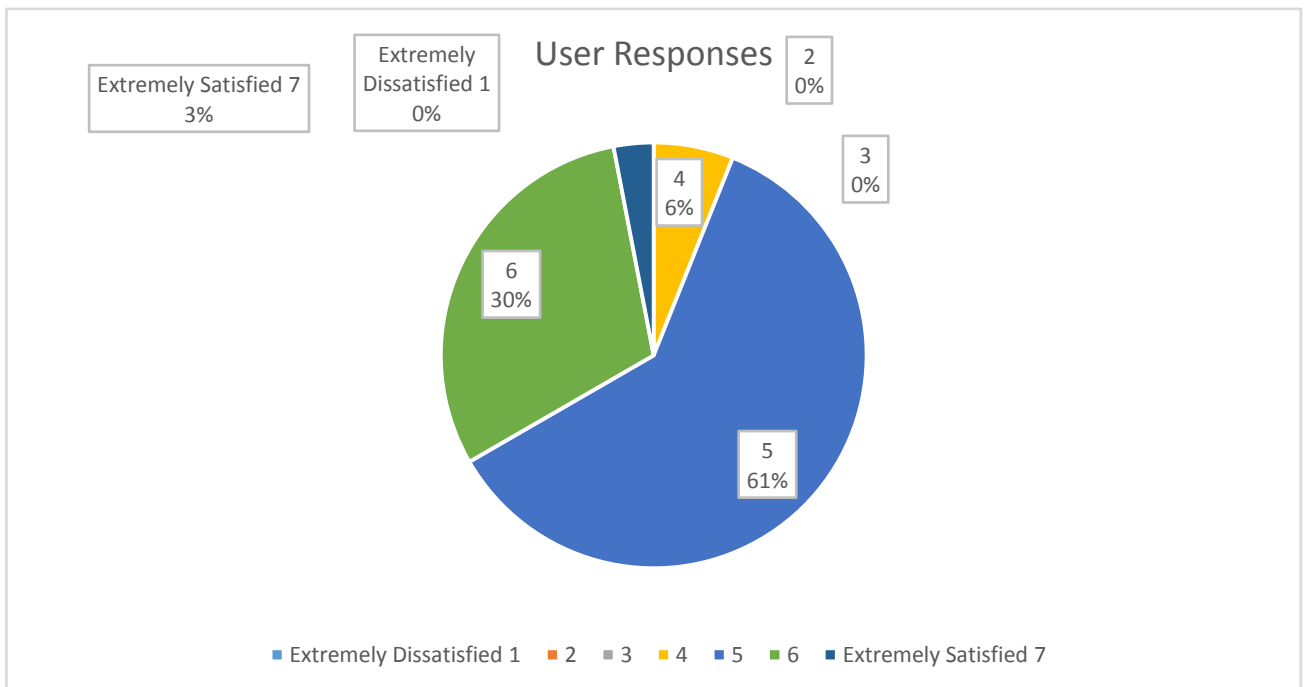
Most of the users learnt the ay of functioning the new system whereas a few had the idea that they would require some more training on the usage of the new system that as developed and planned to be in place for the operations to be automated.

Figure 5.5: Question 6 / Ease of error correction
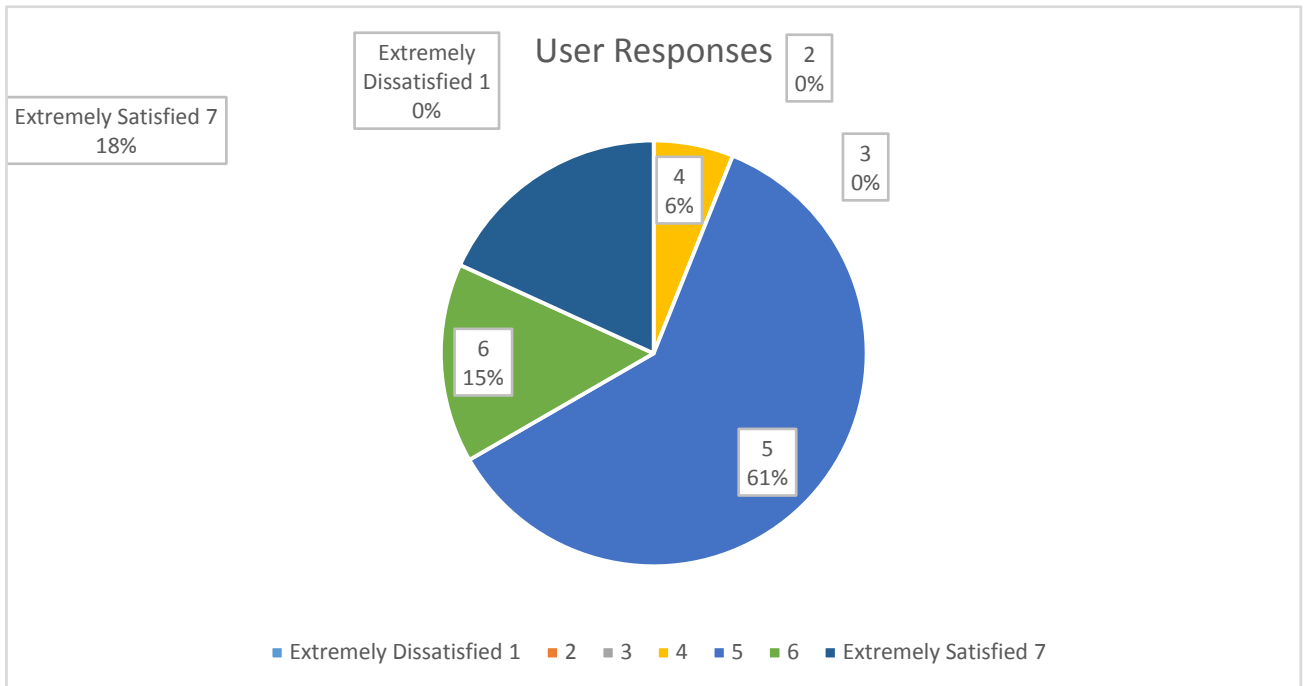
76% of the users found it easy to correct any errors that happened during operations such as data entry/wrong navigations etc... by themselves. 6% of the users had a bit of a second thought on the corrections to be made and the required actions to be taken through the system when they encounter such errors made by them.

CHAPTER 6: CONCLUSION

6.1 Introduction

In the conclusion chapter the challenges faced during the development phase, implementation phase, achievement of client objectives and future enhancements to the system is discussed.

6.2 Challenges Faced

Understanding the initial user requirement was a very daunting task. Initial requirements of the system provided by the users were vague and lacking in clarity. Although they had the idea on the parts to be improved within operations they found it difficult to relate it to a system perspective in order for it to be automated.

Availability of backup restoration and restoration processes was a non-functional requirement that came up late during the implementation phase of the system which was not prepared for or documented during the analysis or system design phase. Although this feature was requested by the client as a high priority, with the existing deadlines the feature was not able to be integrated into the current system developed.

6.3 Achievement of Client Objectives

The main objectives required by the client during the initial phases of the planning phase included the following key points. The newly developed web based system has been successful in achieving all the mentioned objectives

- Patient Registration for Surgical Clinic at NHSL
- Medical history logging for individual patient.
- Storage of medical records against a patient registration number.
- Mark attendance of patient to prescribed clinic sessions.
- Generate medical history log of a patient as at a particular time.
- Online queuing of patients for the surgical clinic to receive medication as they arrive.
- View number of patients remaining to be served in a particular clinic session.
- Authorization, visibility and editing of patient medical history information and other sensitive medical records available only for a doctors login account.

6.4 Critical Assessment of the System.

When comparing and contrasting the already developed similar systems discussed in chapter 2 the newly developed system for NHSL have some additional strengths in certain areas of health related management. Major features enhanced in the system include:

- Strong queue management actions performed through the system for smoothening the flow of patients visiting the surgical clinic of the OPD.
- Easy to use system navigations and controls making it simple for novice users.
- Break down of complex processes to simple ones, which can be handled automatically through a system.
- Integration capable design structure to enable and ease the integrations with third party health software operated within the hospital.
- Highly scalable; enabling expansion to other clinics within the OPD in the future if required.
- High availability since it is a web based system and therefore can be accessed from almost anywhere, enabling a system privileged user to access the system irrespective of location if required.

6.5 Future Enhancements

In the future, NHSL has decided to integrate the other systems within the hospital that are already functioning to ease the operations with the web based patient management system that is developed. To do so the development is done in such a way to enable easy integration with third party systems.

Currently the patient information is saved in the database. In future a development can be planned in order to save the information in a NFC enabled card. The NFC cards can be given to the patients for patient management processes.

REFERENCES

[1] Anderson, 1993:"Survey of 2752 European hospital managers". College of Medicine, University of Illinois, United States

[2] Ariyaratne , 2010: "A private hospital management system". Postgraduate Institute of Medicine, University of Colombo, Sri Lanka

[3] Smith M. and Gert van der Pijl, 1999: "Developments in Hospital Management and Information Systems". Tilburg University School of Economics, Netherlands.

[4] Rannan-Eliya RP, De Alwis S, Amarasinghe S, Fernando T, Balasundaram A (2012). Private hospitals and nursing homes survey (draft report) Colombo: Institute for Health Policy.

[5] IOSR Journal of Mobile Computing & Application (IOSR-JMCA) e-ISSN: 2394-0050, P-ISSN: 2394-0042.Volume 2, Issue 1. (Mar. - Apr. 2015), PP 32-36. http://www.iosrjournals.org/iosr-jmca/papers/Vol2-issue1/F0213236.pdf

[6] Mensah, J., Asamoah, D. &Tawiah, A.A. 2014: "Optimizing Patient Flow and Resource Utilization in Out Patient Clinic: A Comparative Study of Nkawie Government Hospital and Aniwaa Health Center", The Journal of Applied Business and Economics, vol. 16, no. 3, pp. 181.

[7] Praveen K.A and Gomes L.A, 2006: "A Study of the Hospital Information System (HIS) In the Medical Records Department of A Tertiary Teaching Hospital" Journal of the Academy of Hospital Administration, Vol. 18, No. 1 (2006-01 - 2006-12).

[8] MySQL Community, http://www.mysql.org, Accessed 23 February 2015

[9] PhpMyAdmin, http://www.phpmyadmin.net, Accessed 23 February 2015

[10] Cooper, R.B.: Introduction to Queuing Theory, 2nd,Ed., pp.178-185, Elsevier North Holland, Inc. New York (1981)

[11] E-Dompe System, State-ofArt HMS system in Srilanka, http://www.dailytimes.com, Accessed 23 December 2017

APPENDICES

Appendix A -User Evaluation Questionnaire

For the following questions, please circle the number which best represents your experience with the web based patient management system.

1. Please rate your overall feeling of the system from 1 to 7, where 7 represents extreme satisfaction and 1 represents total dissatisfaction

Considering the system as a whole, I am

1	2	3	4	5	6	7
Dissatisfied						Very Satisfied

2. Please Indicate ease of system navigation, are the items of the menu ease to use and placed in expected place of the screen.

I found the system

1	2	3	4	5	6	7
Very Difficult to navigate						Very Easy to navigate

3. Please indicate whether the system performs as of expected and you think it would ease the day to day operations which are currently handled manually.

1	2	3	4	5	6	7
Does not perform well and not as expected						Performs extremely well and beyond expectations

4. Please rate the overall look and feel of the system (whether the colors used are pleasant and background is appropriate)

I found the look of the system

1	2	3	4	5	6	7
Unprofessional and boring						Very visually appealing

5. Please rate the difficulty of learning to use the new system.

In order to use the system effectively I would need

1	2	3	4	5	6	7
Intensive training						Hardly any training

6. Please comment on the ease of correcting yourself if an error was made.

I found it

1	2	3	4	5	6	7
Extremely hard						Extremely easy

7. Please comment on any other enhancements that can be made to the system.

_____
_____
_____
_____
_____

Appendix B –Patient Listing Report

The National Hospital of Sri Lanka

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இலங்கை தேசிய வைத்தியசாலை

OPD Surgical Clinic

Patient Listing Report

As At 2018-08-05 01:49:06pm

Patient Name	Age	Gender	Registered Date
Sanjeewa Thanthrige	25	MALE	2018-10-08 22:37:17
K.A.D.S Perera	43	FEMALE	2018-10-08 22:39:06
D.A.R Wimalarathna	38	MALE	2018-10-08 22:41:32
E.D.S Senanayake	32	FEMALE	2018-10-08 22:43:02
D.S.L Thanthrige	39	FEMALE	2018-10-08 22:44:30
D.S.L Perera	43	MALE	2018-11-08 23:33:35
D.L.A Siribaddana	68	MALE	2018-08-09 08:51:30
sarath	12	MALE	2018-02-09 14:23:08
sumanadasa	0	MALE	2018-07-03 19:14:46
sumanadasa	0	MALE	2018-09-15 09:40:07
a.d.s Perera	0	MALE	2018-12-15 12:27:35
dus	0	MALE	2018-09-21 09:45:21
a.d.s.perera	0	MALE	2018-07-24 07:29:48
a.s.a.karunarathna	0	MALE	2018-10-24 10:59:29
test34	0	MALE	2018-11-24 11:19:21

Appendix C –Clinic Queue Report

The National Hospital of Sri Lanka

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இலங்கை தேசிய வைத்தியசாலை

OPD Surgical Clinic

Clinic Queue Report

Generated Date : 2018-08-05 01:50:27pm

Queue Date 2018-04-09

Patient Name	Age	Gender	Total Time In Queue
Sanjeewa Thanthrige	25	MALE	15.7500
E.D.S Senanayake	32	FEMALE	16.9833
Sanjeewa Thanthrige	25	MALE	16.9500
Sanjeewa Thanthrige	25	MALE	1.8167
Sanjeewa Thanthrige	25	MALE	4.0500
K.A.D.S Perera	43	FEMALE	8.7833
Sanjeewa Thanthrige	25	MALE	26.9000
Sanjeewa Thanthrige	25	MALE	1.4167
K.A.D.S Perera	43	FEMALE	4.3500
D.A.R Wimalarathna	38	MALE	-259.7500
Sanjeewa Thanthrige	25	MALE	-259.8167

Appendix D –Medicine Prescription

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இலங்கை தேசிய வைத்தியசாலை
The National Hospital of Sri Lanka

Medical Prescription

Patient Name : Sanjeewa Thanthrige

Patient Age : 25 years

Medicine:

Drug Name	Dosage (mg)	Frequency (per day)
panadol	50mg	2

Medical Tests:

Test Name	Comments by doctor
blood test	fasting blood sugar test

Date : 2018-08-05

Signature
Reffered Doctor : Admin

Navigate back to home? Home

Appendix E –Patient Medical History Report

ශ්‍රී ලංකා ජාතික රෝහල
இலங்கை தேசிய வைத்தியசாலை
The National Hospital of Sri Lanka

Patient Medical History Record

PREVIOUS DOCTORS REFERRED

Doctor Name	Specialization
Sarath De Silva	Cardiology Consultant
K.H.A Jayasinghe	General Physician

SURGERY DETAILS

Surgery Status	Surgery Date	Comments by Doctor	Allergies
Done	2000-01-01	Patient examined.Approved to carry out bypass	test2

MEDICINE PRESCRIBED

Drug Name	Dosage	Frequency	Prescribed_Date
arythromycine	mg	2	2018-07-14
calpol	mg	2	2018-07-14
20	20mg	3	2018-04-09
Ciprol	40	2	2018-04-08
Menthrol	50	2	2018-04-08