ADDIS ABABA UNIVERSITY

SCHOOL OF INFORMATION SCIENCE

AND

SCHOOL OF PUBLIC HEALTH

M.Sc. in Health Informatics Program

Designing a Web-Based Blood Bank Information Management System for the National Blood Bank of Ethiopia

Gadisa Kebede

June/2016
Addis Ababa, Ethiopia

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A Project Submitted to the School of Information Science and Public Health of Addis Ababa University in Partial Fulfillment of the Requirement for Degree of Master of Science in Health Informatics

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Advisor	Signature	Date
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Advisor	Signature	Date

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LIST OF ACRONYMS

AAU	Addis Ababa University
ADSL	Asymmetric Digital Subscriber Line
BBIMS	Blood Bank Information Management System
BDS	Blood Donation System
BTS	Blood Transfusion Services
CC	Cloud Computing
CSS	Cascading Style Sheets
FMoH	Federal Ministry of Health
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immune Virus
HTML	Hyper-Text Markup Language
HTTP	Hyper-Text Transfer Protocol
MC	Mobile Computing
MySQL	My Structured Query Language
NBTS	National Blood Transfusion Services
OO	Object Oriented
PHP	Hypertext Preprocessor
RBBSSD	Regional Blood Bank Support and Supervision Department
SDLC	System Development Life Cycle
TTI	Transfusion-Transmissible Infection
UC	Use Case
UI	User Interface
UI	User Interface Prototype
UML	Unified Modeling Language
WHO	World Health Organization

ABSTRACT

Background: Many medical advances that have improved the treatment of serious illness and injuries have increased the need for blood transfusion for patients' survival to support them through recovery or to maintain their health. Demand for blood is driven by an array of factors that include obstetric hemorrhage, road traffic accidents, armed conflict, sickle cell disease and childhood anemia, malnutrition, Human Immune Virus (HIV), malaria, and parasitic infections. Blood bank is a place where blood is collected from donors, typed and separated into components, stored, and prepared for transfusion to recipients. The blood bank information management system is used to control and manage the overall activities performed in the blood bank centers.

Objective: The main objective of this project is to design a web-based blood bank information management system for the National Blood Bank of Ethiopia.

Methodology: This project is carried out at National Blood Bank Center, Addis Ababa. The project follows a design science methodology and an object oriented system analysis and design approach to analyze and design the system. In-depth interview, document review and inventory were done to analyze the existing situation. To model the analysis and design of the proposed system Unified Modeling Language (UML) modeling techniques is used and both Hyper-Text Transfer Protocol (HTML) and Hypertext Preprocessor (PHP) is used to develop the system prototype. And My Structured Query Language (MySQL) database management system is used to design the prototype database.

Results: All the system's processes and its boundary were identified and described by using use case diagram. Eight processes with their corresponding actors were identified for the system. The flow of the process were presented using activity diagrams. The object model were described by using class diagram. And finally, the system prototype was developed for the user interface testing. The results of the user interface testing shows that User test for the system prototype was done and it shows that 75% of the participants in the evaluation and testing has shown positive attitude and response for the system usability.

Conclusion: This project shows only the system prototype of the blood bank information management system. The prototype can be developed through iterative process along with users' feedback. From the user test for the system prototype it is identified that some parts need to be improved.

Recommendation: It is recommended for future researchers to implement the complete web-based blood bank information management system by enriching it with additional functionalities. Such functionality may include: integration with Smart Care, adding a knowledge based component, Short Message Service (SMS) based promotion.

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Blood supplies all nutrients and oxygen in the body. It has been medically proven that no human being can survive without blood (1).

Many medical advances that have improved the treatment of serious illness and injuries have increased the need for blood transfusion for patients' survival, to support them through recovery or to maintain their health (2). Demand for blood is driven by an array of factors that include obstetric hemorrhage, road traffic accidents, armed conflict, sickle cell disease and childhood anemia, malnutrition, HIV, malaria, and parasitic infections (3).

Blood bank is a place where blood is collected from donors, typed, separated into components, stored, and prepared for transfusion to recipients. A blood bank may be a separate free-standing facility or part of a larger laboratory in a hospital.

Globally, over 81 million donations of blood are collected annually, but only 45% of these are donated in developing and transitional countries, where 81% of the world's populations live (2). According to the World Health Organization (WHO), about 8,000 blood centers in 159 countries report on their collections shows, the average annual collection per blood center is 30,000 in high-income countries, 7,500 in middle-income countries and 3,700 in low-income countries, demonstrating wide differences in the efficiency of blood collection across countries and income groups (4).

Approximately 8 million unit of blood are currently needed to meet transfusion demand for a population of nearly 800 million in Africa, according to the World Health Organization (WHO) guidelines of 10 unit per 1000 population. However, only 3 million unit of blood are collected annually, satisfying a mere 40% of this estimated need (3).

As the National Blood Bank of Ethiopia disclosed in 2015[1], some 87,000 units of blood were donated for transfusion in Ethiopia, although the country needs 200,000 units of blood annually (5).

Blood services are essential part of any health-care delivery system. Every government has a responsibility to ensure the availability, accessibility, adequacy and safety of blood supply for its people (6).

[1] Note: The years indicated in this project report are all in Gregorian calendar unless it is indicated otherwise.

However, maintaining a safe and sufficient supply of blood remains a major challenge in many developing countries. Two key problems are the gap between the supply and demand of a safe blood supply, and the serious safety concerns associated with inadequately screened blood. A major constraint to solving these problems is the lack of strong infrastructure and systems to support the management of blood programmes (6).

Management of blood and blood transfusion services in Ethiopia is carried out by the National Blood Bank, which is nonprofit governmental organization established with core functions of community mobilization & education on voluntary blood donation, blood collection, laboratory processing, testing & production of blood, distribution to health facilities, promotion of appropriate clinical use of blood, and research & capacity building in blood transfusion services (BTS).

The Ethiopian National Blood Transfusion Services (NBTS) was established in 1969 by the Ethiopian Red Cross Society. Since 2012 it has been transferred to the Federal Ministry of Health and entrusted with the responsibility of managing the blood donors, collection, testing and transfusion of blood and blood products. Its main center is located in Addis Ababa and it has also the responsibility to oversee, support and monitor the activities of regional blood banks in the country which are administratively under their respective regional health bureaus (7).

Placing the Blood Transfusion Service (BTS) under the mainstream health care delivery system has improved efficiency of managing the blood banks to ensure the whole population has access to safe blood supply (6).

Twenty-five blood banks were functional in Ethiopia in 2014; 24 regional blood banks are serving eight to 12 hospitals each in a radius of about 100km. Thirty mobile blood collection teams are working throughout the country with five fully functional teams in Addis Ababa alone. The proportion of blood collected from voluntary blood donors has increased from 10% in 2012 to 98% in 2014. The Addis Ababa center alone collects over 40,000 units from 100% voluntary blood donations and for a population of 2.5 million, achieves the self-sufficiency target of 10 units/1000 of the population (8).

Therefore, this project is executed with the aim of improving the inventory management system of the blood bank, the gap that exists between the supply and demand of a safe blood supply, and donor/donation management.

1.2. Statement of the Problem

One case study on Blood Bank information management system which was conducted in Kenya stated that as "the cost of creation, processing and distribution of information continues to decrease, there has been increased penetration of technology based applications in the various sectors of the economy and the health sector has not been left behind" (9).

Without an automated management system, there are problems in keeping track of the actual amount of each and every blood type in the blood bank, which blood group is going to finish, etc. In addition, there is also no alert mechanism available when the blood quantity is below its par level or when the blood in the bank has expired. Further, there is no automated way of reminding donors when the next donation time is expected (10).

Human error, leading to potential or actual mistakes, in blood administration can occur at any step in the blood bank service process. Error reductions are most likely to be obtained by a systems approach having the goals of reducing incomplete or erroneous identification of patients or blood products, simplifying processes. Systems that reduce reliance on human data entry and human double-checking through increased use of computer technology for these functions have the potential to substantially increase productivity and accuracy (11).

Currently in the National Blood Bank of Ethiopia, there is no centralized database that stores donors' records in one place. Rather, each blood bank center has its own records. Therefore, it is difficult to trace donors who already registered and donated on different blood bank centers and can be considered as a new donor.

In addition, blood donation events are publicized through radio, newspaper or television advertisements. There is no information regarding the blood donation programs which is disseminated through any web portal. Moreover, for those who want to make blood donation, they cannot make early reservation or booking online.

To the knowledge of this researcher, there is no project work done to address the need for a web-based blood bank information management system in Ethiopia. One related project, which was done by Guesh Dagnew on "a knowledge based system for blood transfusion" which aimed to acquire knowledge necessary in blood transfusion and designing a knowledge base system that can provide advice to experts involved in blood transfusion (12).

So that, due to the absence of a web based blood bank information management system there are many gaps, such as a problem of registering a single donor in multiple places which creates data redundancy, problems on proper management of stock, inability to send directed promotion automatically and long queue that donors should wait to donate blood even if it can be solved by reserving blood donation time slot online.

The aim of this project is therefore, to design a web-based blood bank information management system that will carry out the above activities in easy and quick manner, which is not possible with the current system.

1.3. Objective of the Project

1.3.1. General Objective

The aim of this project is to design a web-based blood bank information management system for the National Blood Bank of Ethiopia.

1.3.2. Specific Objectives

The specific objectives are to:

- Identify user and system requirements of the blood bank information management system;
- Analyze and design system model of the blood bank information management system;
- Design high level system architecture of the blood bank information management system;
- Design the user interface prototype and develop a prototype of the blood bank information management system;
- Test User Interface prototype model of the system.

1.4. Significance of the Project

The proposed Blood Bank Information Management System is envisaged to provide different benefits for the different stakeholders.

Health Professionals

- The system will simplify the process of searching for blood in case of emergency and let the health professionals to efficiently use their time on giving a care.

Donors

- Since the system supports online reservation, it will simplify the donation process for the donor and increase motivation among the donors.
- It lets the donors to know the blood donation campaign being organized at different places.

Blood Bank Centers

- For the employees of the blood bank center this system will reduce the work load.
- The blood bank center's manager can easily control the stock.
- Wastage of blood will decrease.

Researchers

- It provides complete and aggregate information for those researchers who conduct research on blood and blood transfusion areas.
- It can be used for implementing the system in the future.

Federal Ministry of Health and Policy Makers

- Since the National Blood Bank in one of the mainstream health care delivery system of the FMOH, the system can help the ministry to monitor and control the whole blood transfusion service throughout the country.
- The policy maker can use the reports generated from the system to conduct evidence based planning and decision making.

Regional bureaus

- It provides information about the blood transfusion service of the specific region and helps identify and fill the gaps.
- It provides summary performance reports on each blood bank center in the regions.

Funding agencies

- It provides an aggregate information to monitor the activities of the particular blood bank center to which the fund is granted.

Knowledge base

- It helps as a way for acquiring a good practical knowledge for software development in general and for health informatics professions in particular.

1.5. Scope of the Project

This Web-Based Blood Bank Information Management System Project is limited to the design of the system and development of a prototype. That means the project does not proceed to the implementation, testing and deployment of the whole system.

The project will be implemented on the National Blood Bank main center and as it is a web-based it can be accessed anywhere.

The project will be executed from November 2015 up to May, 2015/16.

For analyzing and designing the system the project will use an object oriented methodology approach with iterative process modeling. Unified Modeling Language (UML) modeling will be used as a technique. For user interface prototype Visio and white star tools will be used. For the implementation of the system prototype both Hyper-Text Markup Language (HTML) and Hypertext Preprocessor (PHP) programming languages will be used for client-side and server-side respectively and also My-Structured Query Language (MySQL) database management system will be used to design the database of the system prototype.

1.6. Organization of the Document

Chapter one is the introduction part and it covers the background, the statement of the problem, objectives of the project, significance of the project and scope of the project. Chapter two is the literature review; it gives related information with this project work. Chapter three is about methodology used to develop this project. Chapter four is the system analysis and modeling; which talked about the existing system and operation of the proposed system. Chapter five is conclusion and recommendation.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. General Literature

2.1.1. Blood Bank and Blood Bank Information Management System

Blood banking refers to the process of collecting, testing, preparing, and storing whole blood and blood components intended primarily for transfusion (14). Blood bank center entails the rigorous controlling, monitoring and the complete documentation of the whole procedure from blood collection to blood infusion (15).

Blood Bank Information Management System is an information system which helps to manage the records of donors and patient at a blood bank. It is mainly designed to store, process, retrieve and analyze information concerned with the administrative and inventory management within a blood bank (16). Such kind of system will allow the authorized blood bank officer to login using a secret password and easily manage the records of the blood donors and the patients in need of blood. In addition, the blood bank information management system is not obsolete to the professionals; rather it plays a great role in attracting the donors and other stakeholders due to its simplicity in the reservation, and notification of donation time to the needy. On top of this any stakeholder and/or regional blood banks in need of blood can easily access to the type and quantity of blood available in any blood bank center.

2.1.2. Information System Development

An Information system consists of input messages, message processing and output messages. It have also processing rules which control the execution of the Information system. If the processing rules are formalized we can have computer based Information systems. But if the processing rules need a lot of personal knowledge, judgment and Intuition, the information systems a manual. A purposeful Information system shall help users to make good decisions and support their actions (17).

Information systems, like other products, are going through a life cycle. Such as Information Systems Development, Information Systems in Use (Operation), Information Systems Maintenance Management and Information Systems Withdrawal.

An information system development is the process of defining, designing, testing, and implementing a new software application or program (18). The system developer uses different tools, techniques, procedure, method and philosophy to implement the information system development.

2.1.3. Contemporary Modeling Approaches

Modeling is a central part of all the activities that lead up to the deployment of good software. It is used to communicate the desired structure and behavior of a system. In addition, models build to visualize and control the system's architecture and to better understand the system we are building, often exposing opportunities for simplification, reuse and manage risks (19).

A Model provides the blueprints of a system and help the users visualize the final product (19).

Different modeling approaches such as, structured and object-oriented, can be used in information system development.

2.1.3.1. Structured System Analysis and Design Approach

It is the traditional view of software development. In this approach, the main building block of all software is the procedure or function. This view leads developers to focus on issues of control and the decomposition of larger algorithms into smaller ones. Such an approach tends to yield brittle systems. As requirements change and the system grows, systems built with an algorithmic focus turn out to be very hard to maintain (19).

2.1.3.2. Object-Oriented (OO) System Analysis and Design Approach

The object-oriented paradigm is currently the most popular way of analyzing, designing and developing application systems, especially large ones. In this paradigm the elements of a given situation is viewed by decomposing them into objects and object relationships (20).

Systems developed with the OO approach are more flexible. These systems can be modified and enhanced easily, by changing some types of objects or by adding new types (20).

2.1.4. Modeling Techniques

Unified Modeling Language (UML)

Notations enable to articulate complex ideas briefly and precisely. In projects involving many participants, often of different technical and cultural backgrounds, accuracy and clarity are critical as the cost of miscommunication increases rapidly (21). In the OO world UML is the industry-standard language for specifying, visualizing, constructing, and documenting the artefacts of software systems (22). UML use different diagraming model to show the analysis and design of a system. There are nine artifacts defined in the UML modeling which mainly categorized under two different views of a system model.

i. Static (or Structural) View

This view emphasizes the static structure of the system using objects, attributes, operations, and relationships. These static parts are represents by, use case, class, package, component, and deployment diagram (22).

Use Case Diagram

The use case diagram is concerned with the interaction between the system and actors (objects outside the system that interact directly with it). It presents a collection of use cases and their corresponding external actors. A use case is a generic description of an entire transaction involving several objects of the system. Use cases are represented as ellipses, and actors are depicted as icons connected with solid lines to the use cases they interact with.

A use case diagram is helpful in visualizing the context of a system and the boundaries of the system's behavior. Each use cases in the use case diagram can also be described using a narrative form (23).

Class Diagram

The class diagram represents the static structure of the system. It identifies all the classes for a proposed system and specifies for each class its attributes, operations, and relationships to other classes. Relationships include inheritance, association, and aggregation (23).

Component Diagram

A component diagram provides a physical view of the system. Its purpose is to show the dependencies that the software has on the other software components in the system (24). It is built as part of architectural specification and developed by architects and programmers.

Deployment Diagram

The deployment diagram shows how a system will be physically deployed in the hardware environment. Its purpose is to show where the different components of the system will physically run and how they will communicate with each other. It is used to identify performance bottlenecks, and is developed by architects, networking engineers, and system engineers (24).

Package Diagram

Package diagram shows how the various classes are grouped into packages. Packages are UML constructs that enable you to organize model elements into groups. It makes your UML diagrams simpler and easier to understand (25).

ii. Dynamic(or Behavioral) view

Behavioral diagrams basically capture the dynamic aspect of the system by showing collaborations among objects and changes to the internal states of objects. Dynamic aspect can be further described as the changing or moving parts of a system. These dynamic parts are represented by sequence, collaboration, state chart, and activity diagram (22).

Activity Diagram

Active diagrams are used to model the flow of an object as it moves from state to state at different points in the flow of control. It is essentially a flow chart that emphasize the activity that takes place over time.

Activity diagrams can be used to model higher-level business process at the business unit level, or to model low-level internal class actions. It is "Less technical" in appearance, compared to sequence diagrams, and business-minded people tend to understand them more quickly (24).

Sequence Diagram

A sequence diagram shows interaction among a set of objects in temporal order, which is good for understanding timing issues. It show a detailed flow for a specific use case or even just part of a specific use case (24)**.**
A sequence diagram deals with the sequence of messages flowing from one object to another. It is mainly used to visualize the sequence of calls in a system to perform a specific functionality.

Collaboration Diagram

Collaboration diagram is used to explore the dynamic nature of the software. Collaboration diagrams show the message flow between objects in an object-oriented application, and also imply the basic associations (relationships) between classes (25). The purpose of collaboration diagram is similar to sequence diagram. But the specific purpose of collaboration diagram is to visualize the organization of objects and their interaction.

State Chart Diagram

The state chart diagram models the different states that a class can be in and how that class transitions from state to state. Every class has a state (which is a situation during the

life of an object, which satisfies some condition, performs some activity or waits from some event), but that every class shouldn't have a state chart diagram (24).

The state chart diagrams are used to capture event-oriented dynamic behavior, model object lifecycle and reactive objects (user interfaces, devices, etc.)

While the UML provides nine artifacts to model the system, it is not important to use all as each of them provide a different perspective of the same system.

2.1.5. Modeling Procedure

Procedure models are fixed sequences of activity to implement projects. There are various modeling procedures which have been widely in use to develop software products. While there are many flavors, the two most common models are the Waterfall and Iterative/Incremental approaches.

2.1.5.1. The Waterfall Model

The Waterfall Model is the oldest and the most well-known SDLC model. This model is widely used in government projects. The special feature of this model is its sequential steps. It goes downward through the phases of requirements analysis, design, coding, testing, and maintenance (26). Stages that construct this model are not overlapping stages, which means that the waterfall model begins and ends one stage before starting the next one. This kind of approach is slow to response to change (27).

This model works well for projects in which quality control is a major concern because of its intensive documentation and planning (28).

The following steps briefly describe the waterfall process.

i. **Requirement Analysis:**

   It is a description of a system behavior to be developed. Usually, it is the information provided by clients. Hence, it establishes the agreement between the clients and the developers for the software specifications and features. In short, requirements are gathered, analyzed and then proper documentation is prepared, which helps further in the development process.

ii. **Design**

   The gathered information from the analysis phase is evaluated and a proper implementation is formulated. It is the process of planning and problem solving for a software solution. It deals with choosing the appropriate algorithm design, software architecture design, database conceptual schema, logical diagram design, and data structure definition (29).

iii. **Implementation**

   In this phase the whole requirements will be converted to the production environment and implements the detailed design specification. Coding of the software is done at the implementation phase.

iv. Testing

Real testing and checking of the software solutions that have been developed to meet the original requirements and finds any errors present in the code.

v. Maintenance

After the software is already released, it may need some modifications, improvements, errors correction, and refinement accordingly. Thus, this phase addresses problems and enhancement requests after the software releases.

2.1.5.2. Iterative Model

Collecting all the requirements from the user at the beginning of project development is very difficult. Users typically have difficulty explaining what they need, and the problems increase when developers fail to translate requirements into working software.

The idea behind iterative approach is to develop a software system incrementally. It start with a simple implementation of a subset of the software requirements and iteratively enhance the evolving sequence of versions until the full system is implemented. The basic requirements are addressed in the first increment, and it is the core product, however, many supplementary features (some known, others unknown) remain undeliverable at this increment. At each iteration, design modifications are made along with adding new functional capabilities. This kind of approach allows the developer to take advantage of what was being learned during the development of earlier, incremental, deliverable versions of the system (30).

This model works well on a project with new technology, allowing the user to adjust to the system in smaller incremental steps rather than leaping to a major new product and when it is high risky to develop the whole system at once (26).

2.1.6. System Architecture

The system architecture describes the system's hardware, software, and network environment, which is the plan for how the information system components will be distributed across multiple computers and what hardware operating system software, and application software will be used in each computer. The deliverables include the architecture design and the hardware and software specification (31).

Different system developers used different types of architecture in certain situations.

Server-Based Architectures

The server (usually, a central mainframe computer) performs all four application functions i.e. presentation logic, application logic, data access logic, and data storage. The clients (usually, terminals) enabled users to send and receive messages to and from the server computer (31).

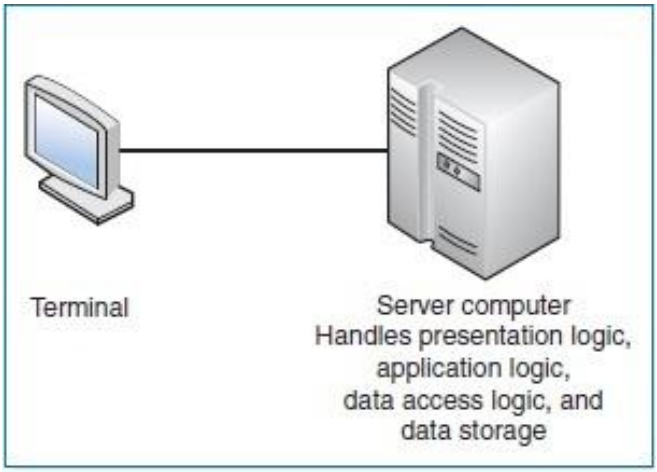


Figure 2.1: Server-Based Architecture

Client-Based Architectures

With client-based architectures, the clients are micro-computers on a local area network, and the server is a server computer on the same network. The application software on the client computers is responsible for the presentation logic, the application logic, and the data access logic. The server simply provides storage for the data (31).

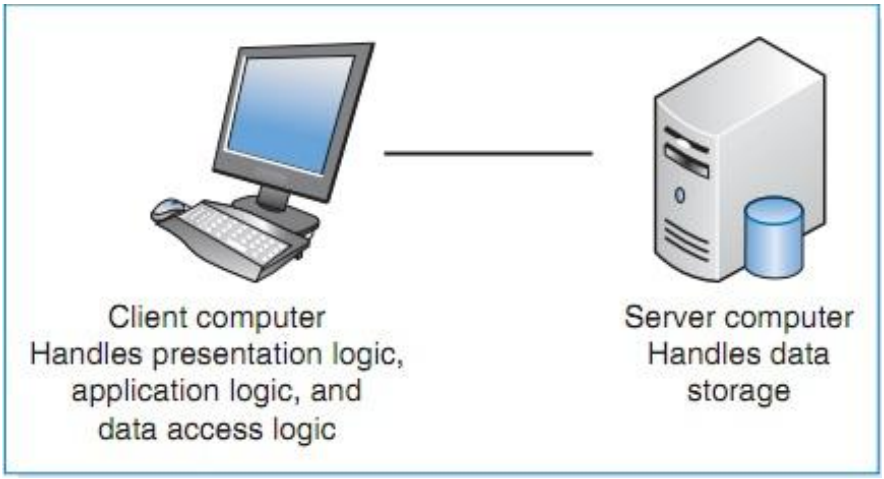


Figure 2.2: Client-Based Architecture

Client-Server Architectures

The most common architecture used today, which attempt to balance the processing between client devices and one or more server devices. In these architectures the client is

responsible for the presentation logic, whereas the server is responsible for the data access logic and the data storage. The application logic may reside on the client, reside on the server, or be split between both. This architectures are scalable and can support many different types of clients and servers (31). There are many ways in which the application logic can be partitioned between the client and the server. The common configuration includes:

i. Two-Tiered Architecture

In this case, the server is responsible for the data and the client is responsible for the application and presentation.

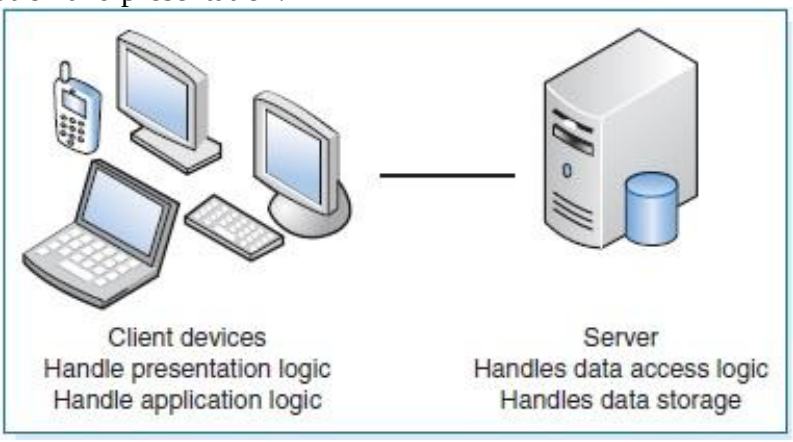


Figure 2.3: Two-Tiered Client–Server Architecture

ii. Three-Tiered Architecture

In this case, the software on the client computer is responsible for presentation logic, an application server(s) is responsible for the application logic, and a separate database server(s) is responsible for the data access logic and data storage. Typically, the user interface runs on a desktop PC or workstation and uses a standard graphical user interface. The application logic may consist of one or more separate modules running on a workstation or application server. Finally, a relational DBMS running on a database server contains the data access logic and data storage.

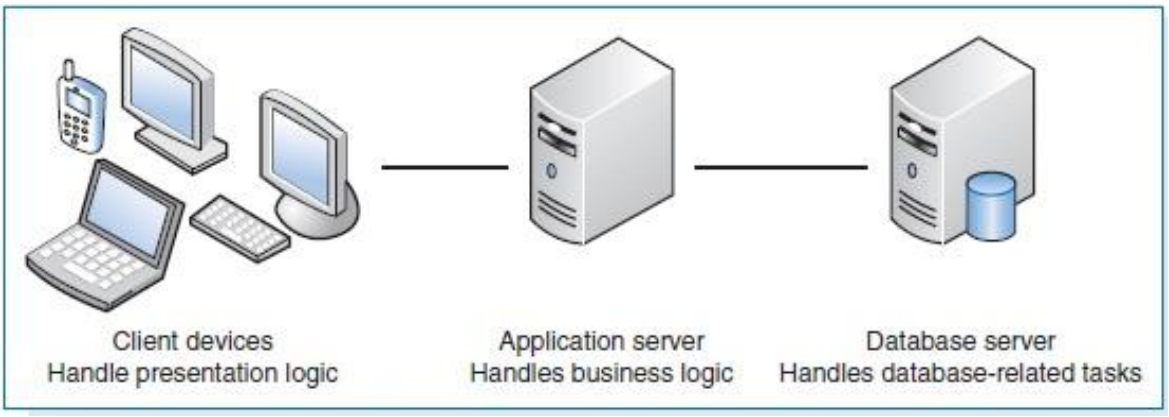


Figure 2.4: Three-Tiered Client–Server Architecture

2.1.7. Application Types

Desktop Based Application

It is a native application that executes on a user's local machine. In most cases these application software could be used by single person only. Desktop applications have traditionally been limited by the hardware on which they are run. They must be developed for and installed on a particular operating system, and may have strict hardware requirements that must be met to ensure that they function correctly. Updates to the applications must be applied by the user directly to their installation, and may require hardware upgrades or other changes in order to work (32).

Mobile Based Application

An application built to run natively on a mobile device. Mobile devices often include applications that invoke services over the telephone network or the Internet via a web browser and affect data and displays on the device (33).

Web-based System Development

It is an information system development that can be accessed through the world-wide-web and works with resources available over the internet, including storage and CPU processing power (34). The World Wide Web provides a new medium for storing, presenting, gathering, sharing, processing, and using information (35). Additionally, the use of existing web browsers and their multimedia capabilities has allowed developers to create more interactive, media-rich user interfaces. A web based system is easy to be scalable, troubleshooting and it can be run in different platforms.

2.2. Related Project Works to Blood Bank Information Management System

While many articles, books and other materials have been reviewed as part of the project, in this section a presentation of only a few of the most related works is presented.

2.2.1. Blood Donation Management System

Blood Donation Management System is a web application with supporting mobile application aimed to serve as a communication tool between patients (who need blood) and blood donor. The system was designed at Jahangirnagar University, Dhaka, Bangladesh (36).

The objective of this system was to present an online edge for bringing mutually giving blood donors and patients (blood requesters) who need blood creating an interactive blood donors, blood requesters and blood bank clinics To become members of the system, donors need to create their profiles by providing fundamental information like name, blood group, email address, password, and exact location from "Google Map". In order to find out the exact location of a donor, Google Map is integrated with this application (36).

The mobile application always updates the location of a donor. As a result, the system can automatically find a registered donor wherever he/she goes. Visitors can search blood donors from the home page by blood group and the place where blood is needed. The system shows the available donors along with their phone number, email address and mailing address through arranging them by the nearest place and blood donation expiry date (36). The project was able to execute the objective of the investigators even though, they are yet to develop the mobile application which will provide the users (with multimedia cell phones) the service of finding a blood donor with map interface.

2.2.2. Blood Donation System Based on Mobile Cloud Computing

The Blood Donation System (BDS) is designed as a framework and planned to be developed and implemented for the Kingdom of Saudi Arabia. The system is comprised of two main components, which are the Cloud Computing (CC) component and the Mobile Computing (MC) component (37).

The main aim of this work was to design a framework for blood donation system using cloud computing and mobile computing technology. The Blood Donation System (BDS) is an information system that deploys mobile computing empowered by cloud computing to provide efficient blood donation services. This system is developed to facilitate communication between blood donors and blood donation centers and integrates the blood information dispersed among different blood donation centers and health organizations. Stakeholders used the blood donation system as an application installed on

their smartphones to help them complete the blood donation process. The application helps the people receive notifications on urgent blood donation calls, know their eligibility to give blood, search for the nearest blood center, and reserve a convenient appointment using temporal and/or spatial information (37). The result show that the investigators finally designed a framework that contains cloud computing component which represent the cloud with all its service models and it provides stakeholders in the mobile computing environment with all blood donation services and the mobile computing component which represents the mobile environments where the blood donation stakeholders interact and request services from the cloud component.

2.2.3. KBase Life

KBase Life is a knowledge base's blood bank information system. It is a web based system to manage, control and monitor each and every aspect of a blood bank. It helps in managing and tracking information right from donor recruitment to the components final transfusion, including all production steps, latest lab activities. In addition to the core blood bank activities, it manages inventory to laboratories/clinical tests, back office application like HR, Finance and billing and health education as well. This system is deployed at the Malaysia National Blood Bank (38).

2.2.4. Punjab Online Blood Bank Management System

This system is a web based blood bank management system that is designed to store, process, retrieve and analyze information concerned with the administrative and inventory management within a blood bank (39).

The Punjab online blood bank management system provides different functionality like blood donation camp and camp organizer management, donor management, inventory management, blood requisition and issuance of blood, online transfer of blood from one blood bank to another, discarding of expired and unsuitable blood, etc. (39)

A user can check the availability of blood based on both district as well as blood group wise. The system also generates different reports (39).

2.2.5. Blood Bank India

This is a web based blood bank system which provides the functionality of online blood donor registration, city wise and blood group wise search of the blood (a person who needs blood). A person or a hospital can request the blood from the blood bank when they need and it also gives information on the importance of blood donation, the requirements to become a donor and so on (40).

2.2.6. A Knowledge Based System for Blood Transfusion

This system was designed for the national blood bank center of Ethiopia. The aims of the system was to acquire knowledge necessary in blood transfusion and designing a knowledge based system that can provide advice to experts involved in blood transfusion. The system cross matches the compatibility of the patient's blood and the blood going to transfuse. The researcher used a rule based knowledge representation method to represent the relationship between facts and rules. The result shows that the system registers 83.3% complete knowledge of blood transfusion task. This system can be integrated as one module in the whole blood bank information management system (12).

CHAPTER THREE

3. METHODOLOGY

3.1. The Case

The project is carried out at the national blood bank center, Addis Ababa. The National Blood Transfusion Services (NBTS) was established in 1969 by the Ethiopian Red Cross society. Since 2012, the Federal Ministry of Health of Ethiopia is overseeing the national blood bank entrusting with the responsibility of community mobilization & education on voluntary blood donation, managing of blood donors, collection, testing and transfusion of blood and blood products in Ethiopia, promotion of appropriate clinical use of blood, research and capacity building in BTS. The national blood bank has a total of 282 employees with various qualifications including health professionals, IT experts, and administrative staffs. Its main center is located in Addis Ababa and it has also the responsibility to oversee, support and monitor the activities of nine regional and two city administrative blood banks in the country which are administratively under their respective regional health bureaus.

3.2. The Method

Information systems are implemented within an organization for the purpose of improving the effectiveness and efficiency of that organization. The utility of the information system and characteristics of the organization, its work systems, its people, and its development and implementation methodologies together determine the extent to which that purpose is achieved (41).

In information system discipline, there are two complementary but distinct paradigms, natural (or behavioral) science and design science. The behavioral science paradigm seeks to develop and justify theories (i.e., principles and laws) that explain or predict organizational and human phenomena surrounding the analysis, design, implementation, and use of information systems. Such theories ultimately inform researchers and practitioners of the interactions among people, technology, and organizations that must be managed if an information system is to achieve its stated purpose, namely improving the effectiveness and efficiency of an organization. The design science paradigm is fundamentally a problem solving paradigm. It seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished (41). The Design Science process includes six steps: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication (42).
This project, therefore, follows the design science methodology, which is a paradigm that seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts (41).

Object-Oriented methodology approach is used for analyzing and designing the system. As it is discussed in section 2.1.3.2, this approach is selected because it has an advantage of modularity, extensibility, reusability as well as maintainability and also the investigator has a better knowledge on Object-Oriented approach.

3.3. The Procedure

As discussed in section 2.1.5, the Object-Oriented approach, which is supported by an iterative procedure, is used. This helps to improve the system step by step in a cyclical way until it satisfies the users need. It starts with a simple implementation of a subset of the software requirements and iteratively enhance the evolving sequence of versions until the full system is implemented. At each iteration, design modifications are made along with adding new functional capabilities.

The iterative process model is selected because, collection of all the requirements from the user at the beginning of project development is very difficult.

3.4. The Techniques

To obtain all the required information for the system development there are different kinds of requirement elicitation techniques. The techniques which are used to identify both the user and system requirements in this project are presented below.

3.4.1. In-depth interview

The in-depth interview is selected because it helps the investigator to get the information required in detail, and some information is better described in interview rather than other data collection techniques. The interview is made with the manager, two laboratory technologist and IT expert who work at the national blood bank. The reason only four individuals are selected in this project is that, for one reason it is qualitative study so that we don't have to bother for the number of sample size to be included though some qualitative studies recommend some level of sample size, The other reason is that it is these individuals are the only people currently working as a team leader on the specific area the project is trying to address in its objective. All the respondents have first degree and above qualification and they are selected purposively. The investigator asked the stakeholders about any system currently they use, their potential needs, and organizational management in general. The in-depth interview is conducted in a private room so as to ensure the privacy of the respondents. The recorded audio of respondents were transcribed in a way it do not miss a single point raised by the respondents in to written format and then content analysis was done for each response the study participants gave. The interviewer used an interview guide which is attached in appendix C.

3.4.2. Document review

In addition to the interview, document review is applied to collect the forms and documents used in the center. In the process of reviewing the document the investigator find out the types of documents exist in the National Blood Bank Center and determine the specific documents those are important for BBIMS. The document review was included in the project with regard to routine data recording, compilation, processing and reporting such as donor registration form, blood distribution form, blood discard form and etc. A document like blood discarded form need special permission to access, so that the investigator get permission from the concerning body before reviewing.

3.4.3. Modeling Technique

To model the analysis and design of the system UML modeling technique is used. For the analysis parts Use Case diagram and narrate Use Cases to identify the boundary of the system and also Activity diagram, which is used to model the flow of an object as it moves from state to state at different points in the flow of control, is used for the analysis part of the system model. Class diagram, which identifies all the classes for a proposed system and specifies for each class its attributes, operations, and relationships to other classes, is used to model the design part of the system. The UML technique is selected because it is supported by the object oriented approach as well as the investigator have a better knowledge on it.

3.5. Tools

To collect the requirement in-depth interview and document review guides are used, which is a self-designed semi-structured questionnaire.

For the development of the information management system for the national blood bank, Microsoft Visio and White Star are used as tools to model the user interface prototype.

For the implementation of the system prototype, both HTML and PHP programming languages are used for client-side and server-side respectively. The MySQL database management system is used to design the database of the system prototype.

The main reason for using the aforementioned tools is because they are open source. This means, these tools and servers are freely available on the web. Developers can freely download these tools and servers from their websites. In addition to this the investigator has a good experience on using the above mentioned tools.

3.6. Evaluation of the Project

After designing the system, prototype was developed and then its system performance is evaluated to see the functionalities of the system followed by user acceptance test so as to evaluate the usability of the system. For this process user test checklist is used.

3.7. Method of Dissemination of Results

Being an academic project, at the end of the project the principal investigator will deliver the already developed system prototype and the documentation to AAU as partial fulfillment of MSc in health informatics. Furthermore the result of this project will be disseminated to Federal Ministry of Health (FMoH) and National Blood Bank Center.

3.8. Operational Definitions

Software Design

Software design refers to all the activities involved in conceptualizing, framing, implementing, commissioning, and ultimately modifying complex systems" or "the activity following requirements specification and before programming (43).

Web-based Application

A Web-based application refers to any program that is accessed over a network connection using HTTP, rather than existing within a device's memory. Web-based applications often run inside a Web browser. However, Web-based applications also may be client-based, where a small part of the program is downloaded to a user's desktop, but processing is done over the Internet on an external server.

Management Information System

Information systems that provide information for users with similar needs. The main purpose of Management Information Systems is to provide managers with the information they need to take decisions and solve problems. Management Information Systems are supported by corporate databases, which include data generated by transaction processing (44).

System Requirements

A requirement is simply a statement of what the system must do or what characteristics it needs to have. During a systems development project, requirements will be created that describe what the business needs (business requirements); what the users need to do (user requirements); what the software should do (functional requirements); characteristics the system should have (nonfunctional requirements); and how the system should be built (system requirements) (31).

3.9. Ethical Clearance

The project is carried out after obtained ethical clearance letter from Institutional Review Board (IRB) of College of Health Sciences of Addis Ababa University. In addition, concerned bodies in the National Blood Bank Center were informed about the project during data collection, The project participants were informed that they have a right to

withdraw anytime from the interview should they need it. The potential benefit of the project execution after its implementation is told to the respondents prior to data collection. The study participants were interviewed in private room in the national blood bank so that their privacy should be kept. The confidentiality of the questionnaires/ in-depth interview of study participants were kept by allowing only the principal investigator to access the questionnaire throughout the duration of the project and thereafter. Study participants were informed the potential benefit of the project for them and the country as well, and also they are informed there is no any physical and psychological harm poses to them by solely participating in the study. The consent form used is attached in the appendix C.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1. Introduction

As mentioned in chapter three, an object oriented modeling methodology with an iterative process model is used to analyze, design and implement the project. To obtain all the required information for the system development, in-depth interview, document review and inventory were conducted. In addition, the UML modeling technique was used to model the analysis and design of the system. In this chapter the key findings, the requirement analysis and design of the system are discussed.

4.2. The Existing System

The in-depth interview and the documents reviews done at the center helped the investigator to acquire the required information for the BBIMS. The key findings both from the in-depth interview and document review are described in the following sub sections and the sub-headings are organized based on the in-depth interview and document review guides.

4.2.1. In-depth Interview

The interview was conducted with manager, health professionals and IT expert who works in the National Blood Bank Center on issues ranging from blood donation processes, information management system, and management issues. For the simplicity of the presentation of the report, here under the results of in-depth interview is presented in a sequence of health professionals, IT expert and manager.

Health Professionals in-depth interview result:

According to the result of the interview with the professionals, currently the center collects blood from donors using various approaches and areas. It collects blood at the main office of the blood bank and at different mobile case teams which are responsible for conducting blood collection sessions outside the premises of the central blood bank. The entire process of blood collection from registration to refreshments takes approximately 45 minutes. The details of the processes followed during blood collection, according to the interview, are presented as follows:

i. Blood Donor Reception and Registration

In the reception area, general information (name, address, etc.) is recorded. In order to maintain accurate records, all donors are asked to present their proper identification. On this stage potential donors will be given proper pre donation information by receptionist nurse and through different leaflets. Here also voluntary donors are given donor questionnaire to fill which is helpful to check eligibility for donation.

ii. Pre Donation Counseling and Medical Interview

The nurse takes medical history, gives pre donation counseling and undertakes mini-physical checkup. During the checkup, the potential donor's weight and blood pressure will be checked. Then a drop of blood will be taken from the donor's finger and tested to make sure the donor has enough iron-carrying red blood cells to safely donate blood. Then the donor will be asked to sign on the donor questionnaire and confirm whether the donor agreed to post donation counseling and result notification.

iii. Donation

The donor will be taken to the actual donation area, where a phlebotomist will sterilize the area of the donor arm from which the blood will be drawn. The actual donation takes less than ten minutes as approximately as one pint of blood is collected. All materials used during the donation are pre-packaged, sterile and disposable. They are used only once and then discarded. At this step the phlebotomy nurse will give the donor on donation counseling.

iv. Refreshments and Relaxation

After the donation, the donor will be directed to the canteen area, where he/she will rest while enjoying light refreshments. After 15 minutes, donor will be permitted to leave the canteen area and resume his/her daily routine activities.

v. Post Donation Counseling

All donated blood should be screened for markers of Transfusion-Transmissible Infection (TTI) to ensure the microbial safety of the blood supply and verify that the donation is safe to be used for therapeutic purposes. The assays used for blood screening usually have high sensitivity; however, there are some trade-offs on their specificity and false-reactive results sometimes may occur. In the case of reactive screening results, confirmatory testing should be performed to identify truly infected donors or donors with nonspecific reactivity or inconclusive results; this should be done before the donors are informed, notified and counseled about their infectivity status. Counseling donors who have unusual or abnormal TTI test results is an essential part of quality donor service and care.

- Donors confirmed to be infected should be notified of their infection status, counseled, deferred from blood donation and referred for treatment, care and support.
- Donors showing repeated reactive results on screening and negative results on confirmatory testing should be informed, reassured, counseled and temporarily deferred until they are non-reactive in a screening assay. Once this becomes negative, they can be accepted again as blood donors.
- Donors with unclear confirmatory testing results, where infection cannot be ruled out at that point in time, should be informed, counseled and deferred temporarily, usually for up to six months. If screen non-reactive and confirmed negative on follow-up, they can be accepted as blood donors in the future.

On top of this, the result of in-depth interview with professionals on the current software application shows that there is a database application in which the laboratory technologist used to record discarded blood information.

IT-expert in-depth interview result:

The interview conducted with the IT expert who works as a data manager at the national blood bank center was addressed on existing software application, hardware, network infrastructure and reporting procedures of the organization. The interview results were presented under the following sub headings.

Software

Currently, the center uses a database application which is developed using MS-SQL database management system. The center uses the database for the recording of donors' profile, blood distribution to health facilities, screening information and discarded bloods information. In addition, the center generate reports using the information recorded in the database.

As the data manager explained, the database does not have a front end, which could have made it easy to learn and operate. In addition, the center does not have a web portal, which is essential to promote voluntary blood donation in the country and to announce different campaign activities.

Hardware

There are different computer related hardware devices in various departments of the National Blood Bank Center. As the center did not have hardware inventory data, the investigator undertook an inventory of the existing hardware devices together with the data manager. The inventory process was performed in each case team of the center and it is mainly focused on computer and network hardware devices.

Accordingly, 30% of the computer hardware are relatively old and has limited capacity in RAM, Hard Disk and Processor type and speed. In addition, the center uses Compaq desktop computer having 160GB Hard Disk and 512MB RAM capacity as a server, which apparently is old and very low in capacity to manage and respond to different client requests. (See Appendix B for complete inventory list).

Network Infrastructure

The National Blood Bank Center currently has a relatively small network, which connects the data center with different departments with a maximum of 15 users. The center uses plug and play switches (not configurable). So, it is not well structured and controlled that enables users to better use and manage the resources.

Regarding to the internet usage the data manager says "The center uses an ADSL broadband internet connection with a bandwidth of 3MB."

Manager in-depth interview results:

The interview demonstrate that, the National Blood Bank administer directly its main center and oversee and give support for the remaining twenty four blood bank center throughout the country. The National Blood Bank Center performs core functions including blood collection, laboratory processing, testing & production of blood and distribution to health facilities. The center collects different reports from the various centers and it uses them and disseminate to relevant stakeholders.

Concerning the reservation system, asked the manager, if the blood bank is currently using any mechanism through which donors reserve prior to visiting the bank before blood donation in person, he said that there is no any mechanism for reserving time for donors and they are in need of web based reservation system so that it can easily help donors reserve and visit the bank whenever they need.

Regarding to the National Blood Bank plan towards meeting its goal using different means like using software applications, the manager said that "we have a plan to get a software application that helps us on the management of the blood bank inventory as well as to achieve our goals on community mobilization & education on voluntary blood donation".

In the National Blood Bank Center, the manager claims that, there are a total of 282 employees (including laboratory technologists, nurses, IT experts and administrative staffs) that work in the various teams and departments. The organizational structure (figure 4.1) presents the organizational context as represented by the various departments and services. Here under, the information technology and laboratory and medical services directorate activities are presented, as they are mainly the areas the project has given due attention.

Information Technology

In the National Blood Bank Center under information technology team, there is one data manager and five data encoders. They are responsible for recording of donor information and all the information that result during the collection processing and distribution of blood and blood products. They also work closely with all departments to ensure all donor related information are recorded and handled properly. This unit prepares weekly, monthly and annual performance reports of the national blood transfusion service. In addition, under the reception room there is one receptionist who receives donors and registers and checks whether they are able to donate a blood or not.

Laboratory and Medical Service Directorate

Under this directorate, there are two departments namely, laboratory service department and medical service department. Under the laboratory service department there are a total of 31

employees. They are responsible for screening the collected blood for transfusion transmissible infections (HIV, HBV, HCV and syphilis), carry out blood typing, prepare blood components (concentrated red cells, fresh frozen plasma, platelets and cryoprecipitate) and distribute safe blood for health institutions. The laboratory department has ABO, infectious screening and component preparation case teams.

Organizational Structure

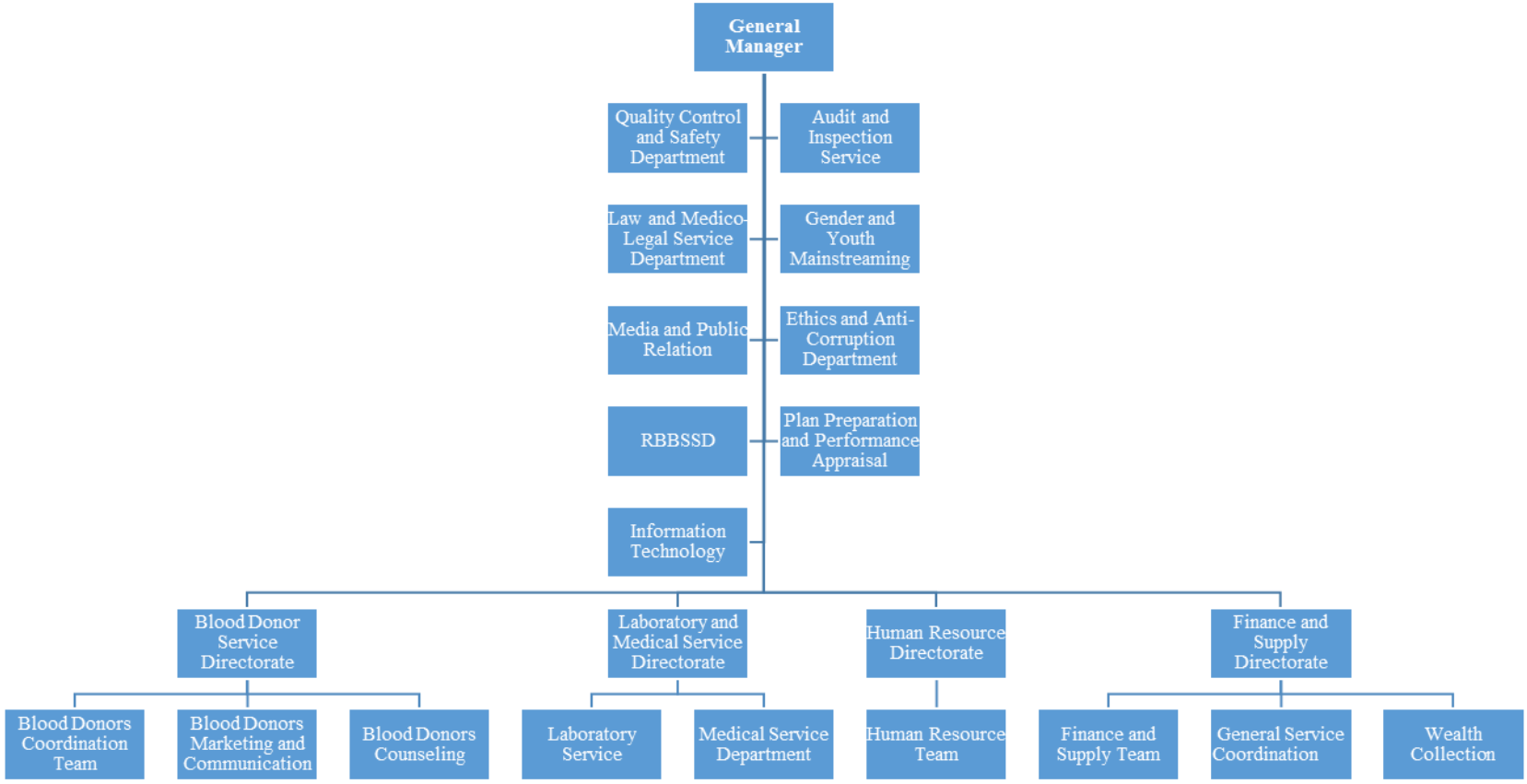


Figure 4.1: The Organizational Structure of National Blood Bank Center, Ethiopia, May 2016.

Vision of the National Blood Bank Center

- To be center of excellence in the discipline of blood transfusion (7).

Mission of the National Blood Bank Center

- To provide safe and adequate blood and blood products to all in need of blood transfusion as part of their treatment (7).

4.2.2. Document Review

The investigator reviewed different types of documents. This review helped the investigator know exactly what this documents are for about, what specific information they include and what they lack (for example, the problem of not having a separate donor registration form and blood registry form; the reporting format lacking blood specific (O,A,B,AB) output). Those forms currently used in the bank includes donor registration, blood distribution, blood discard and reporting formats. Readers may find the forms currently the bank uses at the end of this document under appendix E.

4.3. Proposed System

The new proposed system is applicable for all blood bank centers in the country. The blood bank management system is used for online reservation, donor management, stock inventory management and report generating system.

4.3.1. Context Diagram of the New BBIMS

Figure 4.2 show the context diagram of the new proposed system, which represents all external entities that may interact with the system. Such a diagram pictures the system at the center, with no details of its interior structure, surrounded by all its interacting systems, environments and activities. It also shows the system's boundaries and scope.

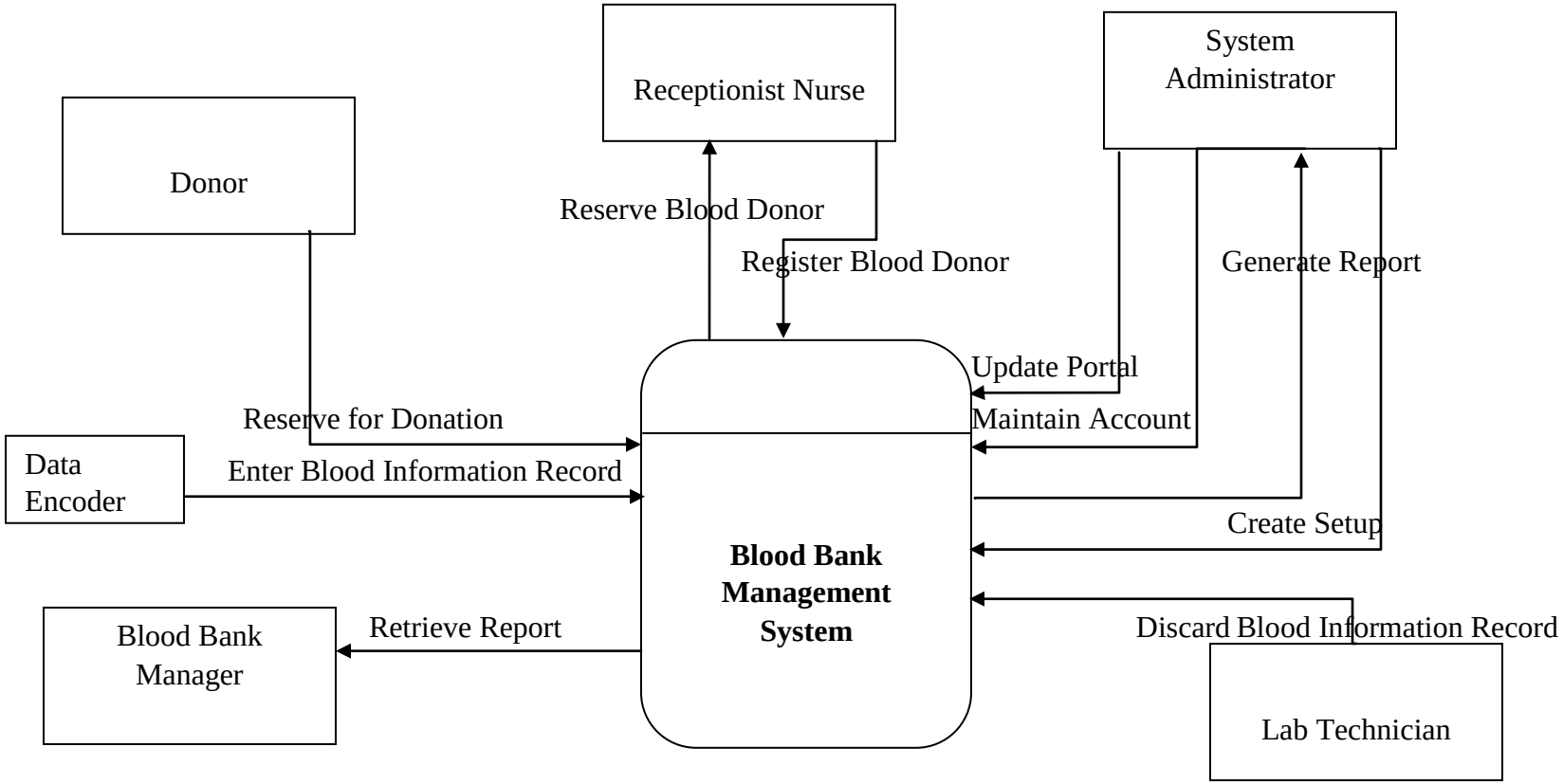


Figure 4.2: Context Diagram of the Blood Bank Management System

4.3.2. Stakeholders

Stockholders are a person, group, or organization that is actively involved in a project and is affected by its outcome, or can influence its outcome. Table 4.1 below presents the stakeholders identified from the existing system.

Table 4.1: List of stakeholders and their responsibilities for the web based BBIMS of Ethiopia, Addis Ababa, 2016.

S_No.	Stakeholders	Role and Responsibility
1.	System Administrator	❖ Responsible for maintaining accounts. ❖ Responsible for creating organizational setup. ❖ Responsible for updating the portal. ❖ Responsible for generating different reports. ❖ Responsible for managing and controlling the accuracy of data entry. ❖ Responsible for conducting training for data encoders and provide supportive supervision and feedbacks.
2.	Laboratory Technician	❖ Responsible for registering discarded blood information. ❖ Responsible for generating report and use the reports for the improvement of service provision.
3.	Donor	❖ Responsible for reserving blood donation time slot.
4.	Receptionist Nurse	❖ Responsible for registering blood donor. ❖ Responsible for giving proper pre donation information to donor.
5.	Blood Bank Manager	❖ Responsible for generating reports and disseminating the report for decision makers.
7.	Data Encoder	❖ Responsible for recording Screening information, blood distribution information and donor details.
8.	Health Institution	❖ Responsible for requesting blood from blood banks ❖ Responsible for give blood for patients.
9.	FMoH	❖ Responsible for using the reports for planning and decision making.
10.	Marketing and Communication	❖ Responsible for the preparation of promotional and educational materials to promote voluntary blood donation in the country.

Note: The Marketing and Communication stakeholder is outside of the scope, but the materials used for the promotional purpose is prepared by them.

4.4. Analysis Models

4.4.1. Use Case Diagram

The use case diagram shows the boundary of the system and it is a representation of a user`s interaction with the system and depicting the specification of a use case.

Based on the existing system assessment findings, the system process is modeled. As part of the analysis, the investigator identified the use cases and the primary and secondary actors and relate them with the corresponding use cases. Figure 4.3 shows the use cases identified for the BBIMS process and also shows the actors of the system

Use Cases:

Use case represent functionality provided by a system unit and expressed by sequence of message exchange by the system unit and one or more actors of the system. The following use cases have been identified for the proposed system specification.

1. Login
2. Create Setup
3. Reserve Donation
4. Register Donor
5. Store Blood
6. Discard Blood
7. Check Availability
8. Generate Report

ACTORS:

An actor represent roles played by human users, external hardware, or other subjects interacting with the system and each actor can participate in one or more use cases. The actors that will participate in the system are:

1. System Administrator
2. Receptionist Nurse
3. Donor
4. Data Encoder
5. Lab Technician
6. Laboratory Head
7. Blood Bank Manager

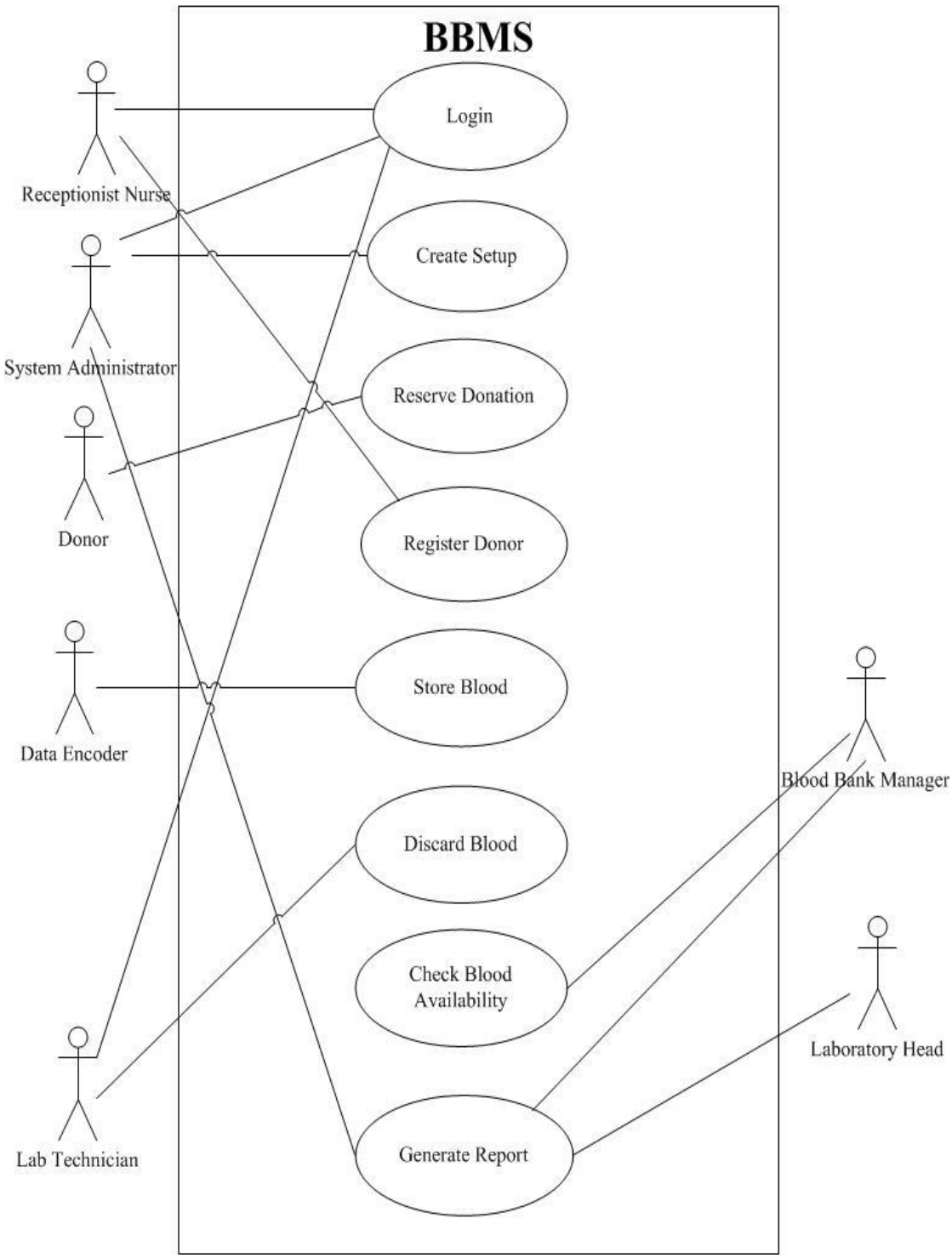


Figure 4.3: System use case diagram for blood bank information management System.

4.4.2. Use Case Narrations

Use case narration is a textual representation of the course of events encountered when an actor is interacting with the system. Use case narrations help clear possible misunderstandings during the early stages of development (45). The sample of the use case narration is presented below and the complete document is available in appendix A.

Use Case ID	**UC-03**
Use Case Name	Reserve Donation
Description	Describes how a donor reserve donation time slot.
Actor	Donor
Pre-Conditions	The donor access the blood bank portal by entering the URL.
Post-Conditions	The system reserve donation time slot for the donor.
Main-Success Scenario	1. The donor opens the blood bank information management system portal; 2. The donor selects individual reservation option; 3. The system displays individual reservation form; 4. The donor enters the necessary information such as, Name, Gender, Donation Date, Email etc..; 5. The donor clicks "**Reserve**" button; 6. The system sends confirmation number to the donor's email. 7. The system lets the donor to enter confirmation number; 8. The donor enters confirmation number; 9. The donor clicks **"Submit"** button; 10. The system reserve donation time slot.
Alternative Scenario	2.1 If the donor selects group reservation option; 3.a The system displays group reservation form; 4.a The donor enters the necessary information such as, Company Name, Number of Donors, Donation Date, Company Email etc..; 5.a The donor clicks "**Reserve**" button; 6.a The system sends confirmation number to the

	company's email. 7.a The system lets the donor to enter confirmation number; 8.a The donor enters confirmation number; 9.a The donor clicks **"Submit"** button; 10.a The system reserve donation time slot.
Rules	The system allows three attempts maximum for the donor to enter confirmation number.

4.4.3. Activity Diagram Modeling

The activity diagrams are used to model the flow of an object as it moves from state to state at different points in the flow of control (19). Figure 4.4 shows the activity diagram of donation reservation process and the complete document is attached in appendix A.

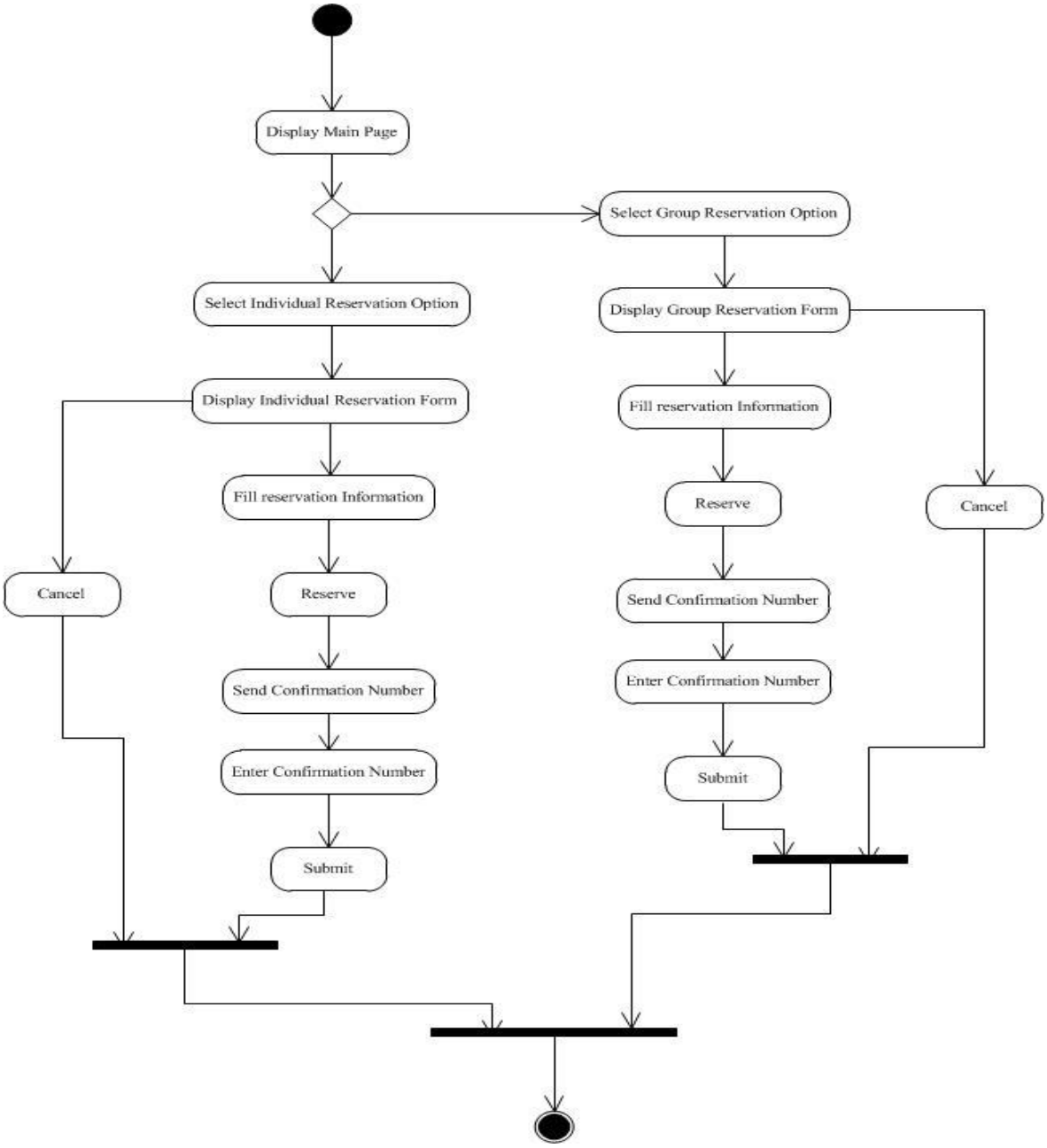


Figure 4.4: The activity diagram for donation time slot reservation process

4.4.4. User Interface Prototype

User interface prototyping is an iterative analysis technique in which users are actively involved in the mocking-up of the UI for a system. It uses as an analysis artifact that enables developers to explore the problem space with the stakeholders. And also used as a design artifact that enables system developer to explore the solution space of the system. The user interface prototype helps the user to test the system at early stage of the system development. It can be developed using

hand drawing or using tools like Visio. The figure 4.5 show the user interface prototype developed using Visio, the complete document is attached in appendix A.

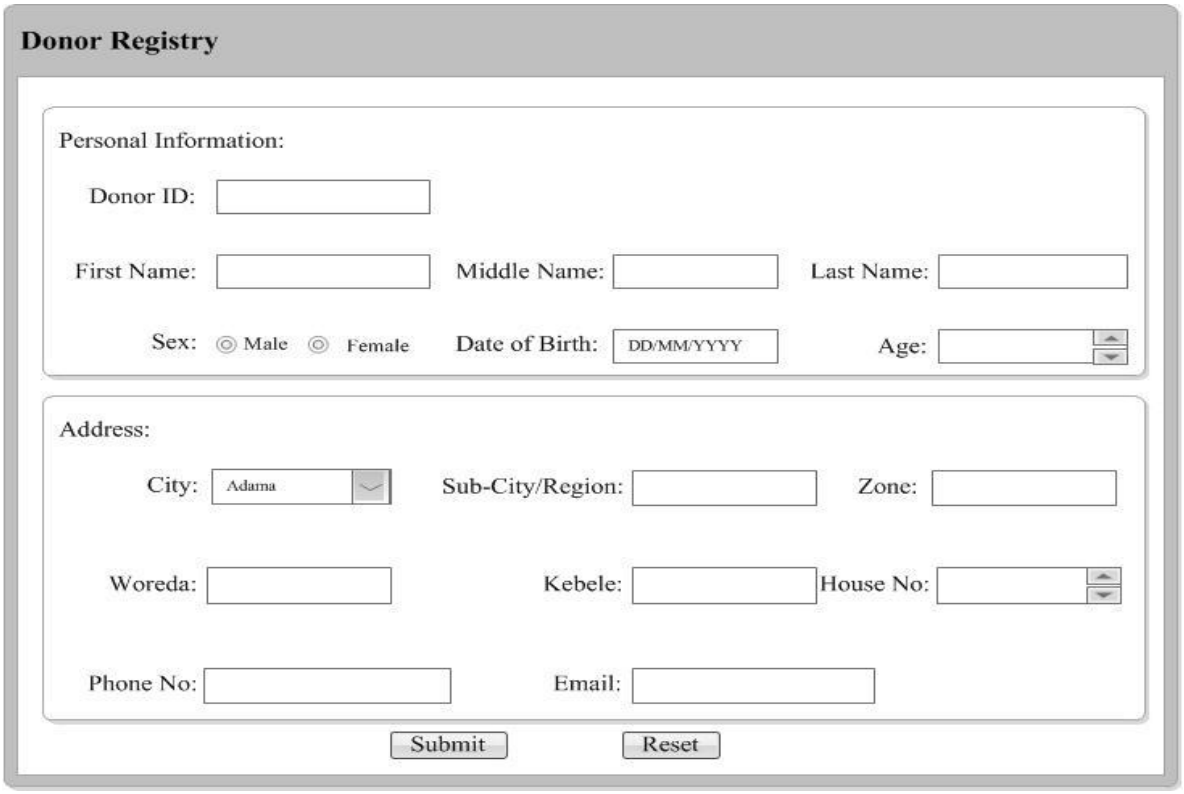


Figure 4.5: Donor Registry User Interface Prototype

4.5. System Requirements

Requirement is a careful assessment of the needs that a system is to fulfill and which constitute a specification for the new system (31). The requirements are identified from the process of the new system and the information gathered during the interview with the stakeholders.

4.5.1. Functional Requirements

The functional requirements describes the processing (functions) to be supported by the new system, which includes inputs into the system, output of the system and the data that must be managed by the system (46). The high level functional requirements identified in the system are presented in table 4.2.

Table 4.2: Functional requirement list for the web based BBIMS of Ethiopia, Addis Ababa, 2016.

Req. ID	Requirement Description	Requirement Source	Ranking	
			Mandatory	Optional
1	The system should enable authenticated user to login into the application	UC-01	✓	
2	The system should enable the administrator to create, delete, and update user setup	UC-02	✓	
3	The system should enable the administrator to create, delete, and update center setup	UC-02	✓	
4	The system should enable the blood donor to reserve donation time slot	UC-03	✓	
5	The system should enable the user to register blood donor's profile	UC-04	✓	
6	The system should enable the user to store blood details	UC-05	✓	
7	The system should enable the user to record discarded blood details	UC-06	✓	
8	The system should be protected from unauthorized users and access.	Login (Figure 4.18)	✓	
9	The system should allow a health institution to check availability of blood at the center	UC-07	✓	
10	The system should allow a health institution to send blood request	UC-08	✓	
11	The system should generate standard reports	UC-09	✓	
12	The system should generate ad-hoc reports	UC-09		✓

4.5.2. Non-functional Requirements

The non-functional requirements describe how well the system supports the functional requirements (46). The non-functional requirements in the new system are presented in table 4.3.

Table 4.3: Non-Functional requirement list for the web based BBIMS of Ethiopia, Addis Ababa, 2016.

Req. ID	Requirement Description	Requirement Source	Ranking	
			Mandatory	Optional
1	The system should provide appropriate error message when the user enters unexpected/ wrong data.		✓	
2	The system should be available for 24 hours a day and 7 days a week.	Interview(1,2)		✓
3	The system should at least use English language for all interfaces.	All user interface	✓	
4	The system should use Amharic language for all interfaces.			✓
4	The system should have a very simple and user friendly interfaces for everyone to understand the functionalities easily.		✓	
5	The system should use client-server architecture.	Reference No. 31	✓	

4.6. System Design Models

4.6.1. System Class Diagram

To model the design of the system, the investigator used class diagram from the UML. The class diagram identifies all the classes for BBIMS and specifies for each class its attributes, operations, and relationships to other classes. The classes identified were, 'UserAccount' class, which is inherited by 'User' and 'Administrator' class. 'Donor' and 'Center' classes are managed by the administrator. The 'Registration' class capture information about 'Blood' and 'user'. The 'Report' class is manipulated by the user. Based on the document review, the attributes and the types are identified. Figure 4.6 shows the class diagram for blood bank information management system.

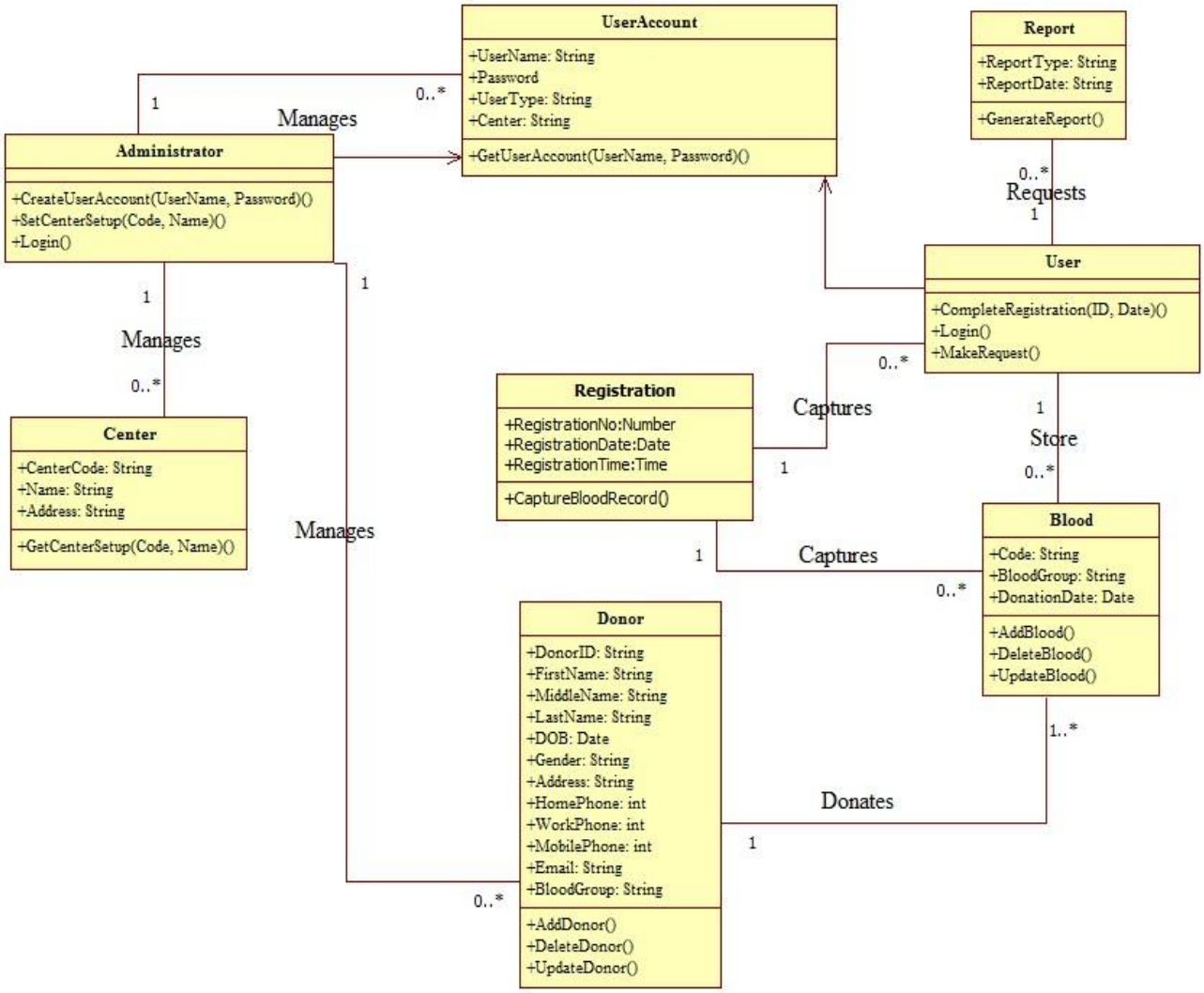


Figure 4.6: Class Diagram for Blood Bank Information Management System

4.6.2. System Architecture

The system architecture describes the system's hardware, software, and network environment. The BBIMS is designed to have a three-tier client-server architecture. The client server architecture is the most common architecture used today, which attempt to balance the processing between client devices and one or more server devices. In a three-tier the software on the client computer is responsible for presentation logic, an application server(s) is responsible for the application logic, and a separate database server(s) is responsible for the data access logic and data storage (31). Since this architectures are scalable and can support many different types of clients and servers, the investigator proposed for this project. Figure 4.7 shows the client/server system architecture design for the blood bank information management system.

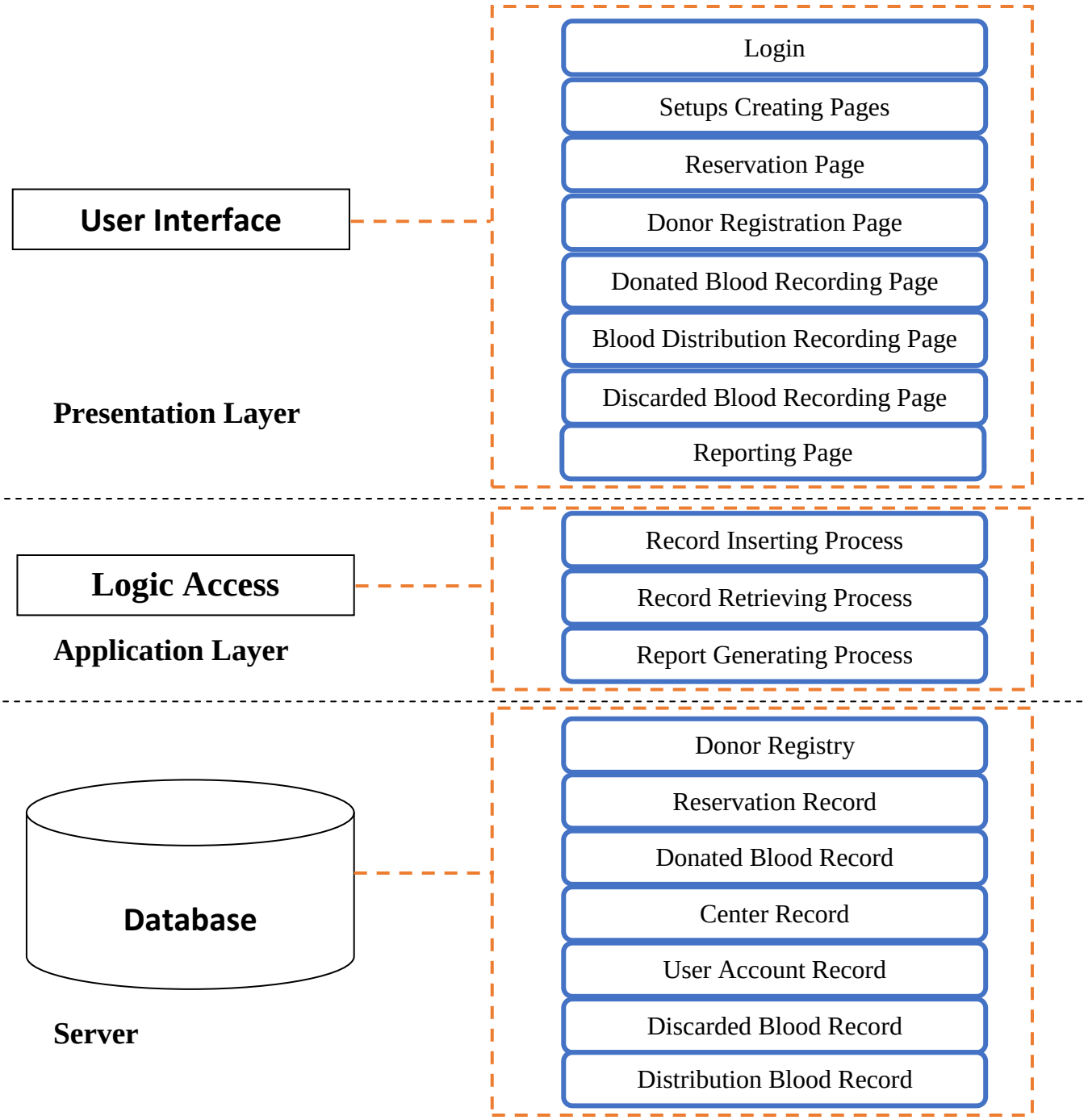


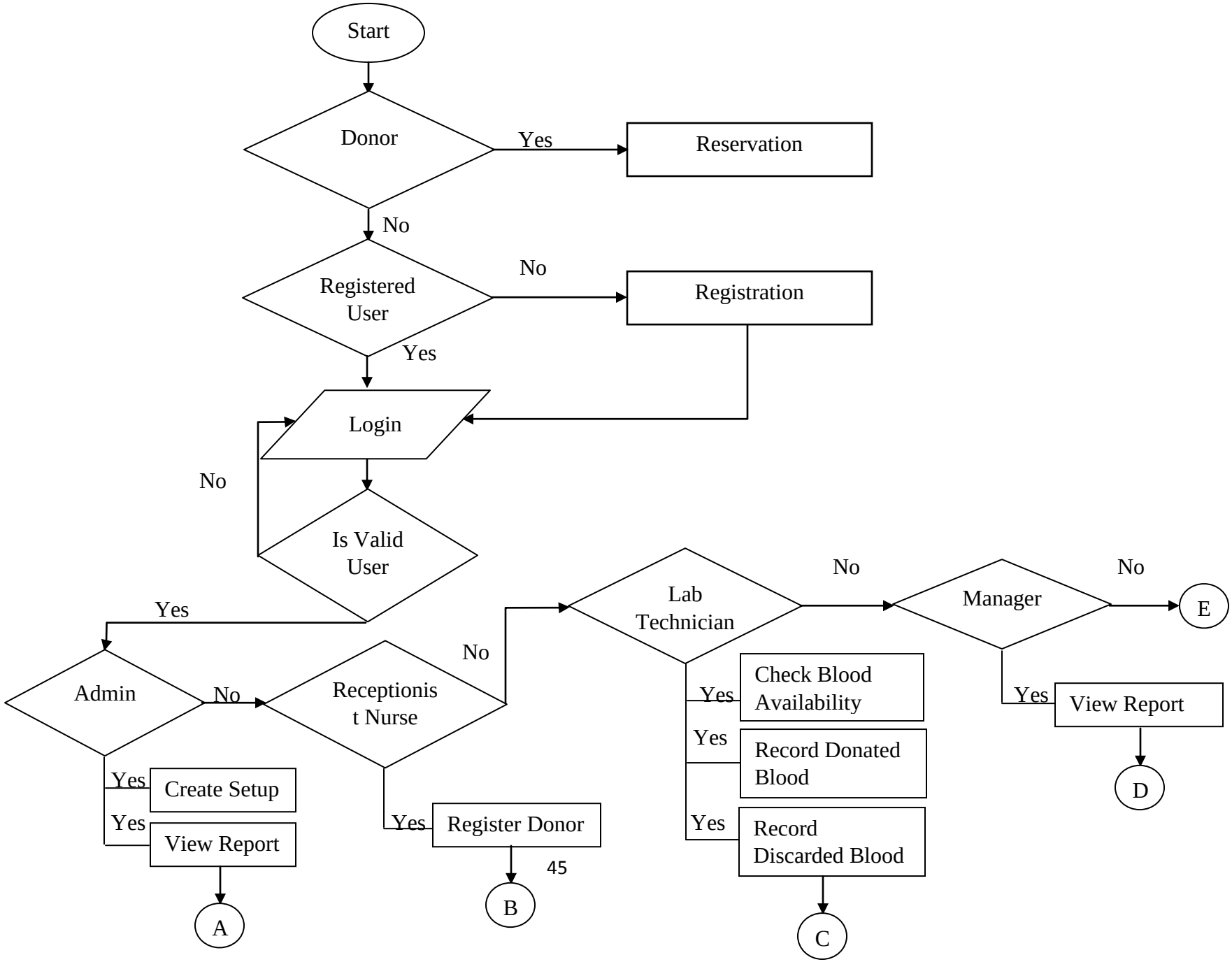
Figure 4.7: Blood Bank Information Management System Architecture

4.7. Prototype Implementation

The implementation of BBIMS prototype is done in three different parts. The user interface is implemented using HTML and CSS. The MySQL database management system is used to develop the database and php code is used as a middleware to connect the user interface and database.

4.7.1. Flowchart Diagram

Flowchart is a visual representation of program flow. A flow chart normally uses a combination of blocks and arrows to represent actions and sequence. Blocks typically represent actions. The order in which actions occur is shown using arrows that point from statement to statement (47). Figure 4.8 shows the flowchart that represent basic function of the BBIMS system.


Start
Donor
Yes
Reservation
No
Registered User
No
Registration
Yes
Login
No
Is Valid User
Yes
Admin
No
Receptionis t Nurse
No
Lab Technician
No
Manager
No
E
Yes
Create Setup
Yes
View Report
A
Yes
Register Donor
B
Yes
Check Blood Availability
Yes
Record Donated Blood
Yes
Record Discarded Blood
C
Yes
View Report
D

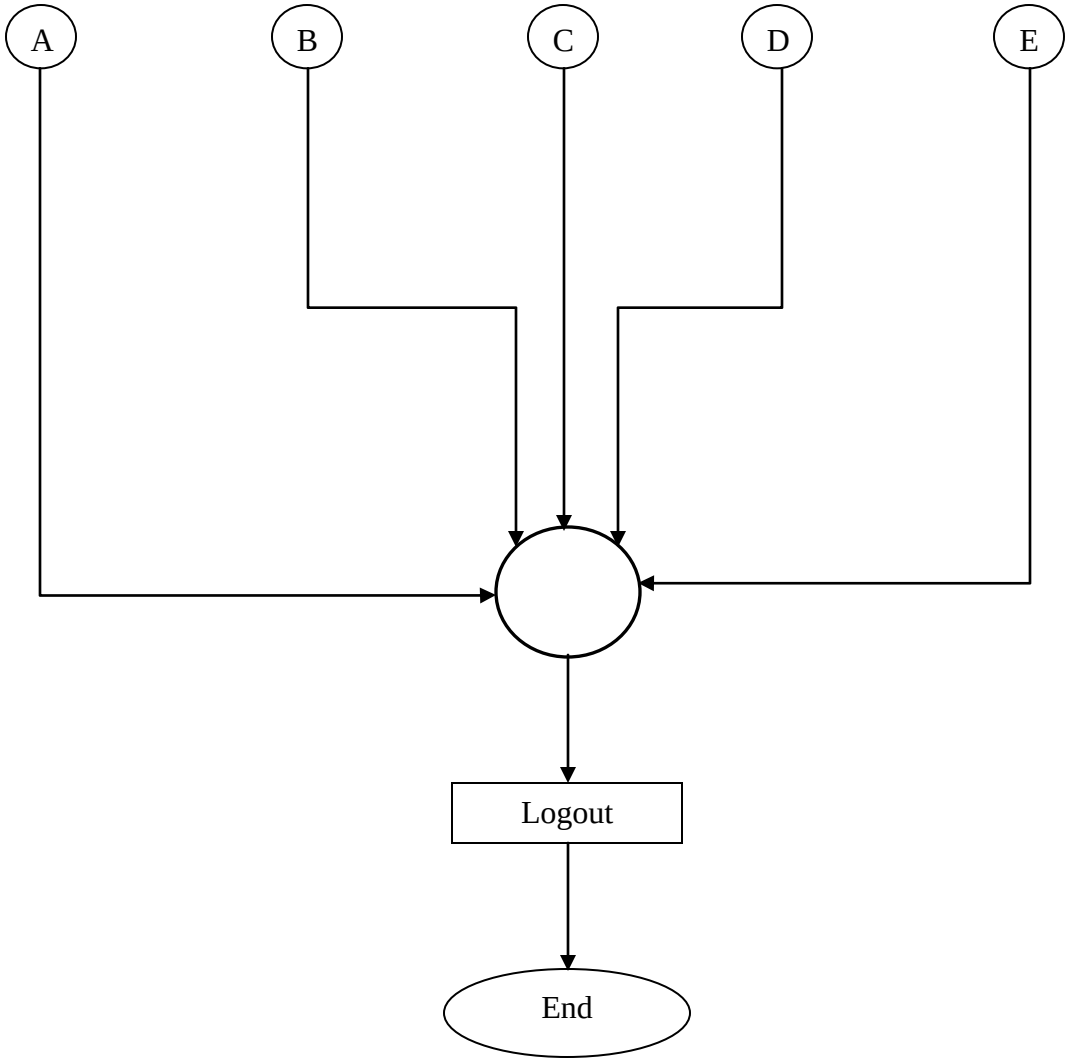


Figure 4.8: Flow chart diagram to represent basic function of the BBIMS system.

4.7.2. Presentation Layer

4.7.2.1. Donors Registry Form

Donor registry allows the user to register new potential donor's profile into the system. To open the donor registry form, the user selects donor registration button on admin page. The form contains every details profile about a single potential donor. Figure 4.9 shows the sample of the form. All the forms are appended in appendix A.

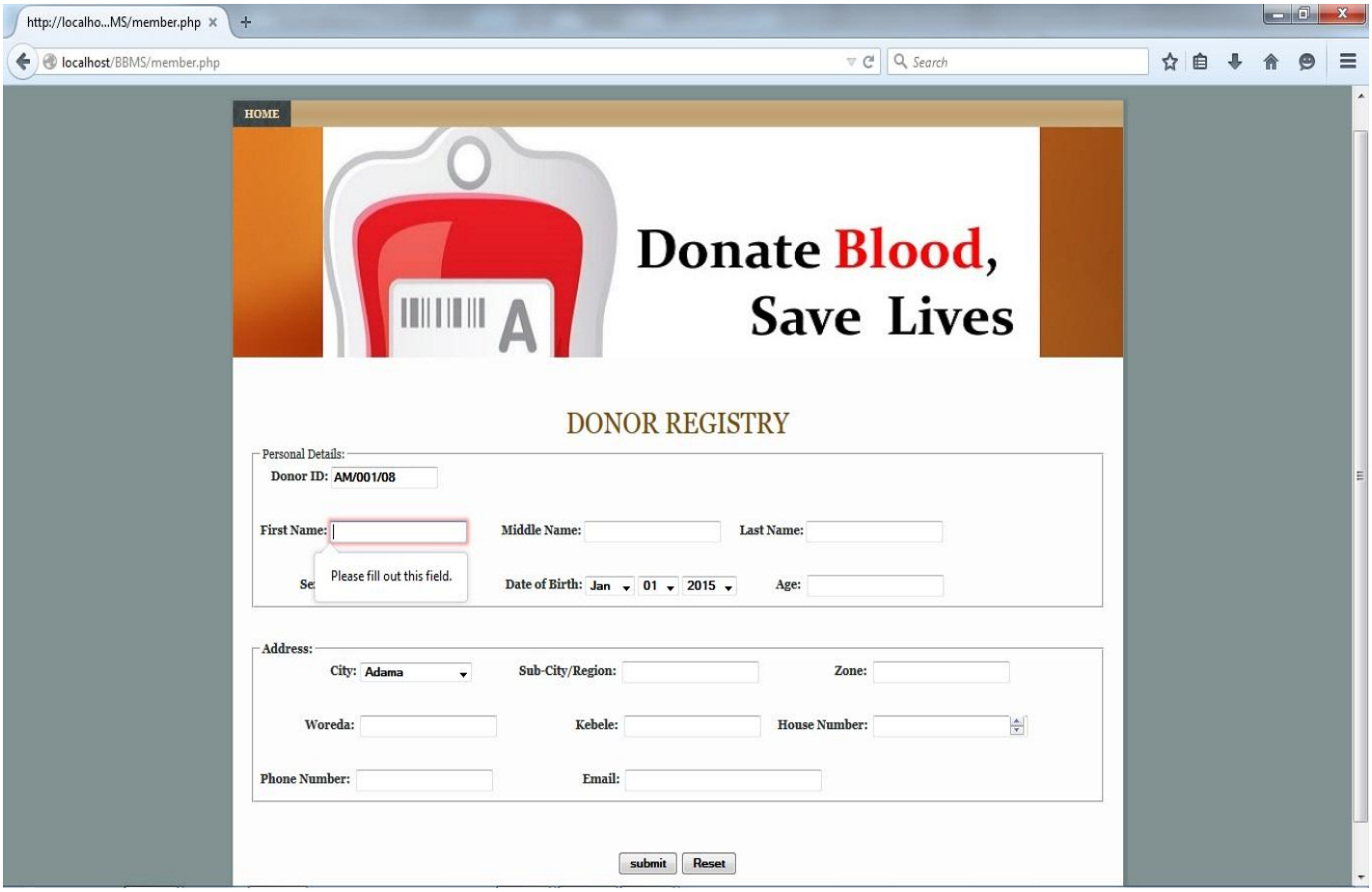


Figure 4.9: Donor Registry Form

4.7.3. Database Layer

4.7.3.1. Database Model

The results of the data model mapping phase is a set of relational schemas. The bases of these relational schemas are the class diagram. The relational schemas are the bases for the table definition. The data storage is created using tables in the database. All fields in the tables are identified and the corresponding primary keys, which is used to identify each instances in the table uniquely, are assigned. To eliminate data redundancy in the database, normalization

process is applied in the tables. After applying the normalization process relational database modeling is used to model the database. To create a relationship between tables a foreign key is used. A foreign key is a primary key in one table and become a field in another table in the database. The storage tables includes Donor, Reservation, Blood, BloodDistribution, BloodDiscard, Center and UserAccount.

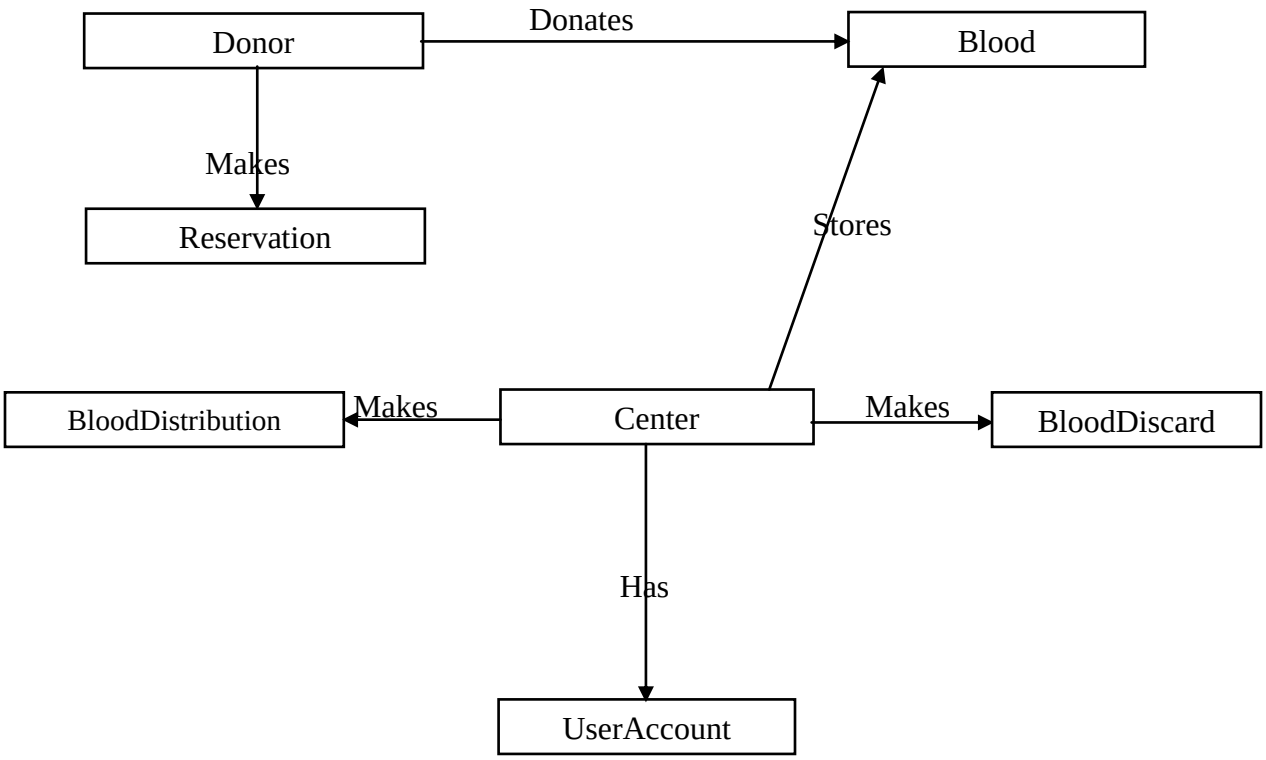


Figure 4.10: Database table and their relationships.

4.7.4. Middle Layer

Php codes are used as a middleware to connect the user interface and database. Figure 4.11 is the sample php code to register a donor.

donor - Notepad

File Edit Format View Help

```
<?php
    $id=$_POST['did'];
    $fname=$_POST['fname'];
    $mname=$_POST['mname'];
    $lname=$_POST['lname'];
    $sex=$_POST['sex'];
    $dob=$_POST['dobYear']."-".$_POST['dobMonth']."-".$_POST['dobDay'];
    $age=$_POST['age'];
    $city=$_POST['city'];
    $subcity=$_POST['subcity'];
    $zone=$_POST['zone'];
    $woreda=$_POST['woreda'];
    $kebele=$_POST['kebele'];
    $house=$_POST['house'];
    $phone=$_POST['phone'];
    $email=$_POST['email'];


    $dbhost="localhost";
    $dbuser="root";
    $dbpass="";
    $dbname="bloodbank";

    $connection = mysqli_connect($dbhost,$dbuser,$dbpass,$dbname);
        if(mysqli_connect_errno())
        {

                die("Faield to Connect Database");
        }


    $query= "INSERT INTO donor(DonorID,FirstName,MiddleName,LastName,Sex,DOB,Age,City,SubCity,Zone,Woreda,Kebele,HouseNumber,PhoneNumber,Email)VALUES
        ('$id','$fname','$mname','$lname','$sex','$dob','$age','$city','$subcity','$zone','$woreda','$kebele','$house','$phone','$email')";
        $result=mysqli_query($connection,$query);

        if($result)
        {
                echo "sucess!";
        }
        else
        {
                die("Database query failed.");
        }

        header("location: confirmationreg.php?remarks=success");
        mysqli_close($connection);

?>
```

Figure 4.11: Sample php codes.

4.7.5. Discussion of results (the system)

Ethiopian national blood bank has no centralized web based blood bank information management system. This project has tried to design this centralized web based BBIMS based on the requirement gathered from the study participants. The designed system has a capability to reserve a time slot for donating a blood and records all information regarding donors, donated blood, distribution of blood to health facility and discarded blood. It also performs stock management for the blood bank. In addition the system generates different standard reports for the stakeholders.

On the other hand, the system is also helpful in serving as a promotional page in relation to the blood donation and other activities should the blood bank needed it. The investigator has also undertaken the user test and evaluation concerning the designed web based BBIMS. Here under it is presented in the following subtitle.

User Test

User testing is a technique for ensuring that the intended users of a system can carry out the intended tasks efficiently, effectively and satisfactorily. For this particular project user test was done for the developed prototype which is used to address any significant issues identified. Four users are participated in the testing process and are presented with eight different questions that the investigator believes will address the user requirement using Likert scale evaluation methods.

Table 4.4: User test result for the prototype of web based BBIMS of Ethiopia, Addis Ababa, 2016.

S. no	Test Questions	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	The interfaces are attractive			1	2	1
2	I like the font and the color of the interfaces				3	1
3	There is consistency in the system interface		1	1		2
4	I thought the system is easy to use			1	3	
5	I found the interfaces are not cumbersome to use			1		3
6	All-important contents are addressed well				2	2
7	I need less time to learn the user interface			1		3
8	There is no unnecessary content available in the interface		2		1	1
	Average result in percentage		9%	16%	36%	39%

Based on the finding of the result of the user test questions presented to the respondents, 75% of the participants in the evaluation and testing has shown positive attitude and response (either agreed or strongly agreed to) for the system attractiveness of the interface, color of the interfaces, consistency of the system interface, easy usability, low cumbersomeness, addressed essential contents, length of time to learn the system, and presence of unnecessary content in the system in general.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

The Web-Based Blood Bank Information Management System is used to control and manage the overall activities performed in the blood bank centers. The system reserves a time slot for donating a blood and records all information regarding donors, donated blood, distribution of blood to health facility and discarded blood. In addition the system generates different standard reports for the stockholders.

In the developing the system prototype, requirements were acquired by using in-depth interview and document review. The collected requirements were analyzed and designed using UML and during that it is identified there is an internet connection in the center even if it needs to be upgraded to a high speed connection. The security issue were not addressed in this project.

User test for the system prototype was done and it shows that 75% of the participants in the evaluation and testing has shown positive attitude and response for the system usability.

Generally, this project develop only the prototype of the blood bank information management system. Since the project follows an iterative process model it can be developed until it satisfies the end user needs.

5.2. Recommendations

Based on the results of the project, the following recommendations are forwarded to the concerning bodies.

National Blood Bank

The National Blood Bank should provide sustainable budget for the implementation of BBIMS. In addition to that, I recommend the National Blood Bank to upgrade the hardware and network infrastructure of the main center in order for the system to work well.

Regional Health Bureaus

The regional health bureaus should support their respective blood bank centers with necessary hardware, network infrastructure for the web based BBIMS. In addition, for the sustainability of the system in the region the bureau should give guarantee by assigning sufficient budget and manpower.

Other Researchers

It is recommended for future researchers to implement the complete web-based blood bank information management system by enriching it with additional functionalities. Such functionality may include: integration with Smart Care, adding a knowledge based component, adding SMS based promotion component.

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Interview

1. With Mr. Abraham Zeleke, National Blood Bank Service Deputy Director, March 2016, at National Blood Bank Center.
2. With Mr. Tazebachew Tsige, National Blood Bank Center Data Manager, March 2016, at National Blood Bank Center.
3. With Eden Kahassay, National Blood Bank Center Medical Laboratory Technologist, March 2016, at National Blood Bank Center.
4. Yabekal Daniel, National Blood Bank Center Medical Laboratory Technologist, March 2016, at National Blood Bank Center.

Appendix A

Software Requirement Specification Document

For

Web Based Blood Bank Information Management System

CHAPTER ONE

1.1. Introduction

Many medical advances that have improved the treatment of serious illness and injuries have increased the need for blood transfusion for patients' survival, to support them through recovery or to maintain their health (2). Demand for blood is driven by an array of factors that include obstetric hemorrhage, road traffic accidents, armed conflict, sickle cell disease and childhood anemia, malnutrition, HIV, malaria, and parasitic infections (3).

Blood bank is a place where blood is collected from donors, typed, separated into components, stored, and prepared for transfusion to recipients. A blood bank may be a separate free-standing facility or part of a larger laboratory in a hospital.

Approximately 8 million unit of blood are currently needed to meet transfusion demand for a population of nearly 800 million in Africa, according to the World Health Organization (WHO) guidelines of 10 unit per 1000 population. However, only 3 million unit of blood are collected annually, satisfying a mere 40% of this estimated need (3). As the National Blood Bank of Ethiopia disclosed in 2015, some 87,000 units of blood are donated for transfusion in Ethiopia, although the country needs 200,000 units of blood annually (5).

Management of blood and blood transfusion services in Ethiopia is carried out by the National Blood Bank Services Office, which is the nonprofit governmental organization established with core functions of community mobilization & education on voluntary blood donation, blood collection, laboratory processing, testing & production of blood, distribution to health facilities, promotion of appropriate clinical use of blood, and research & capacity building in blood transfusion services (BTS). Twenty-five blood banks were functional in Ethiopia in 2014; 24 regional blood banks are serving eight to 12 hospitals each in a radius of about 100km increasing the number of hospitals accessing a safe blood supply to about 90%. Thirty mobile blood collection teams are working throughout the country with five fully functional teams in Addis Ababa alone. The proportion of blood collected from voluntary blood donors has increased from 10% in 2012 to 98% in 2014. The Addis Ababa center alone collects over 40,000 units from 100% voluntary blood donations and for a population of 2.5 million, achieves the self-sufficiency target of 10 units/1000 of the population (7).

The Blood Bank Information Management System is used to automate the inventory management system of the national blood bank, which is the gap existing between the supply and demand of a safe blood supply, and donor/donation management.

1.2. Objective

The aim of this project is to design a web-based blood bank information management system for the national blood bank of Ethiopia.

1.3. Purpose

The Blood Bank Information Management System provides different benefits for different stakeholders. Since it support online reservation, it simplify the donation process for the donor and increase motivation among the donors. In addition it lets the donors to know the blood donation campaign organizing at different places. For the user of the system it reduce the work load and helps the blood bank center's manager to control the stock easily. The policy maker use the reports generated from the system to conduct evidence based planning and decision making. For the regional health bureaus it provides information about the blood transfusion service of the specific region and helps identify and fill the gaps.

1.4. Scope

This web-based blood bank information management system project is limited to the design of the system and development of a prototype. That means the project does not proceed to the implementation, testing and deployment of the whole system. The project will be implemented on the national blood bank main center and as it is a web-based it can be accessed anywhere. For analyzing and designing the system the project uses an object oriented methodology approach with iterative process modeling. UML modeling will be used as a technique. For user interface prototype Visio and white star tools will be used. For the implementation of the system prototype both HTML and PHP programming languages will be used for client-side and server-side respectively and also MySQL database management system will be used to design the database of the system prototype.

CHAPTER TWO

2. Functional Requirements

Requirement is a careful assessment of the needs that a system is to fulfill and which constitute a specification for the new system (31).
The functional requirements describes the processing (functions) to be supported by the new system, which includes inputs into the system, output of the system and the data that must be managed by the system (46). The high level functional requirements identified in the system are presented in table 2.1.

Table 2.1: Functional requirement list for the web based BBIMS of Ethiopia, Addis Ababa, 2016.

Req. ID	Requirement Description	Requirement Source	Ranking	
			Mandatory	Optional
1	The system should enable authenticated user to login into the application	UC-01	✓	
2	The system should enable the administrator to create, delete, and update user setup	UC-02	✓	
3	The system should enable the administrator to create, delete, and update center setup	UC-02	✓	
4	The system should enable the blood donor to reserve donation time slot	UC-03	✓	
5	The system should enable the user to register blood donor's profile	UC-04	✓	
6	The system should enable the user to store blood details	UC-05	✓	
7	The system should enable the user to record discarded blood details	UC-06	✓	

8	The system should be protected from unauthorized users and access.	Login (Figure 4.18)	✓	
9	The system should allow a health institution to check availability of blood at the center	UC-07	✓	
10	The system should allow a health institution to send blood request	UC-08	✓	
11	The system should generate standard reports	UC-09	✓	
12	The system should generate ad-hoc reports	UC-09		✓

CHAPTER THREE

3. Non-Functional Requirements

The non-functional requirements describe how well the system supports the functional requirements (46). The non-functional requirements in the new system are presented in table 3.1.

Table 3.1: Non-Functional requirement list for the web based BBIMS of Ethiopia, Addis Ababa, 2016.

Req. ID	Requirement Description	Requirement Source	Ranking	
			Mandatory	Optional
1	The system should provide appropriate error message when the user enters unexpected/ wrong data.		✓	
2	The system should be available for 24 hours a day and 7 days a week.	Interview(1,2)		✓
3	The system should at least use English language for all interfaces.	All user interface	✓	
4	The system should have a very simple and user friendly interfaces for everyone to understand the functionalities easily.		✓	
5	The system should use client-server architecture.	Reference No. 31	✓	

CHAPTER FOUR

4. SYSTEM MODELING

4.1. Analysis Models

4.1.1. Use Case Diagram Presentation

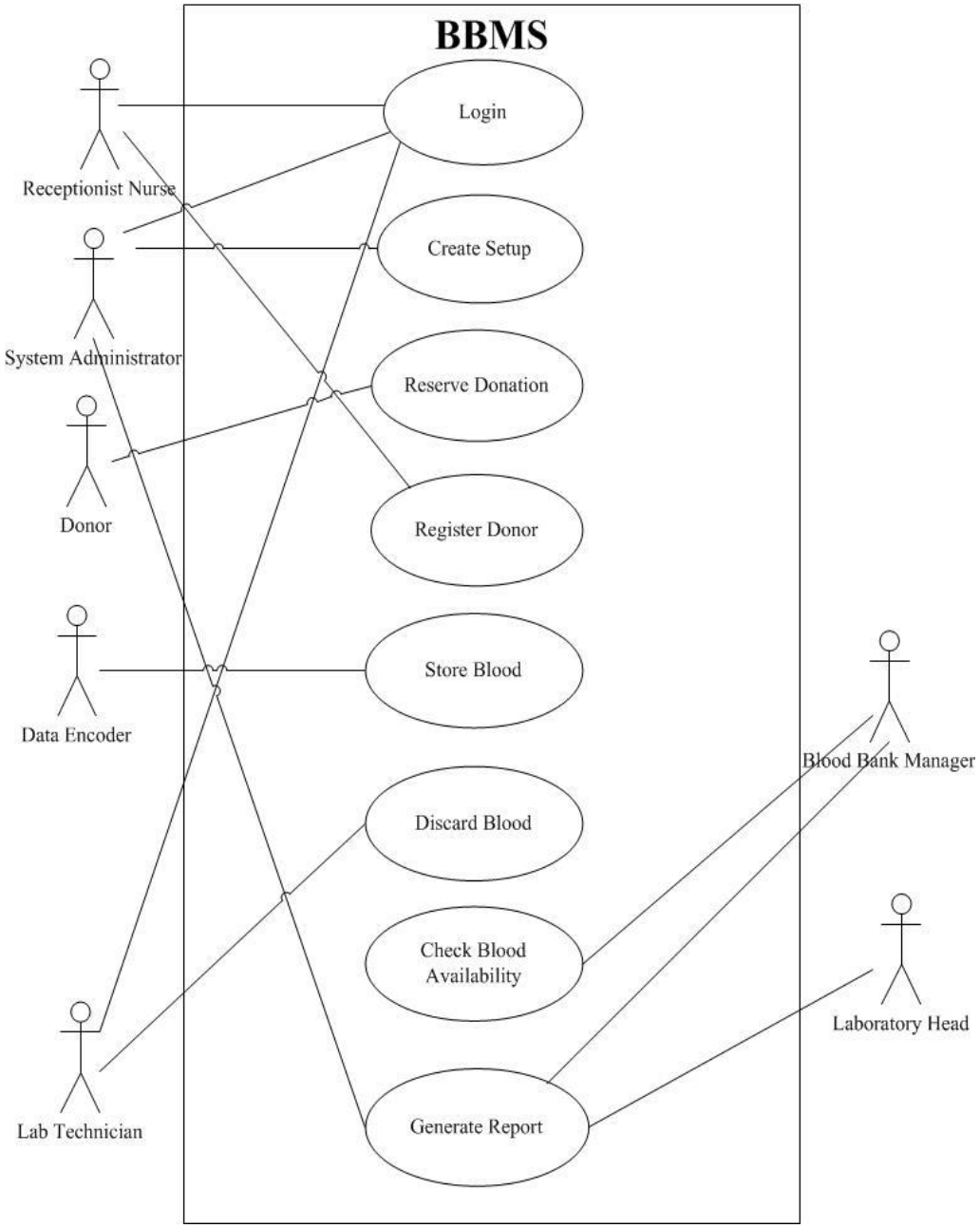

Figure 4.1. System Use Case Diagram for Blood Bank Information Management System.

4.1.2. Use Case Narration and Activity Diagram Presentation

Use Case ID	**UC-01**
Use Case Name	Login
Description	Describes how the user is authenticated by the system.
Actor	Receptionist Nurse, System Administrator, Lab Technician.
Pre-Conditions	The user has authorized user name and password.
Post-Conditions	The user logs into the system and the system displays system main page.
Main-Success Scenario	1. The user opens the blood bank information management system; 2. The user clicks login button; 3. The system displays login form; 4. The user enters user name and password and press login button; 5. The system displays main page based on the user privilege.
Alternative Scenario	4.1 If the user enters wrong user name and password 5.a The system notifies the user that he/she entered wrong user name and password; 5.b The system let the user to try again.
Rules	The system allows three attempts maximum for the user to access the system.

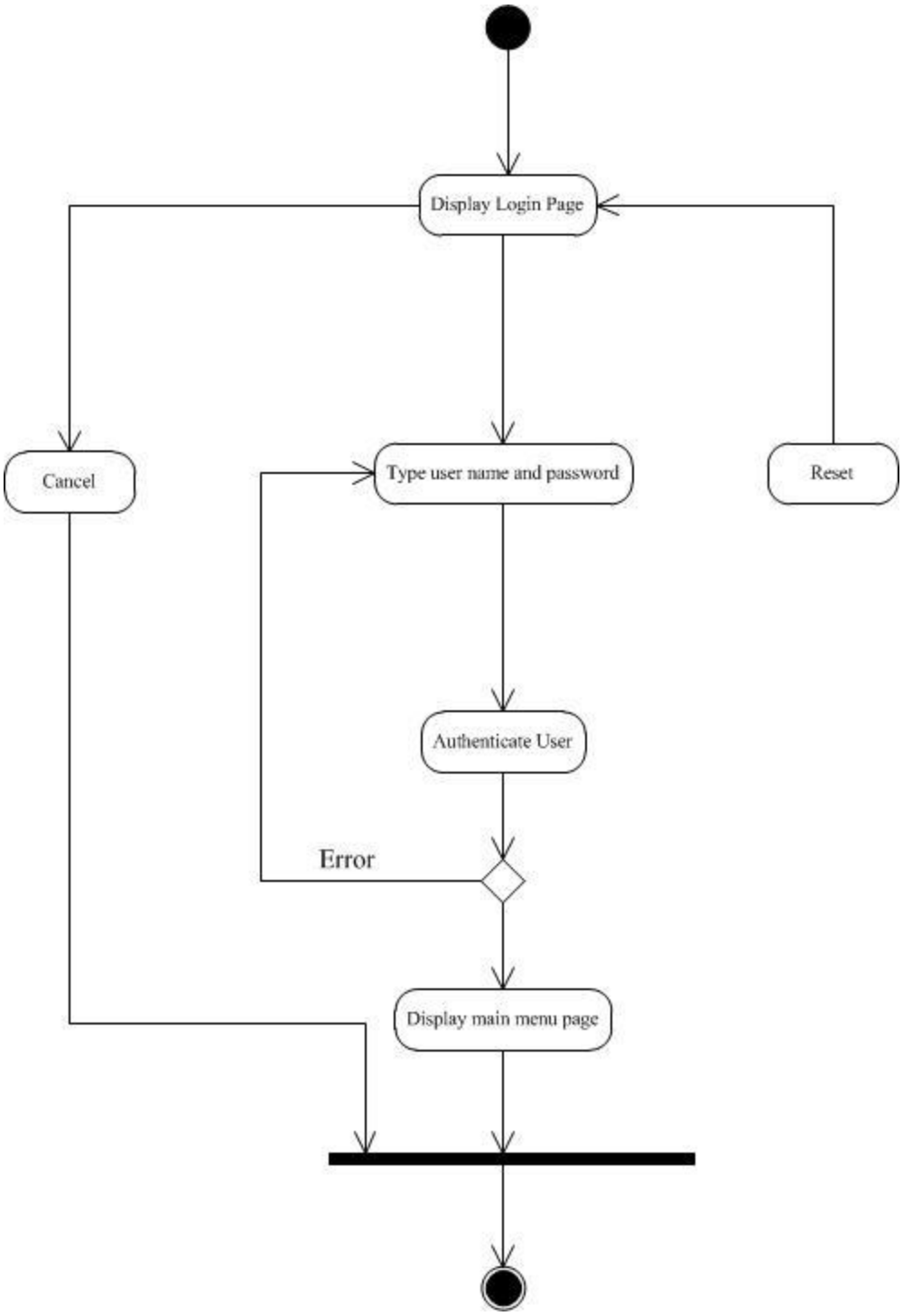

Figure 4.2: The activity diagram for login process

Use Case ID	**UC-02**
Use Case Name	Create Setup
Description	Describes the processes of creating user and center setup
Actor	System Administrator
Pre-Conditions	The administrator is logged into the system using administrator account
Post-Conditions	The system setup User and Center.
Main-Success Scenario	1. The system displays administrator screen with sub menu; 2. The administrator selects User setup option; 3. The system displays User setup form; 4. The administrator enters the new user information and clicks save button; 5. The system setup new user account.
Alternative Scenario	2.1 If the administrator selects center setup option 3.a The system displays center setup form; 4.a The administrator enters new center information and clicks save button; 5.a The system create new center setup.
Rules	

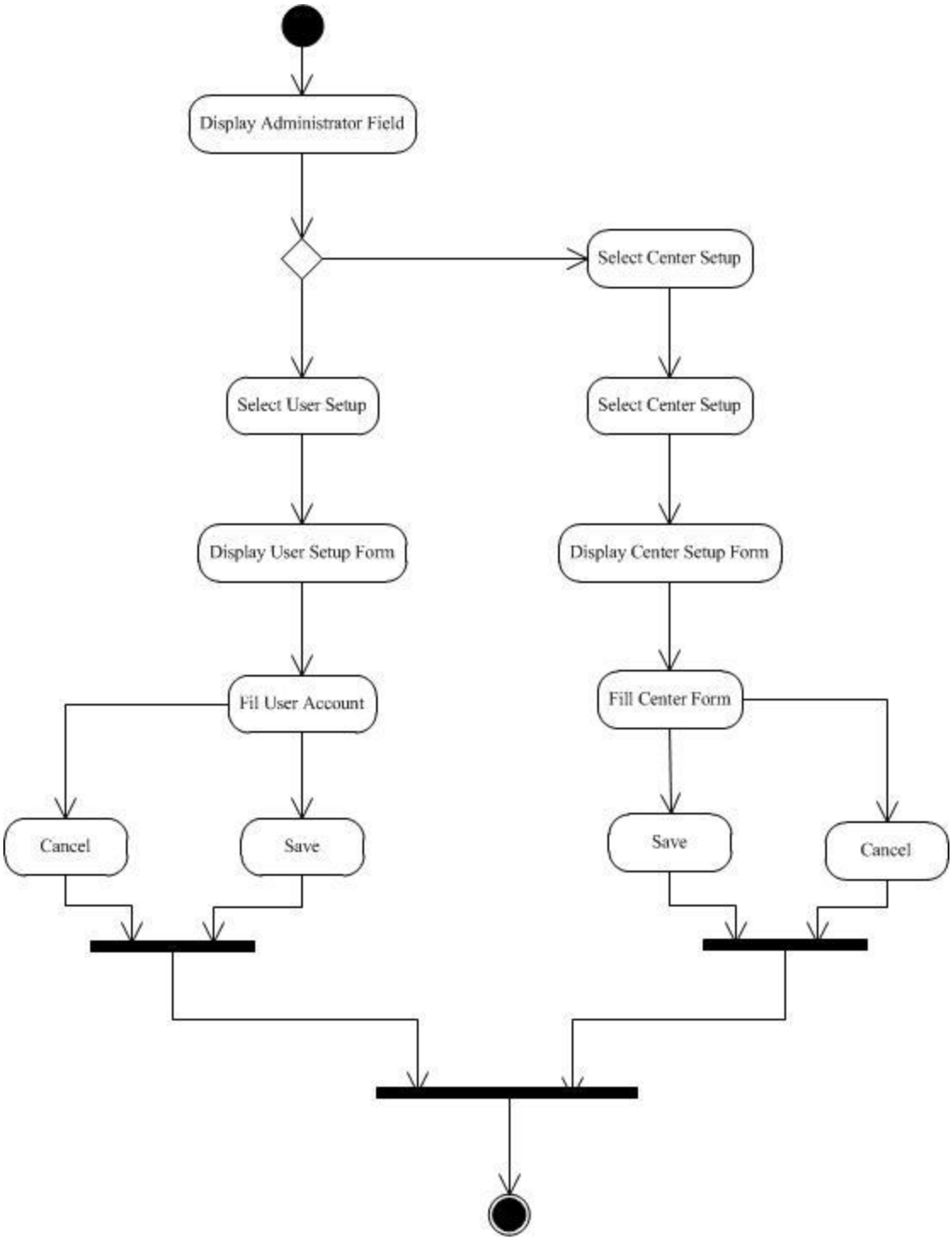

Figure 4.3: The activity diagram for administration process

Use Case ID	**UC-03**
Use Case Name	Reserve Donation
Description	Describes how a donor reserve donation time slot.
Actor	Donor
Pre-Conditions	The donor access the blood bank portal by entering the URL.
Post-Conditions	The system reserve donation time slot for the donor.
Main-Success Scenario	1. The donor opens the blood bank information management system portal; 2. The donor selects individual reservation option; 3. The system displays individual reservation form; 4. The donor enters the necessary information such as, Name, Gender, Donation Date, Email etc..; 5. The donor clicks "**Reserve**" button; 6. The system sends confirmation number to the donor's email. 7. The system lets the donor to enter confirmation number; 8. The donor enters confirmation number; 9. The donor clicks **"Submit"** button; 10. The system reserve donation time slot.
Alternative Scenario	2.1 If the donor selects group reservation option; 3.a The system displays group reservation form; 4.a The donor enters the necessary information such as, Company Name, Number of Donors, Donation Date, Company Email etc..; 5.a The donor clicks "**Reserve**" button; 6.a The system sends confirmation number to the company's email. 7.a The system lets the donor to enter confirmation number;

	8.a The donor enters confirmation number; 9.a The donor clicks **"Submit"** button; 10.a The system reserve donation time slot.
Rules	The system allows three attempts maximum for the donor to enter confirmation number.

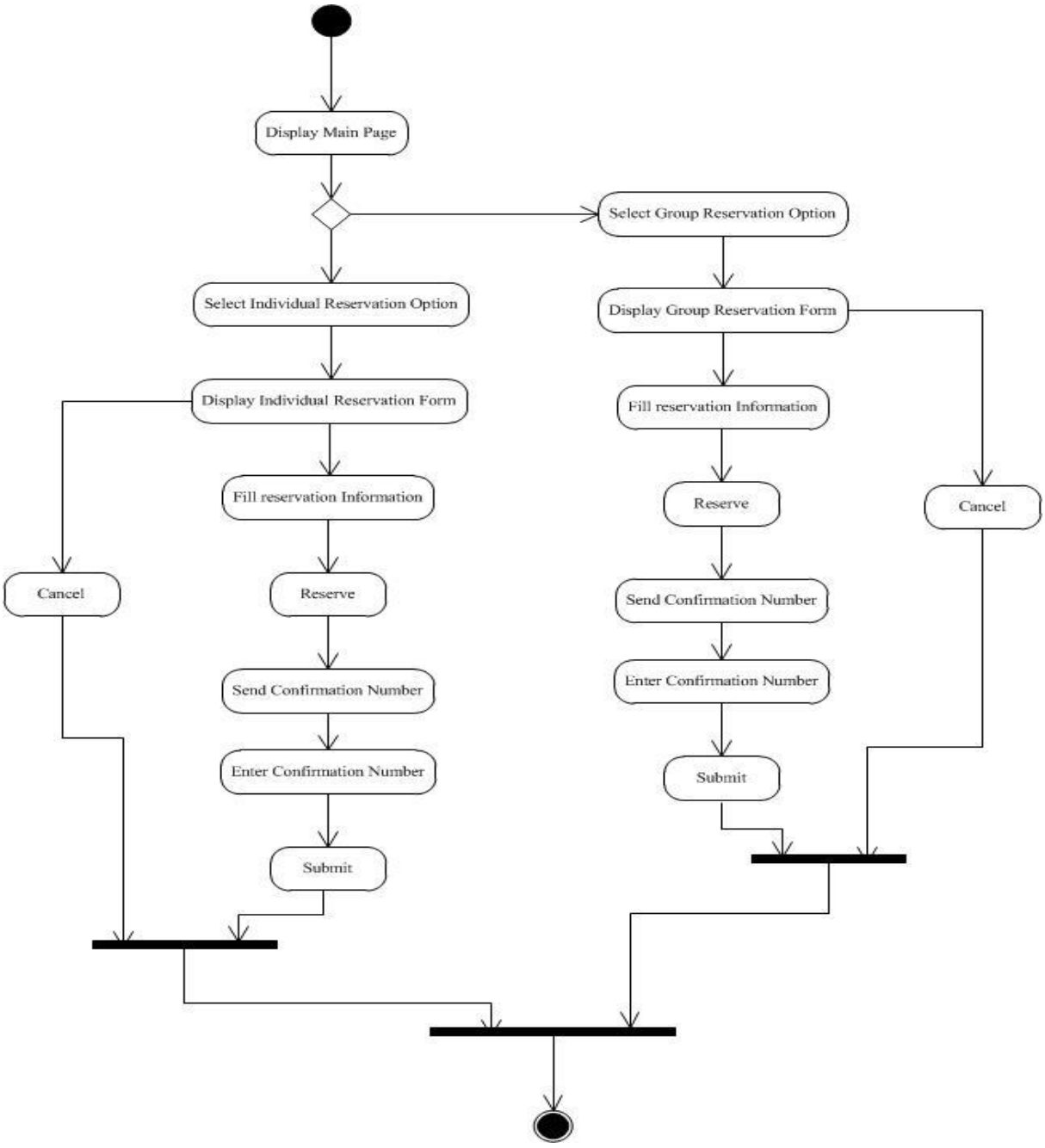

Figure 4.4: The activity diagram for donation time slot reservation process

Use Case ID	**UC-04**
Use Case Name	Register Donor
Description	Describes the process of registering donor information
Actor	Receptionist Nurse
Pre-Conditions	The user is logged into the system
Post-Conditions	Donor detail is recorded in the system database
Main-Success Scenario	1. The user select donor registration button; 2. The system displays donor registration form; 3. The user enters donor profile; 4. The user click save button; 5. The system save donor details on the database and make the form ready for the next donor.
Alternative Scenario	4.1 If the user click on cancel button 6.a The system returns to main menu 4.2 If the user click on reset button 6.b The system clear the input box
Rules	

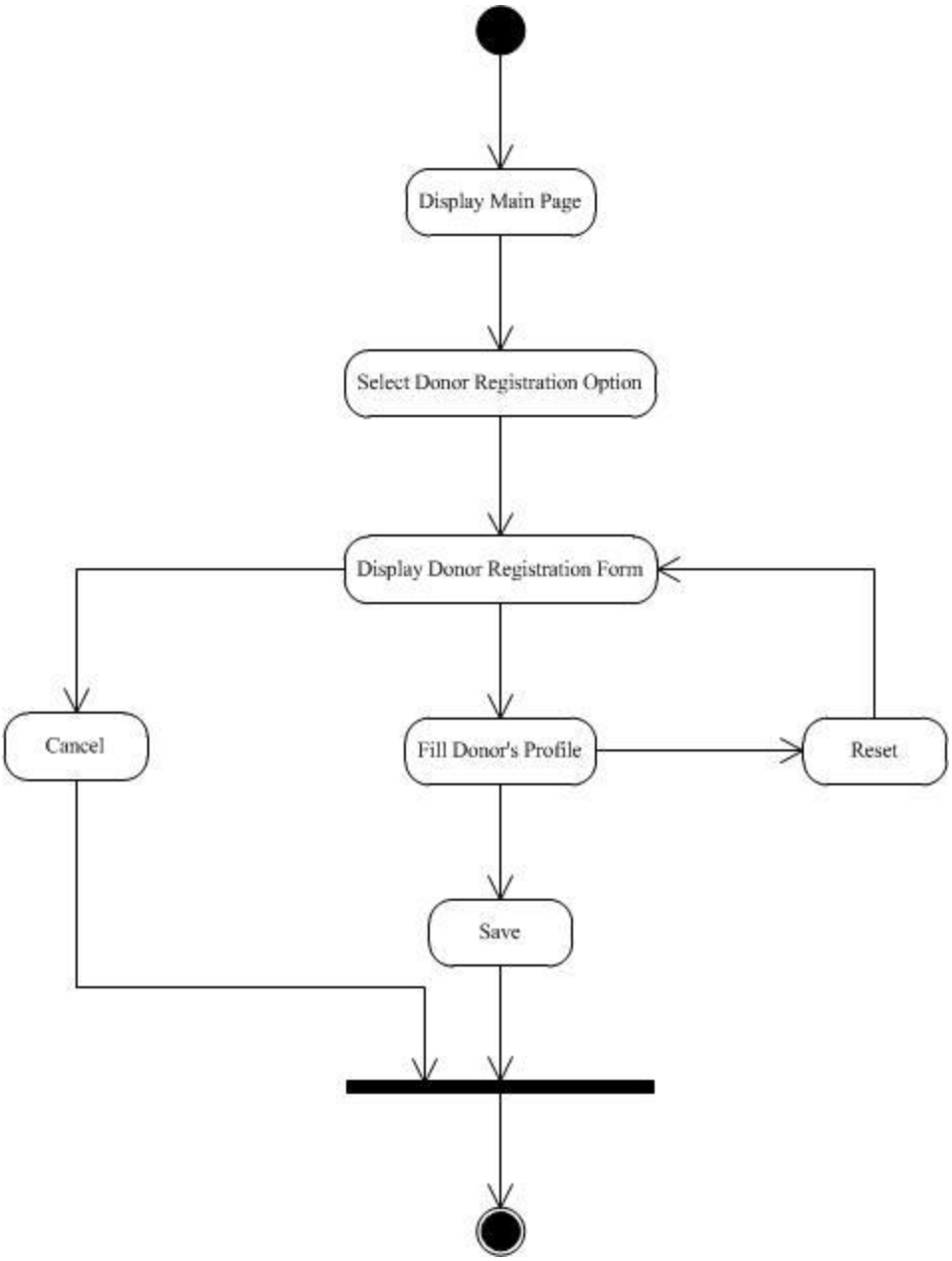

Figure 4.5: The activity diagram for blood donor registration process

Use Case ID	**UC-05**
Use Case Name	Store Blood
Description	Describes the process of storing blood information
Actor	Data Encoder
Pre-Conditions	The user is logged into the system
Post-Conditions	Donated blood information is recorded in the system database
Main-Success Scenario	1. The user select blood storage option; 2. The system displays blood storage form; 3. The user enters donated blood details; 4. The user click save button; 5. The system save blood information on the database and make the form ready for the next blood information.
Alternative Scenario	4.1 If the user click on cancel button 5.a The system returns to main menu 4.2 If the user click on reset button 5.b The system clear the input box
Rules	

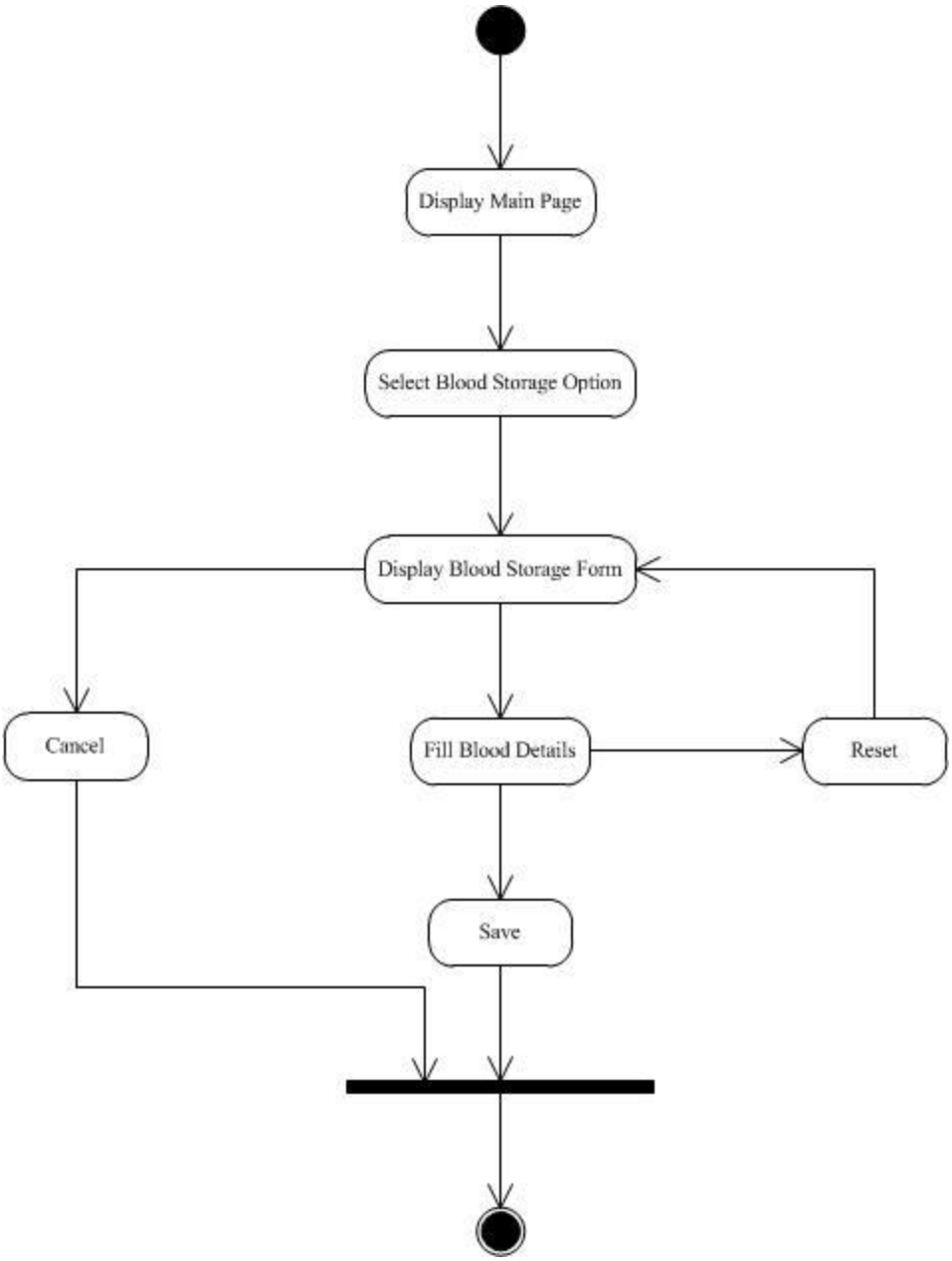

Figure 4.6: The activity diagram for storing blood process

Use Case ID	**UC-06**
Use Case Name	Discard Blood
Description	Describes the process of registering discarded blood information
Actor	Lab Technician
Pre-Conditions	The user is logged into the system
Post-Conditions	Discarded blood information is recorded in the system database
Main-Success Scenario	1. The user select discard blood button; 2. The system displays discarded blood registration form; 3. The user enters discarded blood details; 4. The user click save button; 5. The system save discarded blood details on the database and make the form ready for the next record.
Alternative Scenario	4.1 If the user click on cancel button 5.a The system returns to main menu 4.2 If the user click on reset button 5.b The system clear the input box
Rules	

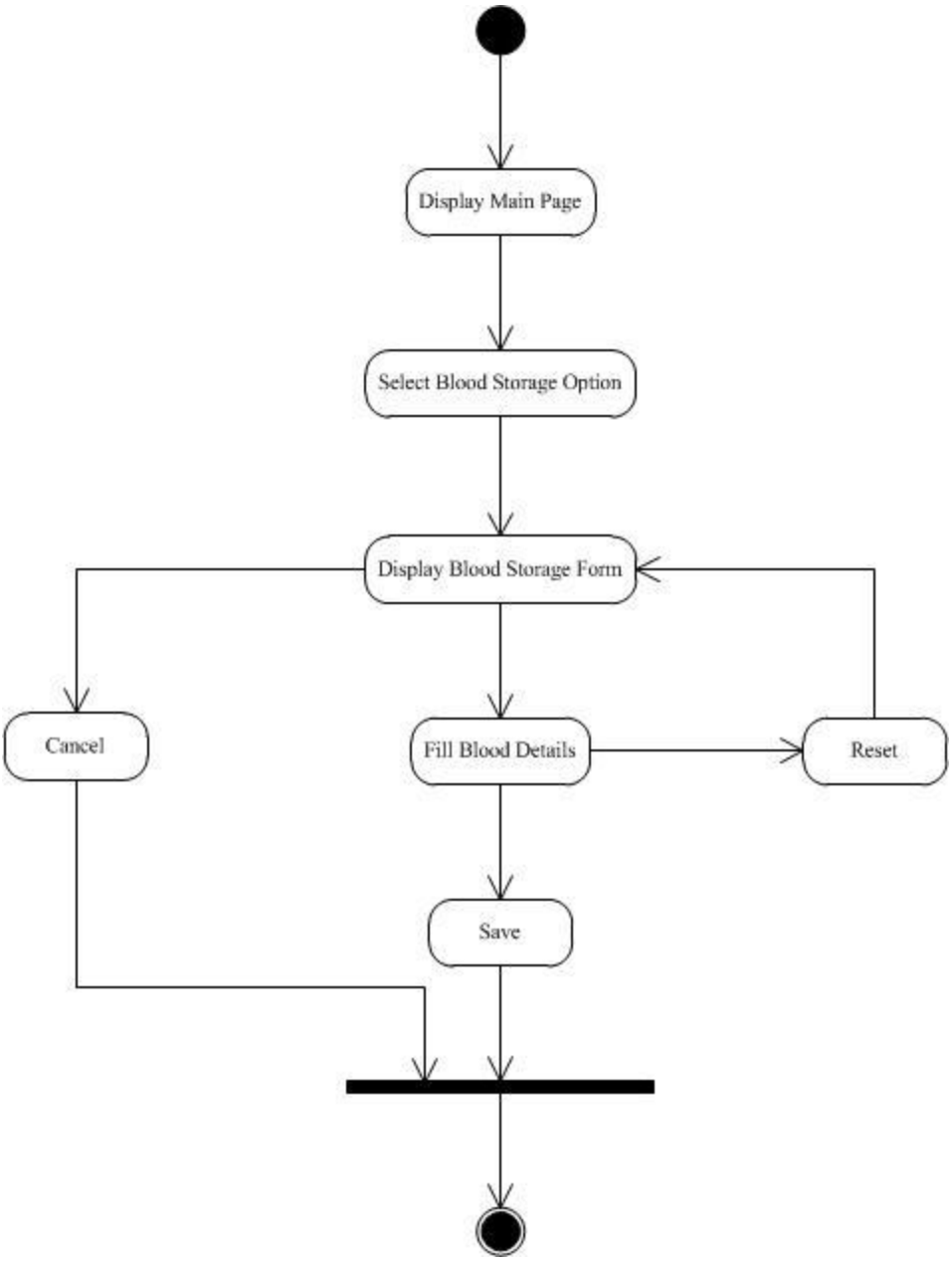

Figure 4.7: The activity diagram for blood discarding process

Use Case ID	**UC-07**
Use Case Name	Check Blood Availability
Description	Describes how health institution checks availability of blood at blood bank center.
Actor	Health institution.
Pre-Conditions	The user is logged into the system.
Post-Conditions	The system displays blood availability.
Main-Success Scenario	1. The user selects blood availability button; 2. The system displays blood availability check form; 3. The user selects blood type information in the searching field; 4. The user click check availability button; 5. The system displays amount of blood and the center where it is available.
Alternative Scenario	3.1 If the user selects center wise information 5.a The system displays specific center blood availability information.
Rules	

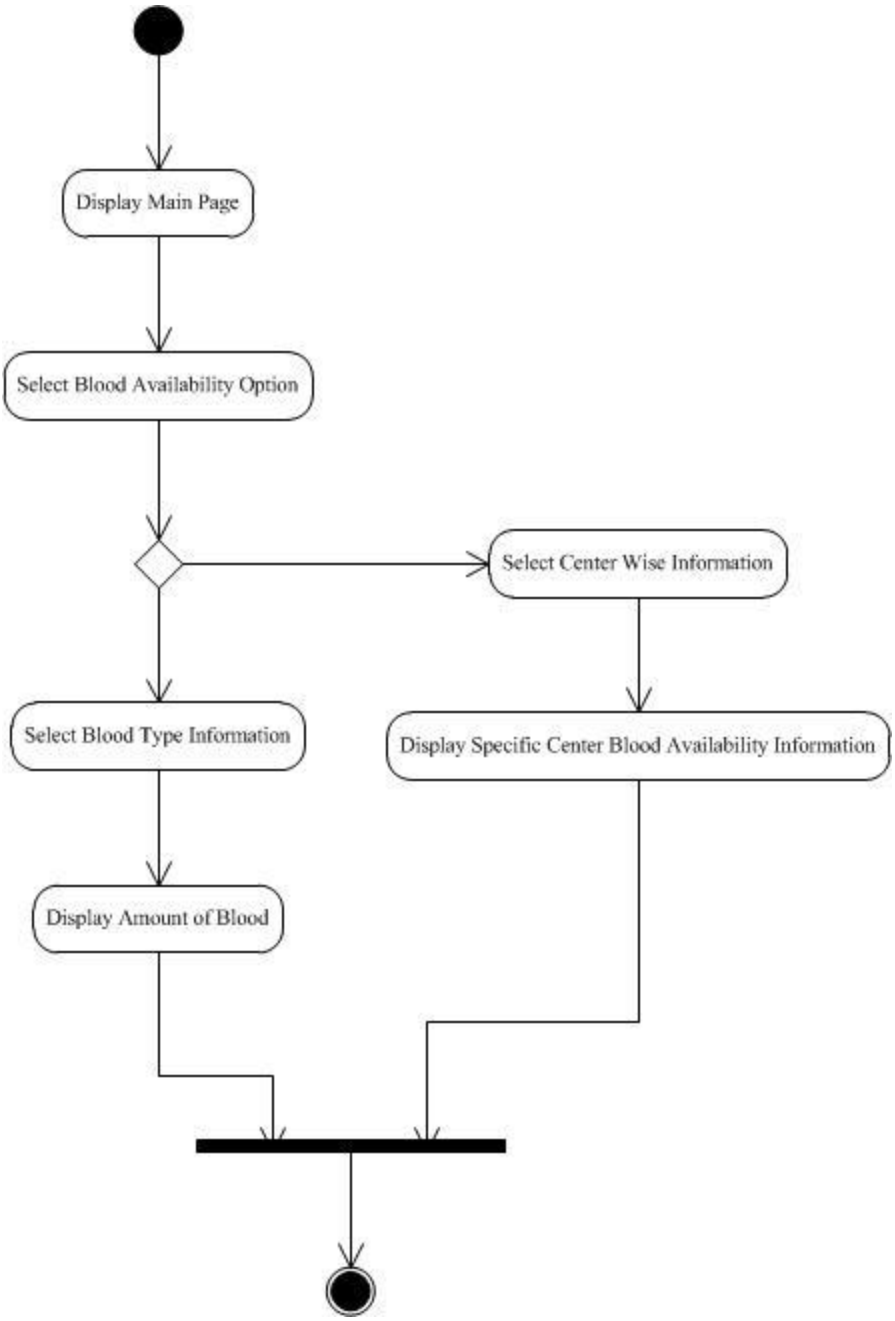

Figure 4.8: The activity diagram for checking blood availability process

Use Case ID	**UC-08**
Use Case Name	Generate Report
Description	Describes the process of generating different reports
Actor	System administrator, blood bank manager, lab head
Pre-Conditions	The user is logged into the system
Post-Conditions	The system generate reports
Main-Success Scenario	1. The user select report menu; 2. The system displays report option; 3. The user selects option of the report to be generated and click on generate report button; 4. The system generates report from the database.
Alternative Scenario	3.1 If the user click on export button; 4.a The system export the report in different format. 3.2 If the user click on print button; 4.b The system print out the report 3.3 If the system click on cancel button; 4.c The system return to the main menu
Rules	

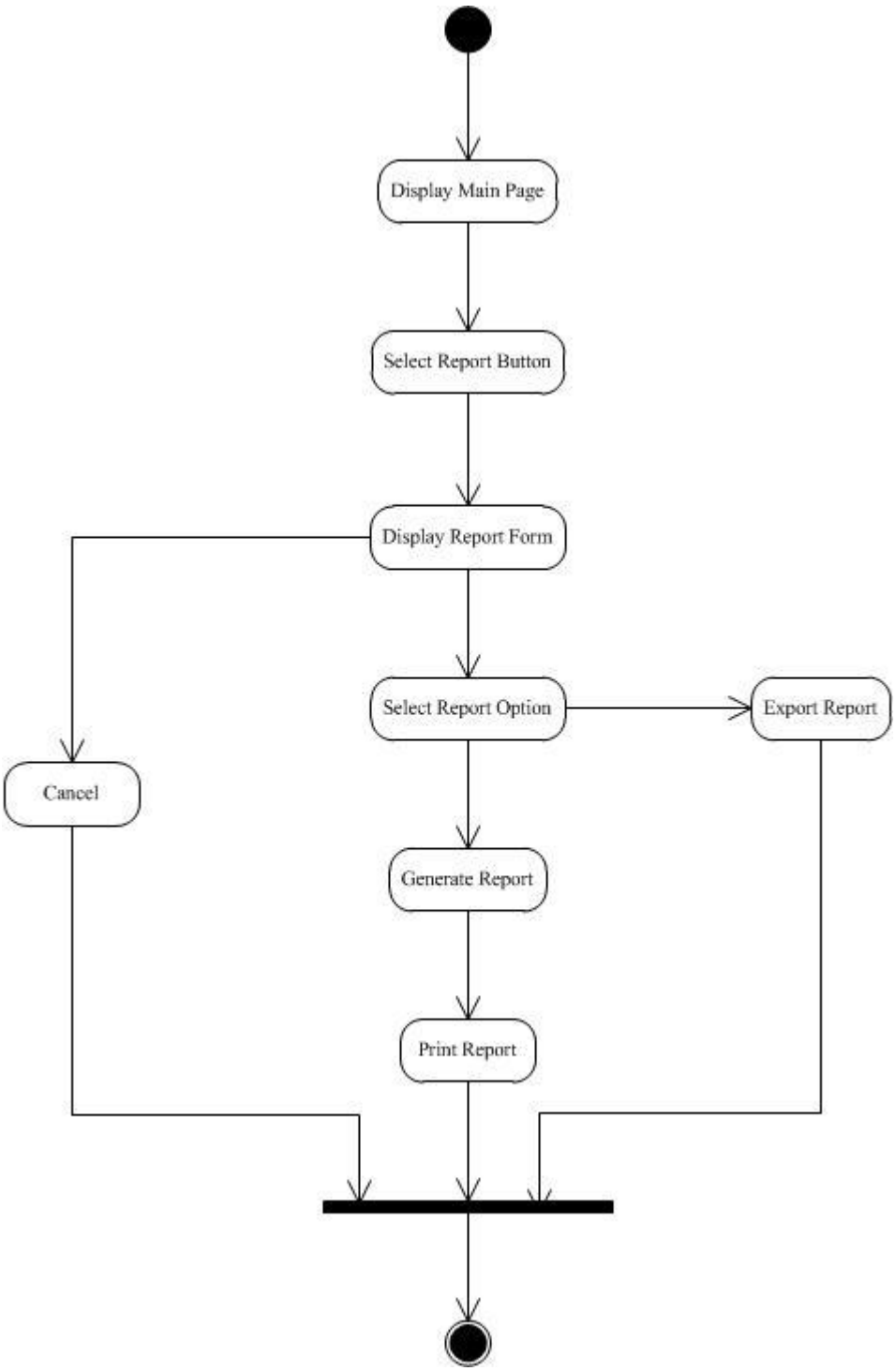

Figure 4.9: The activity diagram for generating report process

4.1.3. User Interface Prototype Presentation

User interface prototyping is an iterative analysis technique in which users are actively involved in the mocking-up of the UI for a system. It uses as an analysis artifact that enables developers to explore the problem space with the stakeholders. And also used as a design artifact that enables system developer to explore the solution space of the system. The user interface prototype helps the user to test the system at early stage of the system development. It can be developed using hand drawing or using tools like Visio. The following diagrams show the user interface prototype developed using Visio.

Login User Interface

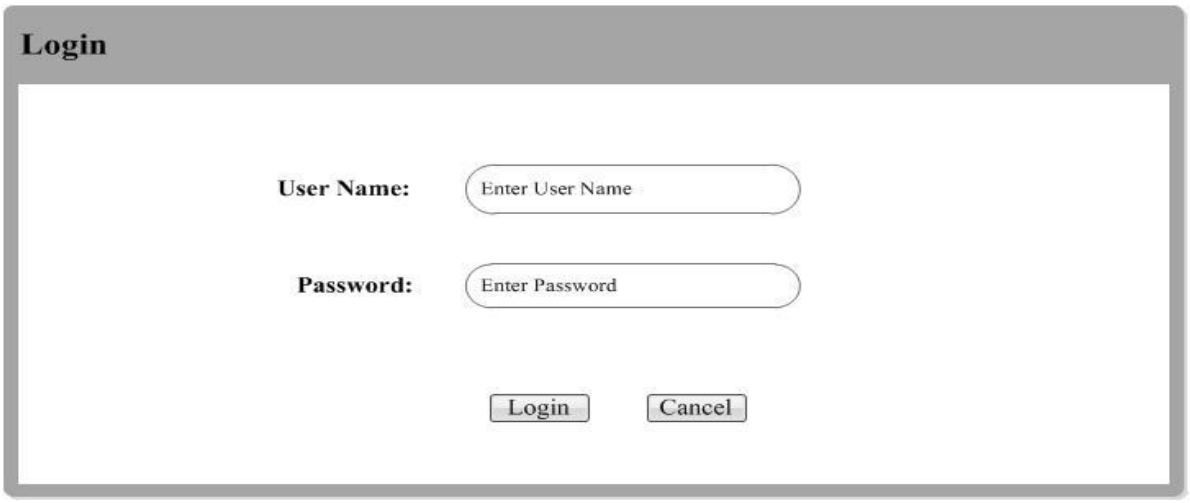

Figure 4.10: Login User Interface Prototype

Blood Donation Reservation

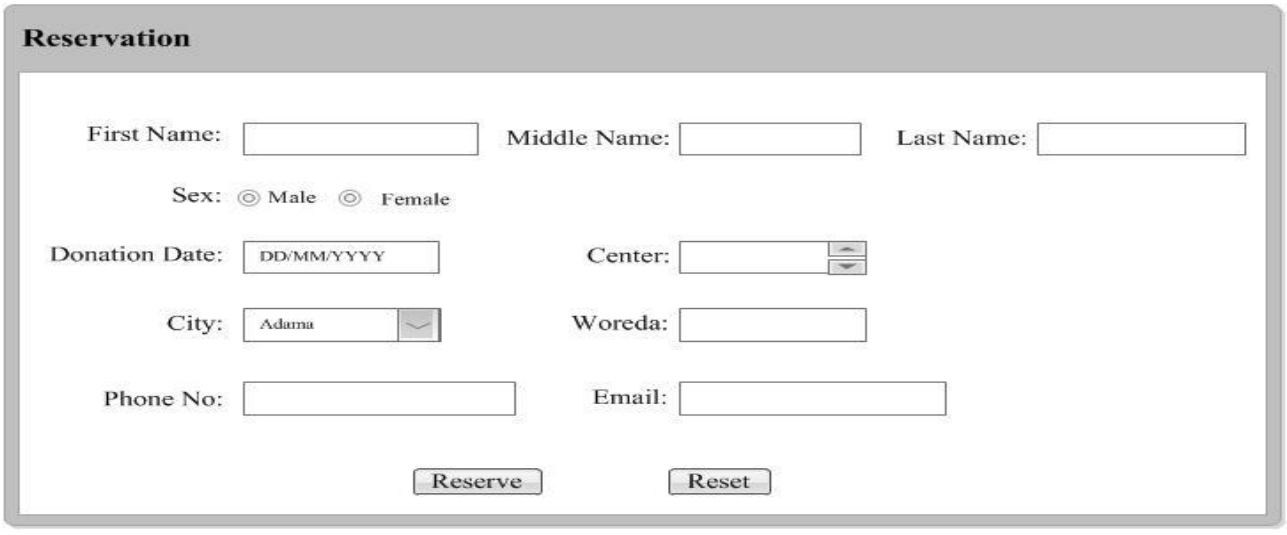

Figure 4.11: Donation Reservation User Interface Prototype

Donor Registry User Interface

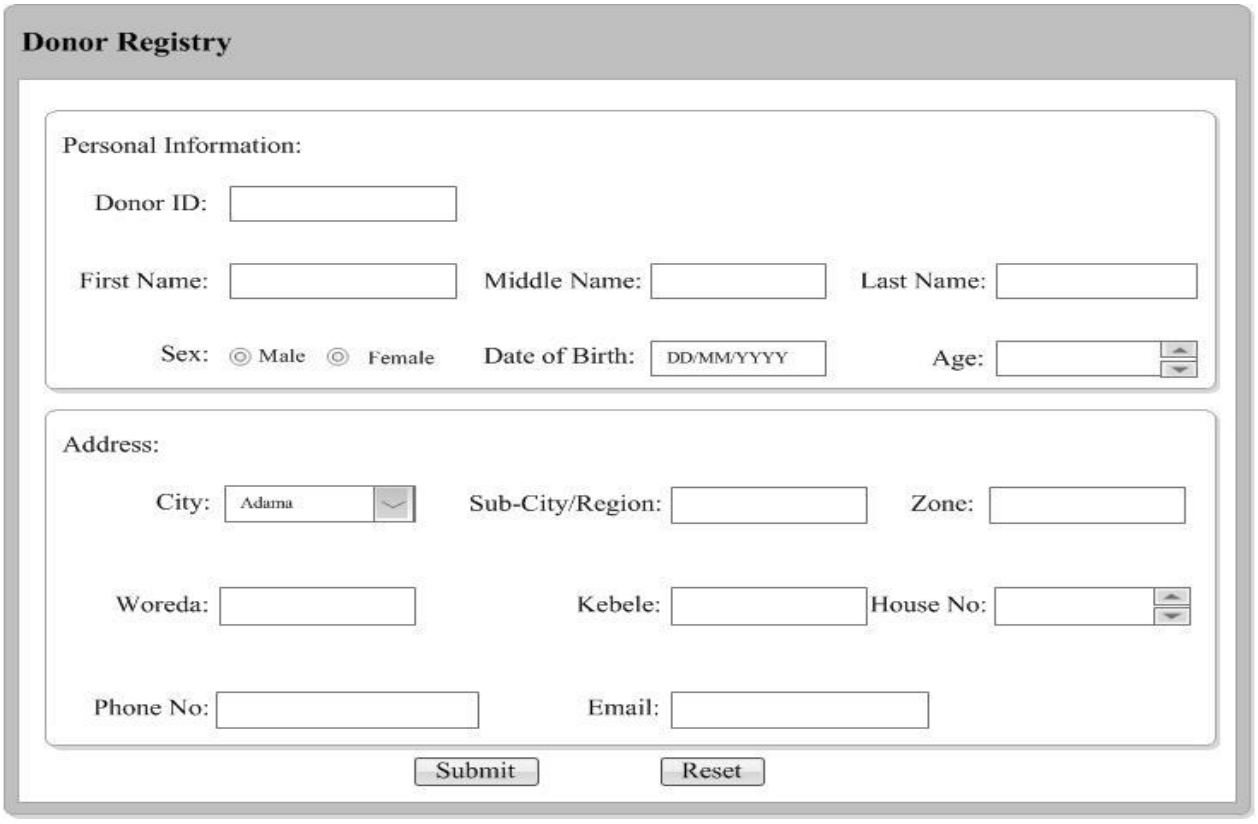

Figure 4.12: Donor Registry User Interface Prototype

Blood Registry User Interface

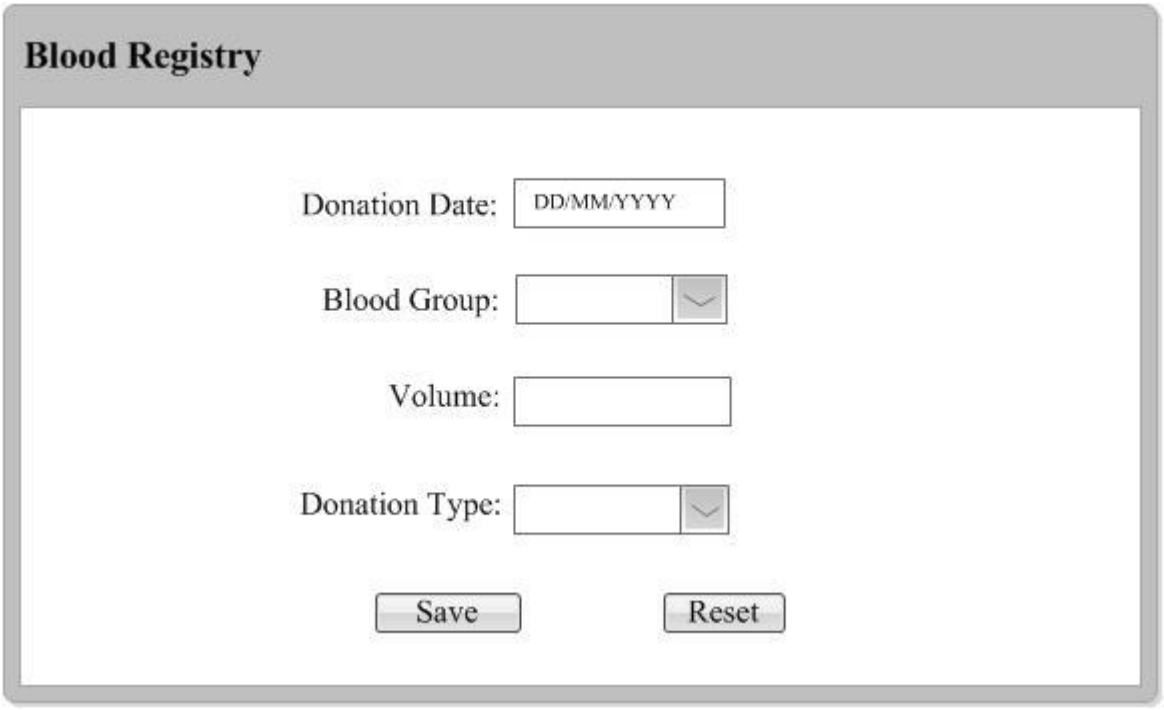

Figure 4.13: Blood Registry User Interface Prototype

Blood Distribution Registry User Interface

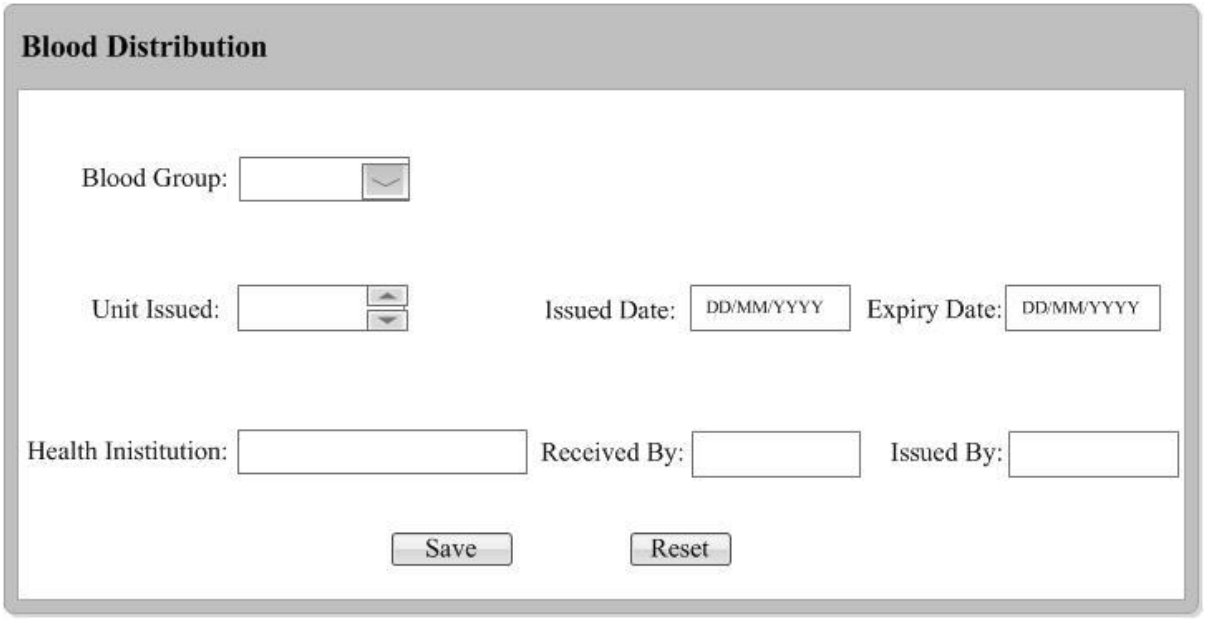

Figure 4.14: Blood Distribution Registry User Interface Prototype

Discarded Blood Registry User Interface

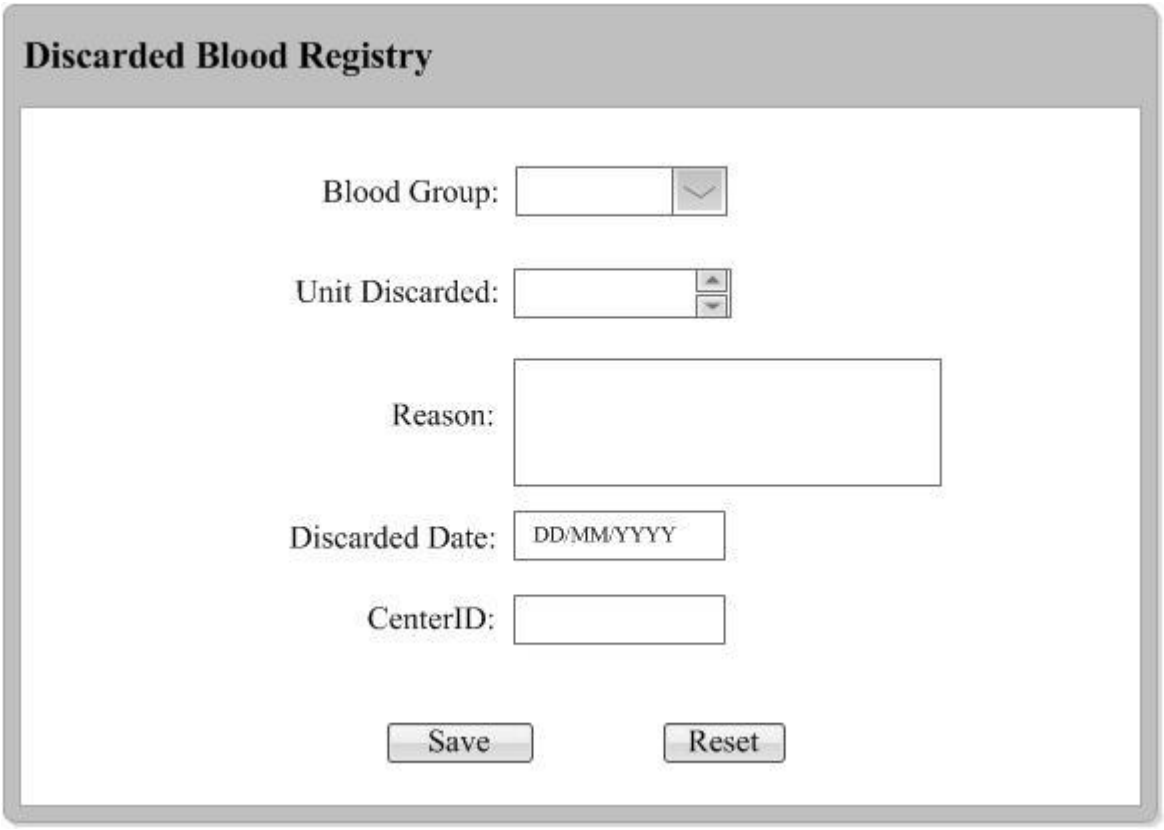

Figure 4.15: Discarded Blood Registry User Interface Prototype

Blood Collection Report User Interface

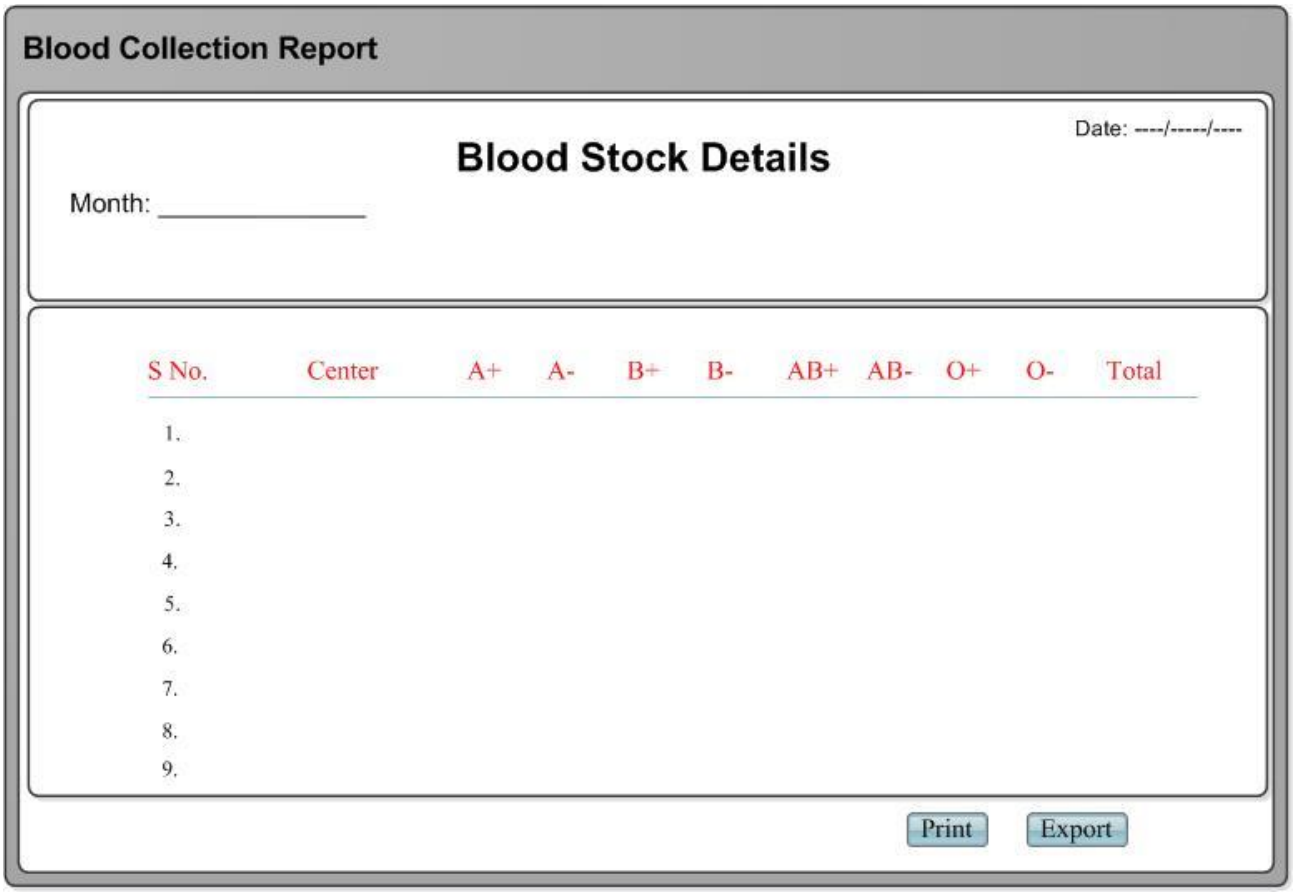

Figure 4.16: Blood Collection Report User Interface Prototype

4.2. Design Model

The system design model is presented using class diagram.

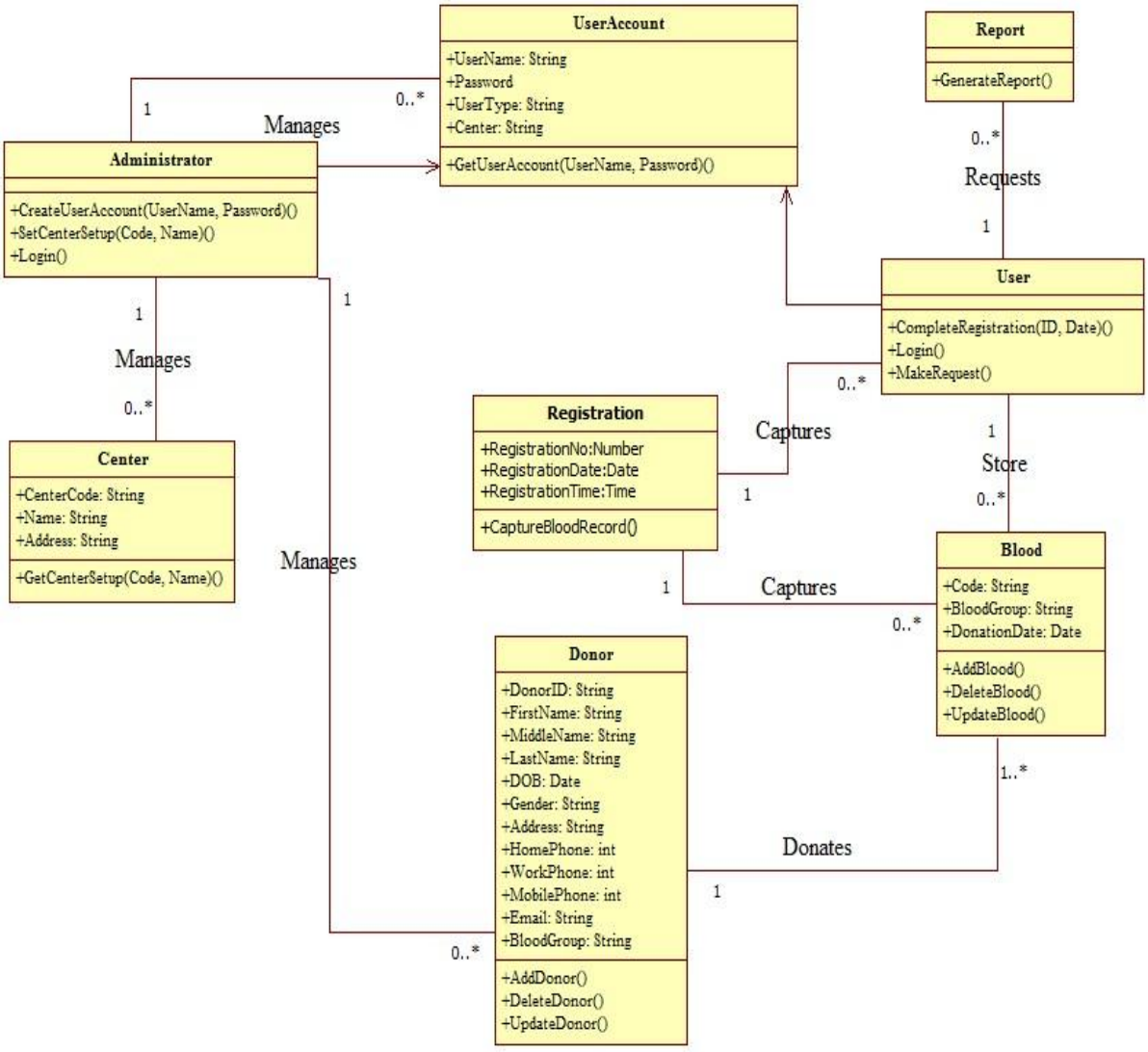

Figure 4.17: Class Diagram for Blood Bank Information Management System

4.3. System Prototype Presentation

Login Form

Login page allows authenticated user to enter into the system. The user accesses the login page by selecting "**Login**" button from the home page and its needs to enter a valid user name and password to login into the system.

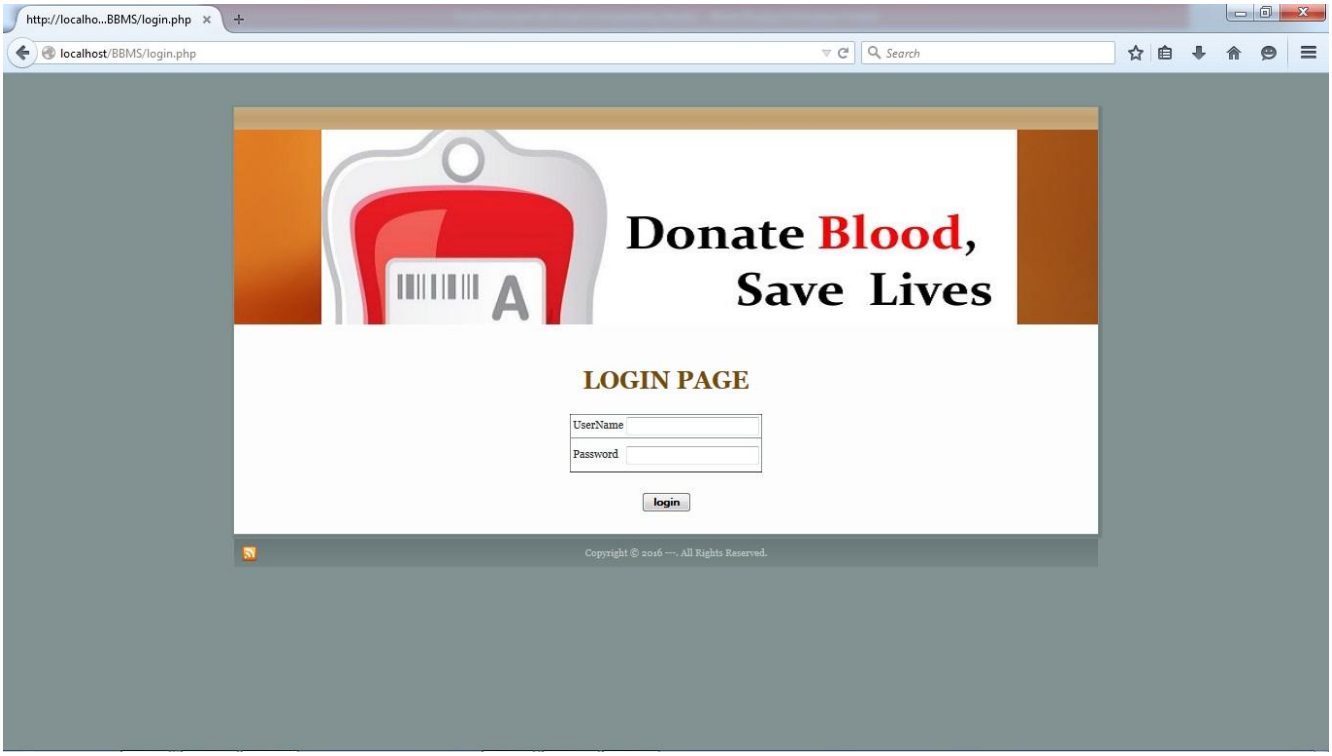

Figure 4.18: Login Form

Blood Donation Reservation Form

"Blood Donation Reservation" helps a potential donor or group of donors to make early reservation or booking of donation time slot online. The donor accesses the reservation page by selecting "**Reservation**" button on the main page. While the donor clicks "Reserve" button after entering the details, the system sends a confirmation code to the donor's email. The user needs to enter the confirmation code for the system to reserve a time slot.

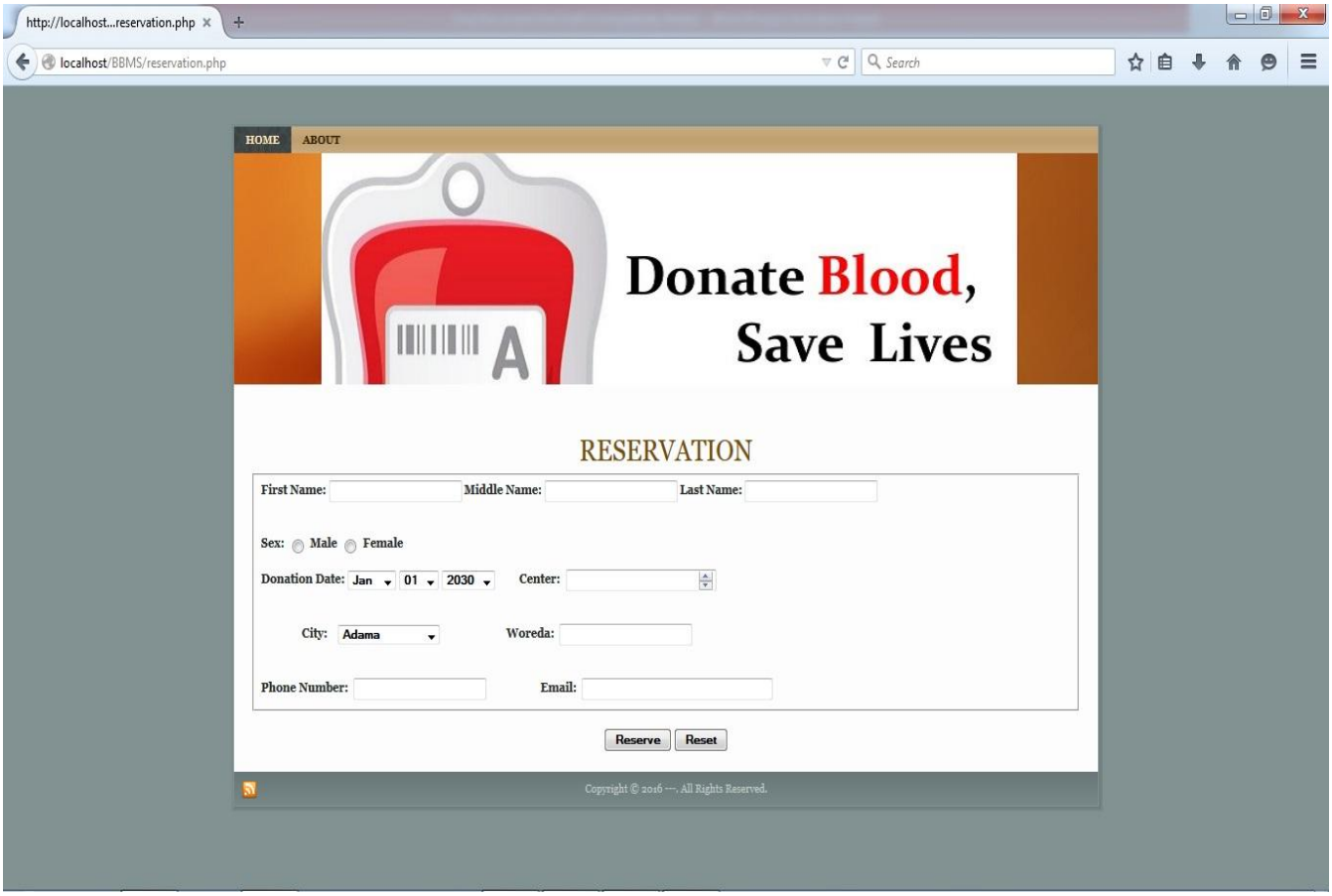

Figure 4.19: Donation Reservation Form

Donors Registry Form

"**Donor Registry**" allows the user to register new potential donor's profile into the system. To open the donor registry form, the user selects "**Donor Registration**" button on admin page. The form captures the profile of a single potential donor.

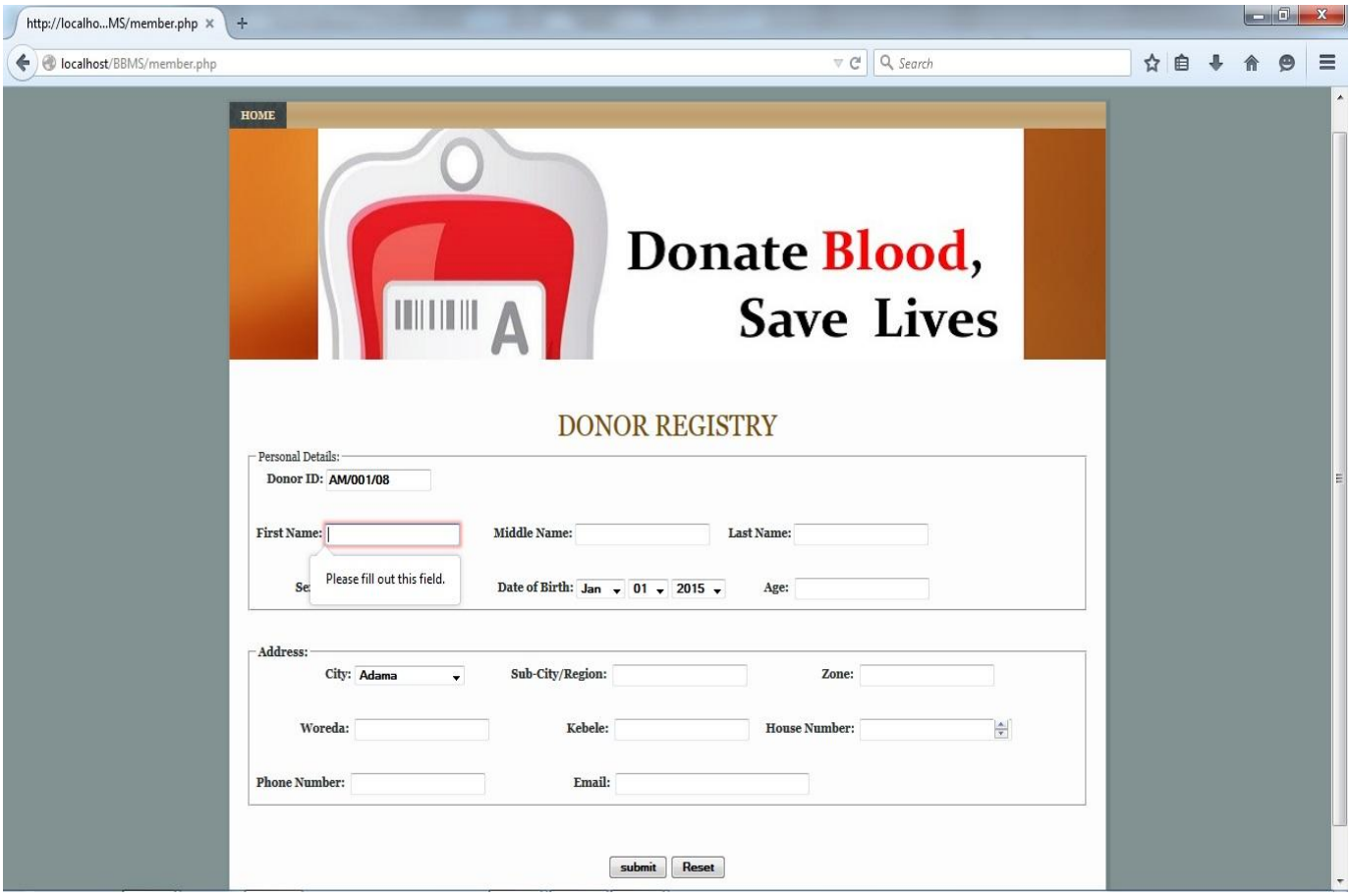

Figure 4.20: Donor Registry Form

Blood Registry Form

"**Blood Registry**" is the form used to record donated blood. The user selects "**Donation**" button to open the blood registry form on the admin page. The form captures detailed information about blood registry.

Figure 4.21: Blood Registry Form

Blood Distribution Registry Form

"**Blood Distribution Registry**" form helps the user to capture distribution of bloods to a health institution. The form captures detailed information about blood and health institution. The user access the form by selecting "**Distribution**" button on the admin page.

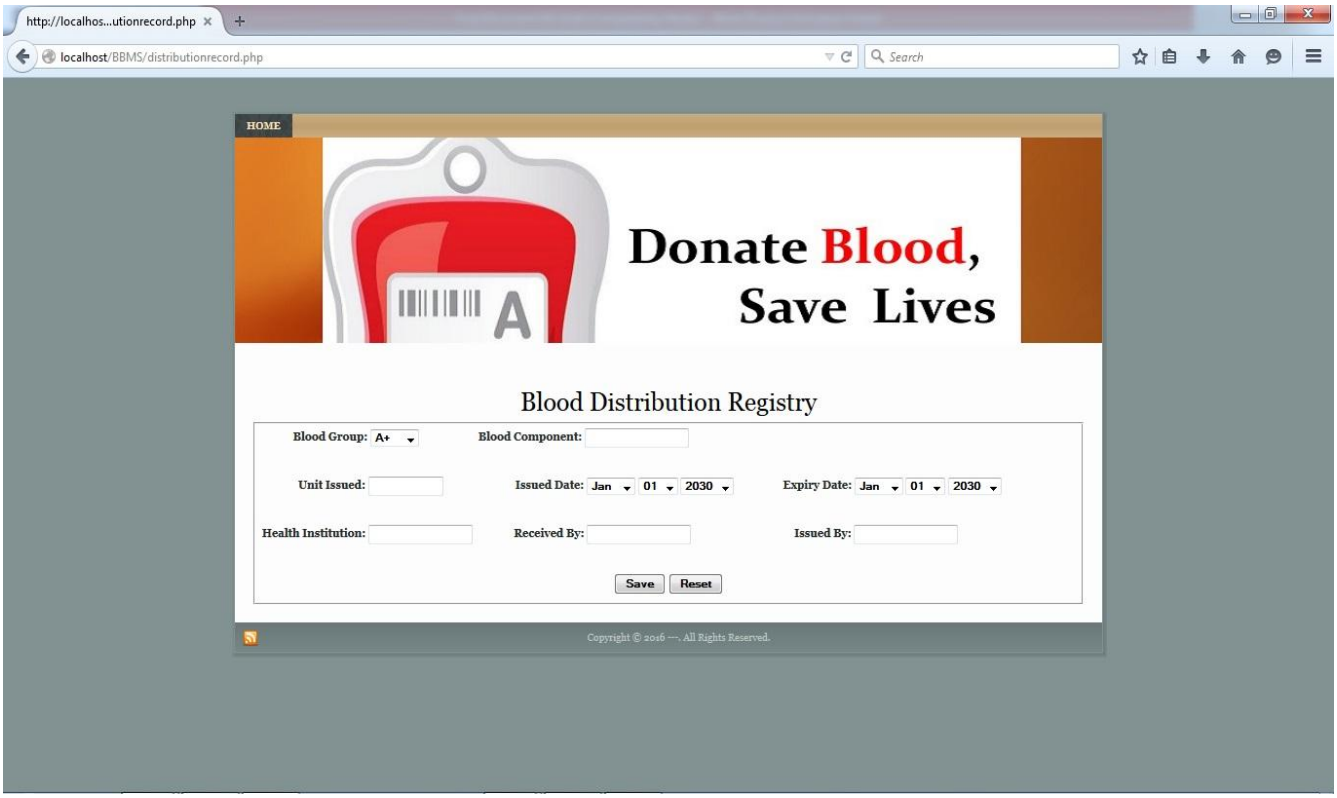

Figure 4.22: Blood Distribution Registry Form

Discarded Blood Registry Form

"**Discarded Blood Registry**" form is used to record bloods that are discarded for different reasons. The user access the form by selecting the "**Discard**" button on the admin page.

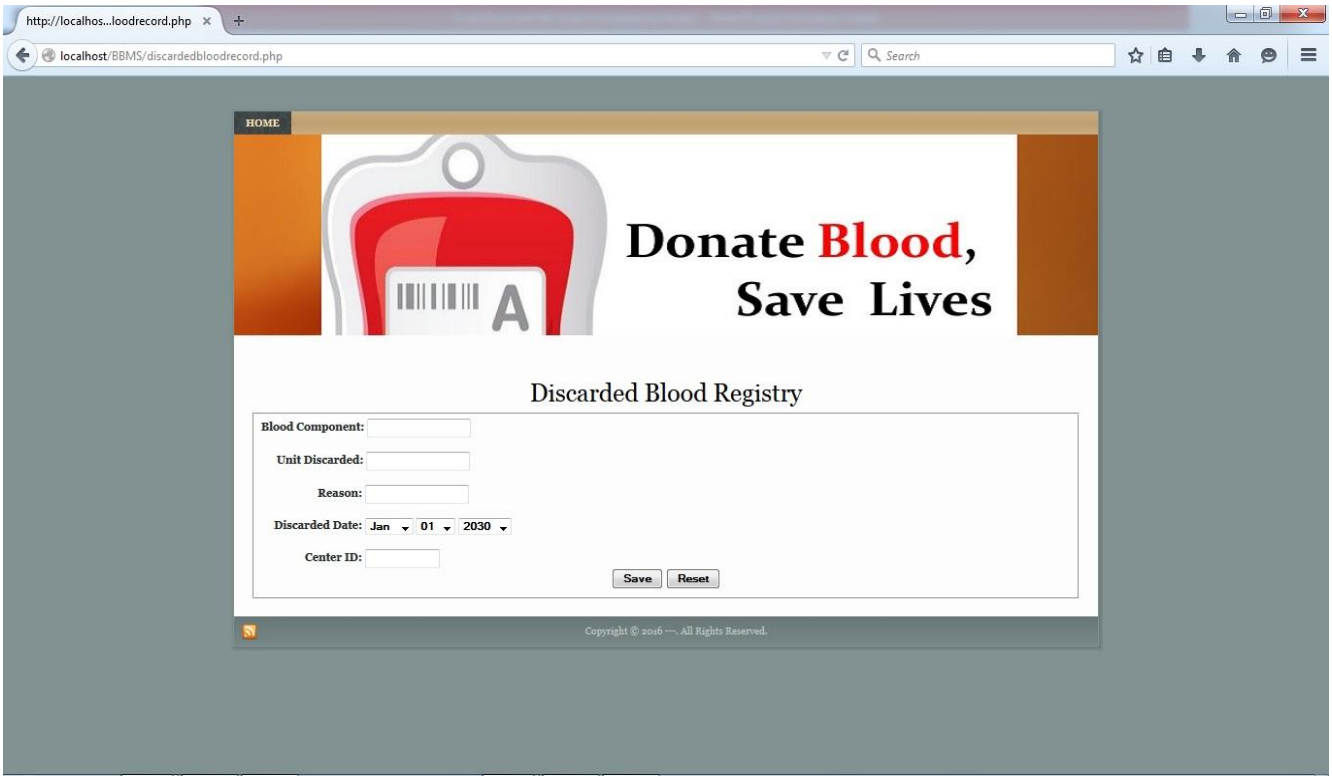

Figure 4.23: Blood Discard Registry Form

Appendix B

Hardware Inventory

Table 1: Hardware inventory of the existing system of the National Blood Bank of Ethiopia, 2016

S. No.	Department	Quantity	Type/ Specification	Capacity		Remark
				Hard Disk	RAM	
1	Data Management Case Team	1	Compaq	150 GB	512 MB	Server
		1	Dell 3020	500 GB	4 GB	
		1	Dell 3020	500 GB	4 GB	
		1	Dell 3020	500 GB	4 GB	
		1	Dell 760	250 GB	2 GB	
		1	Dell 280	80 GB	512 MB	
		1	Dell 780	320 GB	4 GB	For Bar Code
2	Mobile Case Team 1	1	Dell 780	320 GB	4 GB	
3	Mobile Case Team 2	1	Dell 780	320 GB	4 GB	
4	Mobile Case Team 3	1	Dell 780	320 GB	4 GB	
5	Mobile Case Team 4	1	Dell 755	150 GB	1 GB	
6	Mobile Case Team 5	1	Dell 620	40 GB	256 MB	
7	Mobile Case Team 6	1	Dell 780	320 GB	4 GB	
8	Component Case Team	1	Dell 780	320 GB	4 GB	
		1	Dell 780	320 GB	4 GB	For Bar Code
9	Distribution Case Team	1	Dell 755	160 GB	1 GB	
		1	Dell 780	320 GB	4 GB	For Bar Code
10	Store	1	Dell 780	320 GB	4 GB	For Office Use
11	ABO Case Team	1	Dell 780	320 GB	4 GB	For Bar Code
12	Counseling Case Team	1	Dell 780	320 GB	4 GB	

		1	HP Laptop	320 GB	2 GB	
13	Record	1	Dell 745	160 GB	512 MB	
14	Infectious Case Team	1	Dell 780	320 GB	4 GB	For Bar Code
		1	Dell 760	250 GB	2 GB	
15	Quality and Safety Case Team	1	Dell 780	320 GB	4 GB	
		1	Dell 3020	500 GB	4 GB	
		1	Dell 620	150 GB	1 GB	
		1	Dell 780	320 GB	4 GB	
		1	HP Laptop	320 GB	2 GB	
16	Laboratory Head	1	Dell 780	320 GB	4 GB	
17	HRM	2	Dell 780	320 GB	4 GB	Office Use
18	General Director	2	Dell 780	320 GB	2 GB	Office Use
		1	HP Laptop	320 GB	2 GB	
19	Finance	5	Dell 3020	500 GB	4 GB	Office Use
20	Donor Service Team Leader	1	Dell 755	150 GB	1 GB	
		1	HP Laptop	320 GB	2 GB	
21	Auditing	1	Dell 3020	500 GB	4 GB	
22	Regional Support Case Team	1	Dell 3020	500 GB	4 GB	
23	Communication Case Team	1	Dell 3020	500 GB	4 GB	
		1	Dell 780	320 GB	1 GB	
24	Medical Service Case Team	1	Dell 780	320 GB	4 GB	
25	Planning	1	HP Laptop	320 GB	2 GB	
26	Logistic	1	HP Laptop	320 GB	2 GB	
NETWORK DEVICE						
27		1	D - Link Switch			24 Port
28		1	3 Com Switch			32 Port

29		1	3 Com Switch			8 Port
30		1	TP Link Switch			24 Port For Bar Code
31		1	D - Link Switch			32 Port
32		1	Cisco Router 1941			
33		1	ADSL Modem			
34		1	Access Point			

Appendix C

Requirements Collection Checklist

Addis Ababa University

School of Information Science and School of Public Health
MSc.in Health Informatics Program

Consent Form

The interview is designed as part of my MSc. Project. It intends to the "Design of a Web-Based Blood Bank Information Management System" for the National Blood Bank.

Dear Respondents,

The result of this interview will be utilized for project purpose only. Your contribution will help the outcome and it's expected that the result of this project work will contribute on the improvement of blood bank information management. Therefore, you are kindly asked to provide genuine to the questions that follow.

I am grateful for your time and effort in completing the interview.

In-Depth Interview Guide

Process

1. What does the blood donation process look like?

   _____

   _____

   _____

2. How do you control the blood inventory process?

   _____

   _____

   _____

3. Is there any mechanism by which donors reserve before visiting the blood bank in person?

   Yes_____ No_____

4. If No to Q3 above, what kind of reservation system/mechanism do you want to have?

   _____

   _____

   _____

5. Is there any problem on the blood bank management system?

   _____

   _____

   _____

Management

6. What does the organizational structure of the National Blood Bank look like?

   _____

   _____

People

7. How many professionals are there in the center?

   _____

   _____

8. How many professionals are involved in the blood bank management information system?

_____

_____

_____

Computer Software

9. Is there any software application in use in the center?

_____

_____

_____

10. What functions should the software provide?

_____

_____

_____

11. Does the National Blood Bank have a plan to develop blood bank information management system?

_____

_____

_____

12. What is the data format you use?

_____

_____

_____

Computer Hardware

13. What kind of computer related hardware devices are being used in the center?

_____

_____

_____

14. To what extent is the center ready to fulfill hardware requirements of the blood bank information management system?

_____

_____

_____

Network

15. Does the center have any network infrastructure?

_____

16. What kind of network does the center have?

_____

_____

_____

17. What is the bandwidth of internet connection the center currently has?

_____

18. How many number of users does the network support?

_____

19. How many departments in the center are connected to the network?

_____

20. What kind of network hardware devices are being used in the center?

_____

_____

_____

Report

21. What kind of report do you produce?

_____

_____

_____

22. How do you produce a report and how often?

_____

_____

_____

23. How and for whom do you generate the reports?

_____

_____

_____

Document Review Guide

1. What kind of forms do you use to record blood inventory management?

_____

_____

_____

2. What information does the forms include?

_____

_____

_____

3. Is there any important information missed in the form? What are they?

_____

_____

_____

4. What is your report formats look like?

_____

_____

_____

Appendix D

User Test Checklist

Table 1: User test checklist for the BBIMS,2016

S. no	Test Questions	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	The interfaces are attractive					
2	I like the font and the color of the interfaces					
3	There is consistency in the system interface					
4	I thought the system is easy to use					
5	I found the interfaces are not cumbersome to use					
6	All-important contents are addressed well					
7	I need less time to learn the user interface					
8	There is no unnecessary content available in the interface					

Appendix E

Donor Enrollment and Report Formats

Federal Democratic Republic of Ethiopia
Ministry of Health National Blood Bank Service

BLOOD DONOR ENROLLMENT FORM

Name_____ Father Name _____ Surname _____
Title _____ Date of Birth(DD/MM/YY) _____ Age ____ Sex ____ Occupation _____
City _____ Sub-city/Region _____ Zone _____ Woreda _____ Keb. _____ H.No ____
Tele (Res) _____ Tele (Off) _____
Cell Phone _____ E-mail _____ P.O.Box: _____
Reg No. _____ Donor's Signature _____ Donor Code

Date	Pack No.	Wt.	Hgt.	B/P	Vol.	Screened by	ABO	Rh	Type of Donation	Remark

1 of 2

ETHIOPIAN NATIONAL BLOOD TRANSFUSION SERVICE
NUMBER OF WHOLE BLOOD UNITS PLANNED, COLLECTED, DISTRIBUTED & DISCARDED
IN 2007 BUDGET YEAR anual report

Month october to jun
Year 2014/15

Region	Blood Bank	Plan	COLLECTED							DISTRIBUTED			DISCARDED	
			voluntary			Family Replacement	total	plan vs Collection %	voluntary vs Collecti	Free	Family Replacement	total	total discard	discard vs Collectio
			Center	mobile	total									
A.A	Addis Ababa													
Amhara	Bahir Dare													
	Gonder													
	Deber Markos													
	Deber Birhan													
	Desse													
	Deber Tabore													
Oromiya	Metu													
	Bale Goba													
	Jimma													
	Adama													
	Woliso													
	Nekemte													
	Chero													
South	Hawasa													
	Arba Minche													
Tegeray	Hosahena													
	Mekele													
	Axum													
Dire dawa	Dire Dawa													
Harare	Harare													
Emerging region	Jijiga													
	Asossa													
	Gambela													
	Afare													
Grand total														

DECLARATION

I declare that this project is my original work and has not been presented for degree in any other university, and that all sources of materials used for the project have been acknowledged.

Gadisa Kebede

This project has been submitted for examination with our approval as university advisors.

_____	_____
Ato Ermias Abebe	Dr. Mulugeta Betre

Place and Date of submission: Addis Ababa, June 2016