ADDIS ABABA UNIVERSITY

SCHOOL OF INFORMATION SCIENCE

AND

SCHOOL OF PUBLIC HEALTH

M.Sc in Health Informatics Program

DESIGN AND DEVELOPMENT OF DRUG SCHEDULING SYSTEM FOR AMANUEL MENTAL SPECIALIZED HOSPITAL

By

Taditi Boko

A project Paper Submitted to the School of Information Sciences and Public Health of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Health Informatics

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ADE	Adverse Drug Event
ART	Antiretroviral therapy
BCMA	Bar code Medication Administration
CSS	Cascading Style Sheets
EDT	Electronic Dispensing Tools
EMR	Electronic Medical Record
HIT	Health Information Technology
HMIS	Health Management Information System
HTML	Hypertext Markup Language
ICT	Information Communication Technology
IT	Information Technology
IM	Intramuscular
IV	Intravein
ME	Medication Error
MYSQL	My structure Query Language
eMAR	Electronic Medication Administration record
SDLC	Software Development Life Cycle
PHP	Hypertext Preprocessor
UML	Unified Modeling Language
UC	Use case
UI	User Interface

V. ABSTRACT

Introduction The application of Information Technology such as computerized physician order entry, automated dispensing cabinets, bedside bar-coded medication administration, and electronic medication reconciliation are important in avoiding medication errors and enhance quality of care. Electronic medication management includes common hospital process such as prescription of medication, dispensing medication orders, and administration of medications. Electronic medication management can reduce medication errors and can also improve efficiency in the medication management process, such as reducing the time required to locate paper medication charts.

Objective The objective of this project is to design and implement Drug scheduling system for Amanuel mental specialized hospital

Methodology The methodology used to develop the system is Object oriented analysis and design methodology. Requirement was collected using tools such as interview, observation and document review. Analysis and design of the proposed system was conducted using tools like the data process model, uses case diagram, and class diagram

Discussion and Result prescription of antipsychotic medication for psychiatric inpatients is not performed with consistent dosage and duration. As the Medical Doctor who prescribes drug for patients told me, knowing the right dosage of medication is difficult. Estimating the range of dosage depends on the current status of the patient and patient's response to the medication. For example patient can take 5mg morning and 10 mg evening at 12 hours interval. Using the new system to schedule drug for long duration and inconsistent dosage is difficult. Because of these, when there is change in medication, dosage and duration the system can help the user to edit and update this information.

Conclusion Administering medication safely is the most crucial part of patient care. Nurse plays a vital role in administering medication. This activity is performed multiple times in a day for an individual patient. It is a complex process therefore accurate documentation of the medication administration is very important.

CHAPTER ONE

1. INTRODUCTION

1.1 Introduction

Amanuel Specialized Mental Hospital is the only physiatrist hospital which is located in the capital of Ethiopia, Addis Ababa. The hospital gives different services for psychiatric inpatients, out patients and other out patients that seeks health care services. The hospital provides training for different health care professionals that are working in the hospital and public health education and awareness campaigns on mental health and mental disorders that targeted the general population [**1**].

In 2009, the hospital launched Masters program in Integrated Clinical and Community Mental Health in collaboration with Gondar University. The hospital gives technical support for some Universities in the country that deliver psychiatric training [**2**].

The hospital had integrated clinical services through facility renovation and expansion, Human resource development, leadership commitment, decentralization of mental health care to improve the delivery efficient and effective services for customers since 2004. Inpatients used to get service in the same ward. The expansion enables the hospital to give services for children, elderly and forensic patients in separate wards [**1**]. The total number of beds of the hospital is 270. There are total number 304 employees working in the hospital.

The common detected mental disorders in the hospital are Schizophrenia followed by bipolar disorder. Admission to the hospital due to psychotic disorder that comes from general medical condition was not common [**3**].

1.2 Automated Drug Scheduling

In recent years, there are an increased number of technologies developed to aid health care service delivery. Hospitals that used computerized systems obtained better patient outcomes that comprise fewer complications, minimized inpatient mortality and lower hospital costs. The application of Information Technology such as computerized physician order entry, automated dispensing cabinets, bedside bar-coded medication administration, and electronic medication reconciliation are important in avoiding medication errors and enhance quality of care [**4**]

Electronic medication management includes common hospital process such as prescription of medication, dispensing medication orders, and administration of medications. Electronic medication management can reduce medication errors and can also improve efficiency in the medication management process, such as reducing the time required to locate paper medication charts [**5**,**6**]. Keeping patient's medication information such as medication order history, demographic data, allergy and diagnosis is very important to monitor inpatient medication treatment. Electronic Medication Administration Record is one of technologies that help nurse to schedule medications for patient. It enables the nurse to have permanent record of medication administered [**7**]. Technologies commonly used to improve medication compliance, mobile based alerting systems, text messages, pill counters, electronic pill dispensers, and bar coded medication administration are among others [**4**]. These technologies are widely used to schedule and alert medication orders for patients.

Better medication management means that the health system and health professionals are organized to ensure that the most appropriate medications are prescribed and consistently taken by the patient with better outcome and fewer adverse reactions. In other words, the right drug is taken the right way to ensure better health outcomes and reduced demand on the health system [**8**].

Currently, Amanuel Specialized mental hospital uses manual system to schedule drug. The new system helps to keep track of drug lists taken by the patient. When changes are made by the physician in the dosage to be taken by the patient it can be rescheduled and the system will be updated. When setting the schedule medication safety problems will be included to avoid side effects that can arise from taking the medicine patient's medical history is important to identify which drugs he/she is currently taking. The time and medications suitable to take the medicine is chosen by the physician to enhance patient medication safety. The physician should have information about patients' medication history to identify the side effects of the medicine before proceeding to scheduling. Keeping up to date patients' medication record is very important in this process. Whenever patients are discharged from the hospital, information about their drug history is updated.

1.2 Statement of the Problem

Medicines are essential in treating illness and preventing disease. The success of medication has made patients to use medication commonly. The use and expansion of medicine has brought an increase in hazards, error and adverse events associated with medication use [**9**]. Medication is widely used for treatment in health care and they also give significant improvements for patients when they used properly. On the other hand, if not used properly the common use of medicine can bring harm, errors and adverse drug events [**10**].

Delivering drug treatment to patient is a difficult task. While administrating drug, errors may arise starting from prescription to provision of the drug to patient [**11**]. Medication errors are incidents in which there has been an error in the process of prescribing, dispensing, preparing, administering, monitoring, or providing medicine advice, regardless of whether any harm occurred [**12**]. Medication administration is the most vulnerable phase of medication provision procedure. The Medication administration process takes one third of estimated nurse's working time. Errors may arise while administrating medication [**13**].

Errors caused by drug administration can be made by the health care provider or by the patient themselves. Many problems in drug administration come from communication. Sometimes patients may not be aware error may arise in poor communication. Most common errors that come from lack of clear communication are: drug name, drug appearance, why the patient is taking the drug, how much and how often to take it, when is the best time to take it, how long to take it, what common side effects could occur, what to do about a missed dose, common interactions with other drugs or foods, and whether this new drug replaces or supplements other therapy [**14**].

Medications are often enhanced with psychosocial treatment to treat psychiatric patients. The provision of this treatment has reduced symptoms of principal generalized anxiety disorder, panic disorder and social anxiety disorder. Most of the psychiatric illnesses need long term or even lifelong therapy, making the patients more prone for the development of significant ADRs and decrease patient compliance [**15**]. Non-adherence to antipsychotic medication brings negative outcome for patients, societies and health care system. Furthermore, most mental disorders are treated for long term or life time. Non-adherence to medication can also lead to frequent visitation of facilities, re-admission and increased need for clinician intervention,

violence, suicide and premature mortality. This can lead to increased costs to healthcare systems [**16**,**17**].

Mental health services are the means by which effective interventions for mental health are delivered. The way these services are organized has an important bearing on their effectiveness and ultimately on whether they meet the aims and objectives of a mental health policy. The aim of mental health service has been to achieve clinical recovery through the treatment of symptoms and the prevention of relapse [**1**].

One way of recovery from mental illness is taking medication on time according to the prescription given by the physician. In Amanuel Specialized General Hospital the prescription of drugs given to patients' are scheduled manually. This leads to errors, work load, unnecessary waste of time and waste of resources. The manual scheduling also has impact on the service given by the hospital. Automated drug Scheduling system will decrease the error that is encountered during scheduling medicine for patients manually. It also enhances patient safety and reduce work load and will give improved service for patient.

This project intends to develop Drug scheduling system for Amanuel Hospital. Schedule can give a very good aid for health care professionals to enable them view patient drug history and schedule medicine easily and continuously. The system intended to be developed calculates the time according to the schedule, the actual time of medicine each patient take. The nurse saves the schedule and whenever the data is needed she/he can print the schedule. This can save the time that takes to manually schedule medicine for patients and enables to easily manage work at hand. This will also minimizes error that occurs while entering data manually and improves the quality of health care service given by the hospital. The new system will aid to the organization's goal to improve mental health problems in the capital and also patients coming from other cities of the country. The new proposed system helps in keeping track of drug lists taken by the patient and allergy/side effects.

1.3 Objectives

1.3.1 General objective

The general Objective of the Project is to Design and implement a Drug Scheduling System for Amanuel Specialized Mental Hospital.

1.3.2 Specific objective

- To study the problem associated with manual drug scheduling system
- To gather user requirement for developing the system
- To identify data needed to develop the system
- To design Drug Scheduling system
- To design a prototype for the system
- To evaluate the implemented system

1.4 Scope and Limitation

The scope of the project is to develop Drug scheduling system in the case of Amanuel Specialized Mental Hospital. The system designs drug scheduling system for inpatients that are admitted in psychiatric ward of the Hospital. Data for designing the system is obtained from interviewing different health care professionals that are involving in caring for the patients and scheduling drug and observing directly how the current system works. Different literatures and related works were reviewed.

Limitation of project there is no method to know the medication errors rate of since there is no study conducted. Other limitation is I was not able to look at other hospitals (in both private and public) if there is such system used to schedule drug.

1.5 SIGNIFICANCE OF THE STUDY

The Significance of the study, enhance good work environment for the health care professionals to enable them to schedule medicine for their patients. This project would be beneficial to the Amanuel Specialized Hospital Patients in providing better service in a more facilitated way. The result of the study will reduce errors that arise from manual data entry, enhance patient safety and reduce work load and will give improved service for patients. In the future, this study can provide baseline information for other projects.

For Patient

Getting good quality service that is given by the hospital. It avoids harm that comes from medication administration error that may cause adverse drug event. This will lead patients in long stay in the hospital. Automating the system will help patients to have good care from nurse and physician/psychiatrist. It also minimizes cost for patient that come from long stay.

For Nurses

To automate drug scheduling task for the nurse and to avoid the risk of human error that comes while scheduling and improve availability, performance efficiency. Minimize work overload for the nurse. The system increase reliability and reduces time that takes processing of information.

For the physician/psychiatrist

It reduces risk of error that comes from prescription. It enables to keep history of drug taken by the patients. The system will also help to record allergy information of patients. This makes to easily get all information for decision making during diagnosis without loss of medication history.

For the Organization

It makes the organization benefit from technology by enabling better quality of care and service using by automated drug scheduling system. Reduces current paper based processing problem while enhancing current work practice. It will be able to minimize cost that arises from medication administration error. It helps to respond to customer demand for better service. Improve productivity.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 General Literature

Information technology based systems are designed to copy existing manual forms and procedures. Medication Administration Record is used to record drugs administrated to patient at facility by health care professionals. The electronic form of MAR is called eMAR. The MAR is a part of a patient's permanent record on their medical chart. eMAR are proven to improve patient safety and reduce time spent to administer medication manually [**18**].

Machine readable bar codes, which is also referred to as data element or a key were developed in the late 1960s. This machine contains data that are read and interpreted by automated device called reader or scanner. The use of scanner to read or interpret the data has replaced human in the process of reading the data elements. In 1994, a nurse that works at Colmery-O'Neil Veterans Affairs Medical Center in Topeka, Kansas brought the idea of machine readable bar codes to also be implemented in medication administration process. She considered the bar coding used by a rental car company to track vehicles could also be used in a similar way to track medications ordered and administered to patients [**19**,**20**].

Bar coding system and Electronic medication administration record are used to administer medications for patients in health care units. eMAR is part of Bar Code Medication Administration Windows application. BCMA is used to compare prescribed medications against medication to be administered. This helps in the assurance of five rights of medication like Right patient, right medication, right dose, right route, right time. BCMA registers date, time, user, patient, medication, and dose of each administered medication. BCMA implementation requires all medication packaging to contain bar codes that can be read by BCMA scanners and all ordered medications to be listed in an eMAR. Bar coding system and eMAR are used interchangeably [**21**].

In Bar-coded medication administration (BCMA) system, the nurse who administers the medication at the bedside should scan the patient's identification bracelet and the unit dose of the medication being administered. The system alerts the nurse to any mismatch of patient identity or of the name, dose, or route of administration of the medication [**22**]. The eMAR system is

designed to be communicated over the internet to send and receive data but also offers offline the capability to continue with medication administration in situations where there is no internet connection. Once the internet becomes available data is re-organized to send and receive the latest changes to residents' medication profiles [**23**].

The focus on patient safety had made U.S Hospitals to use various technologies to improve quality of patient care. The initial idea of BCMA system enabled this developed prototype an award winning model for medication administration. Since 1999 BCMA is used in Veterans Affairs health care system. According to the American Hospital Association, Bar code medication administration is used by 65 % of American hospitals to allow verification of patients, verification of prescriptions electronically and pharmaceutical administration. BCMA is an integral part of the electronic health record [**22**,**24**]

In 2004 Australian health minister planned to use Medchart by 2006 to replace hand written medication chart, prescription and administration record. Medchart is used for prescribing medication; formally review pharmacy and medication administration. Medchart has proven to reduce medication error, enhance communication and modernize pharmacy supply service [**25**]. In 2006 eMAR system was developed by iCareHealth as a component of the existing Clinical and Care Management system. After the first implementation, the eMAR system has undergone some software and hardware changes to redefine of user groups and associated access rights, change of tablets [**26**,**27**]

2.2 Benefit of Technology based system

The need to improve and provide efficient health services has resulted in the increased use of information and communication technology-based solutions in the healthcare sector. The benefit of these technologies has brought reduced medication errors that cause mortality, unwanted suffering and increased cost that may come from prolonged hospital stays, enhance sophisticated decision support and referencing for professionals, minimized health care cost by improving patient outcomes or creating efficiency in the system [**22**].

A study made to evaluate the impact of bar code technology on medication dispensing errors by 36% and potential adverse drug events by 63%. In another study made to evaluate effectiveness of text messaging system after sending daily short-message-service reminders or texts for 3 months to timely take medications. The result of the study implies that there is a significant in reduction of error. A system called Med-emonitor have improved medication adherence from 52% to over 94% according to study conducted [**28**] [**29**]. The implementation of BCMA was helpful for nurses to practice the five rights of patients and enhanced safety it brought for patients while administering drug.

The efficiency of BCMA system has brought additional importance of inventory control, billing accuracy and reduction of rework. Smart systems help the nurse in delivering drug reference information and various alerts for lookalike and sound alike medications and reminders to help in important clinical actions that need to be taken when administering certain medications. Data capture enables retrospective analysis of aggregate data to monitor trends such as percent of doses administered late and errors of omission [**20**].

2.2.1 Mobile based Reminders

mHealth is an emerging and rapidly developing field which has the potential to play a part in the transformation of healthcare and increase its quality and efficiency. Through sensors and mobile apps, mHealth allows the collection of considerable medical, physiological, lifestyle, daily activity and environmental data. In recent years, mobile platforms have become more user friendly, computationally powerful, and widely available. This has brought the development of many mobile based applications for assisting individual health and well being [**30**,**31**].

Smartphone based medication applications which are available for little cost or no cost can benefit patients with complex medication regimens. These smart phone based apps are important for users in many ways. The benefit they provide are reminders for taking and refilling medicines, calendar-based alarm reminders with specific dosages and facilities for data logging that can be accessed by both patients and healthcare providers. Integration of medication lists with pharmacy contact information and prescription drug discount cards. Some apps have been developed to monitor disease such as asthma, monitor blood glucose levels medication

adherence support and health education. Medication adherence applications are a new resource to help patients manage medication regimens and significantly improve adherence [**32**].

According to Food and Drug administration mobile applications may bring potential risks to the public health if they fail to function as aimed. US Food and Drug administration strongly recommends that manufacturers of all mobile apps should follow quality of system and meet the requirements associated with the applicable device while designing and developing of their mobile medical apps and initiate prompt corrections to their mobile medical apps, when appropriate, to prevent patient and user harm [**33**],

A non-profit organization called Medic mobile which was established in 2009 has widely used technologies such as text messaging for immunization reminders and delivering basic life saving information about prenatal care in over 20 countries on a wide variety of projects. The plat form of Medic Mobile runs on feature phones, smartphones, tablets, and desktop computers [**34**]**.**
In developed countries, SMS messages have been broadly used to reminder patients their medical appointments. These reminders help to reduce missed appointments that are a major cause of inefficiency in healthcare delivery which adds large amount of monetary costs for the health system and which also brings delays in diagnosis and appropriate treatment for the non attending patient; and adverse clinical implications for those patients on waiting lists [**35**]. In Ghana, text message reminders are used to remind medication time of patients who are diagnosed with malaria. Short text messages are sent to patients to remind them take medication. As study conducted indicates, a simple text message reminder can increase of completion anti-malarial treatment, which is important, for patients being fully cured as well as maintaining the efficacy of the treatment and improve compliance [**36**].

2.3 Related Works

Many Medication Systems have been developed based upon different platforms and concepts. The uses of healthcare related applications are growing with much functionality.

Morrow and colleagues developed a paper-based medication-scheduling tool called MedTable. The design of the system includes the following key ideas: support for collaboration between patient and provider in the form of a visual representation that encourages the sharing of

information about medications when to take a medication, possible drug–drug interactions and the patient's daily routine such as work schedule, constraints on medication taking and a medium for externalizing the task, which reduces the cognitive load involved in integrating medication and the patient's routine information into an adherence plan [**37**].

Kannampallil and colleagues developed an electronic form of MedTable called e-MedTable. To interact with e-MedTable users should select menu items and use check boxes from the interface to schedule drug. The visual elements of e-MedTable are large enough which address age-related perceptual and motor limitations buttons, better spacing between elements, and feedback. Users of this system were able to create more accurate and optimal schedules. The system is easy to use and reduced subjective workload associated with creating the schedules. Furthermore, the use of MedTable brought improved communication, quality of collaboration, and lower perceived workload. This electronic tools delivers low-cost in terms of effort and time mechanisms to update or modify created schedules and to integrate information about medication regimens with other patient information in addition giving efficient ways to manage medication schedules [**38**].

MyMediHealth is designed for managing medication with chronic conditions. This personal Mobile application is used for management of medication that is designed to interface and share information with a personal health record. My MediHealth is a medication reminder system for children. This application runs on mobile devices such as smart phones, providing user interfaces for configuring medication schedules and user alerts for reminding users about the time and type of medication according to the configured medication schedule [**39**].

Web based application

Medichart Australia

This web based system gives integrated prescription, formal pharmacy review and drug administration uses. Medchart has shown to reduce medication errors, enhance communication and streamline pharmacy supply services [**25**]. [**40**]

MyMedSchedule is a free web based medication scheduling application. The system uses Secure Sockets Layer encryption method to maintain personal information of the users.

MyMedSchedule enables users to create medication schedules and reminds them on the scheduled time. It helps patients and caregivers to manage medications set reminders and communicate with health care providers. MyMedSchedule have new feature named "My Health Tracker" which lets users to keep on track of lab records and vital signs. The system also sends reminders via text or email as scheduled by users. MyMedSchedule mobile enables users to record their medications schedules on iPhone and Android devices [**41**].

Med-eMonitor is a programmable pillbox which alerts the user when it's time to take medication and displays all the details of the drug on screen. This application enables users to maintain medication schedule adherence and also it can report the information to health care providers. The MediSafe has a unique feature in which the database holds photos of all medications taken by users. This can help most forgetful users to remind them with picture which medication they should take [**42**].

Ryan Crook and David Keeley-DeBonis developed Smart-phone-based platform for patient medical compliance which keeps schedules of all medication the user should take daily. The application enables users to view medications on the daily basis. This app is designed to comply with a scheduled event. A particular event is of one of four event types: Done, Missed, Complete, or Pending. Users can add doctor's or pharmacy's information in case they want to contact them. Using the application they can also access their compliance score and view their compliance history. Medication Tab is an alphabetical list of all medications, vitamins or anything that the user has entered into the application. The current proposed features include the ability to edit an existing item, remove an existing item, add a new item, and record a blood glucose reading or blood pressure reading. For individuals with heart disease, diabetes and many other conditions, taking blood pressure and blood glucose reading are a daily occurrence. The ability to record this information allows the user to keep a log of important information relating to their condition in concurrence with their medication logs [**43**].

MyMedList is a tool that helps the general public maintain personal medication lists, storing, and updating, adding, and deleting medications from their personal medication lists and make the records available to health professionals when needed [**44**].

Canada

MyMedRec An interactive iPhone and iPad app, MyMedRec, was developed by ISMP Canada with input from Canadian patient groups and health care provider organizations. This application is launched in 2012 to assist users to manage their own health care and to enable them use their medication safely and properly. MyMedRec allows patients and caregivers to have their medication and immunization record at their fingertips. The tool will help patients and caregivers compile a full list of their medications whether prescription, over-the-counter or natural health products and share the information with their health care team as they see fit. Features included in MyMedRec are refill and dose reminders, medication histories, multiple patient profiles, e-mail and picture capabilities, as well as contact information of prescribers and pharmacies. This medicine application has been used by various users for two decades in association with hundreds of health provider organizations, governments, hospitals, health units, doctors, nurses, pharmacists and patient groups [**45**,**46**].

Ghana

Text-message reminder system developed for patients diagnosed with malaria reminds them to take anti malarial treatment. The text-messaging program was based in the programming language Python version 2.6 and was built on a Django platform. This text message reminder has significant result in medication adherence according to study conducted [**36**].

Various projects have used the short message service (SMS) technology to maintain patient medication adherence. Mobile Med Alert is a mobile based medication alert system that uses short messages to enable users to take medication timely. This will enhance medication adherence for outpatients. Mobile Med Alert was implemented using programming tools such as extensible hypertext markup language (xHTML), hypertext processor (PHP), MySQL and the integration of Ozeki SMS gateway. Mobile Med Alert main features includes alerting patients

about medication they should take at scheduled time, in accordance to drug regimen. The feedback system allows patients to respond alert messages properly.

Mobile-phone based Patient Compliance System (MPCS) has helped to minimize the time-consuming and error-prone processes of existing self-regulation practice to facilitate self-reporting, non-compliance detection, and compliance reminder among patients in Nigeria. Mobile has allowed social interactions more easily. This shows how mobile phone can aid patient to comply to their medication treatment; the existence of mobile phones and its uses in health sectors in Nigeria [**47**]. Another project called WelTel have applied wireless technology in ensuring patient adherence: The WelTel Kenya1 was a multisite randomized clinical trial of HIV-infected adults initiating antiretroviral therapy (ART) in three clinics settings in Kenya. The main outcomes were self-reported ART adherence which is >95% of prescribed doses in the past 30 days at both 6 and 12 month follow-up visits and plasma HIV-1 viral RNA load suppression [**48**].

In Ethiopia, patients are contacted by the ART clinic via cell phone using either An electronic health service readiness assessment study from Ethiopia concluded that mobile-based health services are feasible for consultation, creating awareness, and diagnosis and treatment because the affordability of mobile phones by low income inhabitants and the growth of the mobile network coverage of the country is increasing voice call and/or text to receive text message ART medication reminders.

CHAPTER THREE

3. METHODOLOGY

3.1 Project Area and Period

The project was conducted at Amanuel Specialized Hospital which is located in Addis Ababa city. Amanuel mental specialized hospital, which is located at Addis Ketema sub city of western Addis Ababa, is the only mental hospital established in 1930 E.C. The hospital was built on an area of 15,660.6 m^2, with G+1 buildings & 15 blocks. Currently, the total number of staffs holds 614 of working in the hospital. On the other hand the total number of patients diagnosed in the Hospital in 2007 E.C accounts 110,000.

The project was conducted from February 2016 to January 2017 so as to achieve its expected result.

3.2 Study Design

The methodology used to develop the system is Object-oriented analysis and design methodology. Object-oriented analysis and design system development is a new paradigm which helps in building a maintainable and reusable system. Other main advantage of object-oriented system development is encapsulation of data and functions in to object classes, it holds same concepts in analysis, design and implementation and database view and application program grow together [**49**].

The Object Management Group (OMG) is the body responsible for creating and maintaining the language specifications. They define UML as, “a graphical language for visualizing, specifying, constructing, and documenting the artifacts of object oriented software systems. Object oriented system development models are able to thoroughly represent complex relationships and to represent data and data processing with reliable notation, which allows an easier mix of analysis and design in growth process [**50**].

The overall approach to object-oriented analysis and design is highly integrative. Stepwise refinement works when all requirements must be determined before design can start. In Object Oriented system analysis and design there are four key steps to be performed i.e. identifying objects and classes, identifying the object relationships, identifying the attributes and identifying services [**51**].

In object-oriented analysis this is typically done via use cases and abstract definitions of the most important objects. The subsequent design phase refines the analysis model and makes the needed technology and other implementation choices. In object-oriented design the emphasis is on describing the various objects, their data, behavior, and interactions. The design model should have all the details required so that programmers can implement the design in code [**52**].

3.3 Source Population

The source populations of the study are health care professionals are working at Amanuel specialized mental hospital. Health care professionals who are giving care for psychiatric inpatients and actively participating in drug scheduling system. These health care professionals are: Nurse that schedules drug for patients, physician who prescribes medication for patients and HMIS personnel of Amanuel Hospital and manager of the hospitals and personnel who is coordinating the current automated drug dispensing system used by the hospital.

3.2 Data Collection Method

The method used for data collection is face to face interview and direct observation. The data is obtained by interviewing the person who is involved in prescribing and administering drug for Amanuel specialized mental hospital psychiatric inpatients. Direct observation is done to understand how the manual drug scheduling for inpatients is done by the nurse. Also interviewing the psychiatrist to understand how drugs are prescribed for psychiatric patient admitted in the hospital. This will help to identify how the scheduling process is done.

3.2. 1 Data Collection Procedure

Interviewed the nurse and HMIS personnel how the current system works and asked over how the new system should be designed. The medication administration process is time consuming and should be done with good concentration. While scheduling medications, errors may arise if not done properly. Depending on the user requirement I tried to identify what the technological

advances should be used in designing the new system. Also Direct observation of how drug scheduling procedures are done manually.

Interviewing HMIS Personnel about entire ICT and infrastructure and other technologies used in the Hospital to enhance quality of care. Asking Users of the system and management of the hospital what problem they are facing from the current system and what features they want from the new system.

Document review is done to understand how the current system works. These documents are the current manual form the nurse uses to manually record medication schedule. I also reviewed the prescription form. Review of other literatures to understand the art of state of automated drug scheduling system, to identify problems related in drug administration task.

Currently, there is a software called Drug Dispensing Tools used by the pharmacy of ther hospital. This Softare is used to keep information of drugs being dispensed to different wards. This tool also generates information required to calculate pharmaceutical needs and to make other management decisions. There is also software called Health Management Commodity Information System that controls received (from donors or other place) and issued medication and also balances medication/stock at hand that is used the Hospital Medications stock.

3.4 Study Analysis and Design Method

To design the drug scheduling system object oriented analysis and design is used. The purpose of any analysis activity in the software life-cycle is to create a model of the system's functional requirements that is independent of implementation constraints.

The main difference between object-oriented analysis and other forms of analysis is that by the object-oriented approach we organize requirements around objects, which integrate both behaviors processes and states data modeled after real world objects that the system interacts with. In other or traditional analysis methodologies, the two aspects: processes and data are considered separately [**53**].

Object-oriented modeling (OOM) is a common approach to modeling applications, systems, and business domains by using the object-oriented paradigm throughout the entire development

life cycles. OOM is a main technique heavily used by both OOA and OOD activities in modern software engineering [**54**].

Object-oriented modeling typically divides into two aspects of work: the modeling of dynamic behaviors like business processes and use cases, and the modeling of static structures like classes and components. OOA and OOD are the two distinct abstract levels (i.e. the analysis level and the design level) during OOM. The Unified Modeling Language (UML) and SysML are the two popular international standard languages used for object-oriented modeling [**52**].

The analysis and design process includes activities such as

- Defining Requirements
- Business Scenario
- Use case modeling
- Use case description
- Activity Diagram
- System Architecture
- System Design (Class diagram, Database model)
- System Prototype

3.5 TOOLS AND TECHNICS

Tools are the means by which developers communicate to identify requirements or to design the system. The completion of the projects uses different tools and techniques. To gather the requirement I used self designed questionnaire for interviewing the users. Some of the tools used to Design the system are Microsoft Word for documenting user's specification, Microsoft Visio for modeling, HTML and CSS is used for prototyping the system and PHP server side programming is used to implement the system and MYSQL DBMS is used to implement the database.

MYSQL event is used to create events that schedule drug. These tools are used to develop business scenario, Use case description, Use case diagram, Class diagram and design prototype for the system and implement the new system

3.4 Ethical Consideration

In order to conduct this project, Ethical Approval was obtained from Addis Ababa University Ethical Clearance Committee after reviewing the project proposal. Permission to conduct the study was also obtained from the Amanuel Specialized Mental Hospital.

3.5 Dissemination of Results

The final report of the project will be distributed to Addis Ababa University and Amanuel specialized mental Hospital.

3.7 Operational Definition

Drug Dispensing- Dispensing includes the preparation and transfer of a medication for a client, taking steps to ensure the pharmaceutical and therapeutic suitability of the medication for its intended use, and taking steps to ensure its proper use.

Inpatient - Inpatient means that the procedure requires the patient to be admitted to the hospital, primarily so that he or she can be closely monitored during the procedure and afterwards, during recovery.

EMAR a computer generated schedule for administering medications to a patient for a defined period of time, including dosing, timing of administration and details about the physician's orders.

ERD An entity-relationship diagram is a data modeling technique that graphically illustrates an information system's entities and the relationships between those entities. -

Psychiatric Nurse - is the appointed position of a nursing that has specialised in mental health and cares for people of all ages with mental illness or mental distress, such as schizophrenia, bipolar disorder, psychosis, depression, dementia and many more.

Medication Record - documentation of medication prescription, dispense and administration information (for a defined period of time

Medication Reconciliation is a formal process of obtaining and clinically verifying a complete and accurate list of each patient's current medicines. It refers to the process of [clinically] reviewing the patient's complete medication regimen on admission, at transfer and discharge, comparing it with the regimen being considered for the new care setting. The process aims at avoiding inadvertent inconsistencies in medication regimen across transition in care

Object Oriented Analysis and Design – is a popular technical approach for analyzing, designing an application, system, or business by applying the object-oriented paradigm and visual modeling throughout the development life cycles to foster better stakeholder communication and product quality.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Introduction

Analyzing how the current system works helps to meet user requirement and increase usability, productivity of the new system. As explained in the in previous chapter to analyze and design, I used object oriented analysis and design methodology iterative and incremental method. The reusable and the object oriented gives and iterative and increment while help in the future to easily add new user requirements. Object oriented analysis and design helps to produce safer, more reliable and maintainable code. This will help to upgrade this system easily in the future whenever there new added user requirements.

In this chapter the results and discussion from data collection are described.

4.2 The Current system

4.2.1 Manual Drug Scheduling

The current systems schedules drug manually which is done on paper. The nurse takes prescription order from the physician and schedules patients' drug according the prescription given. Every order is written in the file prepared by the nurse. Schedules are prepared for a week on specific days (on Monday and Thursday). All records of patient medication intake are recorded manually. The current system is tiresome and takes a lot of time and brings nurse work overload. In order to avoid forgetfulness medication orders are immediately recorded on the drug scheduling form used by the hospital. And then these prescribed drugs are scheduled according their duration and dosage. If these ordered medications not recorded immediately, medication errors would arise while administering. As the nurse told me, disturbance from the environment does not affect their job. Medication is being prepared and stored in a cabinet. The capsule which contains medication have patient's name and bed number attached on it. These capsules which contain medicine are kept in cabinet. The schedule for patients is prepared weekly by the nurse. Most of the time patients take medicine twice daily every morning and evening, at 12 time

interval. The patients come to the nurse's office and take their medication at the scheduled time as prescribed by the psychiatrist.

4.2.2 Prescription Procedure

If a new patient is admitted to the hospital, the psychiatrist will order medicine for the patient and wait for one to two weeks monitor for side effects of antipsychotics medicine. Medications are always with minimal dosage from the beginning. If side effect is detected the physician will examine the patient and patients start taking other form of medication with reduced dosage to avoid side effects. Dosage is increased after a week to see improvements on the patient. If no side effects are detected the patient will continue taking the medicine prescribed with normal dosage. Sometimes some patients will refuse to take tablet medicines ordered at this time the psychiatrist will consider others treatment options such as injection and IV. If there are severe conditions such as nausea and vomiting, headache and dizziness, IV is given to them. IV is treatment works slowly when compared to other medications. IV is given through vein. Patients know their medication taking time. Sometimes patients may disappear nurses will look for them and give them their medication so that they won't miss doses/medication. Patients visit the psychiatrist often for checkups. In helping patients recover all are participants including health care professionals and family of patients.

4.2 Findings of the Current system

In Amanuel specialized hospital drug scheduling is done manually. This has many drawbacks as state by previously. The other problem is there is no network installed in the hospital. This will be a problem in exchanging information through the hospital. To overcome this problem the hospital has proposed new system to network the hospital wards. Security and confidentiality

4.3 ICT Infrastructure

4.3.1 Software

There is a drug dispensing system that is used by the Hospital's Pharmacy to distribute drugs for different wards. The system posts available drugs for available for months before it is out of stoke. There is Smartcare in some offices but not functional in different wards of the Hospital. But in the future there is a proposed system to connect every wards of the Hospital with network. This proposed system by the hospital will enable the patients' information to be accessed by the

network directly from triage to the physician; the physician will be able to order prescription to pharmacy etc.

Currently the hospital have Electronic Dispensing Tools (EDT) system is used in the Hospital is ART ward. The system allows a file to be managed for each patient to whom medicines are dispensed at a pharmacy or clinic providing care. Each patient's file includes his or her basic profile and the history of products administered. The pharmacist can access this file at the time medicines are dispensed. This tool also generates reports containing basic statistical data and information that can facilitate patient monitoring and adherence to the prescribed treatment.

The Electronic Dispensing Tool helps maintain basic patient profile information, medication history, and other data that are essential for the dispenser to know at the time of dispensing.

EMR, Windows 2007, Smart care are types of software used in the hospital in addition to EDT. Mostly, the operating system used by different wards is Windows 7.

4.3.2 Hardware

Currently, there is one computer used in Amanuel specialized hospital in ward where patient drug scheduling task is done. There are 10 computers used in IPD psychiatry department. There are a total numbers of 25 computers. But there is much hardware that is used in different ward of the hospital, starting from HMIS section to pharmacy since they use software that is developed to dispense drug and e-HMIS for reporting. These computers are old and newly bought or donated by Tulane University/Ministry of Health. The old ones are 15 with capacity of: RAM 2 GB, Hard disk 300GB, coreI2 CPU with 2.49 GHz. The total numbers of new computers are 10 witch capacity of: RAM 4 GB, Hard disk 500GB, coreI2 CPU with 3.3 GHz.

4.3.1 Network Technology

Currently, there is no network configured in Amanuel Specialized Hospital. There is a proposal that is developed to network hospital is the future.

4.3. 2 Reporting in Current System

In the current system reporting is performed manually. Different departments use paper based reporting format. These reports are sent to HMIS department. The HMIS department uses

electronic based system. The reports are stored in e-HMIS system. These reports are delivered to Addis Ababa Health Bureau and Ministry of Health.

4.3.3 People in current system

The total number of employees working in Amanuel specialized Mental hospital is 304. The total number of health care professional: the total numbers of psychiatric nurse that are currently caring for patients are 15, HMIS personnel are one, the number of clinical nurses are 94. B.Sc nurses 21 and assistance nurse 3, mid wife 1. Totally there are 135 nurses working in the hospital. Currently, the average nurse to patient ration in the hospital is 1 to 5. The hospital gives service for total of 270 psychiatric inpatients.

4.3.4 Document Review

Forms used to schedule medication are evaluated. This helps to know how the existing system works and to identify what feature should be included in to the system. Also prescription papers are reviewed to know how the current system is prescribed. In order to know the behavior of the schedule and how it varies understanding of the prescription procedure is mandatory. There are two types of prescription oral and paper based.

4.4 The Proposed System

The new proposed system designs and implements automated drug scheduling system for Amanuel specialized mental hospital. Design a user friendly system to easily enable authorized users to access the system. This system helps nurse to schedule drug for psychiatric inpatients. The main goal of this project is to improve patient outcomes by creating accurate drug scheduling system. The drug scheduling system is designed to replace the existing paper based system. The proposed system intends to minimize the error and problems that arises from paper based system. The new system keeps information such as schedule time and date for medicine to be taken by the patient, Patient Information and physician who orders medicine for the patient. This system enhances efficiency, minimizes medication errors that occurs during scheduling, Minimizes time taken by the nurse to administer the medicines and minimizes costs that comes from medication Administration errors. The proposed system will improve work flow and improve patient management.

4.5 Modeling

4.5.1 Process Modeling

A process model is a way of how things need to be done. Process models are processes of the same nature that are classified together into a model. Thus, a process model is a description of a process at the type level. Since the process model is at the type level, a process is an instantiation of it. One possible use of a process model is to prescribe how things must/should/could be done in contrast to the process itself which is really what happens. A process model is roughly an anticipation of what the process will look like. What the process shall be will be determined during actual system development.

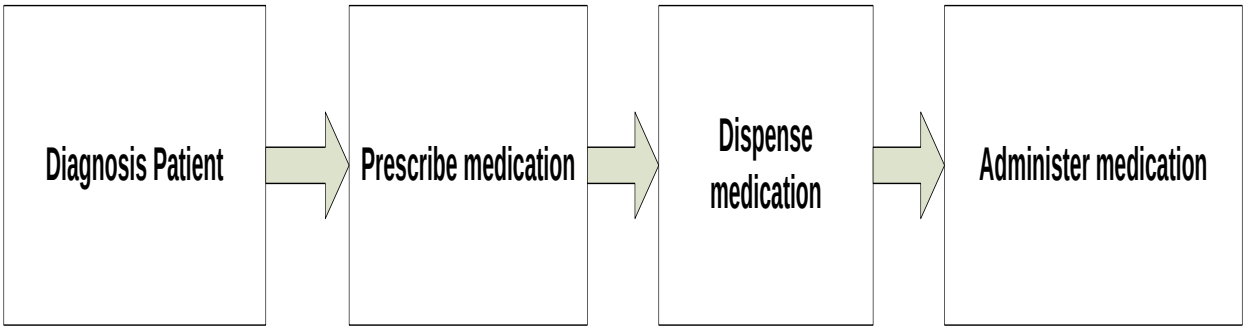


Figure 1: Process Model

Database Model

The basic ER model consists of three classes of objects: entities, relationships, and attributes. Entities are the principal data objects about which information is to be collected; they usually denote a person, place, thing, or event of informational interest. Relationships represent real-world associations among one or more entities, and, as such, have no physical or conceptual existence other than that which depends upon their entity associations. Relationships are described in terms of degree, connectivity, and existence. Attributes are characteristics of entities that provide descriptive detail about them

Conceptual Data Modeling

In conceptual data modeling, the overriding emphasis is on simplicity and readability. The goal of conceptual schema design, where the ER and UML approaches are most useful, is to capture real-world data requirements in a simple and meaningful way that is understandable by both the database designer and the end user. The end user is the person responsible for accessing the

database and executing queries and updates through the use of DBMS software, and therefore has a vested interest in the database design process. At this level you simply describe, in diagram form, the entities, attributes, and relationships that occur in the system to be conceptualized, using semantics that are definable in a data dictionary.

4.6 Analysis Models

4.6.1 Use Case Diagram

Use case analysis enables the designer to identify and to understand what the user requires. It enables to identify actors and interacting in the system after analyzing the system. It also helps to name actors and entities so that it is used in the next phase. It is used to have an understanding of the overall system. This is shown by a use case diagram. A use case diagram consists of use cases and actors and their interaction with in the system.

Uses cases - a use case is a list of actions done by the system. Use case defines the interactions between an actor and a system. The identified use cases for the new system are specified below

1. Login
2. Manage User
3. Register Patient
4. Register Employee
5. Register Prescription
6. Register Diagnosis
7. Register Allergy/Side effects
8. Schedule Drug
9. Search for scheduled drugs
10. Generate report

Actors- An actor is function played by human users, external hardware, or other subjects that interact with the system

The actors of the new system are:

1. System Administrator
2. Patient

3. Nurse
4. Psychiatrist
5. Manager
6. system

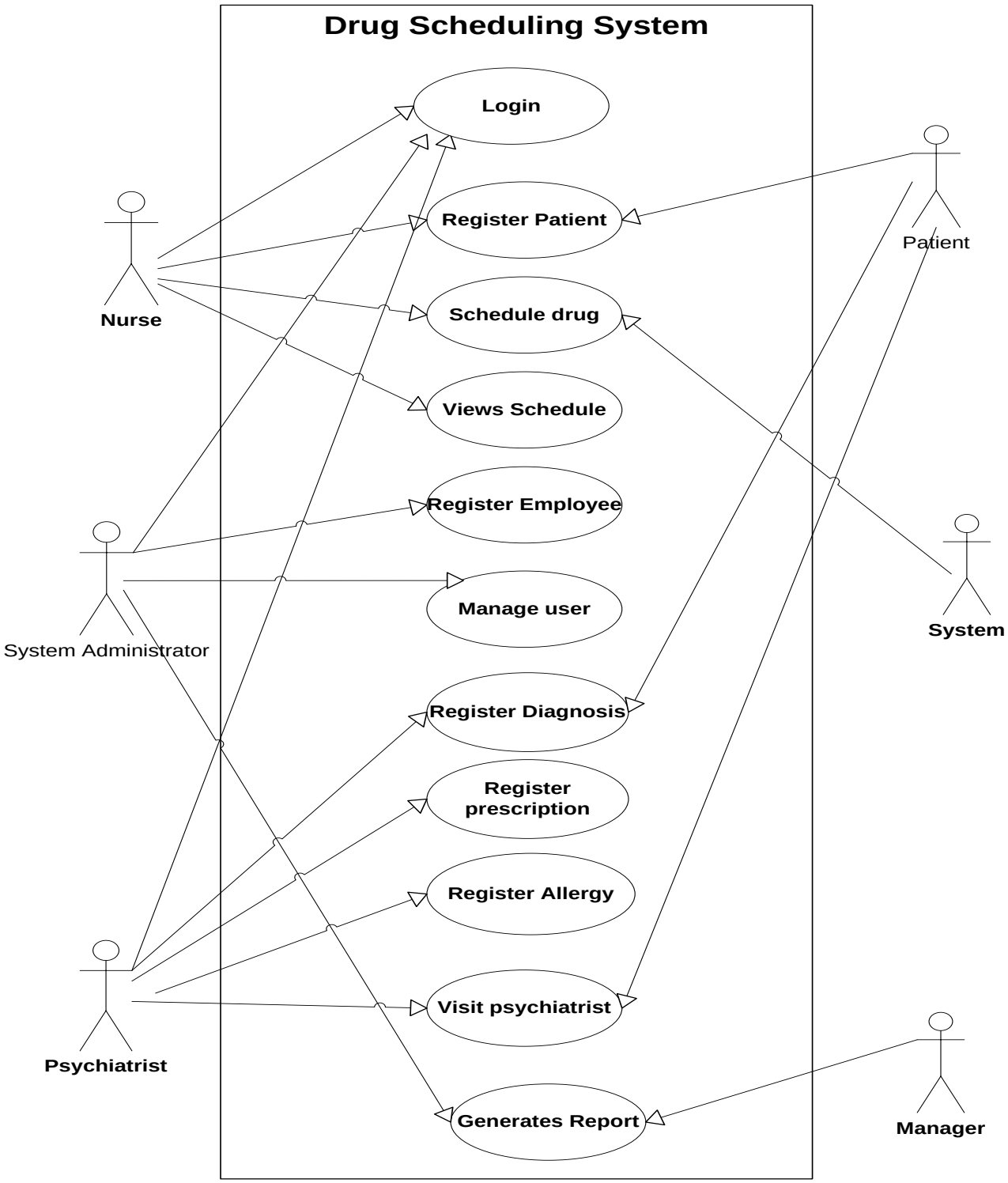


Figure 2: Use case diagram for Drug scheduling system

4.6. 2 Use Case Narration

Use case ID	**UC-1**
Use case Name	Schedule drug
Use case Description	The Nurse schedules medication as prescribed by the physician
Primary Actor(s)	Nurse, system
Use case ID	UC-1
Pre.condition	1. The user must have privilege to access the system 2. User must be logged in to the system 3. Medication should be prescribed by the psychiatrist
Post-condition	The Schedule is created successfully with exact date/time and patients lists and Drug lists.
Basic Scenario	1. The user opens the system 2. The user Logs in to the system 3. The user select schedule tab after logging into the system 4. The system displays the schedule interface 5. The user enters event name for the patient she/he wants to schedule 6. The user enters the time interval of the schedule 7. The user enters the start and end date of schedule 8. The user enters Patient name, drug name, Dosage bed number 9. Save the schedule
Alternative Scenario	If there is time change , medication change or other changes 1. The user Edit Events tab 2. The user selects the of the patient she/he wants to edit drug schedule for 3. The user click on Edit 4. The user enters the new data into the system.

Table 1: Schedule drug Use Case description

4.6.2 Activity Diagram

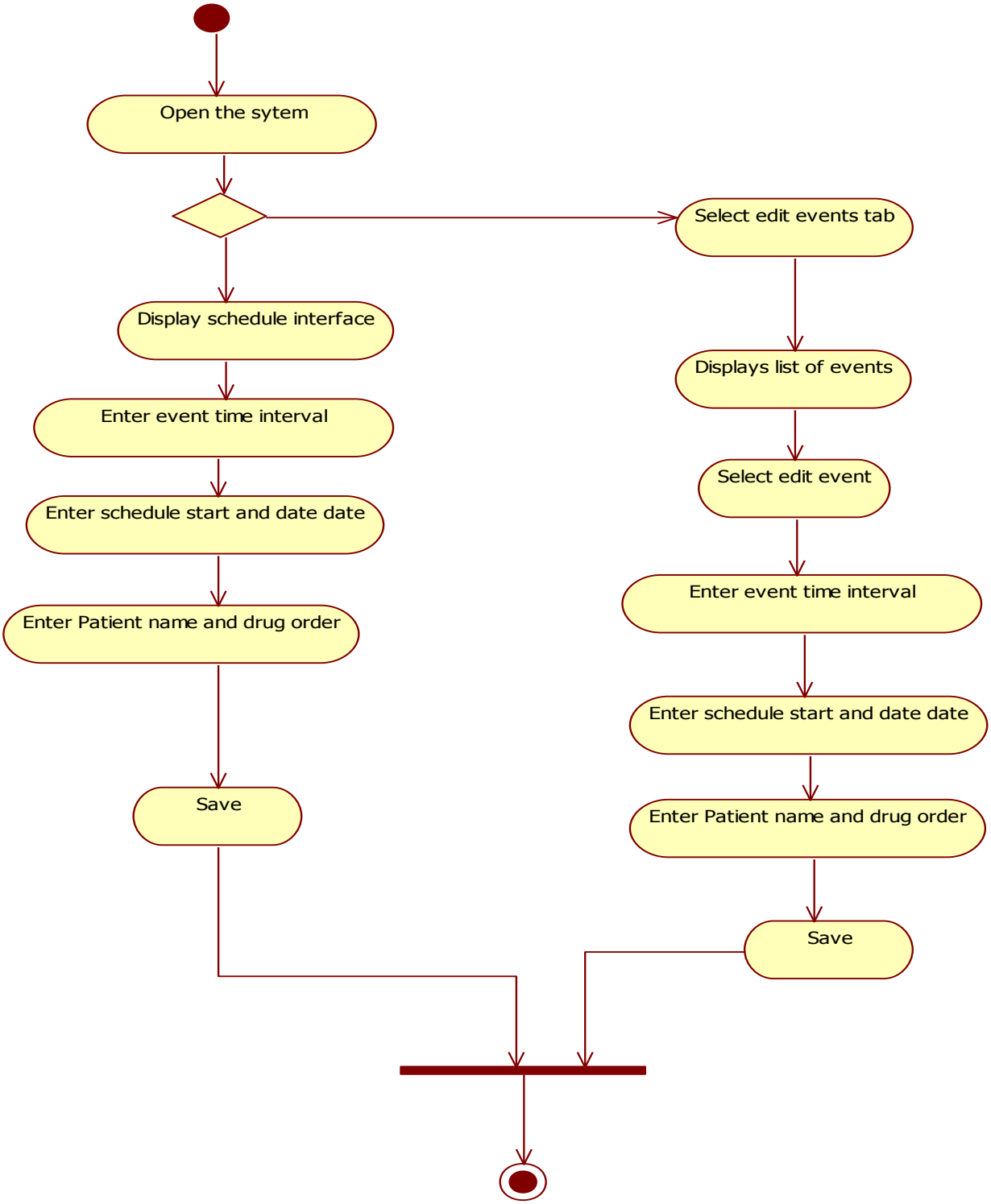


Figure 3: Activity Diagram for schedule drug

4.6.3 Sequence Diagram

The Sequence Diagram models the collaboration of objects based on a time sequence. It shows how the objects interact with others in a particular scenario of a use case.

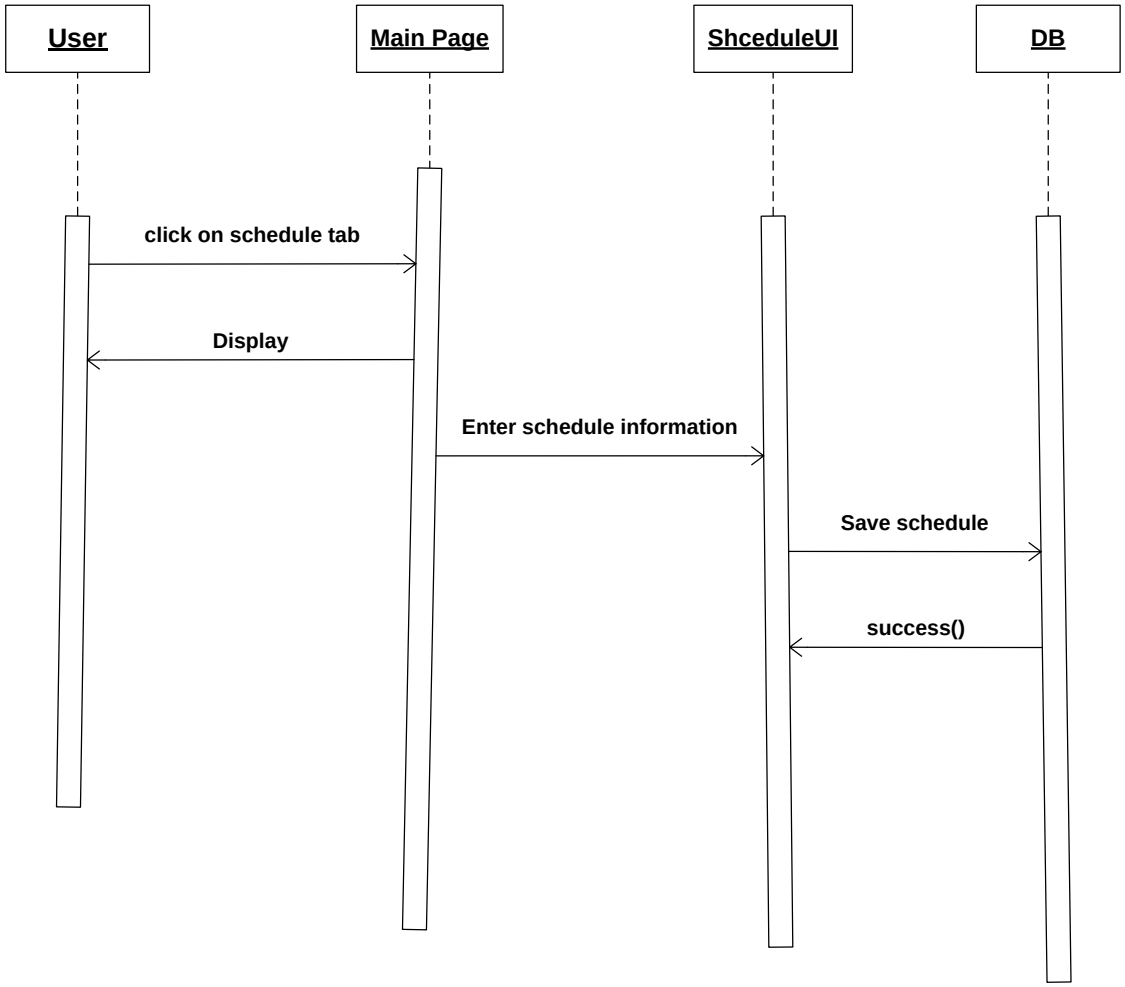


Figure 4: Sequence diagram for schedule drug

4.6 System Design

Class Diagram- UML class diagram is a picture of the classes in an Object Oriented system and their fields and methods. It is a connection between the classes that interact or inherent from each other.

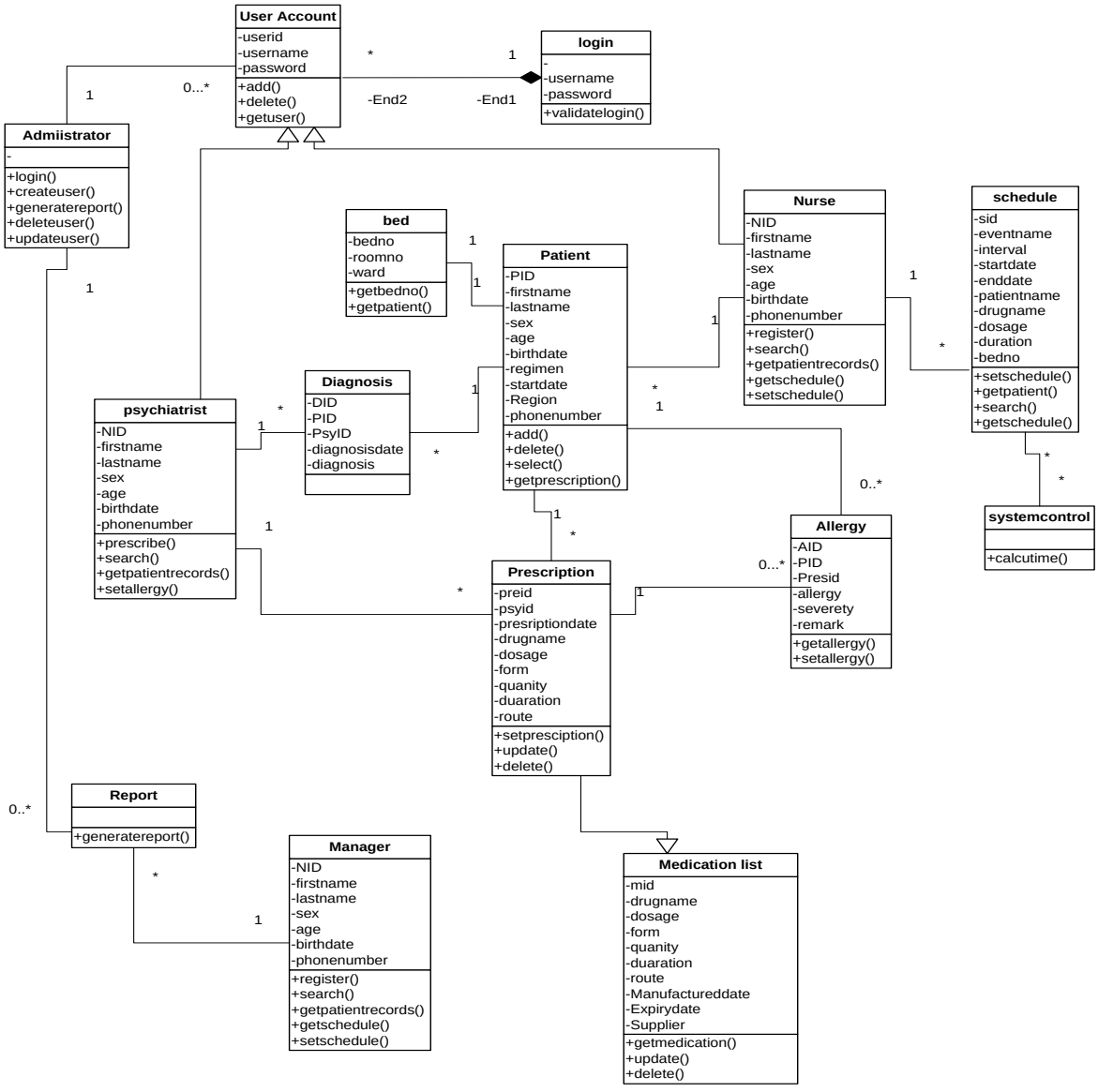


Figure 5: Class Diagram

System Architecture

A software architecture design must conform to the major functionality and performance requirements of the system, as well as satisfy the non-functional requirements such as reliability, scalability, portability, and availability. A software architecture must describe its group of components, their connections, interactions among them and deployment configuration of all components. The proposed system uses three tier system architecture designs. Three tier architecture are programming models the distribution of application functionality across three independent system such as client component which runs on local workstations this tier is called presentation layer this layer gives users access to the application, the second tier is the middle tier or business services layer in which processes that runs on remote servers and consists of business and data rules, the third tier is the data tier which consists of a collection of databases, resource managers, and mainframe applications.

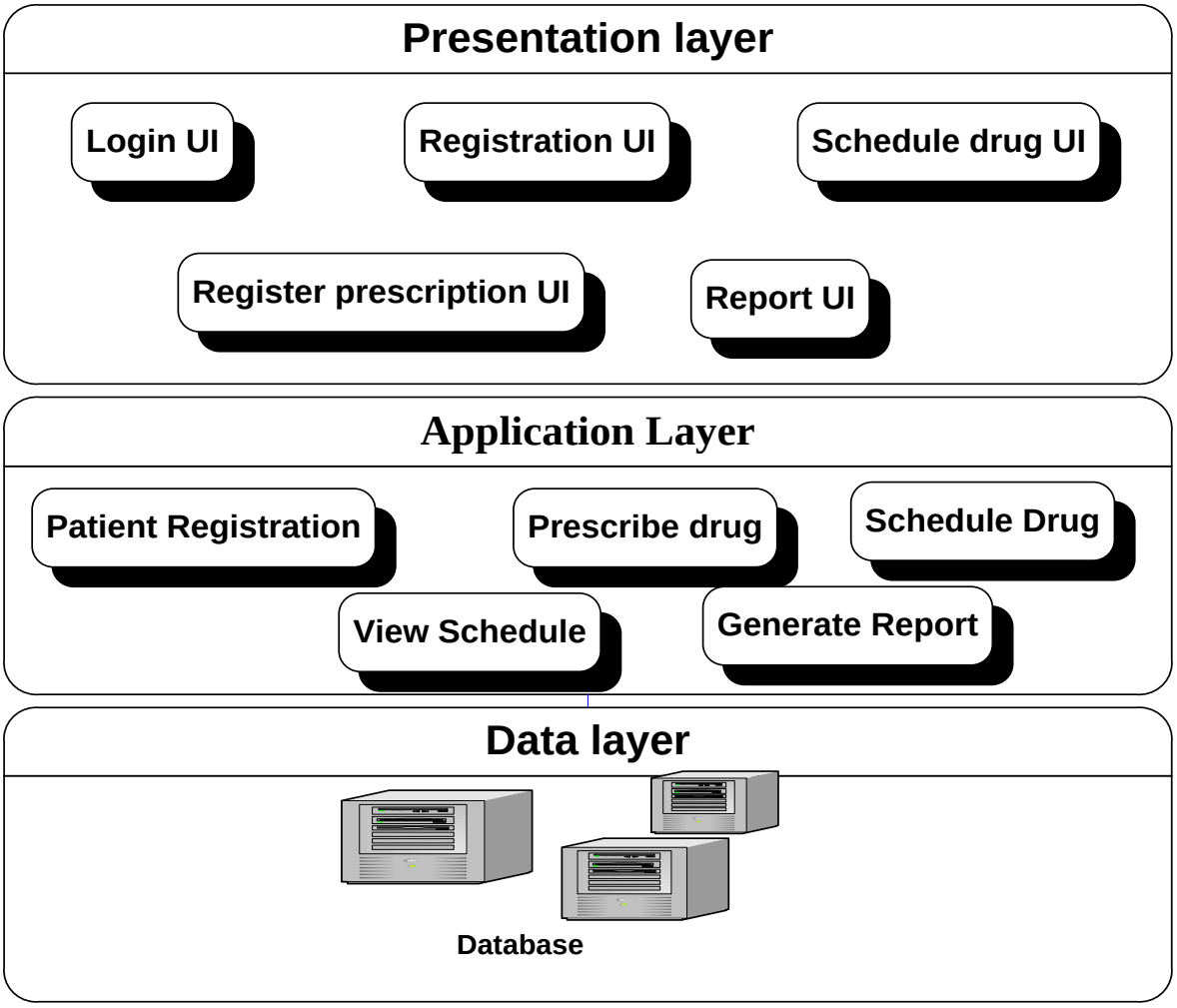


Figure 6: System Architecture for drug scheduling system

4.6 User Interface Prototyping

User interface (UI) prototyping is an iterative analysis technique in which users are actively involved in the mocking-up of the UI for a system. UI prototypes have several purposes. As an analysis artifact that enables you to explore the problem space with your stakeholders. It is a requirements artifact to initially envision the system. As a design artifact that enables you to explore the solution space of your system. A vehicle for you to communicate the possible UI design(s) of your system. A potential foundation from which to continue developing the system if you intend to throw the prototype away and start over from scratch then you don't need to invest the time writing quality code for your prototype.

The Software Prototyping refers to building software application prototypes which display the functionality of the product under development but may not actually hold the exact logic of the original software.

Software prototyping is becoming very popular as a software development model, as it enables to understand customer requirements at an early stage of development. It helps get valuable feedback from the customer and helps software designers and developers understand about what exactly is expected from the product under development.

Functional Requirement

The functional requirements describe the core functionality of the application. The functional requirement expected from the system is described below

- The system should authorized users to login into the system
- The system should enable user to keep patient's personal information – keeping all personal information of patients and their address.
- The system should enable user to schedule drug for patients
- The system should enable user to register prescribed medication
- The system should be able to register allergy information

- The system should be able to modify schedule as medication prescription change- Patients may take one or more medication due to co-morbid diseases the system allows to update any changes in medication prescription and change in medication schedule
- The system should keep diagnosis detail of the patient
- The system should enable administrator to Manage User
- The system should enable user to view scheduled drugs
- The system should enable user to update prescribed medications
- The system should enable administrator to register employee
- The system should generate report

4.4 Non-Functional Requirement

User friendliness

The system should have a good user interface. The novice user can simply follow the instructions to use the system without special computer technique. This is achieved by options to configure the font size, multilingual, optical zoom, quick response time, tool tip, configure themes, auto update feature, and detailed catalog with search feature.

Maintainability

The system should be easy to be maintained by administrators. The system's database should be back up every week. After certain of time, the system should be added new function, new features so that it can provide user good qualities.

Security

In order to design a well system there should be a way of securing the system from unauthorized User. The system should be able to be accessed by only an authorized person with privilege. Usin g virus protection, backup and recovery plan and installing firewall. Physical protection of data s hould also be considered. .

Availability

The system should be available 24 hours a day and 7 days a week.

Usability

Easy to use interface that allows users to work with the system without difficulty.

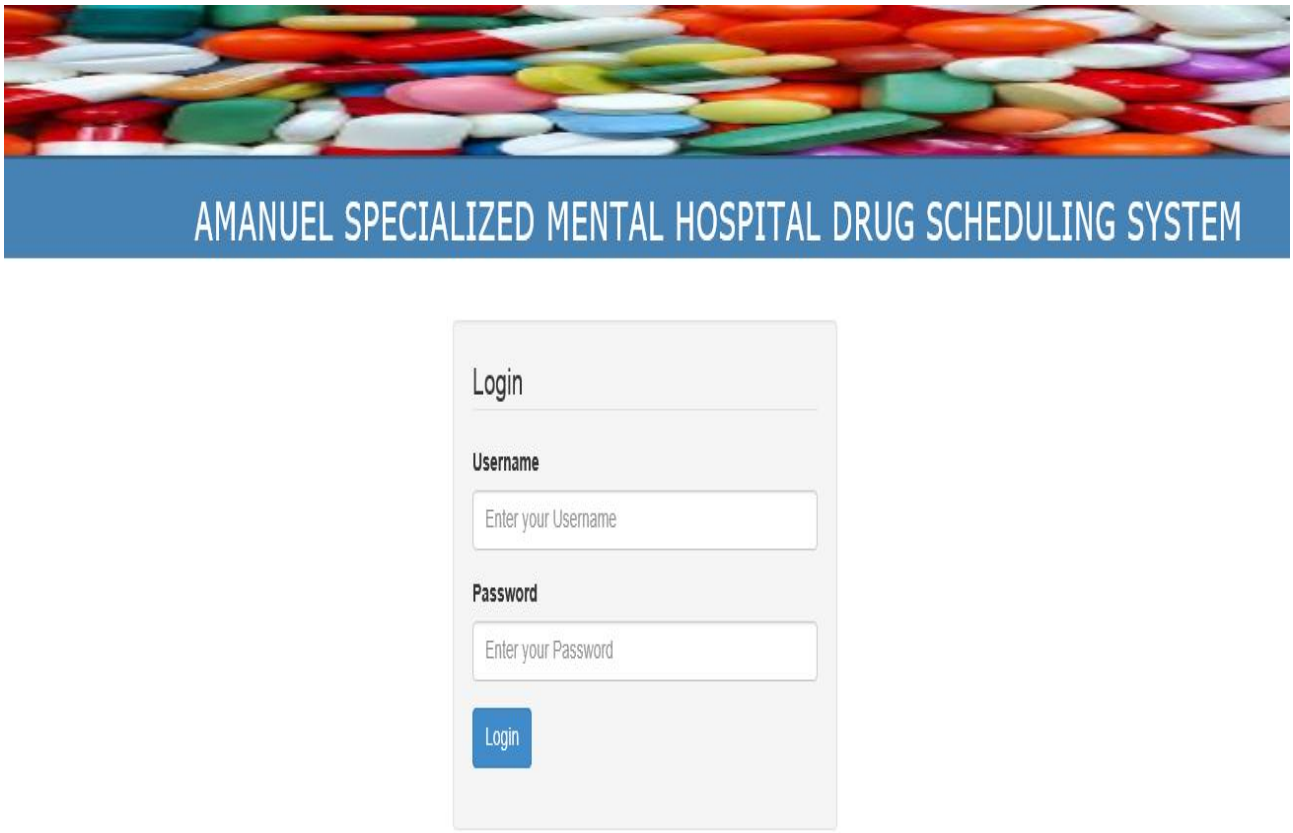
Reliability

The system works properly. Scheduling medication properly and performing other transactions efficiently.

Accuracy and Validity

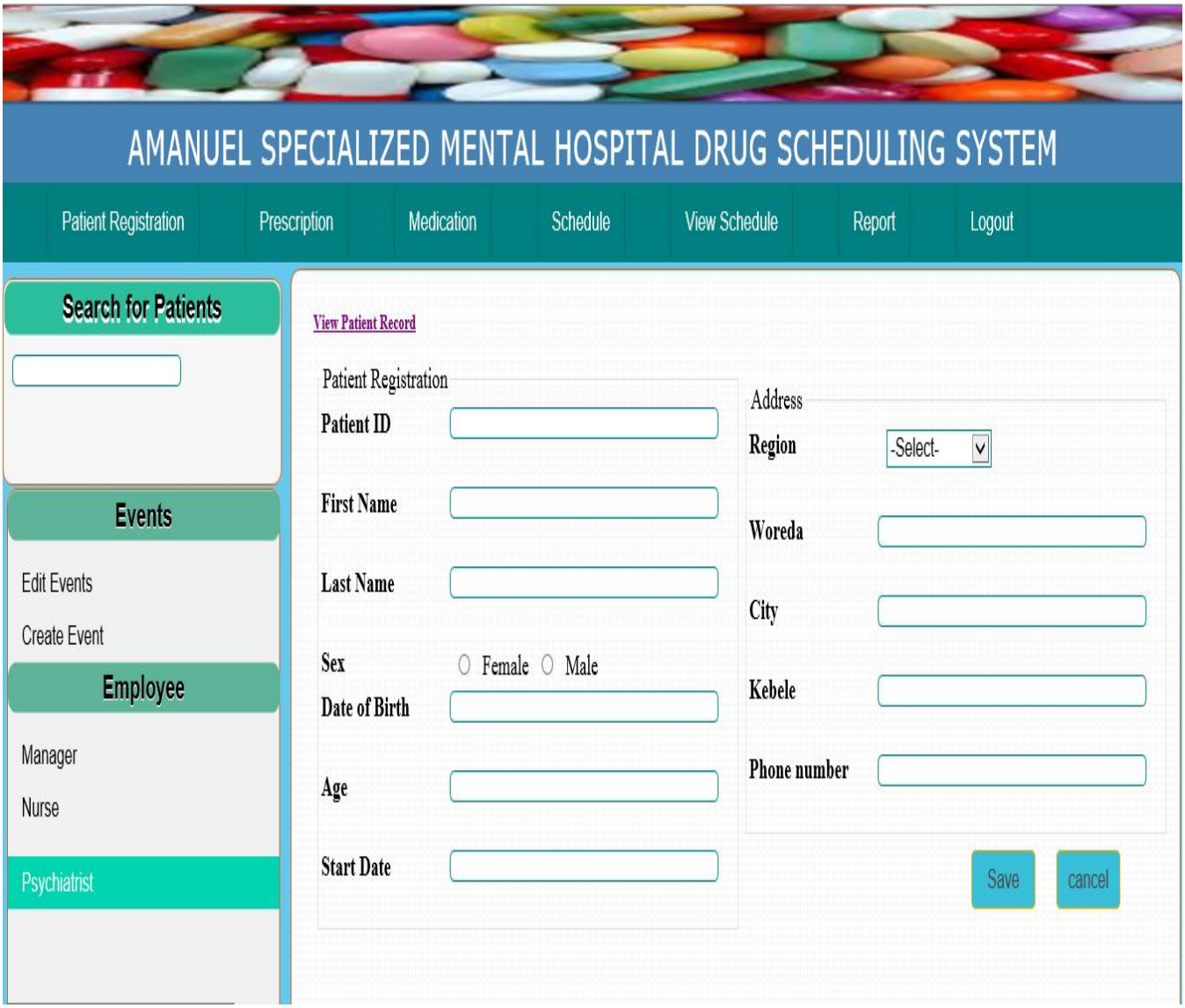
The system should design in a way to accurately entering data in to the system. The nurse will be able to enter data more efficiently with minimized time. To enhance accuracy and validity of the system using Input masks, Drop down lists with standard responses

4.8 User Interface for Drug scheduling system



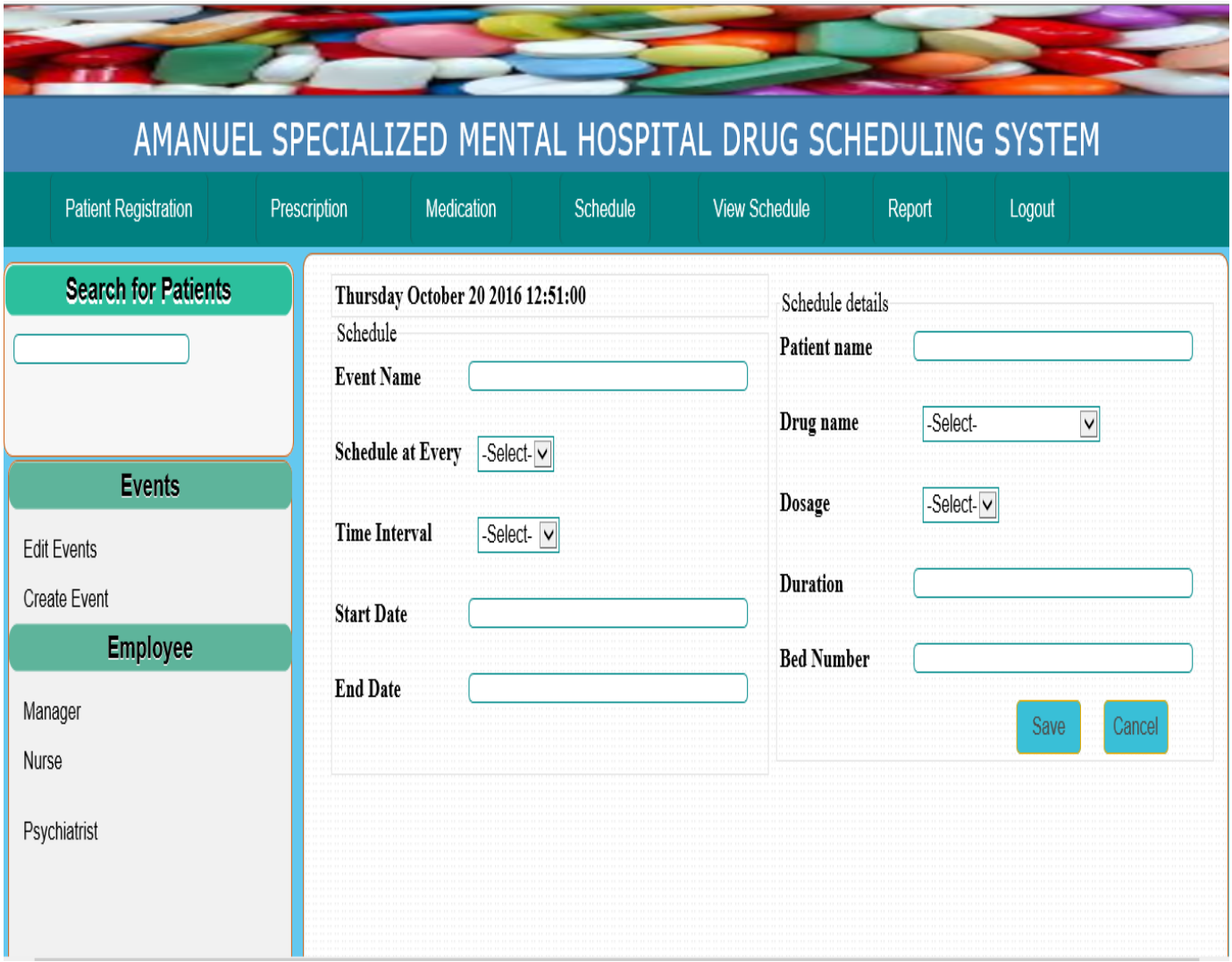
Authorized users will be able to login into drug scheduling sytem

Figure 7: Login page for Amanuel specialized mental hospital drug scheduling system



After logging in to the system the nurse will get patient registration form. This form is used to register new patients who are admitted to Amanuel Hospital.

Figure 8: Patient registration page for Amanuel specialized mental hospital drug scheduling system



The nurse schedules drug for each patients according to the prescription she took from the psychiatrist. Events are created for each patients these events have event name, schedule time interval for if the nurse wants to schedule the drug for 12 hours interval, she enters 12 HOUR interval. Then the start date and end date of the schedule will be entered. Then she will enter patient name, drug name, dosage, duration and Bedno.

Figure 9: Patient registration page for Amanuel specialized mental hospital drug scheduling system

Sample PHP code for registering patient information

```
<?php
$pid = $_POST['pid'];
$firstname = $_POST['firstname'];
$lastname = $_POST['lastname'];
$sex = $_POST['sex'];
$birthdate = $_POST['birthdate'];
$age= $_POST['age'];
$startdate = $_POST['startdate'];
$region = $_POST['region'];
$woreda = $_POST['woreda'];
$city= $_POST['city'];
$kebele = $_POST['kebele'];
$phnumber = $_POST['phonenumber'];

$dbhost="localhost";
$dbuser="root";
$dbpass="";
$dbname="amanuelhospital";
$con=mysqli_connect($dbhost,$dbuser,$dbpass,$dbname);
if(mysqli_connect_errno())
{
die("Database connection failed:" .mysqli_connect_error()."(".mysqli_connect_errno().")");
}

$query="INSERT INTO patient (pid,firstname,lastname,sex,birthdate,age,startdate,region,woreda,city,kebele,phonenumber)
 VALUES('$pid','$firstname','$lastname', '$sex','birthdate', '$age', '$startdate','region','$woreda',
'$city','$kebele','$phnumber')";

if (mysqli_query($con,$query))
{
$msg="Successfully entered data!!";
 echo "<script type='text/javascript'>alert('$msg');</script>";

 }
else
{

die("Data not entered successfully!");
}

mysqli_close($con);
?>
```

Figure 10: Sample PHP code for registering patient information

User interface description

Login Interface - This user interface helps user to login in to the system

Patient Registration interface – this user interface helps to register new patients

Prescription user interface – this user interface enables to keep medication prescribed by the psychiatrist.

Schedule user interface - this user interface enables to schedule drug according to medication prescribed by the psychiatrist.

Nurse registration interface – this user interface registers personal information about nurse

Allergy interface – this user interface enables to keep records of allergy/side effects of medication previously prescribed to patient.

Bed room interface – enables user to enter information of psychiatric patients admitted to the hospital regarding to their bed number, room and ward.

View schedule- this interface enables user to view all scheduled drugs.

View Report – enables to view report.

MYSQL EVENTS

MYSQL events enable tasks to run according to schedule. MYSQL scheduled objects are triggered with passage of time. An event's timing can be either *one-time* or *recurrent*. A one-time event executes one time only. A recurrent event repeats its action at a regular interval, and the schedule for a recurring event can be assigned a specific start day and time, end day and time, both, or neither. Users can create, modify, and drop scheduled events using SQL statements intended for these purposes.

Sample code to schedule drug

```
<?php
$dbhost="localhost";
$dbuser="root";
$dbpass="";
$dbname="amanuelhospital";
$con=mysqli_connect($dbhost,$dbuser,$dbpass,$dbname);
if(mysqli_connect_errno())
{
die("Database connection failed:" .mysqli_connect_error()."(".mysqli_connect_errno().")");
}

$query= "SET GLOBAL event_scheduler = 1";
$query=" CREATE EVENT $_POST[eventname]
     ON SCHEDULE EVERY $_POST[tinterval] $_POST[time]
      STARTS   '$_POST[startdate]'
      ENDS     '$_POST[enddate]'
DO
   INSERT INTO schedule  VALUES
   (NOW(),NOW(),'$_POST[patientname]','$_POST[drugname]','$_POST[dosage]','$_POST[duration]','$_POST[bedno]') ";

if (mysqli_query($con,$query))
{
$msg="Successfully created event!!";
 echo "<script type='text/javascript'>alert('$msg');</script>";

 }
else
{

die("Event not created successfully!");
}

mysqli_close($con);
?>
```

If there is change in prescription drug to be scheduled will be also updated to schedule table. This will make consistency in drug scheduled.

Figure 11: sample code to schedule drug

Discussion and results

Currently, Amanuel specialized mental hospital uses manual drug scheduling system. In this project, I aimed to design and implement automated drug scheduling system based on the user requirement gathered. The system helps the nurse to schedule drug for inpatients automatically and also the psychiatrist to enter prescription and allergy information of inpatients.

To implement drug scheduling system I used PHP for server side programming, HTML, CSS and Java script for client side and also MYSQL for database. For scheduling events I used MYSQL event scheduler.

The nurse they are comfortable with the user interface. While assigning bed number for patients I used unique bed numbers to identify patients who reserved the bed since each of the cups that contain their medication has ward number and bed number of patient the medication is ordered for. In the current system there are a total number of 11 wards for 270 patients. Each ward contains averagely from 12 to 20 beds. For example ward 1 can have bed number 1-12 and ward can also have 1-20 bed numbers. Patient's who reserved the bed are identified by both ward number and bed number. Assignation of unique bed numbers can help to reduce duplication.

This system can help the time that can take to schedule drug manually. Patients can take averagely from 4-12 medications per day both antipsychotic and other drugs ordered for co-morbid diseases. Scheduling these medications for all patients manually is tiresome. When we come to functionality and accuracy, the system will save more scheduling time for drugs prescribed for patients with consistent and fixed dosage.

For most of the time, prescription of antipsychotic medication for psychiatric inpatients is not performed with consistent dosage and duration. As the Medical Doctor who prescribes drug for patients told me, knowing the right dosage of medication is difficult. Estimating the range of dosage depends on the current status of the patient and patient's response to the medication. For example patient can take 5mg morning and 10 mg evening at 12 hours interval. Using the new system to schedule drug for long duration and inconsistent dosage is difficult. Because of these, when there is change in medication, dosage, and duration the system can help the user to edit and update this information.

In addition to schedule drugs the new system can help to keep all medications taken by patients. Keeping all medication prescription, allergy, schedule of drug can support the psychiatrist to have all necessary information aid decision making of process of in delivering better care for patients. This will aid in enhancing medication adherence and compliance for patients. Timely scheduling can help the nurse not to forget medication to be scheduled for the patients.

This system can consistently schedule drug for patients who have prescribed medication for fixed duration and dosage. Most of the time patients will have fixed medication order when they are discharged from the hospital. They take medication with fixed doses because they situation is more stable at this time than they were admitted.

5. CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Administering medication safely is the most crucial part of patient care. Nurse plays a vital role in administering medication. This activity is performed multiple times in a day for an individual patient. It is a complex process therefore accurate documentation of the medication administration very important. Creating drug schedule for patients can be time consuming and error prone.

As medication management improvement achieves significant gains in safety and quality, the change agent argues that it must be transformed to improve processes and reduce the risks involved.

This project aim to design and implement drug scheduling system for Amanuel specialized mental hospital. The system uses MYSQL events scheduler to schedule drug for patients. The system enables users to schedule drug once in is scheduled according the prescription. Drug scheduling system is used to save time and resources that takes to schedule drug manually. This system is helpful in making the nurse more concentrated in care giving to psychiatric patients that wasting time to schedule drug manually who schedules drug if used properly.

The new automated system will enable patients to have a better service from the hospital. This will minimized error and increase efficient care giving. This system will also help to minimize the time taken to schedule drug. This will help the nurse to focus on care giving than doing the scheduling task. This system will help to solve current problems.

5.2 Recommendation

Treating a chronic mental health disorder with medication is a process that requires an ongoing commitment. In order to maintain medication compliance, patients should take medication as prescribed with ordered dosage and time. Drug scheduling system will help patients to obtain their medication history in a managed way.

By integrating the current system with SMS services this application can be developed for outpatient psychiatric patient's mobile based drug scheduling system. So they can keep track of all their medication history and set reminders for medication time after leaving the hospital. Care givers will be able to keep medication history of patients and also will be able to monitor treatment progress of outpatients with their medication regimen. This will not only help for psychiatric patients but also for other chronic diseases like diabetes or pregnant women to remind them to take all prenatal vitamins and prescribed medications. By developing more usable and easily accessed system patients will be able to use such systems to keep their medication list and set reminders at home.

Hospitals can improve their services by using these kinds of system. Patients will be able to get better services both at home and at health care level.

To effectively prevent and treat mental and substance-use illnesses taking medication as prescribed is very important. Since Prescribing and managing psychiatric medication is a complicated process. Government and health care organizations, other public and private-sector can contribute in supporting such kinds of system to help patients receive the high quality care for mental and substance-use conditions. Implementing these systems can enhance treatment adherence for patients. Since there have been strategies tried to enhance patient's medication with technologies such as telecommunication. If such system is widely used it can aid a lot in managing long term illnesses like mental illness.

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Appendix A

Software Requirement Specification Document

For

Amanuel Specialized Mental Hospital Drug Scheduling System

CHAPTER ONE

1. Introduction

Electronic medical records and other digital technologies is known to progress patient outcomes by helping hospitals identify and track infections, medication errors and other adverse events and alerting physicians to drug interactions and other problems. The healthcare industry have been facing demands in technology advances so that it can reduce process inefficiencies; control spiraling healthcare costs, and improve the quality of patient care [**55**].

Electronic medication management systems have become the main mechanism to prevent medication error. The manual based system of physician orders and medication administration brings human errors. The main goal of health care is to utilize Information Technology so that providers can make sure patients receive the highest quality of care and best outcomes while improving operational efficiencies and costs in the healthcare system. Healthcare professionals consider that the use of IT offers the industry tremendous potential for resolving some of its most important problems, namely the rising number of medical errors, poor health service quality, care fragmentation, and limited access and integration to patient information [**56**].

A potential error is a mistake in prescribing, dispensing, or planned medication administration that is detected and corrected through intervention by another health-care provider or patient before actual medication administration. One of the recommendations given by to reduce medication error is the development of organizational system for prescription, dispensing and administering medication [**57**].

Medication compliance is a main factor in minimizing the mortality and hospitalization rate. To reduce the cost and burden on public health systems, it is important to bring down unnecessary hospital admissions due to poor medication compliance but also to increase health and medication awareness among people. There are many benefits of using automated system. The major benefits are increased productivity, minimized time in manual operation, and an increase in decision making and process speed [**58**].

This project the design and implementation of drug scheduling for Amanuel Mental Specialized Hospital.

1.2 Objective

The objective this project is to design and implement drug scheduling system for Amanuel Specialized mental hospital

1.3 Purpose

The system will enable the nurse register patient's demographic data into the system and also helps the nurse to schedule drugs ordered by the psychiatrist. The system will enable the prescriber to enter all prescribed medication for psychiatric patients who are admitted to the hospital and to keep allergy and side effects information. This system will somehow help to overcome the problem that comes from manual scheduling stated in literatures. Scheduling of drug can reduce the time takes the nurse to schedule manually so that she/he can give more time for caring for the patient. The hospital can benefit from time saving feature of automated scheduling system. This system will help patients to keep all information regarding to medication prescribed to them during their stay at the hospital. This system will keep all information about allergies/side effects of medication patient took.

1.4 Scope

The scope of the project system scope is to design and develop automated drug scheduling system for Amanuel specialized mental hospital. The design and development of the system is limited to inpatient psychiatric patients. The project designs system that schedule drug for psychiatric patients who are admitted to the hospital. The design and implementation drug scheduling system does not include scheduling drug for other in patients who are admitted to the hospital. This system will design, prototype and implement and Test Drug scheduling system for Amanuel Specialized Mental Hospital.

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CHAPTER TWO

2. Functional Requirements

The functional requirements describe the core functionality of the application. The functional requirement expected from the system is described below

Req. ID	Requirement Description	Requirement code	Ranking	
			Mandatory	Optional
1	The system should authorized users to login into the system	UC-1	✓	
2	The system should enable user to keep patient's personal information – keeping all personal information of patients and their address.	UC-2	✓	
1.	The system should enable user to schedule drug for patients	UC-3	✓	
2.	The system should enable user to register prescribed medication	UC-4	✓	
3.	The system should be able to register allergy information	UC-5	✓	
4.	The system should keep diagnosis detail of the patient	UC-6	✓	
5.	The system should enable administrator to Manage User	UC-7	✓	
6.	The system should enable user to view scheduled drugs	UC-8	✓	
9	The system should enable administrator to employee	UC-11	✓	
10	The system should generate report	UC-12	✓	

Table 2: Functional Requirements

CHAPTER 3

3. Non-Functional Requirement

User friendliness

The system should have a good user interface. The novice user can simply follow the instructions to use the system without special computer techniques. This is achieved by options to configure the font size, multilingual, optical zoom, quick response time, tool tip, configure themes, auto update feature, and detailed catalog with search feature.

Maintainability

The system should be easy to be maintained by administrators. The system's database should be back up every week. After certain of time, the system should be added new function, new features so that it can provide user good qualities.

Security

In order to design a well system there should be a way of securing the system from unauthorized User. The system should be able to be accessed by only an authorized person with privilege. Usin g virus protection, backup and recovery plan and installing firewall. Physical protection of data s hould also be considered. .

Availability

The system should be available 24 hours a day and 7 days a week.

Usability

Easy to use interface that allows users to work with the system without difficulty.

Reliability

The system works properly. Scheduling medication properly and performing other transactions efficiently.

Accuracy and Validity

The system should design in a way to accurately entering data in to the system. The nurse will be able to enter data more efficiently with minimized time. To enhance accuracy and validity of the system using Input masks, Drop down lists with standard responses.

3.1 System Features

- User will be able to enter patient history
- Physician will be able to enter prescription order of patients
- Update prescription orders
- User will be able to set daily, weekly or monthly schedule.
- Displays on screen scheduled medication for patients
- Search for prescription orders
- Search for medications
- Search for patients
- Keep and search for allergies or side effects
- Rescheduling of the medication for patients with symptoms of side effect or allergies and updating it. The system should allow the user to select a day, time, or event and reschedule all appointments for another day, time, or event. Saving the new medication's time and date.
- Retrieve the medication schedule for specified date, weeks or months
- Generating report

Current Business Scenario of Amanuel Mental Specialized Hospital for inpatient psychiatric patients drug scheduling

- Registration- New Patients are registered. The registration process. Patient's medication history is kept in triage section.
- Prescription – Whenever a new patient is admitted to the hospital new drug prescription is given to patients. Patient's progress will be monitored by the nurse for one up to two weeks. If medication brings side effect other medication is prescribed. Otherwise patients will continue taking the prescribed drug.
- Schedule – The nurse schedules for drug before distributing the drugs to the patients. Schedules are developed twice a week on Monday and on Wednesday. Patients take their medication twice a day. There are other medications that are also administered if patients

are diagnoses with other diseases. Patient queue every morning and evening at the nurse's office.

- Diagnosis – patients visits psychiatrist weekly to monitor their progress. Psychiatrist change prescribed medications if there are drug side effects or patients refuse to take medication. Most of the time medications are given orally. If patients refuses or sometimes cheat, inject able medication are given. There is a medication that is given once a month if the patient totally refuses to take the other kinds of medication. This medication is given by vein, called IV. The progress for this medication is slow compared to other types of medications

CHAPTER 4

4. System Modeling

4.1 Analysis Models

4.1.1 Use case diagram modeling

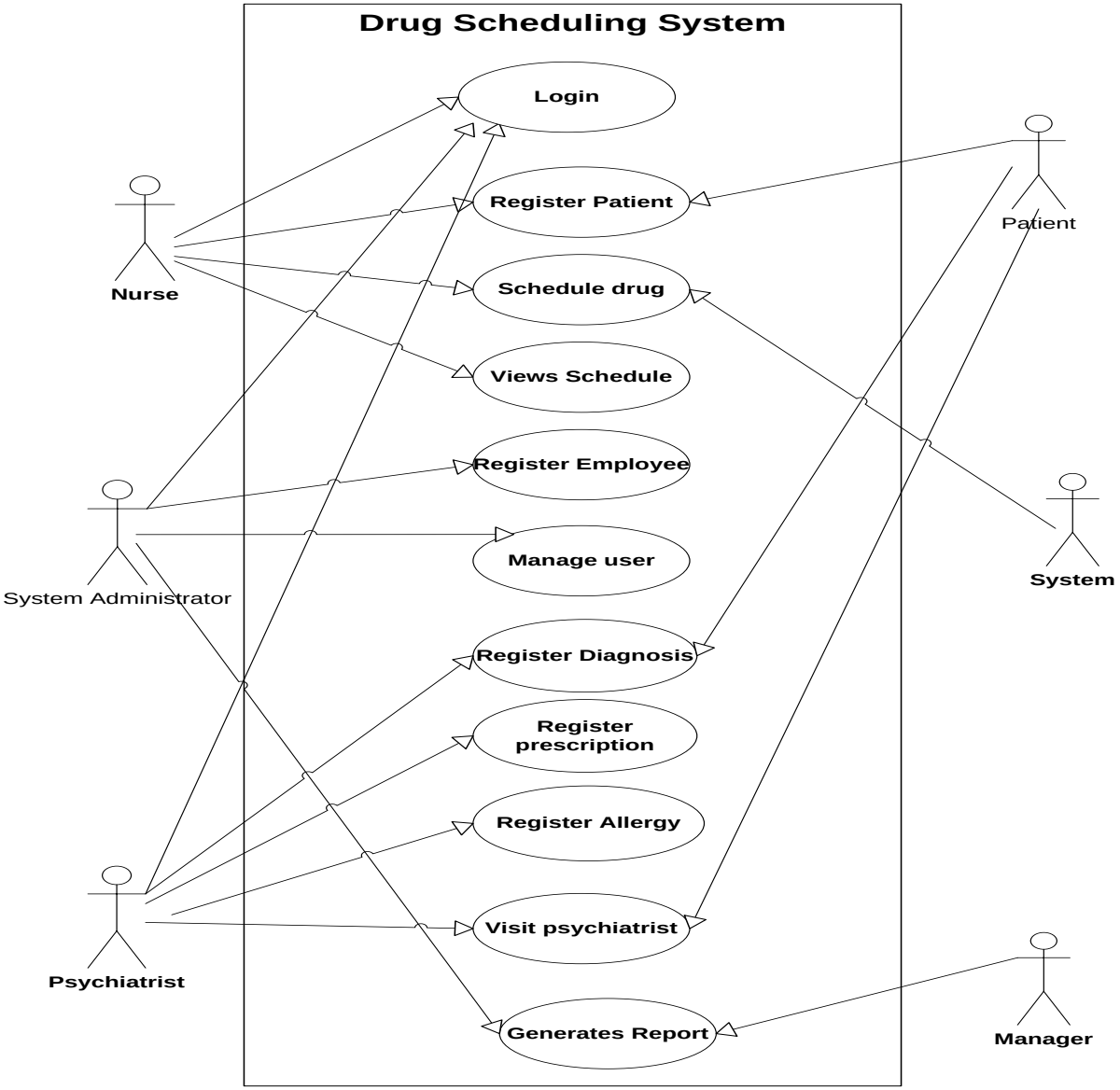

Figure 12: Use case diagram

4.1.2 Use case Description

Use case 1: Log in

Use case ID	**UC-1**
Use case Name	**Log in**
Priority	**High**
Summary Description	This use case describes how the actor logs in to the system to update, change patients' information or register patients
Primary Actors	Nurse, Psychiatrist, Administrator, Manager
Pre-condition	User account is created for the User
Post condition	The user logs in to the system if login in success. If log in is unsuccessful the system is shows the login page
Main Flow	1. The user Opens the system 2. The system displays login page 3. The Actor enters his/her user name and password 4. The system validates username and password and the actor logs in to the system 5. The main page is displayed for the user
Alternate Flow	If invalid username or password the system displays an error message. The system displays a message to re-enter the username and password again. The actor follows the basic steps again to login or leave the login page

Table 3: Login Use case Description

Use case 2: Register Patient

Use case ID	**UC-2**
Use case Name	Register Patient
Priority	High
Use case Description	The Nurse registers patient if new
Primary Actors	Nurse
Pre-condition	Patient's should be admitted to the hospital User should log in to the system
Post condition	New patients will be able to be registered
Main Flow	1. The system is opened 2. The nurse makes sure if the patient is new by the searching patient's information from the system 3. If the patient is new, the nurse will enter all important patients' information in to the system 4. The Nurse saves the new information entered about the patient in to the system
Alternative Condition	If the patient already exists, the nurse will skip the basic flow and do other transaction he/she wants to do.

Table 4: Register Patient use case description

Use case 3: Schedule drug

Use case ID	**UC-3**
Use case Name	Schedule drug
Priority	High
Use case Description	The Nurse schedules medication as prescribed by the physician
Primary Actor(s)	Nurse, system
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system 3. Medication should be prescribed by the psychiatrist
Post-condition	The Schedule is created successfully with exact date/time and patients lists and Drug lists.
Basic Scenario	1. The user opens the system 2. The user select schedule tab after logging into the system 3. The system displays the schedule interface 4. The user enters event name for the patient she/he wants to schedule 5. The user enters the time interval of the schedule 6. The user enters the start and end date of schedule 7. The user enters Patient name, drug name, Dosage bed number 8. Save the schedule
Alternative Scenario	If there is time change , medication change or other changes 1. The user Edit Events tab 2. The user selects the name of the patient she/wants to edit drug schedule 3. The user click on update 4. The user enters the new data into the system

Table 5: Schedule drug use case description

Use case 4: Register Prescription

Use case ID	**UC-4**
Use case Name	Register Prescription
Priority	High
Use case Description	The psychiatrist register prescription order for patients
Primary Actor(s)	Psychiatrist
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system 3. Medication should be prescribed by the psychiatrist
Post-condition	Drug orders are entered to the system
Basic Scenario	1. The user opens the system 2. The user points on prescription tab and selects prescription from drop down menu 3. The system displays the prescription page 4. The user enters prescription details to the system 5. Save the data
Alternative Scenario	If there is change in medications 1. The user should follow the basic scenario to enter the new medications since all prescription orders should be kept to the system. But if there error he/she can edit prescription 2. The user clicks on view prescription from prescription page 3. Click on Edit and enter the new data 4. Save

Table 6: Register Prescription use case desciption

Use case 5: Register Allergy

Use case ID	**UC-5**
Use case Name	Register allergy
Priority	High
Use case Description	The psychiatrist register allergy/side effects of prescribed medication for patient
Primary Actor(s)	Psychiatrist
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system 3. There should known side effects of prescribed medication
Post-condition	Allergy/side effects of must be entered to the system
Basic Scenario	1. The system is opened 2. The user points on prescription tab and selects allergy from drop down menu 3. The system displays the allergy page 4. The user enters allergy details to the system 5. Save the data
Alternative Scenario	User clicks on cancel

Table 7: Register Allergy use case description

Use case 6: Register Diagnosis

Use case ID	**UC-6**
Use case Name	Register Diagnosis
Priority	High
Use case Description	The psychiatrist register diagnosis of admitted patients
Primary Actor(s)	Psychiatrist
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system
Post-condition	Diagnosis data is entered to the system
Basic Scenario	1. The system is opened 2. The user points on prescription tab and selects diagnosis from drop down menu 3. The system displays the diagnosis page 4. The user enters diagnosis details of patient in to the system 5. Save the data
Alternative Scenario	User clicks on cancel

Table 8: Register Diagnosis use case desciption

Use case 7: Manage User

Use case ID	**UC-7**
Use case Name	Manage User
Priority	High
Use case Description	Administrator manages user account
Primary Actor(s)	Administrator
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system
Post-condition	User accounts are managed
Basic Scenario	1. The creates user account for users 2. The grants or deny pages user should access 3. The user deletes or update or create user account
Alternative Scenario	

Table 9: Manage User use case description

Use case 8: View Schedule

Use case ID	**UC-8**
Use case Name	View Schedule
Priority	High
Use case Description	Nurse Views schedule previously created
Primary Actor(s)	Nurse
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system
Post-condition	User will be able to view scheduled drugs
Basic Scenario	1. The system in opened 2. The user clicks on view schedule tab 3. The system displays the schedule page 4. The user views for schedule drug the system 5. Go back to other page
Alternative Scenario	User clicks on cancel

Table 10: View Schedule use case description

Use case 9: Register Employee

Use case ID	**UC-9**
Use case Name	Register Employee
Priority	Optional
Use case Description	The Administrator registers employees who are actively involved in drug scheduling process
Primary Actor(s)	Administrator
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system
Post-condition	Register employees personal information
Basic Scenario	1. The user opens the system 2. The clicks on which employee he/she wants to enter personal information for from side pane(left) 3. The user enter employee information to the system 4. Save the data
Alternative Scenario	User clicks on cancel

Table 11: Register Employee use case description

Use case 10: Generate Report

Use case ID	**UC-10**
Use case Name	Prescribe
Priority	High

Use case Description	The administrator generate repot
Primary Actor(s)	Administrator
Secondary Actor	Manager
Pre condition	1. The user must have privilege to access the system 2. User must be logged in to the system
Post-condition	Report will be generated
Basic Scenario	1. The user opens the system 2. The user points on report tab and selects report from drop down menu 3. The system displays the report page 4. The user enters report details they want to generate 5. System displays generated report 6. Save the data
Alternative Scenario	User clicks on cancel

Table 12: Generate Report use case description

4.1.3 Activity Diagram

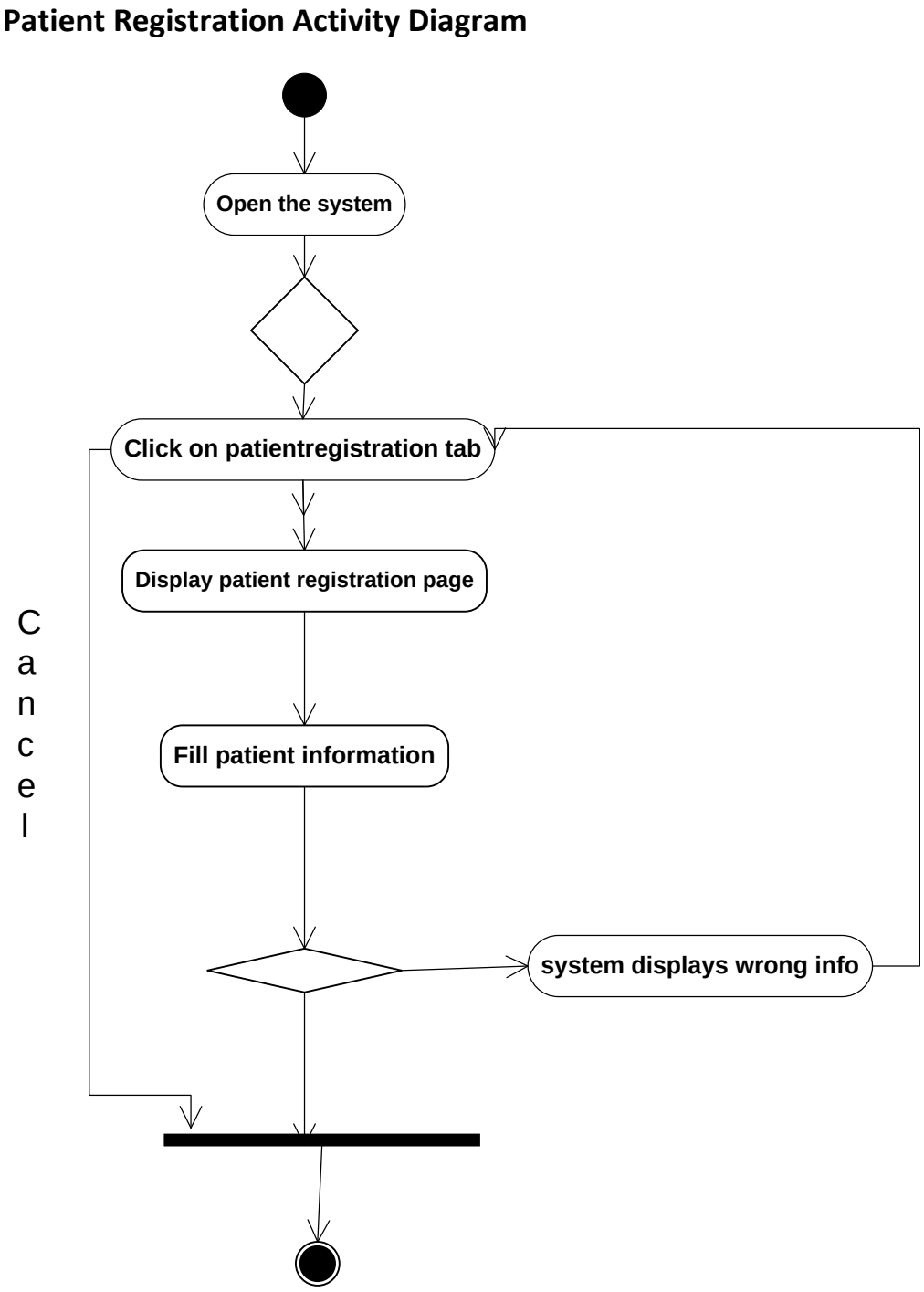

Figure 13: Patient Registration Activity Diagram

Prescription Activity diagram

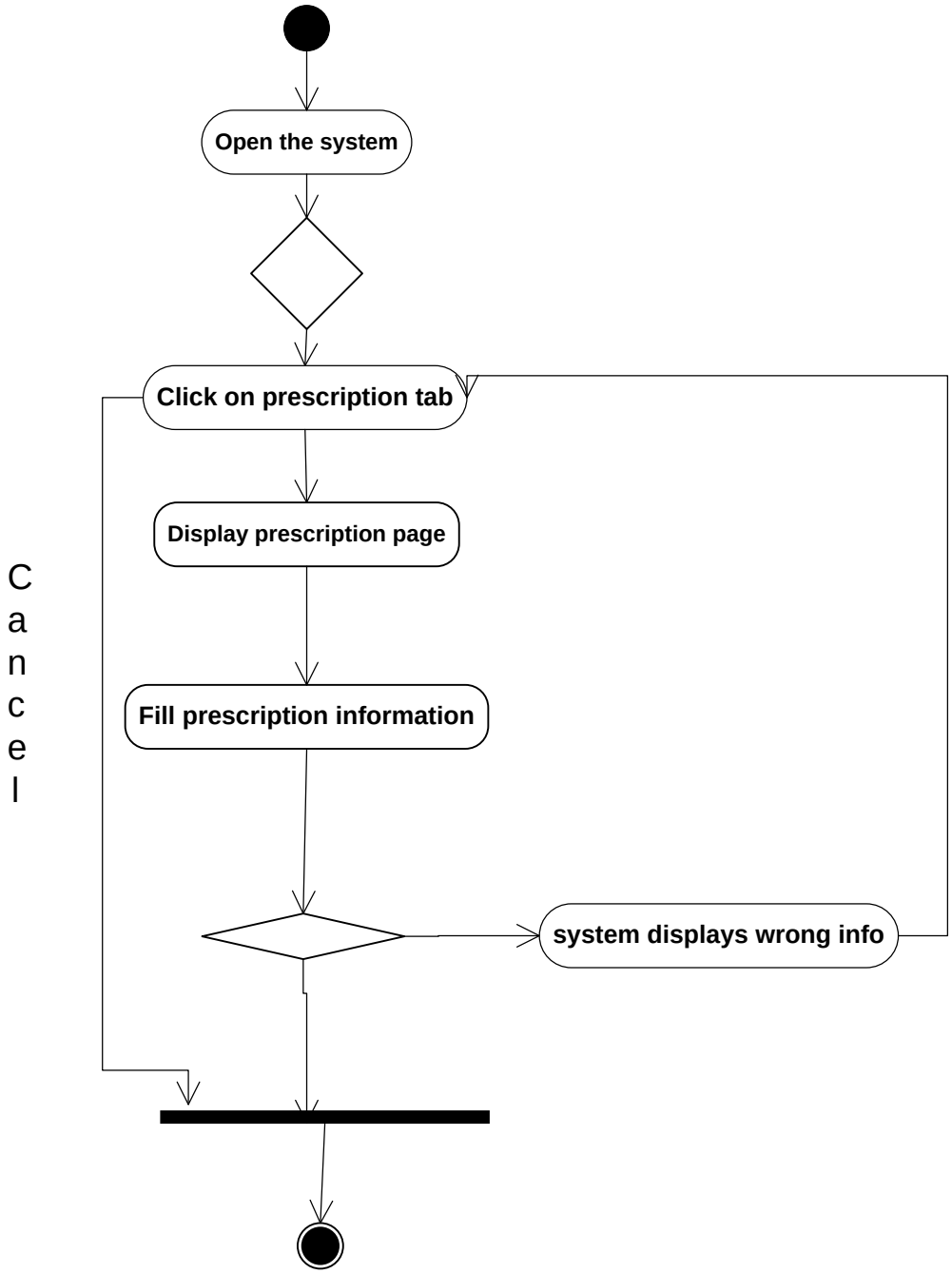

Figure 14: Prescription Activity diagram

Drug Schedule Activity Diagram

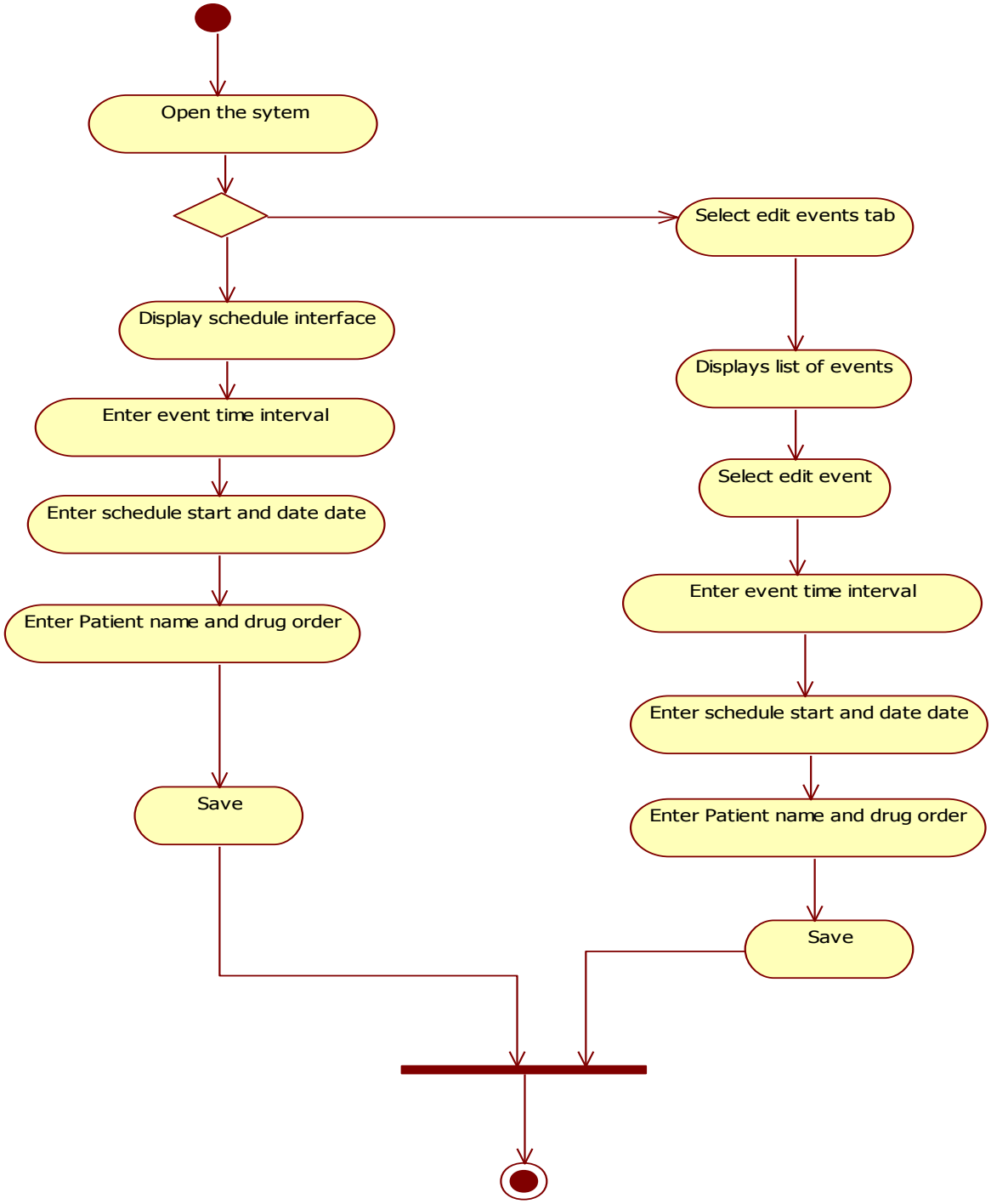

Figure 15: drug schedule activity diagram

Register Allergy Activity diagram

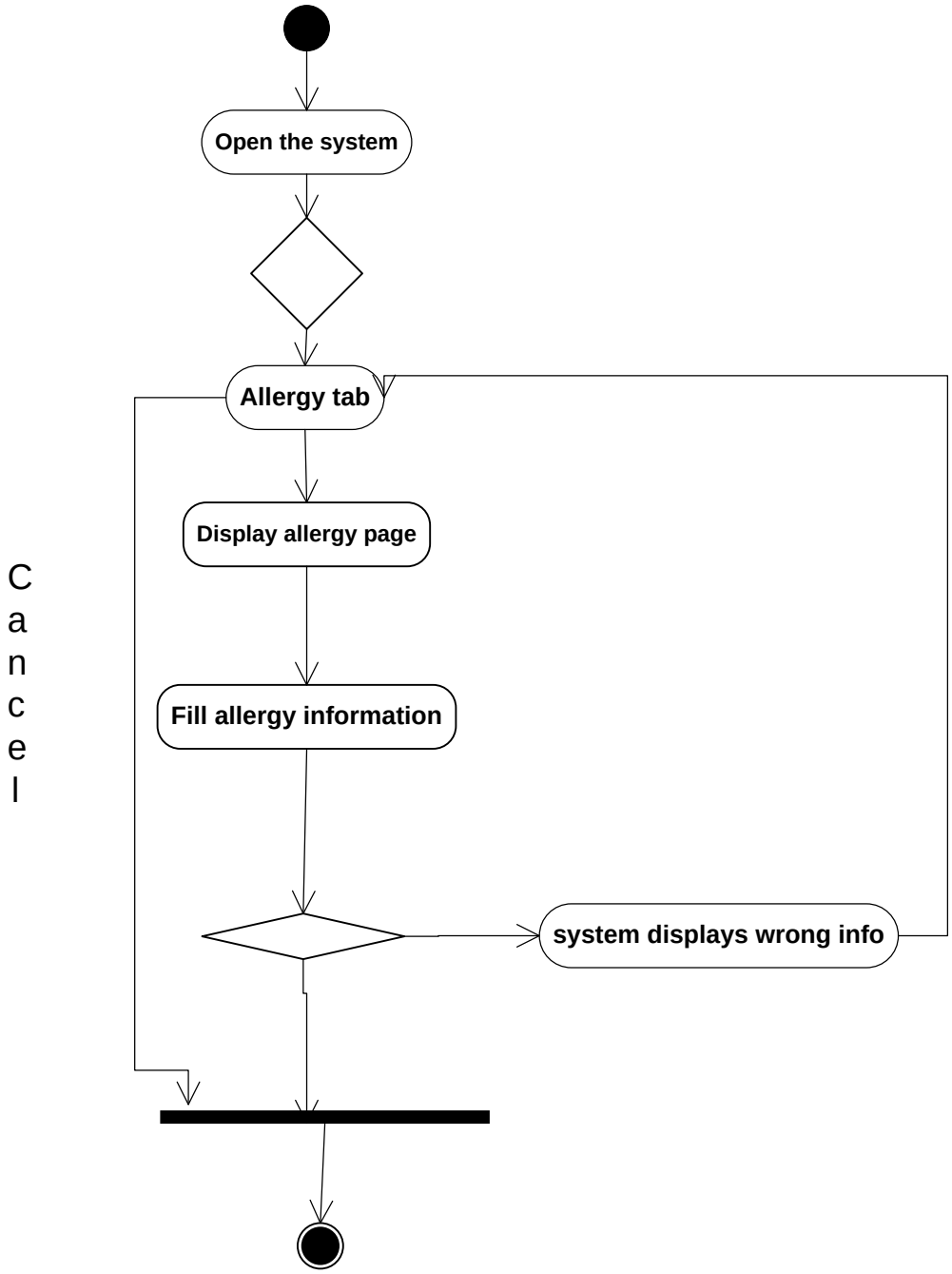

Figure 16: Register Allergy Activity diagram

4.2 Object Modeling

Object and their relationship in drug scheduling system are described in this section.

4.2.1 Data Dictionary

Patient: Patient is a person who is admitted to the psychiatric hospital with in intensive care unit.

Schedule: A medication time chart that saves the time where the patient should take their medicines

User: An authorized person with privileges to access the system, to modify and schedule the drug for the patients.

System: A system calculates the time medication of drug to be taken by patients and executes it according the time set the nurse.

Psychiatrist: A person who regularly checks patient's progress when patient visits him/her. And also prescribe drug

4.2.2 Class Diagram

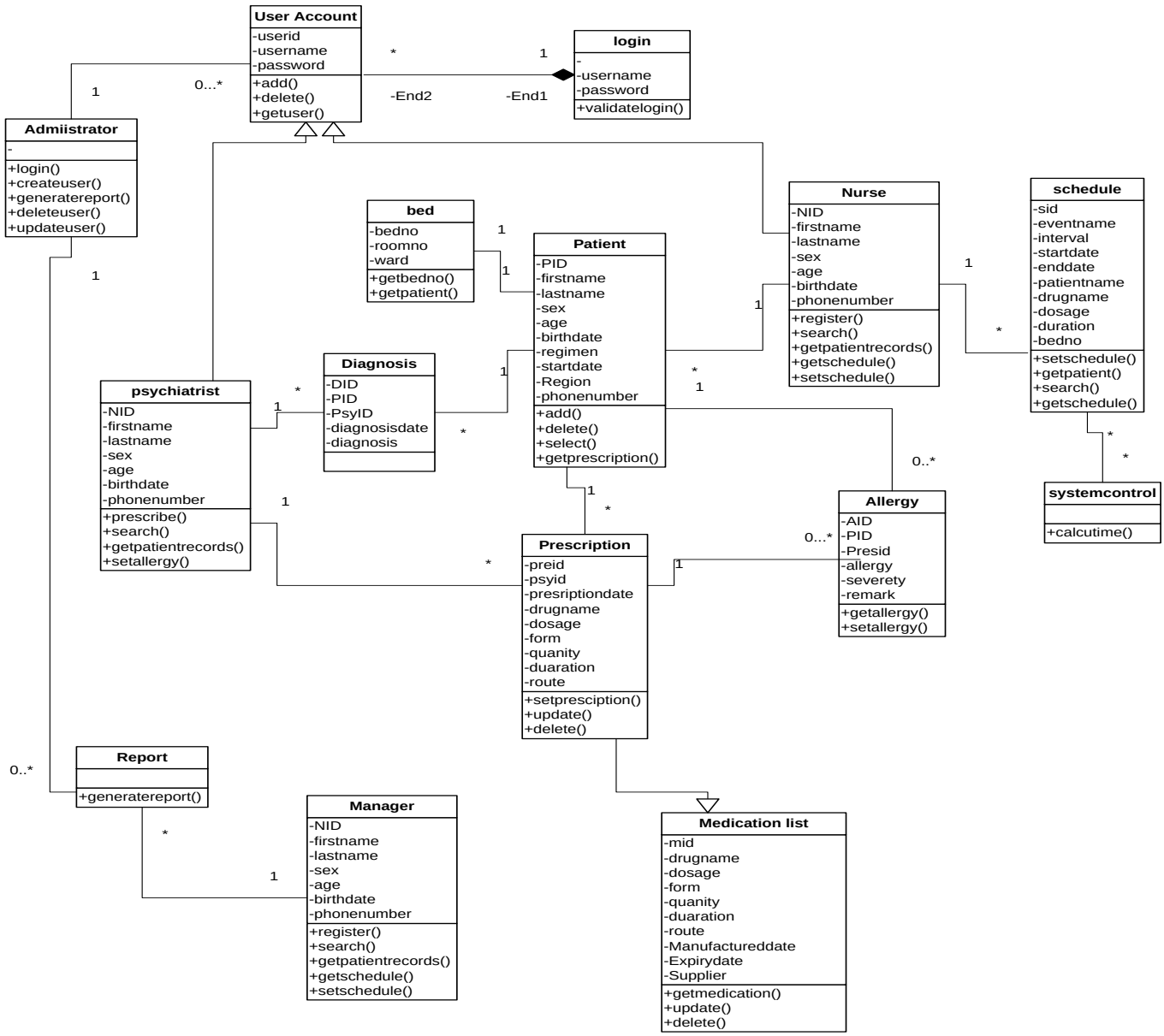

Figure 17: Class diagram

4.3 Prototype Presentation

Patient registration user Interface

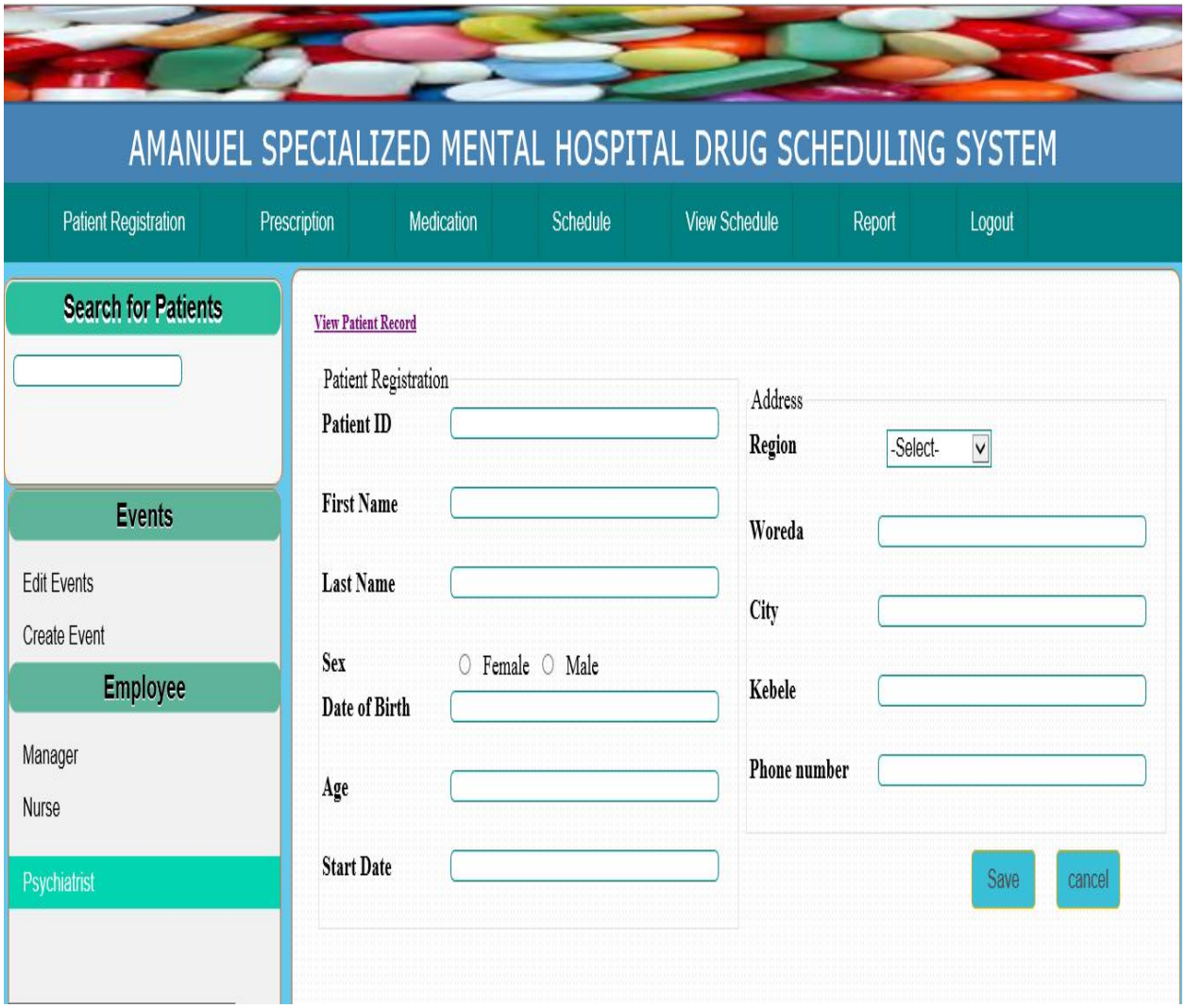

Figure 18: Patient registration interface

Prescription user interface

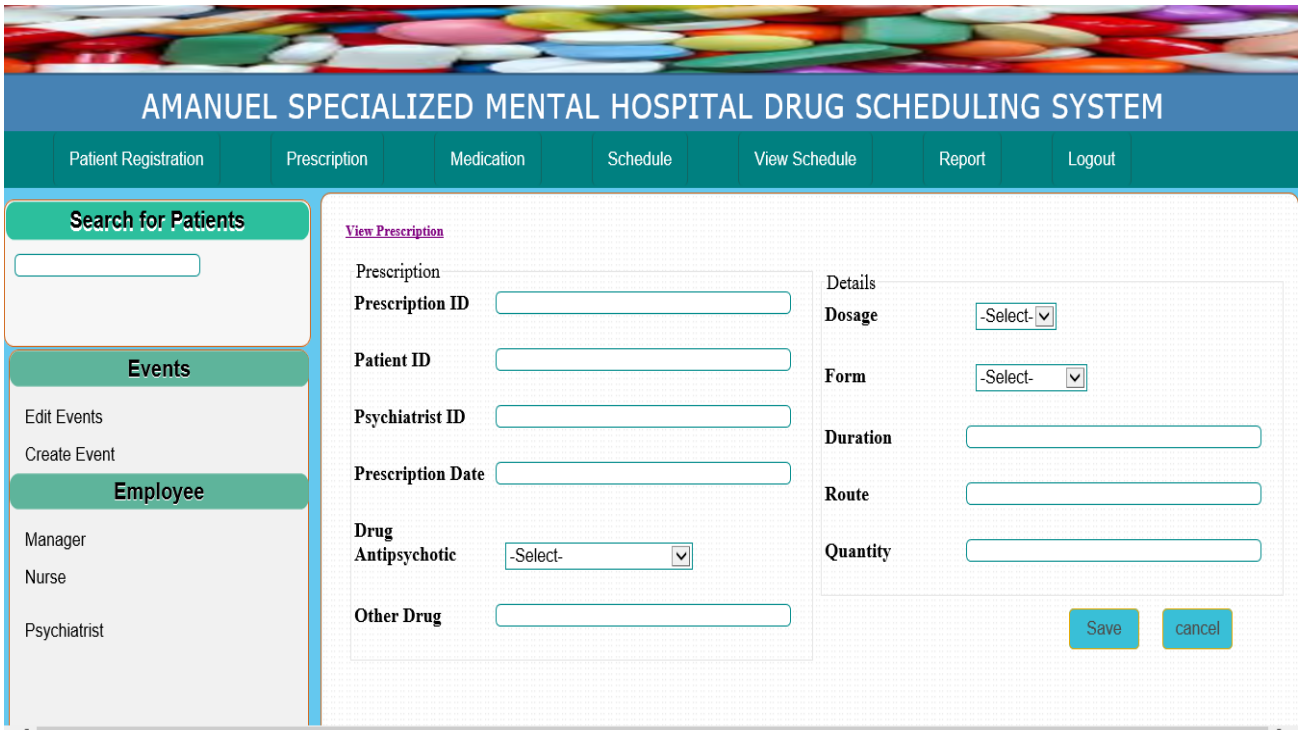

Figure 19: Prescription user interface

Drug scheduling user interface

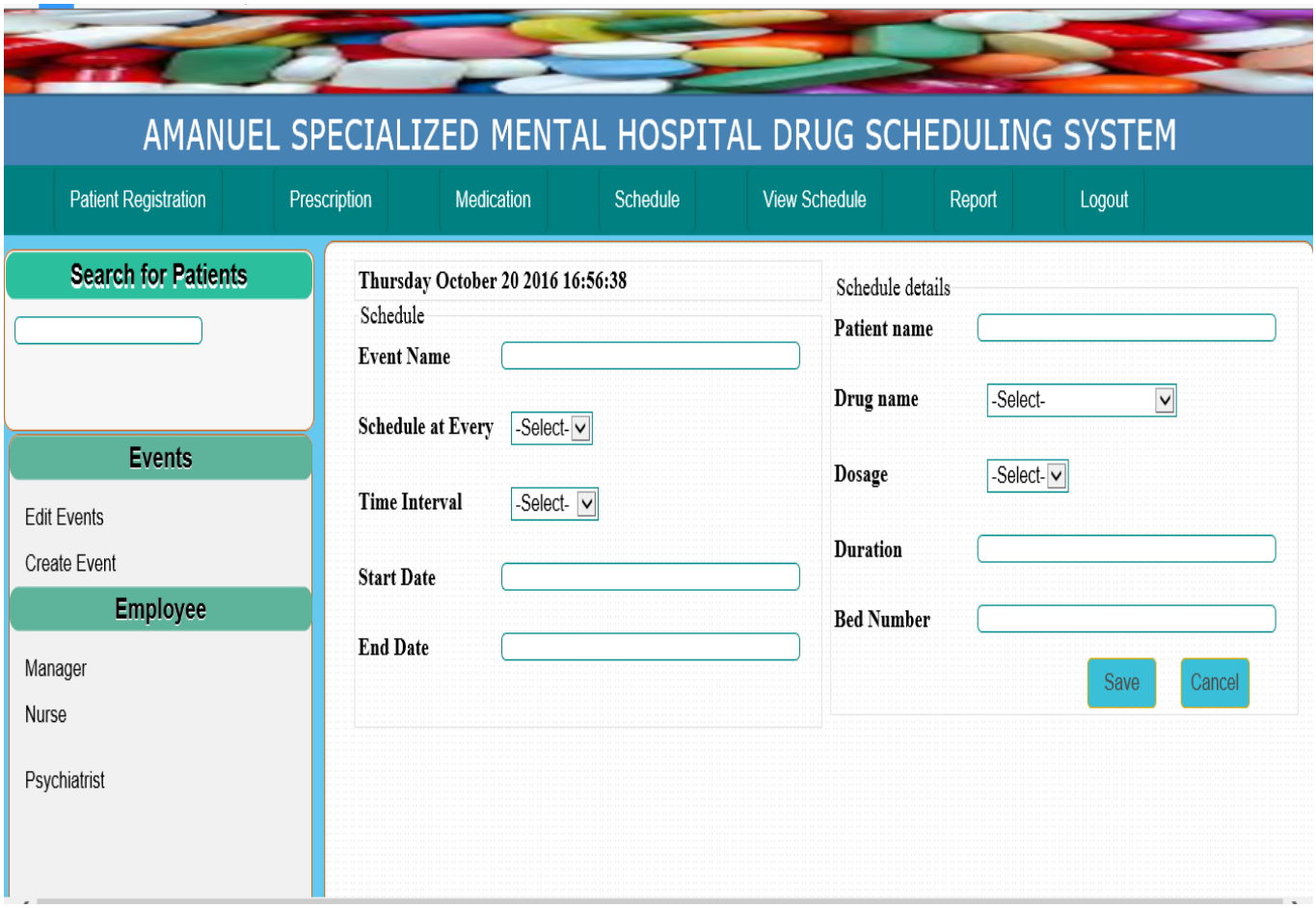

Figure 20: Drug scheduling user interface

Allergy user interface

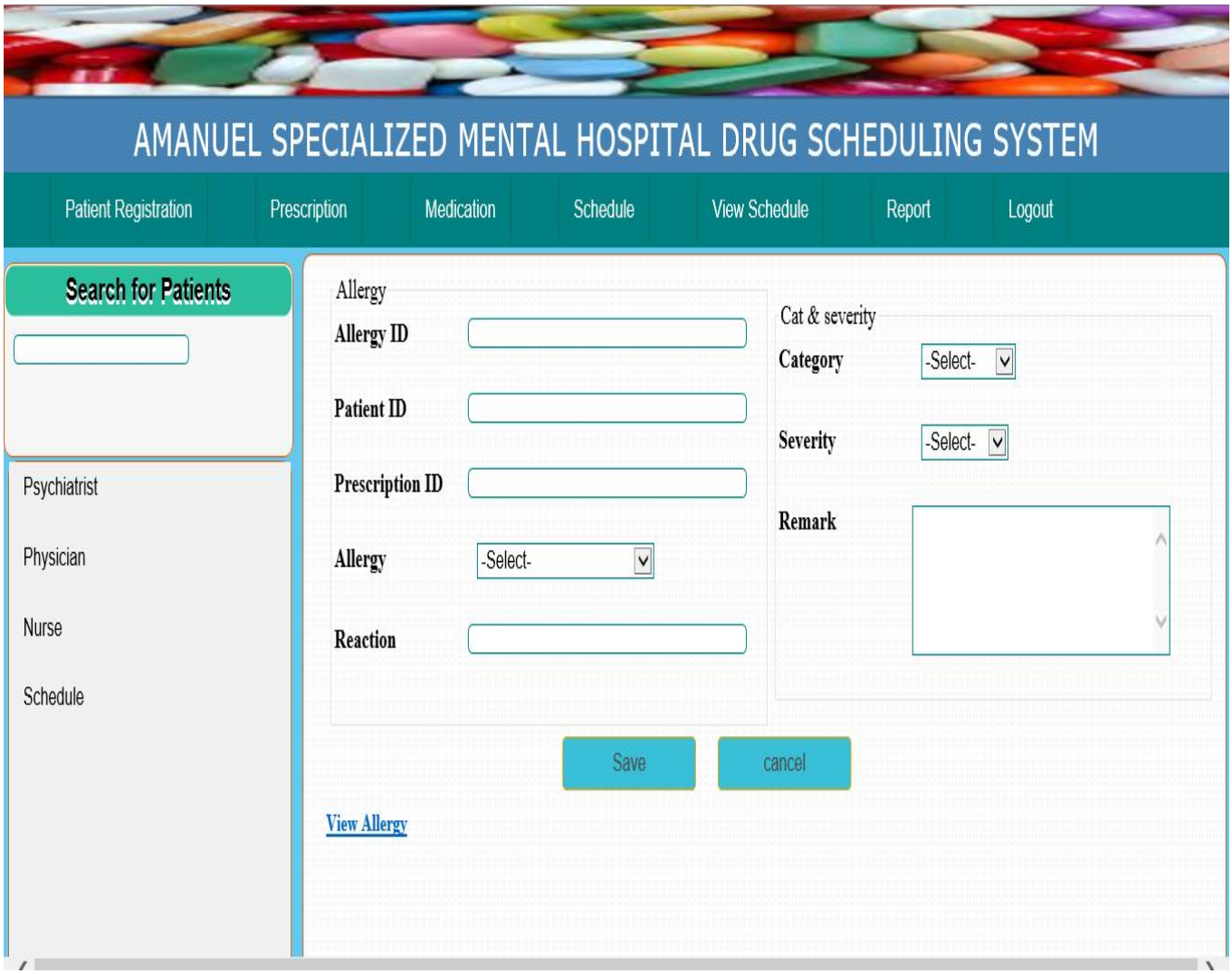

Figure 21: Allergy user interface

In depth Questionnaire

For HMIS Personnel

1. How many Physiatrists and Total Healthcare professionals are there working in the Hospital?

   _____

2. How many Physiatrists nurse are working in the hospital?

   _____

3. How many patients are admitted to the Hospital last year?

   _____

4. What is the Nurse to patient ratio?

   _____

5. Psychiatrist per patient?

   _____

   _____

6. How many beds does the hospital currently have?

7. Is the Hospital using automated system or manual currently?

   _____.

8. How do you record the prescription you got from the psychiatrist

For psychiatric Nurse

9. How do you schedule drug for patients?

   _____

10. When do you schedule drug and for how long do you use the schedule?

    _____

    _____

11. How often error while scheduling drug?

    _____

    .

12. What is the problem of scheduling manually?

    _____

    _____

13. Are there near misses or change in schedule?

    _____

    _____

14. What do you do patients refuse to take prescribed medication or cheating?

    _____

    _____

15. While scheduling, do errors occur drug from disturbance the environment.

    _____

    _____

16. Is the manual scheduling time consuming?

    _____

_____

17. How long does a patient take the medication?

_____

_____

18. How often the medicine and medicine time change?

_____

_____

19. How do you record the prescription you got from the psychiatrist?

_____

_____

For Physiatrist

20. What do you do to avoid side effects?

_____

_____

21. What is the medication preparation method

_____

_____

22. Does medication time vary from medicine to medicine?

_____

_____

23. How do you prescribe if there is other illnesses?

_____

24. How do you prescribe drugs for inpatient psychiatric patients? Is it orally or paper based

For Management

1. How does this system help the organization?

   _____

   _____

2. Do you think it will decrease the time and cost used to schedule drug manually?

   _____

   _____

Manual Drug Scheduling Form used by Amanuel Specialized Mental Hospital

Date	Oral Meds	D/C Date	Injection	D/C Date	Name	Region	Telephone	Bedno

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA

MINISTRY OF HEALTH

AMANUEL HOSPITAL

PRESCRIPTION PAPER

P.O.Box _____ Tel._____

Name of the Patient _____Age_____

Address:Region_____Town_____ Woreda_____

Kebele_____ House No. _____ Card No _____

Inpatient ☐ Outpatient ☐ Section Ward_____

Diagnosis (ICD code No) _____

Treatment given(Drug name, Strength, dosage, dose &duration)	**Price of each Item for (Dispenser use only)**	
	Birr	**Ct.**
Total		

Prescriber's **Dispenser's**

Full name _____ _____ _____

Qualification _____ _____ _____

Registration No_____ _____ _____

Signature _____ **Date**_____ ____ _____

Evaluation of Prototype

No	Prototype Evaluation	High	Medium	Low
1.	The system is user friendly			
2.	I would need technical support to be able to use this system			
3.	The system is easily operable			
4.	I find the system to my work			
5.	The system can be easily displayed			
6.	The system can respond to user actions easily			

Evaluation and Testing

No	System Evaluation	High	Medium	Low
7.	The system have can store information of patient history			
8.	The system have can store schedules efficiently			
9.	The system is easily opera table			
10	The system can be used for scheduling drug easily			
11	The system can store allergy information			
12	The system is secure			
13	The system reduces time to schedule drug			
14	The system can decrease error			