Development Of A Hospital Management Software For A Primary Healthcare Centre

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Abstract— In this paper, the development of hospital management system is presented. The focus is to develop an automated system for managing the flow of patient's data in a primary healthcare centre. An iterative-incremental software development model was used in the design and implementation of the software. The developed software has five modules which include, administration module, staff module, doctor module, pharmacy module and laboratory module. During each iteration in the development process, the current module being developed goes through the planning, requirement, design, implementation, verification and evaluation phases.

The administration module enables the system administrator to register new employees of the hospital and grant them access to the system. The staff, through the module can enrol patient to the system and manage admission and discharge details of patients. The doctor, through the doctor's module can check patients' enrolled into the hospital and prescribe required medicine or tests for the patients. The pharmacy module enables the pharmacist administer drugs to patients based on the required medication prescribed by the doctor. Then, the laboratory module enables the laboratory technologists to carry out required tests on patients based on the prescription admonished by the doctor. The details of the design for each of the module are presented. The system was developed (coded) in Microsoft Visual Studio 2015, using the C# language and the XAML (Extensible Application Markup Language).The database used was implemented using MYSQL database. The completed software was hosted in a local server and tested with some users drawn from the different user categories identified in the system design.
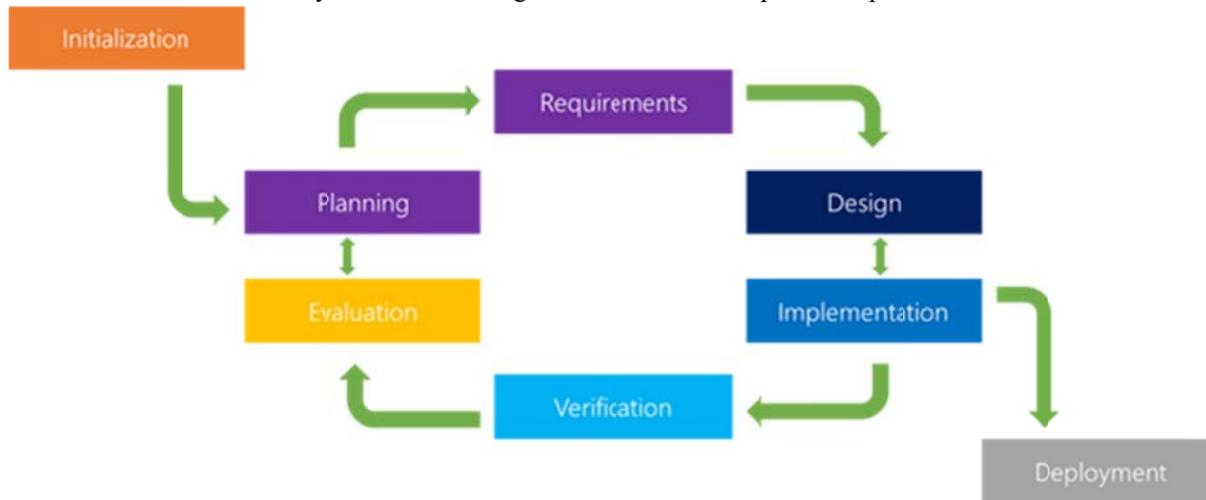
1. Introduction

Health care, globally, is among the most essential needs of mankind [1,2,3,4,5,6]. In the civilized societies, health care are provided through different categories of hospitals which provide patient the needed treatment by specialized staff, in in some cases, the treatment is provided with the help of some specialized equipment [7,8,9,10,11,12,13].

Among the various health care institutions, the primary health care providers usually are distinguished from their secondary and tertiary counterparts by their ability to administer immediate care and treatment for inpatient enrollees whilst the others often are meant for specialized purposes [14,15,16,17,18]. With the aid of primary healthcare providers', the National Health Insurance Scheme (NHIS) enrollees can access nearby entry point for easy and affordable healthcare [19,20,21,22,23,24,25]. Some patients go to a provider just for diagnosis, treatment, or therapy and then leave as outpatients without staying overnight; while others are admitted and stay overnight or for several days or weeks or months as inpatients.

When an enrollee of the National Health Insurance Scheme (NHIS) visits a primary healthcare provider, the following sequence of operation is carried out. First, the enrollee is verified at the registration room, and then the patient goes to the nurses' workbench for basic medical data assessment and intake such as height, weight, blood pressure, temperature. The nurses then carry the patient folder to the doctors' workbench for diagnosis. After the diagnosis, the patient is then sent to the laboratory for test if necessary or the patient is sent to the pharmacy for collection of drugs;

the pharmacy section checks the patients prescribed drugs. Billing is based on terms and condition of the National Health Insurance Scheme (NHIS) payment. After diagnosis the patient can also be referred to a secondary or tertiary provider for extra assessment or treatment.

The focus in this paper is the development of a software that can be used to automate the processes used in managing the work flow, information and administrative tasks in a primary healthcare centre [26,27,28]. The software can be hosted on a web server of on the server of the health centre's local area network. The purpose of the hospital management system is also to automate the system for storage and easy retrieval of data, tracking and management of flow of information and management of the services that are rendered by the various categories of the healthcare provider in the primary healthcare centre. The details of the design and implementation of software system are presented.

2. Methodology

2.1 Description of the software development model

An iterative-incremental software development model (Figure 1) was used in the design and implementation of the software. In each of the iteration, the current module being developed goes through the planning, requirement, design, implementation, verification and evaluation phases. The software development with the core function and then in each subsequent release of the software version additional function is added to the previous software release. The process is repeated until the whole software system is ready as per the requirement.

Figure 1: The flow diagram for the iterative software development model

Each phase of the project has sub phases which produce expected output results. Requirements are fixed after initial and planning stages before proceeding with development plans. In Figure 1, the first phase of the software development after initialization is the planning phase during which the software solution is analysed to see if it was feasible. After the planning phase is the requirement phase where the requisite information about the present operations of the health centre is obtained in order to determine the exact needs requirement specifications for the software solution to be implementation. Particularly, interviews along with study of the existing system and examination of available documents were conducted with help of some of the hospital personnel to gather the requisite data and requirements for the software development.

The second stage is the design phase which came after conducting the necessary requirement elicitation processes. The design of the software was planned based on the gathered requirements. Various software design diagrams and flowcharts for the system modules were also created. The administrator, staff and doctor modules were designed and the workflows were visualized through flow charts.

The third phase in the software development model (Figure 1) is the implementation phase which includes coding, unit testing, integration and integration testing of the software system. After the completion of system codes, deployment of the entire software was done. After implementing the system, each module was further tested in the fourth phase, called the verification process.

In the verification phase, each module was tested and problems encountered were noted and corrected. Specifically, system was allowed to be used in order to determine if all the functions were running, and that the objectives of the software system were met. In view of this, a test plan was conducted which allowed the users to test each of the software modules if it is working or not. Any observed error at this stage is corrected by the software developer.

The final phase, which is the evaluation phase is conducted. Notably, any errors and bugs encountered in the verification phase were fixed at this phase.

2.2 The flow diagram design for the system and its modules

The flow diagram of Figure 2 shows how the hospital management system works. In the system, there are five main users of the system: the administrator, staff, pharmacist, laboratory technologist and doctor. Each of the system users could input their details in the system and the

system would verify if the user exists or not. Once the user is verified, they will be directed to the main window displaying their specific functions based on their job roles in the hospital (or health centre). In general, the user could manage their own page, update information, and check history or hospital records, and print necessary records.

The flow diagram of the software administrator module is shown in Figure 3.The administrator of the software system could register the users and manage the system settings and maintenance, as shown in Figure 3. The administrator could also view necessary reports generated from the gathered information. The flow chart the staff module is shown in Figure 4. A staff can be the nurse or any regular employee in the hospital. The staff module handles the patient enrolment, admission, and discharge after adhere to

management plans to their respective frames, as shown in Figure 4.

The flow diagram of the doctor's module is shown in Figure 5. The doctor who is basically a general practitioner could manage enrolled patients, discharge them, send their details of prescription , tests or management plans to appropriate departments, and check on enrolled patients by recording tests administered and drugs prescribed and they could also view patient history, as shown in Figure 5.

The flow diagram of the pharmacy module is shown in Figure 6. The pharmacist on duty could dispense National Health Insurance Scheme (NHIS) accredited drugs as prescribed by the doctors and could discharge enrollee after dispensation, as shown in Figure 6. The flow diagram of the **Laboratory** module is shown in Figure 7.
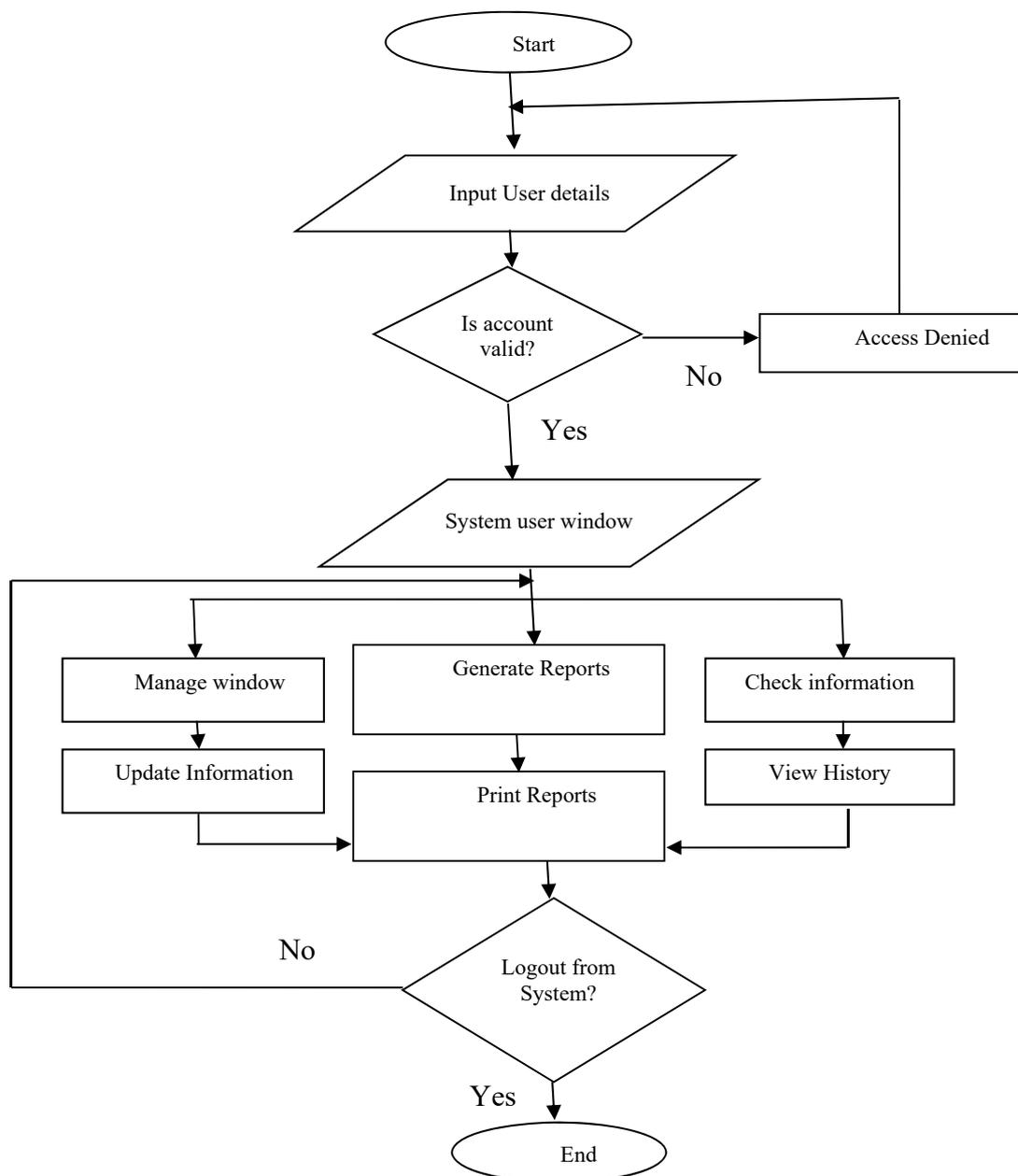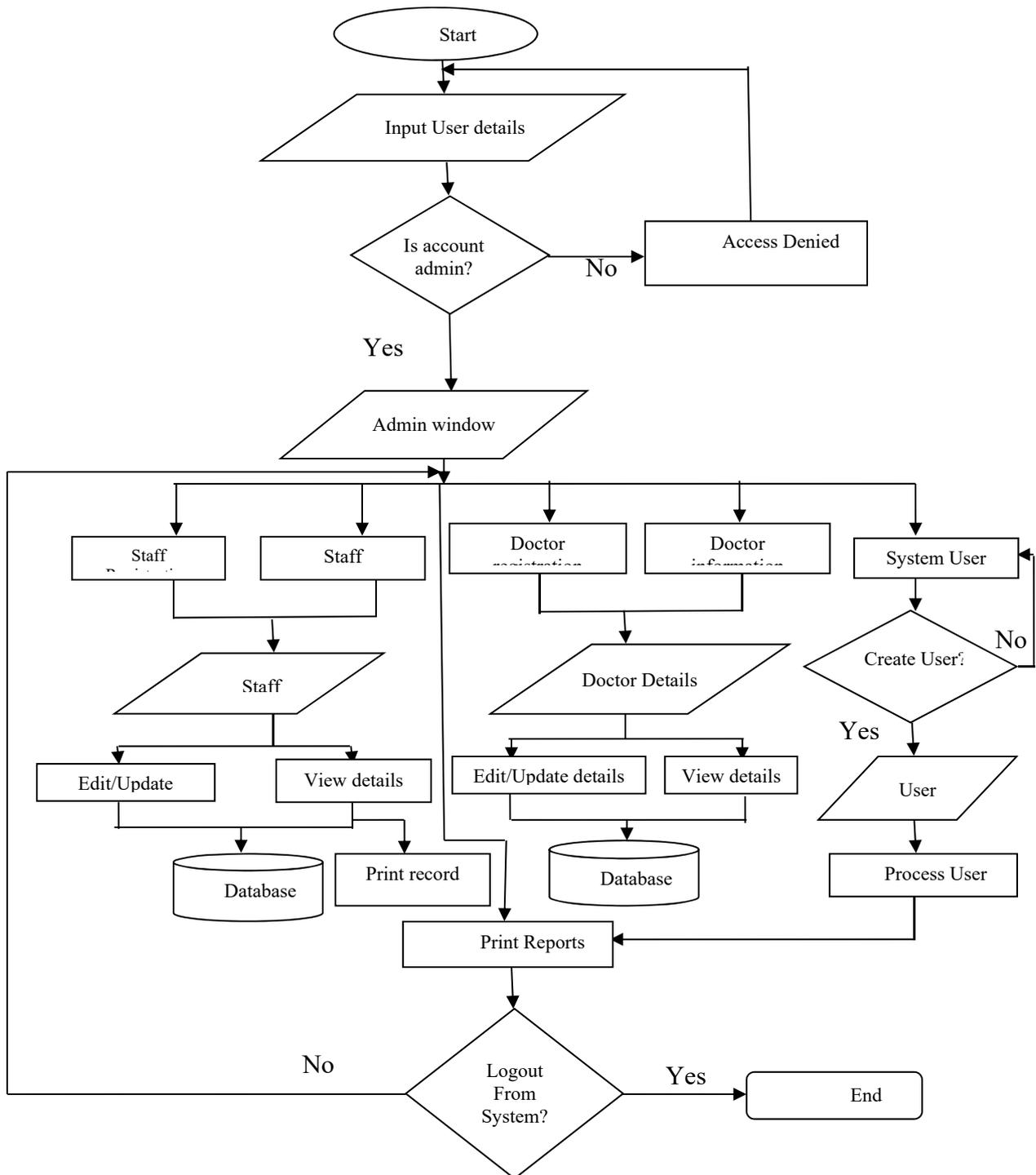

Figure 2 The system flow diagram
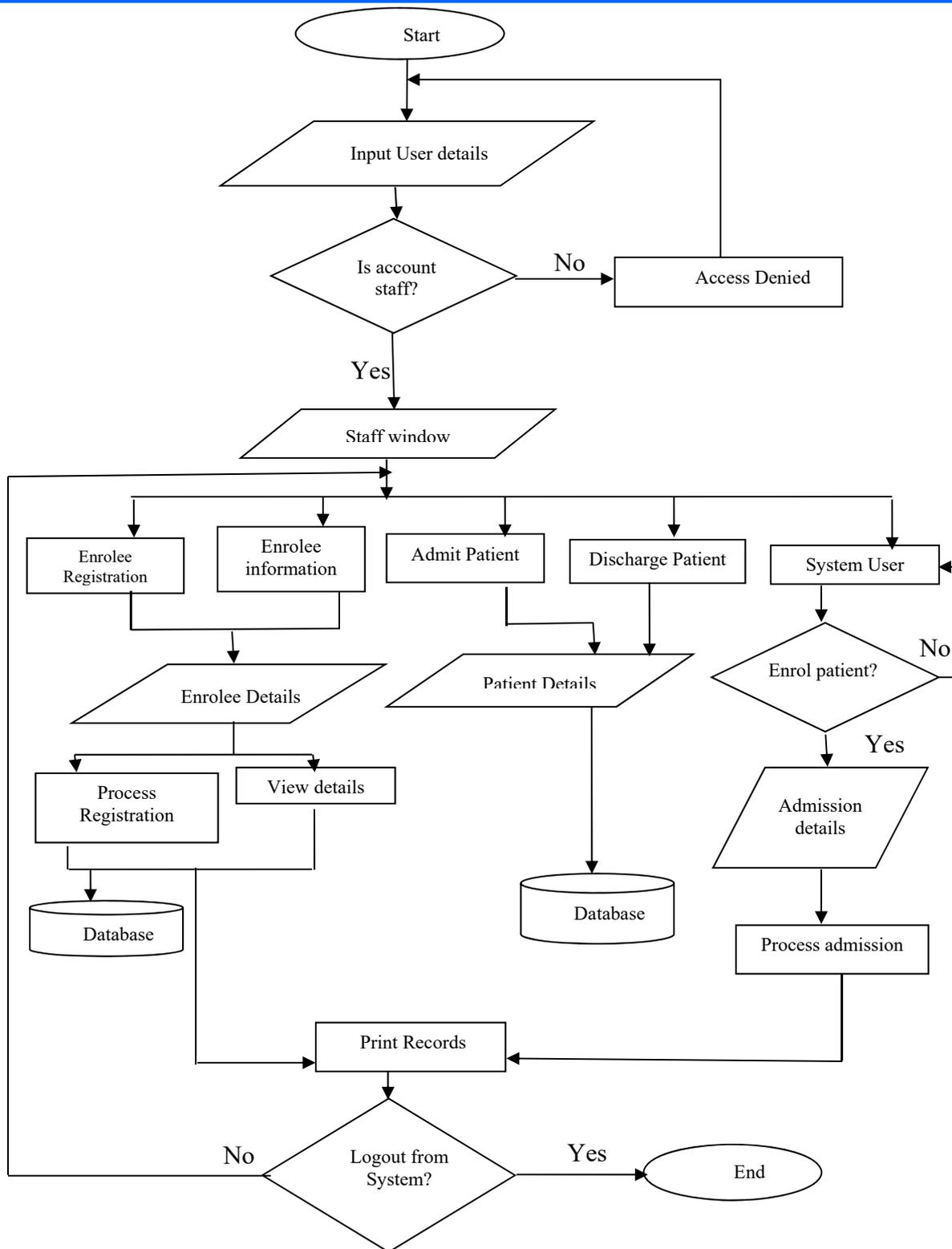
Figure 3 Administrator Module Flow diagram

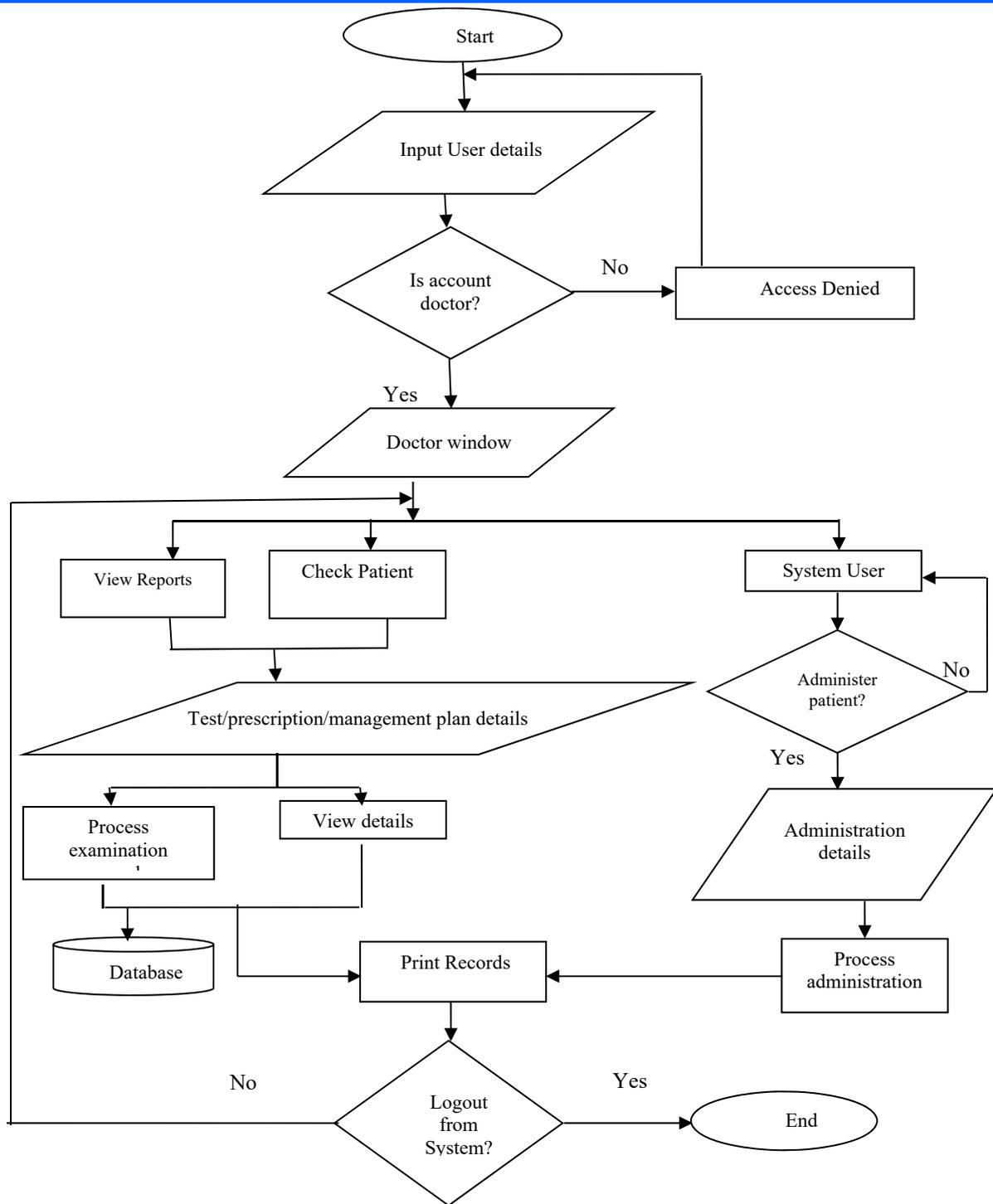**Figure 4 The staff module flow diagram**
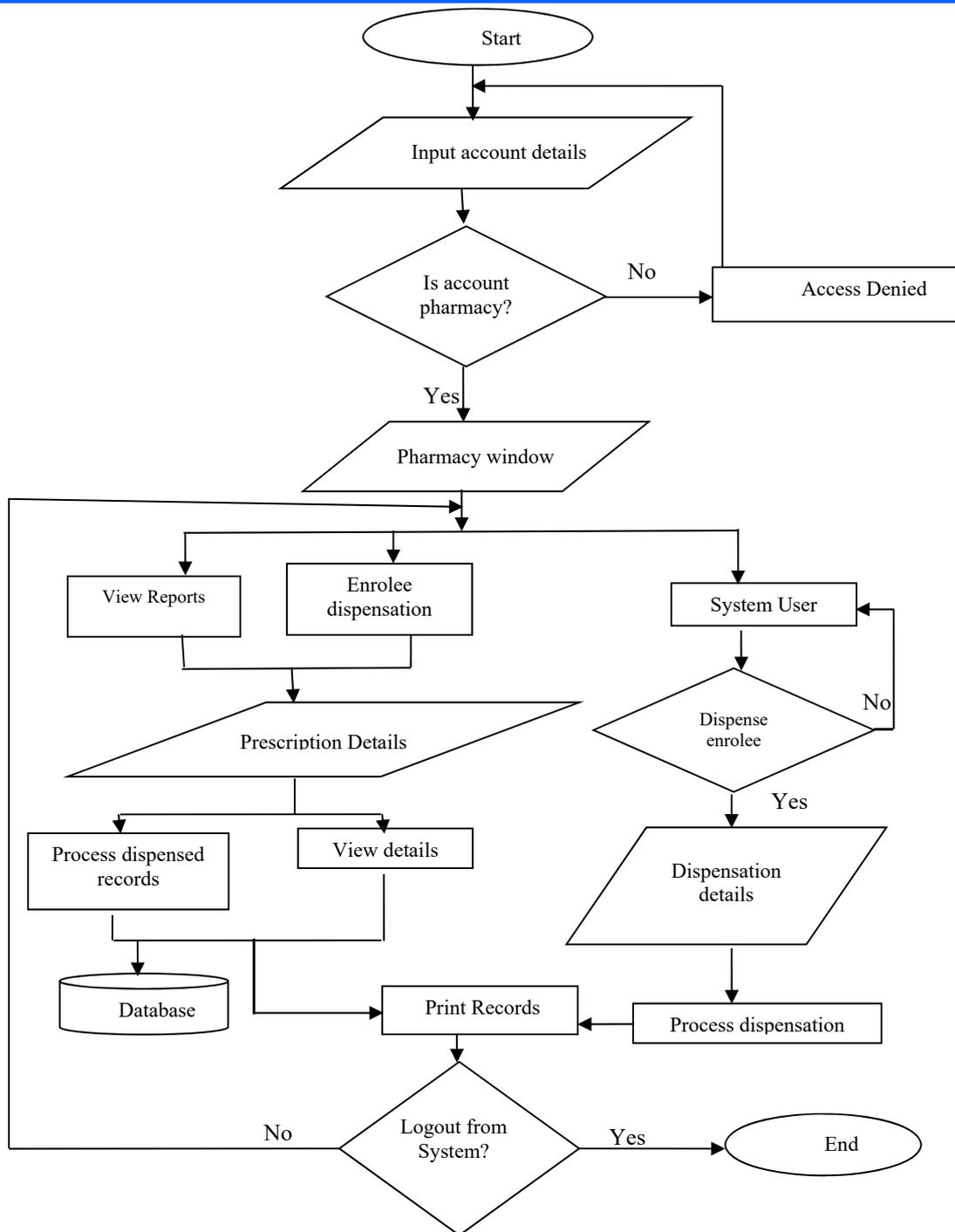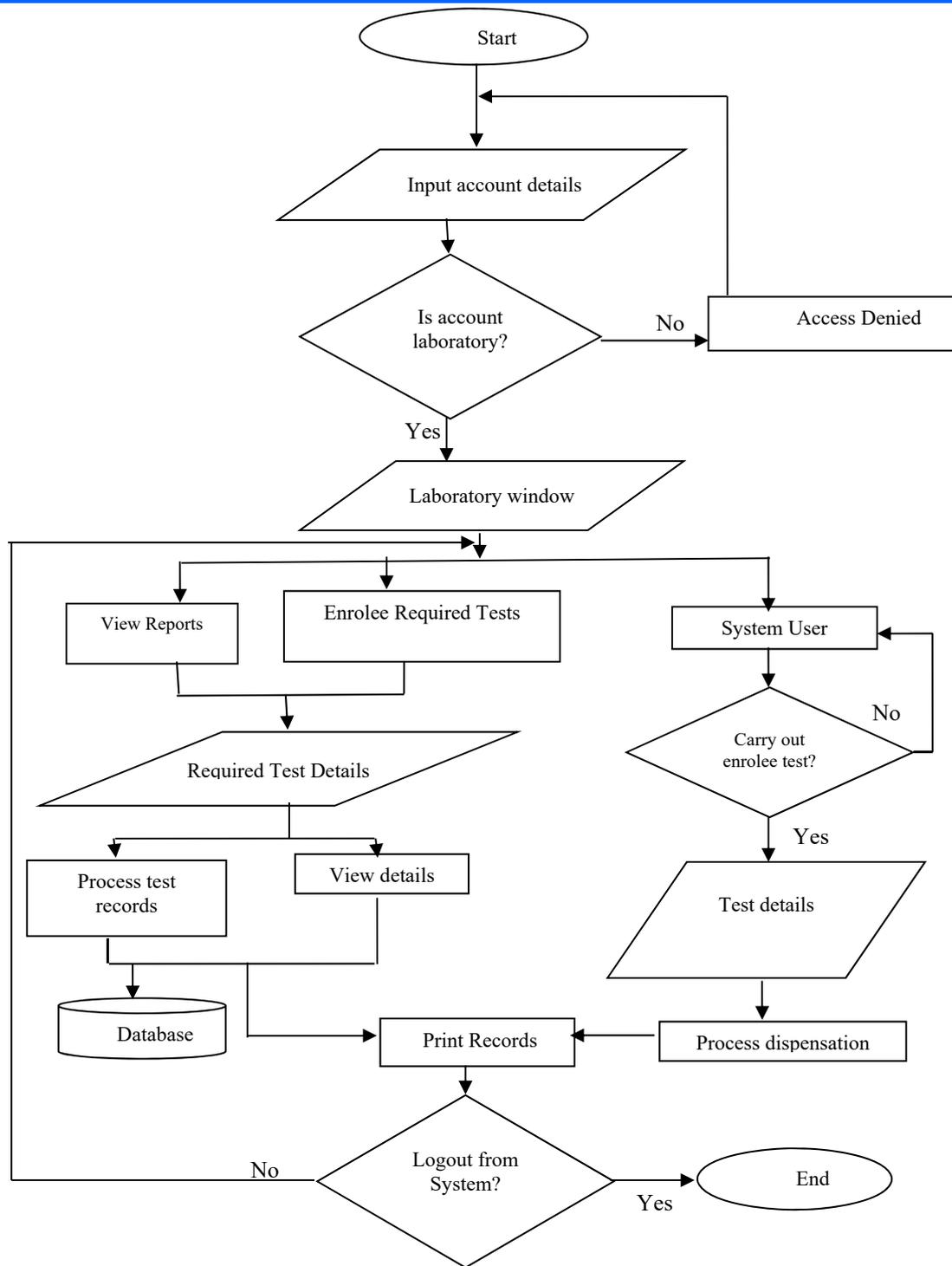
Figure 5 The doctor's module flow diagram

Figure 6 The pharmacy module flow **diagram**

Figure 7 The laboratory module flow diagram

2.3 Object Modelling and database design

The roles of the system stakeholders (or users) and their interactions with the system are shown in use case diagram of Figure 8. There are five types of users that can access the system: the staff, the doctor, the pharmacist, the laboratory technologist and the administrator.

The MySQL entity-relationship model (in Figure 9) provided graphical presentation of the database tables, their columns, and their relationships to each other. The database structure was composed of users, available doctors, bed/ward availability, reports, patients, and other entities which were connected to each other to provide sufficient information for maintaining the system.
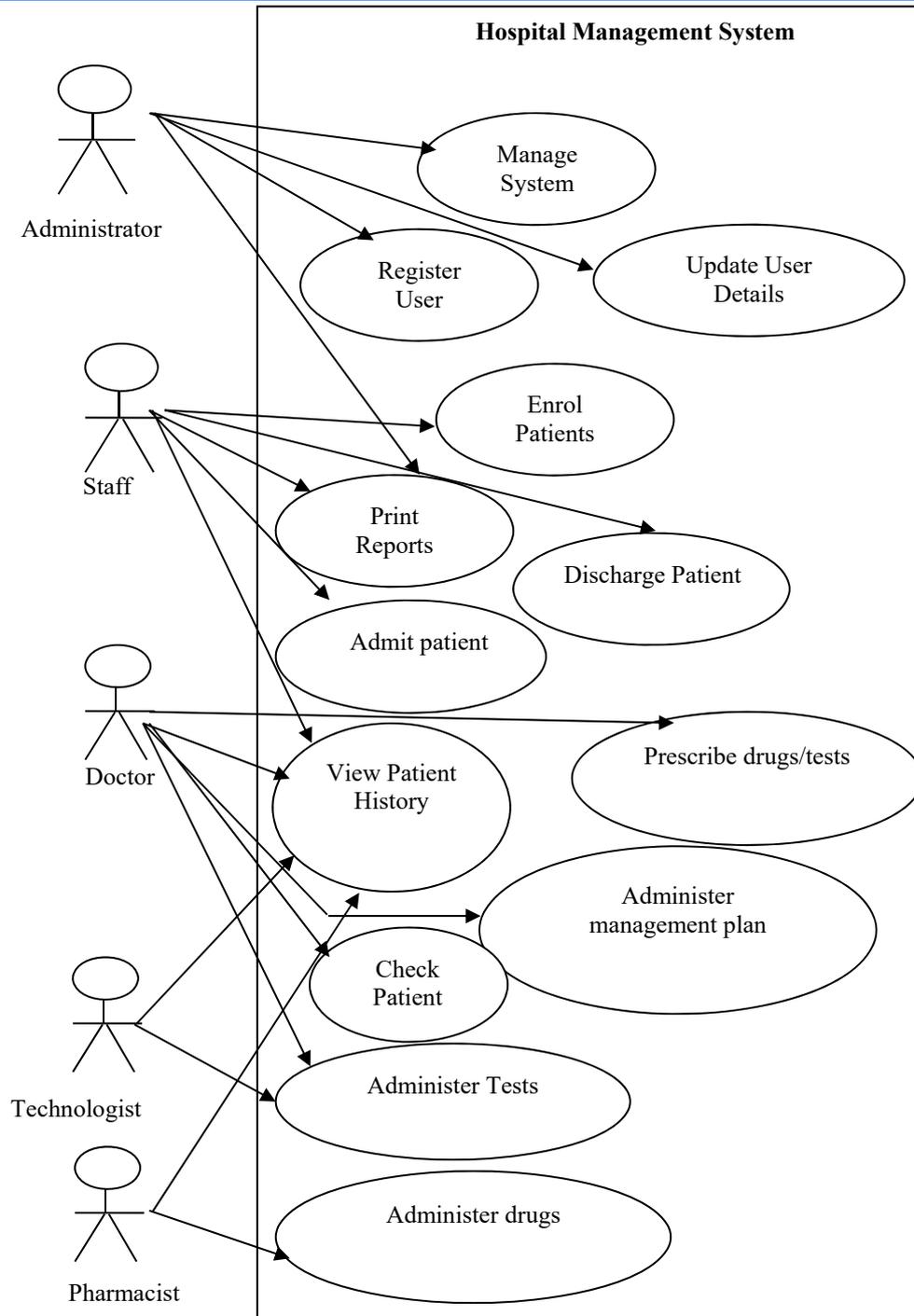
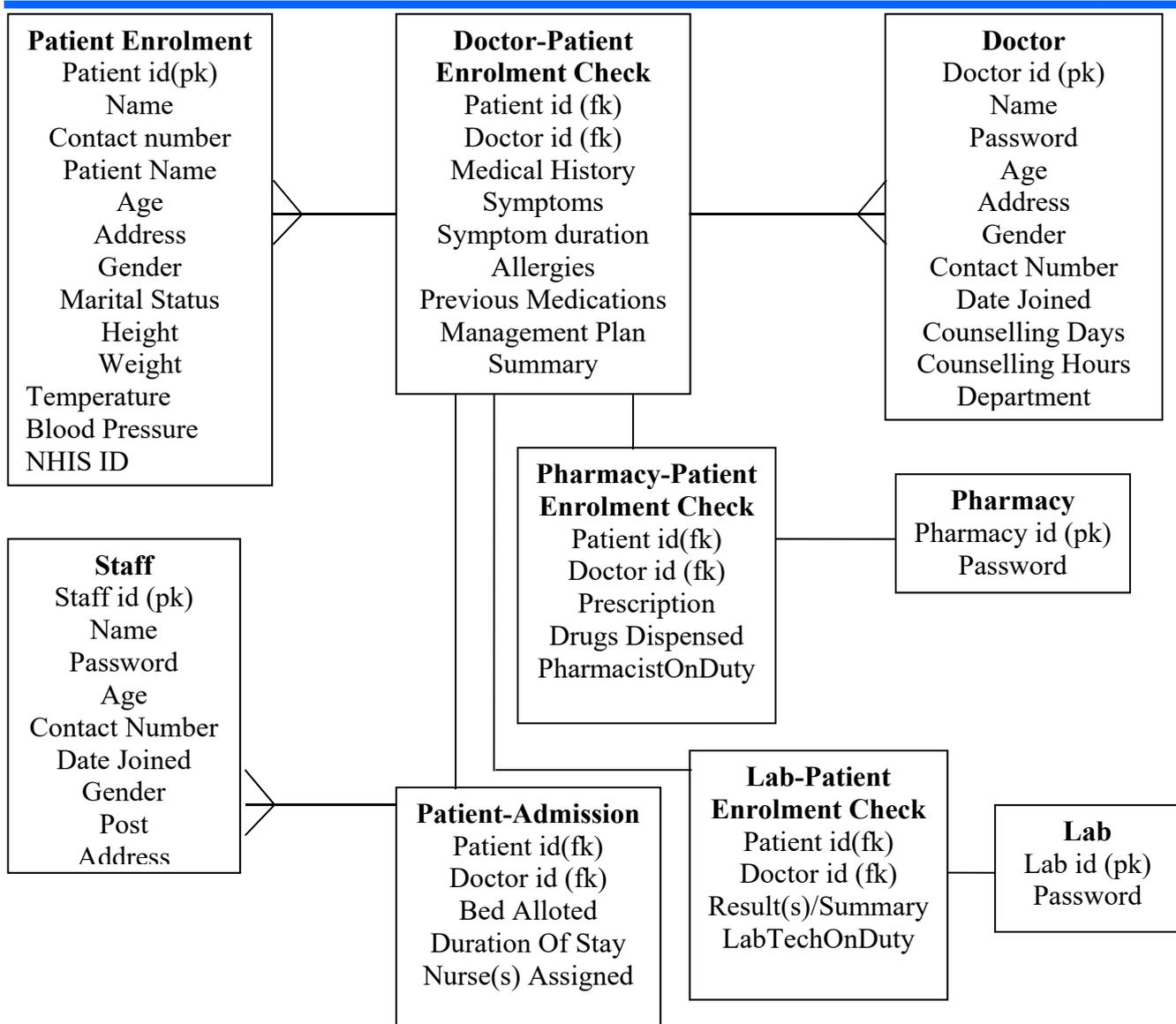Figure 8 The use case diagram for the system users

Patient Enrolment
Patient id(pk)
Name
Contact number
Patient Name
Age
Address
Gender
Marital Status
Height
Weight
Temperature
Blood Pressure
NHIS ID

Doctor-Patient Enrolment Check
Patient id (fk)
Doctor id (fk)
Medical History
Symptoms
Symptom duration
Allergies
Previous Medications
Management Plan
Summary

Doctor
Doctor id (pk)
Name
Password
Age
Address
Gender
Contact Number
Date Joined
Counselling Days
Counselling Hours
Department

Pharmacy-Patient Enrolment Check
Patient id(fk)
Doctor id (fk)
Prescription
Drugs Dispensed
PharmacistOnDuty

Pharmacy
Pharmacy id (pk)
Password

Staff
Staff id (pk)
Name
Password
Age
Contact Number
Date Joined
Gender
Post
Address

Patient-Admission
Patient id(fk)
Doctor id (fk)
Bed Alloted
Duration Of Stay
Nurse(s) Assigned

Lab-Patient Enrolment Check
Patient id(fk)
Doctor id (fk)
Result(s)/Summary
LabTechOnDuty

Lab
Lab id (pk)
Password

Figure 9 The MySQL entity-relationship model

2.4 Implementation of the software

The system was developed (coded) in Microsoft Visual Studio 2015, using the C# language and the XAML (Extensible Application Markup Language).The database used was, MYSQL database which is compatible with Microsoft Visual Studio and any physical computer with an Operating System not below Windows XP.

In order for the system to be protected and secured, it was a requirement to establish the system security. For this reason, only the administrator or authorized personnel could operate the system in full function to prevent data loss and to secure the important data. The Hospital Management System software had an authentication login graphical interface wherein only the administrator and the authorized personnel could access through. Each authorized personnel had his own unique username and password with his own user privileges that the administrator of the system could create.

3. Results and discussion

The administrator's login window is shown in Figure 10. The administrator's main window is shown in Figure 11. In this window, the administrator of the system has the right and privilege to add and/or modify users of the system such as the staff and doctors. The administrator also has the right to view enrolled patient history as well as print them for evaluation by the management. The staff login window is shown in Figure 12. Here, the staff (usually the receptionist who may be a nurse) gains access into the hospital management system.

The staffs' main window is shown in Figure 13. In this window, the staff has the right to enrol patient into the system, admit patient based on doctor's management plan, discharge patient. He also has the right to view enrolled patient history as well as doctor's schedule.

Figure 10 Administrator login window

Figure 11: Administrator main window

Figure 12 Staff login window

Figure 13 Staff main window

The patient's enrolment page is shown in Figure 14. In this page, the staff (including nurses at the desk), examines and records vital information from the patient to be enrolled which includes basic medical data such as weight, height, blood pressure etc. Here, an available doctor is also assigned to the enrolled patient for diagnosis.

The doctor's login window is shown in Figure 15.Here, the doctor who performs the diagnosis gains access into the hospital management system. The doctor's main window is shown in Figure 16. Here, the doctor who performs the diagnosis can check an enrolled patient. The doctor can also view records and results sent in by other hospital departments.
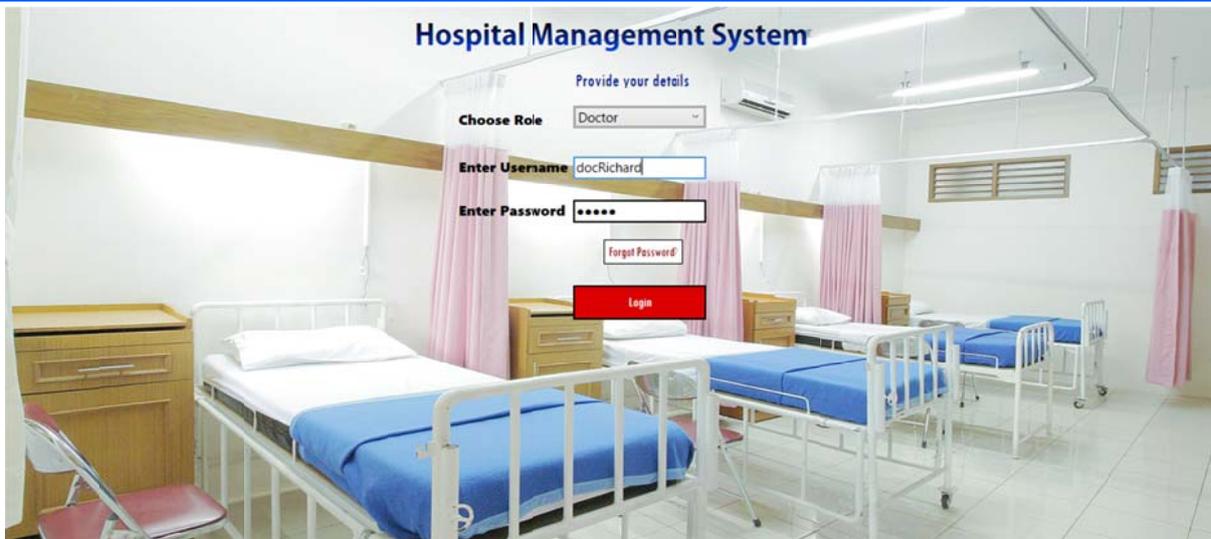

Figure 14 Enrol Patient Page

Figure 15 Doctor Login window

Figure 16 Doctor's Main Window

The patient's check page is shown Figure 17. In this page, the doctor records vital information about the diagnosis on the enrolled patient. This includes the management plan, prescription and/or required tests. The requests and records could also be sent to the corresponding department for evaluation and feedback.
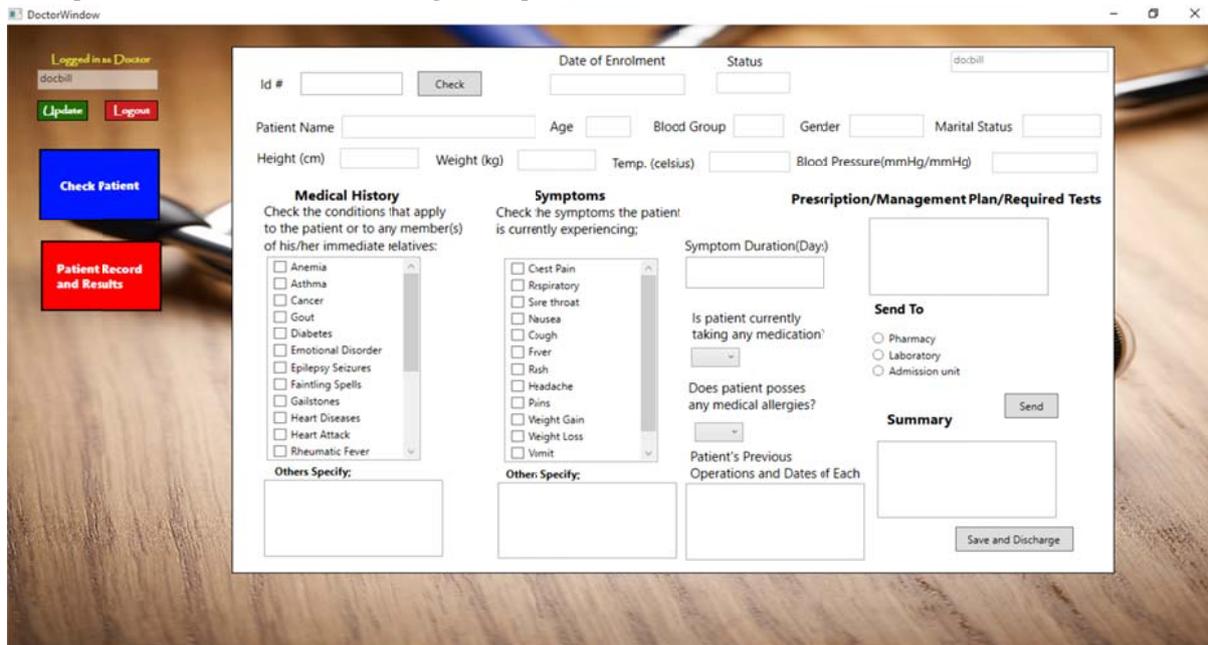

Figure 17 Check Patient Page

Figure 18 Pharmacy Login Window

The pharmacy login window is shown in Figure 18. Here, the pharmacist on duty who dispenses drugs based on the doctor's prescription gains access into the hospital management system. The pharmacy main window is shown in Figure 19. Here, the pharmacist on duty can dispense drug. The doctor can also view records and history. The pharmacy dispensation page is shown in Figure 20. In this page, the pharmacist on duty records vital information about the drugs dispensed to the enrolled patient. Drugs dispensed are based on prescription by the doctor.
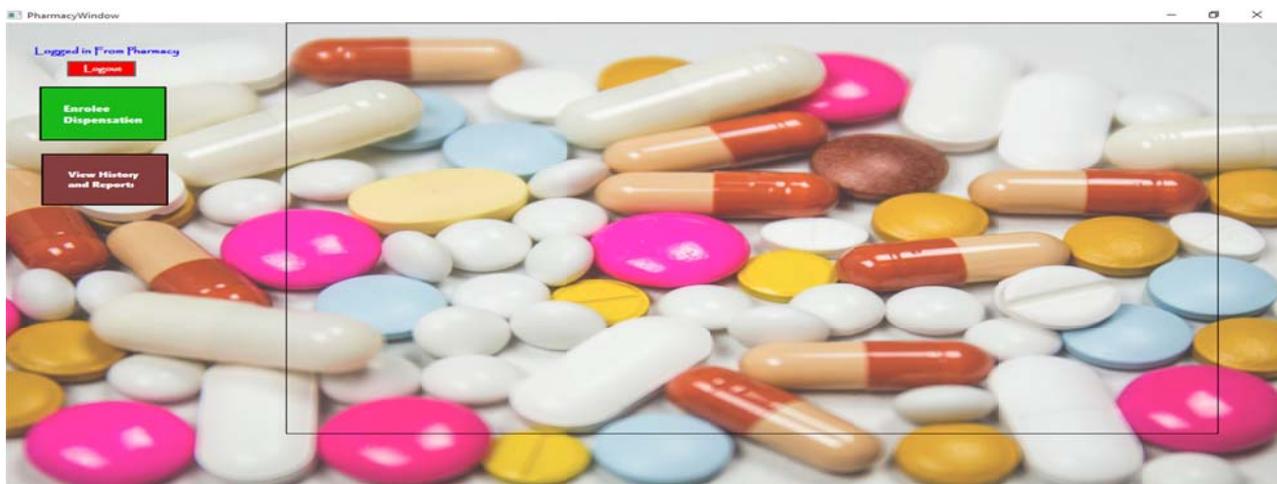
Figure 19 Pharmacy Main Window

Figure 20 Pharmacy Dispensation page

The laboratory login window is shown in Figure 21. Here, the laboratory technologist on duty performs test based on the doctor's required test for an enrolled patient gains access into the hospital management system. The laboratory main window is shown in Figure 22. Here, the laboratory technologist on duty can perform test. The laboratory technologist can also view records and history.


Figure 21 Laboratory Login Window

Figure 22 Laboratory Main Window

The laboratory enrolee tests page is shown in Figure 23. In this page, the laboratory technologist on duty records vital information about the tests carried out on the enrolled patient. The laboratory technologist sends back the result and summary of the test to the doctor for further evaluation.
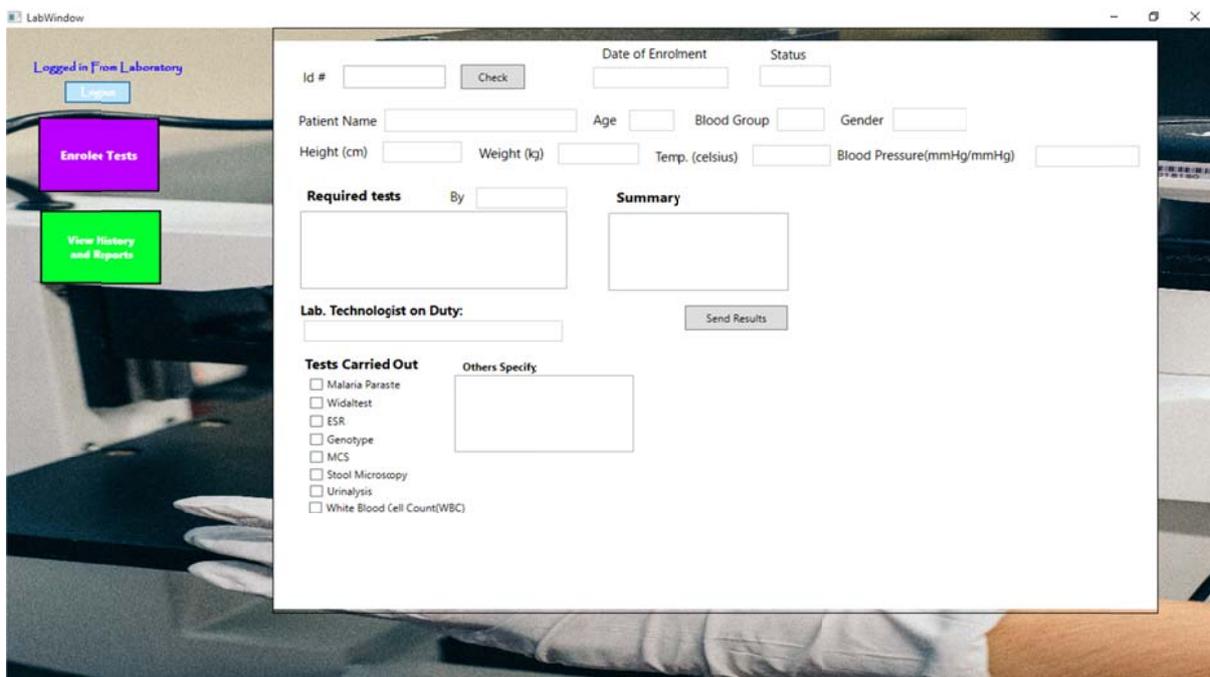
Figure 23 Laboratory Enrolee Tests Page

4. Conclusion

The design and implementation of the software for an automated hospital management system is presented. The software has five modules which include, administration module, staff module, doctor module, pharmacy module and laboratory module. The administration module could register new employees of the hospital and grant them access to the system. The staff module could enrol patient to the system and manage admission details. The staff module could also admit and discharge patients based on doctor's management plan. The doctor module could check patients' enrolled into the hospital and prescribe required medicine or tests for them. The pharmacy module could help the pharmacist administer drugs to patients based on the required medication prescribed by the doctor. Furthermore, the laboratory module could help laboratory technologists to carry out required tests on patients based on the prescription admonished by the doctor. The software was tested with some sample users' data and the results show that the developed software can be used to manage the operations of the hospital.

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