UGANDA MARTYRS UNIVERSITY

MOBILE-BASED BLOOD BANK AND DONOR MANAGEMENT SYSTEM

CASE STUDY: KABOYO HEALTH CENTRE III

By

Nassaazi Jovia

2020-B072-31834

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION SYSTEMS

FACULTY OF SCIENCE

jovia.nassaazi@stud.umu.ac.ug

A Project Report Submitted to the Faculty of Science in Partial Fulfillment of the Requirements for the award of the Degree of Bachelor of Science in Information Technology of Uganda Martyrs University

July, 2024

ACKNOWLEDGEMENT

First and foremost, I give thanks to the almighty God who has granted me the gifts of life, knowledge and guidance that has enabled me to complete this research proposal. Then special heartfelt appreciation goes to my sponsor Mrs Julia Nurjahja and the entire Every Child Ministry project (ECM), you have been my inspiration and encouragement through my life and academic journey. I would also like to thank my project Supervisor, Madam Babirye Nanteza Lucy for the professional guidance and direction rendered to me to achieve this success. Finally, I thank my classmates; Bwire Conrade, Mugerwa Isma, and Ssembuya Vicent, with whom I spent long hours doing research together. May the Almighty God Bless you.

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ACRONYMS

AECT	Association for Educational Communications and Technology
AIDS	Acquired Immunodeficiency Syndrome
API	Application Programming Interface
BBMS	Blood Bank Management System
BSIS	Blood Safety Information System
ECM	Early Child Ministry
GPS	Global Positioning System
GUI	Graphical User Interface
HIV	Human Immunodeficiency Virus
ICCIT	International Conference on Computing, Communication and Information Technology
ID	Identification or Identifier
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
NBTS	National Blood Transfusion Services
RDBMS	Relational Database Management System
UAT	User Acceptance Testing
UI	User Interface
WDI	World Development Indicators
WEB	World Wide Web
WHO	World Health Organization

ABSTRACT

The purpose of this study was to develop a mobile-based blood bank and donor management system and the main aim of the project is to save lives of the people by providing blood. The system is developed using android so as to bring together donors and those in need of blood in an emergency. The donors as those in need of blood have to register themselves by providing their basic details in the mobile application. When there is a need for blood, the person should raise a request through the mobile application that is visible to all donors. After the request a notification is sent to all donors and the donor can accept or reject the request. This application reduces the time that would have been used in searching for the required blood through the blood banks and hospitals.

CHAPTER ONE
INTRODUCTION

This chapter gives the introduction to the problem, research objectives, scope of the study, and the benefits of a mobile-based blood bank and donor management system.

According to (Roy, 2022) In day-to-day life, people come across a lot of requests on social media in need of blood for major causes due to accidents, injuries, organ transplants, etc. The first thing the seeker's family does is search for blood in the blood bank(Das and Iqbal, 2020). Even if the requested blood is available in the blood bank, the blood bank will ask for some units of blood as a replacement. Donors participate to save many human beings each year, although some still die or suffer because of the lack of access to a safe blood transfusion(Nureye and Tekalign, 2019; WHO, 2021) .

Blood donation is an essential aspect of healthcare services, and blood banks play a critical role in ensuring the availability of safe blood for transfusion(WHO, 2021). However, managing blood banks and donations can be challenging, especially with the increasing demand for blood and the complexity of the donation process(Das and Iqbal, 2020).

According to (Alharbi, 2020) advent of computer technology has provided opportunities to develop computerized systems for blood bank and donation management. A computerized system can improve the efficiency and accuracy of managing blood banks and donations, leading to better patient outcomes. Additionally, such a system can provide a platform for information sharing between different blood banks, which can enhance the effectiveness of the blood donation process.

Despite the potential benefits of computerized blood bank and donation management systems, few studies have investigated the implementation and impact of such systems in blood banks. Thus, this research proposal seeks to explore the implementation and impact of a computerized mobile based blood bank and donation management system at Kaboyo Health Center III.

The proposed mobile-based blood bank and donor management system aims to provide an efficient and effective solution to the challenges faced by blood banks in managing their blood donation programs. By leveraging the power of mobile technology and social media, this system will enable blood banks to

increase donor participation rates, improve donor behavior, and maintain a steady supply of safe and compatible blood products.

The system will be designed to enable donors to easily register and donate blood through a mobile app, receive regular blood donation reminders, and share their donation experience with friends and family on social media. The system will also allow blood banks to manage their inventory, track blood donations, and communicate with donors more effectively.

1.1 Background to the Problem

According to (Howard, 2020), Blood banking refers to the process of collecting, separating, and storing blood. The concept of blood banks and organized blood transfusion systems can be traced back to the early 20th century. The first successful blood transfusion was carried out by Dr. James Blundell in 1818, and the techniques for storing and preserving blood were later developed in the 1910s(Boysen and Bacon, 2021). However, the establishment of formal blood banks began during World War II, when the need for blood transfusions to treat wounded soldiers became apparent(Jordan, 2018).

One of the significant milestones in the establishment of blood banks was the development of blood typing and cross-matching techniques in the early 20th century by Karl Landsteiner, which laid the foundation for safe blood transfusions(Biro, 2022). The practice of voluntary blood donation also gained momentum after World War II, reducing the risks associated with paid donors and ensuring a safer blood supply.

(WHO, 2021) recommends that all activities related to blood collection, testing, processing, storage and distribution be coordinated at the national level through effective organization and integrated blood supply networks. The national blood system should be governed by national blood policy and legislative framework to promote uniform implementation of standards and consistency in the quality and safety of blood and blood products. About 118.54 million blood donations are collected worldwide. 40% of these are collected in high-income countries, home to 16 % of the world's population (WHO, 2021).

In Africa, access to safe blood remains a significant challenge due to various factors, such as inadequate infrastructure, low awareness about voluntary blood donation, limited resources, and insufficient funding(Dei-Adomakoh *et al.*, 2021). However, many countries have made efforts to improve their blood transfusion services to meet the growing demand(Roberts *et al.*, 2019).

The World Health Organization (WHO, 2020) has been actively working with African countries to strengthen their blood transfusion systems, promote voluntary blood donation, and ensure the safety and availability of blood and blood products. It is impressive that the BSIS solution in Africa has so far made it feasible to trace, store, and protect 63,670 blood units throughout the continent (Lesotho, Ghana, and Ethiopia). This accomplishment demonstrates the solution's viability for adaptation and application on other hemispheres as regards to blood donation in Africa (Clyde *et al.*, no date). Though it cannot extend to other nations like Uganda because its contract with the US government has expired, it is restricted in terms of funding.

In Uganda, the healthcare system faces significant challenges in ensuring an adequate and safe blood supply (Dei-Adomakoh *et al.*, 2021). The country has made efforts to improve blood safety and availability, particularly in response to the HIV/AIDS epidemic, which raised concerns about the risk of transfusion-transmissible infections. Uganda's National Blood Transfusion Service (NBTS) is responsible for coordinating blood donation and distribution. The NBTS has been working towards promoting voluntary blood donation, improving testing and screening procedures, and establishing regional blood banks to enhance accessibility.

At Kaboyo Health Center III they happen to use a manual system but exhibit a lot of ineffectiveness and inefficiency and therefore are prone to errors. Using paper cards to recruit blood donors, collect and keep blood donor records, and disseminate results to blood donors who are scattered throughout the country. Unfortunately, unauthorized persons however can easily access the paper system and hence making it impossible to enforce the privacy and confidentiality of donor records and medical results. This has made the security of medical results inadequate as any person could easily access them.

1.2 Problem statement

The timely availability of blood can significantly impact patient outcomes, particularly in emergencies where every second counts(Raghuwanshi & Maheshwari, 2021). Despite the universal need for blood donations and their essential role in healthcare, the current blood donation and administration system faces several significant obstacles. First, the unpredictability and inconsistency of blood availability is a result of the reliance on voluntary donations causing shortages in regions where the culture of blood donation is less prevalent. Furthermore, blood banks frequently experience difficulty regulating their blood supply. Moreover, Without a reliable system to monitor blood types, expiration dates, and

quantities, there is a high risk of waste. Moreover, communication systems exist between blood banks and donors, which further hinders donation coordination.

On the side of the potential donors, they are frequently unaware of donation eligibility requirements, the need for their particular blood type, and the locations of nearby blood banks. This scarcity of information can discourage potential blood donors, exacerbating the current blood shortage crisis. Although digital solutions to these problems have been attempted, they frequently fail to provide a platform that serves both donors and blood banks. In addition, they occasionally disregard stringent data privacy and security requirements necessary for handling sensitive health data.

The Mobile-Based Blood Bank and Donor Management System seeks to address these issues by providing an integrated platform that enhances blood donation recruitment, streamlines blood inventory management, improves donor-blood bank communication, and ensures stringent data security.

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1.3 Objectives of the study

The objectives of this research were categorized into the main and specific objectives as seen below

1.3.1 Main Objective

To improve accessibility to blood donations by developing a Mobile-Based Blood Bank and Donor Management app that enables blood donors to register and donate blood easily and conveniently.

1.3.2 Specific Objectives

The specific objectives were:

i. To analyze the current system blood bank management processes in order to understand its strengths and weaknesses to determine the requirements for the Mobile Based Blood Bank and Donor Management System (MBBBDMS).

ii. To design the proposed MBBBDMS, to come up with models representing the system.

iii. To implement the MBBBDMS to transform the design into a working system.

iv. To test and validate the implemented system to ensure that it functions properly and meets the user's requirements.

1.4 Research Scope of the Study

The researcher categorized the research into geographical, time, and functional scope as seen below.

1.4.1 Geographical scope

The research project used the blood bank management processes of Kaboyo Health Center III. This Blood bank is physically located in Lwengo district along Masaka-Mbarara Road. It was chosen due to ease of accessibility enabling the acquisition of reliable information.

1.4.2 Time Scope

The process of developing a mobile-based blood bank and donor management system started with writing a research proposal and then planning started followed by analysis, design, and implementation were done concurrently to develop a prototype which was later transformed into a system that was presented. Finally report writing was done and the above activities took 7 months, which- is from January, 2024 to July 2024.

1.5.3 Functionality Scope

The objective of the project is to create an all-encompassing platform that facilitates the connection between blood donors and recipients. The essential features include:

i. Donor enrollment and profile creation: Users will be able to register as donors, create profiles, and provide pertinent information such as blood type and location.
ii. Messaging System: To facilitate seamless communication, the app will include an integrated messaging system that enables donors and recipients to communicate safely within the platform.
iii. Reservation Scheduling: The implementation of a scheduling feature will allow recipients or blood banks to schedule appointments with donors for blood donations.
iv. Data Privacy and Security The system will guarantee high levels of data security and confidentiality.

1.6 Significance of the Study

By creating a mobile blood bank and donor administration system, the importance of the application is as analyzed below:

I. Improved access to blood supply: The mobile-based platform will make it simpler for potential blood donors to register and donate, thereby increasing the blood supply available to those in need.
II. Increased efficiency: The search and matching feature will make it easier and more efficient for blood donors to communicate with recipients, reducing the time and effort required to locate compatible donors.
III. The use of social media integration, blood donation reminders, and donor feedback and rating features will encourage donors to participate more actively in the blood donation process and promote long-term engagement.
IV. Improved data management: The donor and recipient management system will enable more efficient and secure management of donor and recipient data, thereby reducing the likelihood of errors or data breaches.
V. Reduction in medical errors: Using a donor and recipient management system will reduce medical errors, such as incorrect blood transfusions, by matching the correct blood type with the correct recipient.
VI. Cost-effectiveness: The mobile-based platform will reduce the cost of administering blood donation programs by automating numerous blood donation processes, such as donor registration, appointment scheduling, and data administration.

CHAPTER TWO

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter reviews literature from closely related studies that have been carried out on people's knowledge and uptake of blood transfusion services, the description of the online blood bank management system, an overview of current systems in use, and an assessment of the literature about the current systems and provides a summary, comparison, and evaluation of these systems.

2.1 The Development of Mobile Blood Bank Management Systems

The introduction of mobile technologies has caused a paradigm shift in the healthcare industry, including blood bank management. Blood depots, donors, and recipients are interacting differently due to mobile applications. According to a study by (Sundermann and Leipnitz, 2019)), a mobile application for blood donation significantly increased the number of donors and frequency of donations. In addition, it increased donor retention rates and accelerated the matching process between donors and recipients.

(Ismael, Hussein and Salih, 2022) demonstrated similar advantages of a mobile-based blood donation system in Saudi Arabia, including an increase in the number of donors and a decrease in matching periods. This evidence strongly suggests that mobile technology has the potential to improve blood bank management.

2.2 Social Media Integration's Role

Social media platforms have emerged as potent instruments for contacting potential blood donors(Bin-Nashwan and Al-Daihani, 2021). Report that incorporating social media with blood donation systems has the potential to substantially increase the donor pool and stimulate donation campaigns. In a separate study, (Chen and Wang, 2021) reached similar conclusions, indicating that social media integration could be useful in addressing blood shortages.

2.3 Feedback and Rating Systems for Donors

According to (Özener, Ekici and Coban, 2019) donor feedback and evaluations can assist blood banks in improving their services. Discovered that mobile-based blood donation systems with feedback and rating capabilities increased donor satisfaction and frequency. This suggests that promoting donor feedback could help blood banks strengthen their relationships with donors.

2.4 Online blood bank management system

The Blood Bank Management System (BBMS) is an android application that is designed to store, process, retrieve and analyze information concerned with the administrative and inventory management within a blood bank. It aims at maintaining all the information pertaining to blood donors, different blood groups available in each blood bank and help them manage in a better way.

(Shah *et al.*, 2022) explain that an application for Blood Bank Management System is a way to synchronize Blood banks and Hospitals with the help of Internet. Hospitals can check the availability of required Blood and can send Request for blood to the nearest blood bank or donor matching with blood requirement and can be ordered online as and when required. Blood bank can also send a request to another blood bank for unavailable blood

2.5 Online Blood Bank Management System using Android

Ashita Jain, Amit Nirmal, Nitish Sapre, and Shubhada Mone created an online system for managing blood banks using Android. The internet-based system was created with three views in mind: hospital, blood bank, and patient/donor. Its major purpose is to enable users to browse information about neighboring hospitals and blood banks.

This software provides an alarm system for serious accidents by locating the closest hospital online instantaneously and tracking it down using GPS. Using that feature, an ambulance will be dispatched to your area without wasting any time. This program significantly cuts down on the time spent looking through blood banks for the necessary blood and donor/patient. This software provides an alarm system for serious accidents by locating the closest hospital online instantaneously and tracking it down using GPS. Using that feature, an ambulance will be dispatched to your area without wasting any time. The time spent looking through blood banks and hospitals for the necessary blood is significantly shorter thanks to this program. As a result, this application offers the necessary information quickly and aids in

making decisions more quickly (Jain et al., 2014). However, this system does not inform donors about the blood donation campaign.

2.6 Web-Based Blood Donation System

Aware Sachin B, Arshad Rashid, Ansari aadil, and Bombale R.R. created the Web-based blood donation system to keep the stock database on a centralized server system. When someone needs any type of blood, they can quickly check to see if it is available and how much it would cost on the web server because all blood banks update their regular stock there. To prevent anyone from having to pay more for the blood bag, it helps to maintain the database and costs. Each hospital is capable of keeping both patient and blood bank records, making them readily accessible. The primary advantages of this web-based system are record-keeping and convenience for determining whether blood is available. However, the system is too expensive to run and is unable to inform contributors about the donation campaigns (Jalalzai, 2018).

2.7 Machine Learning Implemented Blood Donation Application

The creator of this method is Sadia Nadira Diba. For Android smartphones, there is a free blood donation app called Blood Donation Application. In a few easy steps, Blood Donor finds, alerts, and connects thousands of blood donors. An app for blood donors offers hassle-free blood donation and donor privacy. By bringing together blood donors and those in need, time is saved, increasing the chance of saving lives while also eradicating the blood shortage. The location-based, free blood donation app "BLOOD DONOR" is dedicated to the cause. The application can also using machine learning methods, bl was able to choose the finest donors from the pool of available ones. The algorithms are capable of looking through each donor's profile to determine which ones are the best fits in terms of lifestyle and health. Additionally, the app can display the precise location of blood donors on a map who are eager to give their blood. (Diba, 2018). The system is inefficient in terms of cost, though.

2.8 Conclusion

Therefore, the researcher carefully examined the strengths and weaknesses of the management systems of the aforementioned blood banks, as well as the various procedures and stakeholders, in the aforementioned literature to develop a system that will coordinate and enhance the quality of the different operations that are carried out and economically efficient by analyzing data.

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

In this chapter, the researcher presents the methodology that was used in carrying out the research to achieve the objectives of the study. It shows the research design and system development methodologies, target population, and sampling procedures including the sampling techniques and sample size.

3.1 Research Design

A research design is a systematic approach that a researcher uses to conduct a scientific study. The researcher used both qualitative and quantitative research. These helped the researcher to get a deeper understanding of the problems facing the BBMS and the requirements for the development of the system.

3.2 System Development Methodology

A system development methodology, according to selecting a development approach, (2008), is created. the framework used to organize, design, and control the process of constructing an information system. The researcher applied the Prototyping methodology. This method was selected because it reduced development costs, enabled the researcher to gather quantified user feedback, and allowed for the design to be as straightforward as feasible for all user levels. It aided in the creation of a high-quality system with input from end users, who offered suggestions for tweaks and upgrades to each iterative prototype development until a workable

System was

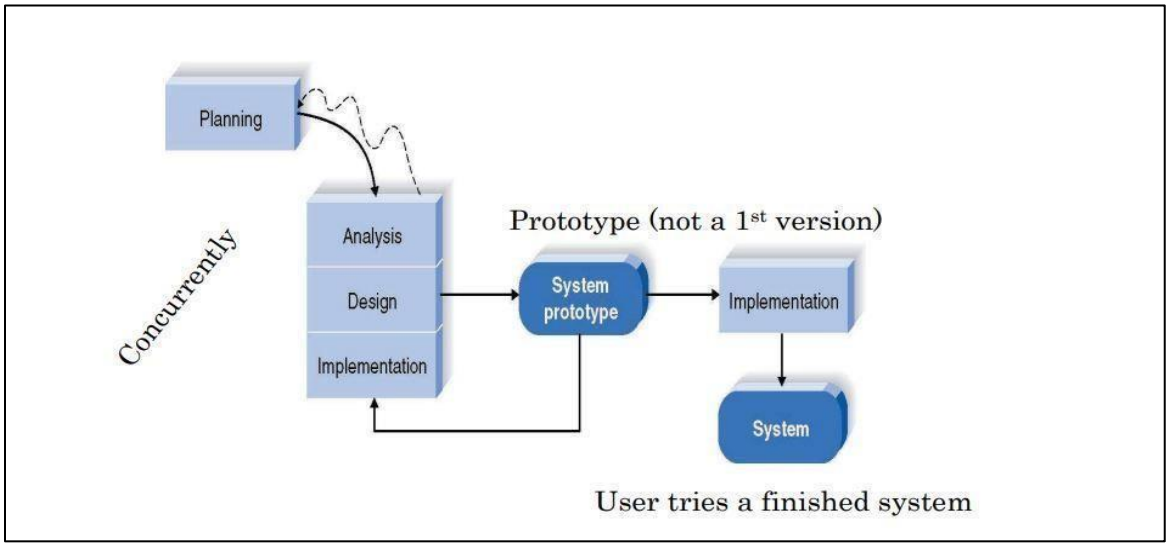

Figure 3.1: prototyping methodology phases

Source: (*PadaKuu.com*, 2024)

3.2.1 Planning Phase

This involved identification of the study area, target population, sample size estimation, sample selection and data collection techniques.

3.2.1.1 Area of Study

The area of the study was Kaboyo Healthy Centre III along Masaka - Mbarara road roughly 1 km to Kinoni Town.

3.2.1.2 Target Population

The researcher used Kaboyo Health Center III as a case study and the study population included administrators, blood seekers, and finally the donors who were found at the blood bank.

Below is the table that summaries the respondents and their numbers.

Table 3.1: target population

Categories of respondents	Sample size
Administrators	4
Patients	10
Blood Donors	31
Total	45

3.2 Sampling techniques

$$n = \frac{z^2 . p. (1 - p)}{E^2}$$

n = Sample size

Z = Z-value (for the desired confidence level)

p = Estimated proportion of the population

E = Margin of error

$$n = \frac{1.96^2 . 0.5. (1 - 0.5)}{(0.05)^2}$$

$$n = \frac{(3.8416).0.5.(1-0.5)}{0.0025}$$

$$n \approx 384.16$$

Calculating using the infinite population correction formula

$$= \frac{n}{1 + \frac{n-1}{n}}$$

$$\frac{50}{1.098} \approx 45$$

3.2.1 Simple Random Sampling

Simple random sampling is a type of probability sampling in which the researcher randomly selects a subset of participants from a population. The study includes a total of 45 respondents, divided into three groups: 4 administrators providing insights into management practices and operational challenges in healthcare facilities, 10 patients sharing their experiences and opinions on treatment effectiveness and patient care, and 31 blood donors offering crucial feedback to enhance recruitment and retention strategies. This diverse sample ensures balanced representation and enables valid, generalizable conclusions that can inform future healthcare practices and policies.

3.2.2 Purposive Sampling

Purposive sampling is a non-probability method for obtaining a sample where a researcher uses their expertise to choose specific participants so the study meets its goals. These participants have particular characteristics that the researcher needs to evaluate their research question. The researcher has chosen this technique to select blood donors in order to focus on those that are most knowledgeable and with experience about what to investigate.

3.3 Data Collection Techniques

The researcher had to go through data gathering procedures in which data collection methods were used, and these included observation, interviewing, and questionnaires as our research methods. This is the process of determining user expectations for a new system. This allowed the researcher to gather first-hand information from the case study. Secondary data was gathered through the review of documents.

3.3.1 Examining Documents

This required reading current research articles on blood transfusion services, online blood bank management systems, newspapers, and multimedia system-related literature. This was mostly done to incorporate concepts that those systems and the proposed system had in common.

3.3.2 Interviewing

The system's most important users were questioned informally in person. In this process, user expectations are ascertained for a new system. This method of data collection was used to gather information from administrators, phlebotomists, councilors, and selected donors located in blood banks because it is expected that the main issues will emerge from the interviewee rather than being imposed by the interview's structure the less structured the interview is. Interviews are crucial for investigating unexpected outcomes or confirming any interpretations made using other data-gathering and processing techniques. They primarily assisted in bringing up questions that were not comprehended in the questionnaires.

3.3.3 Questionnaires

Questionnaires were given to the administrator, phlebotomist, councilor, and donors who all were considered potential users of the proposed system. They came in conveniently in a way that key questions were put forward and answered in precise statements. This made data analysis easy. Fortunately, the response time was also short as all respondents were able to return them within five days.

3.3.4 Direct observation

Observations involved physical presence at the blood bank. This allowed the researcher to observe and take notes about the challenges of using manual systems for blood bank management. This method was used to see how the blood bank administrator inputs data, how blood requests are made, and how long data takes to be recorded in the system. Several observation sessions were carried out to confirm the answers obtained from other methods. The observation method brought many requirements to light and provided original information for determining the functional requirements of the proposed system.

3.4 Data Analysis

Qualitative and quantitative data analysis methods were used to analyze both secondary and primary data collected. The researcher used frequency tables to organize data into a list of numbers that represent the frequency of a certain outcome in a sample for each question and respondent. Putting this kind of data into a table helps make it simpler to understand and analyze. Also, data collected from observations, interviews, and document reviews was analyzed to achieve the researcher's objectives.

3.5 Conclusion

The research methodology chapters explain the methods of both research and development that were used in this research to design and implement MBBBDMS. Chapter three was a summary of the following chapters.

CHAPTER FOUR

PRESENTATION OF DATA ANALYSIS, SYSTEM ANALYSIS AND DESIGN

4.0 INTRODUCTION

In this chapter, we present the implementation plan and the details of the system testing process for the Mobile-Based Blood Bank and Donor Management System. The objective of this phase is to validate the system's functionalities and ensure its effectiveness in managing blood donations efficiently.

4.1 Analysis of data results

The data and information gathered from the data collection phase was critically categorized, coded and analyzed to come up with system requirements. Purposive sampling was used to select some of the respondents, especially the health workers and patients. The total sample size was 45. The analyzed data is shown in the table below,

Table4.2 usability

I.C.T knowledge and skills	**Number of Respondents**	**Percentage (%)**
Excellent	30	66.67
No	0	0
I don't know	2	4.44
Poor	13	28.89
Total	**45**	**100**

Table 4. 3: Access to the internet

Do you have access to the internet	**Number of Respondents**	**Percentage (%)**
Excellent	21	46.67
No	11	24.44
I don't know	0	0
Poor	13	28.89
Total	**45**	**100**

Since the system was to be mobile-based, the researcher had to find out if the users can access the internet and fortunately, 46.67 percent of the total respondents can access the internet hence easy implementation as shown in Table 2.

Table 4.4 : Blood results

Does the application give notification to the donors and patients about the release of their blood results?	**Respondents**	**Percentage (%)**
No	5	11.11
Yes	33	73.33
I don't know	7	15.56
Total	45	100

Table 3 shows that 73.33 percent of the users had responded that the system notified donors and patients about the release of their blood results

Table 4.5: Weakness in the current system

Level of satisfaction in	**Number of Respondents**	**Percentage (%)**

the current system		
Very satisfied	4	13.33
Less satisfied	26	80
Not satisfied	2	6.67
Total	**45**	**100**

Question 5 asked users if they were content with the current system. From the analysis done more than 80 percent were not content with the current system hence paving the way for the development of an MBBBDMS.

Table 4.6: User friendly

Is the current system user-friendly	**Number of Respondents**	**Percentage (%)**
Tiresome	28	62.22
Time-consuming	14	31.11
I don't know	3	6.67
Total	**45**	**100**

Question 6 asked users how they feel when entering data and more than 62.22 expressed their experience and thus a need for system implementation.

4.2 Current System at Kaboyo Health Center III

Kaboyo Health Center III happens to use a manual system but exhibits a lot of ineffectiveness and inefficiency and therefore is prone to errors. Using paper cards to recruit blood donors, collect and keep blood donor records, and disseminate results to blood donors who are scattered throughout the country. Unfortunately, unauthorized persons however can easily access the paper system hence making it impossible to enforce the privacy and confidentiality of donor records and medical results. This has made the security of medical results inadequate as any person could easily access them. When a new donor comes to donate blood, they are required to fill out their personal information during the registration process before donating.

After the donation process, the donor is given a donation card with their name, blood type and a barcode to be used for future donations. At the back end of the card is a table that contains several donations, date, location, and the blood collector's signature. Hospitals can request blood by traveling directly to the blood bank and submit their requests on paper having the blood groups needed and the quantities that are needed. The administrator is responsible for checking the available blood in the inventory and if available, transfer it to the hospital and if the blood is not available, will inform the personnel representing the hospital.

4.2.1 Challenges of the Current System

The blood bank management at Kaboyo Health Center III exhibited a lot of inefficiency and ineffectiveness that had an impact on the decisions taken by the management. The system is based on paper cards to collect blood donor data. The system had weaknesses that needed IT-based solutions.

1. The system cannot analyze data about the donors.
2. The system could not notify donors of when to donate blood.
3. The system could not notify the donors about donation campaigns.

Therefore, the existing system was reviewed and an effective mobile-based blood bank and donor management system was needed to assist in implementing its strategic plan to achieve the overall mission, goals, and objectives.

4.3 Solutions to the Current System

The solutions to the current system were mainly addressing the problems of awareness about donation, analysis of data collected and the release of the results, minimizing workload and burden on the administrator to increase efficiency, minimizing cost and time as seen below,

Monitoring of the results and performance of the blood donation activity and hence relevant and measurable objectives at the blood bank.

Improving the planning and decision-making process by providing management with timely, secure, and confidential medical reports related to blood donation.

4.3.1 System Requirements

During a system development project, requirements were created that describe what the business needs; what the user needs to do; what the software should do; the characteristics the system should have, and how the system should be built(Dennis, Withom, and Roth, 2012).

4.3.2 Functional Requirements

functional requirements are product features that developers must implement to enable users to accomplish their tasks. Generally, functional requirements describe system behavior under specific conditions. Below are the functional requirements of the MBBBDMS;

1. Allow registered users to log in.
2. Update records stored in its database.
3. Track time and date when the records were entered into the database.
4. Allow its users to enter data through form users.
5. Authenticate its users when they try to login.
6. Notify its users in case of any feedback.
7. Allow its users to make schedules for blood donation.
8. Allow its users to edit their accounts.
9. Allow hospitals to request blood online.
10. Generate reports based on the data in the database.

4.3.4 Non-Functional Requirements

Nonfunctional requirements describe how the system must behave and establish constraints of its functionality. This type of requirements is also known as system's quality attributes. Below are non-functional requirements of the system as categorized based on usability, security, reliability, multi-threading and availability.

Reliability: The system should be able to produce acceptable results**.**
Multi-threading: The system should be able to allow several users to access it at the same time.
Usability: The system should be as easy to use to the administrators and voters.
Maintainability: The system should be easy to maintain.

Security: Only administrators can set limits and user accounts, the administrator cannot generate the same ID for another user and students have their unique login for relevant areas.

Availability. The system should be available for its authorized users 24/7.

4.4 System Analysis and Design

During this phase, the researcher studied and identified problems of the existing system and then developed a context diagram for the existing system to show the entities that interact with the system and its boundaries. The researcher also developed a class diagram and a user case diagram diagram for the proposed system using Microsoft Visio 2013 as a tool and UML as a technique. Then basing on the analysis phase, the researcher converted the E-R diagram into the relational database model and created a physical data design. User interface designs and a system architecture were also designed in this process. The following are diagrams used in these phases as discussed below;

4.4.0 CLASS DIAGRAM

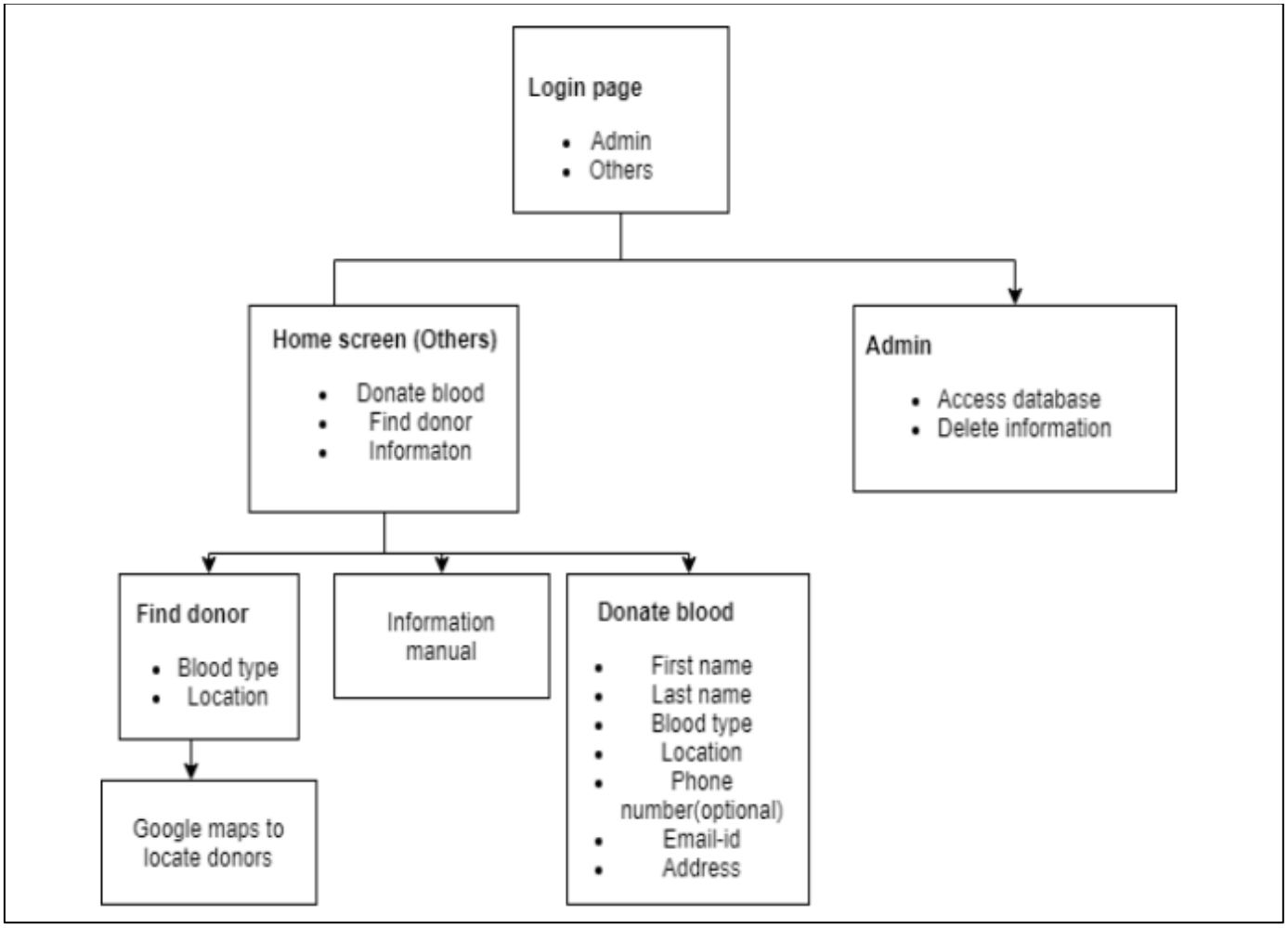

Figure 4. 2: class diagram

The class diagram here is used to show the different objects in the blood bank system, their attributes, their operations & the relationships among them.

4.4.1 User Case Diagram

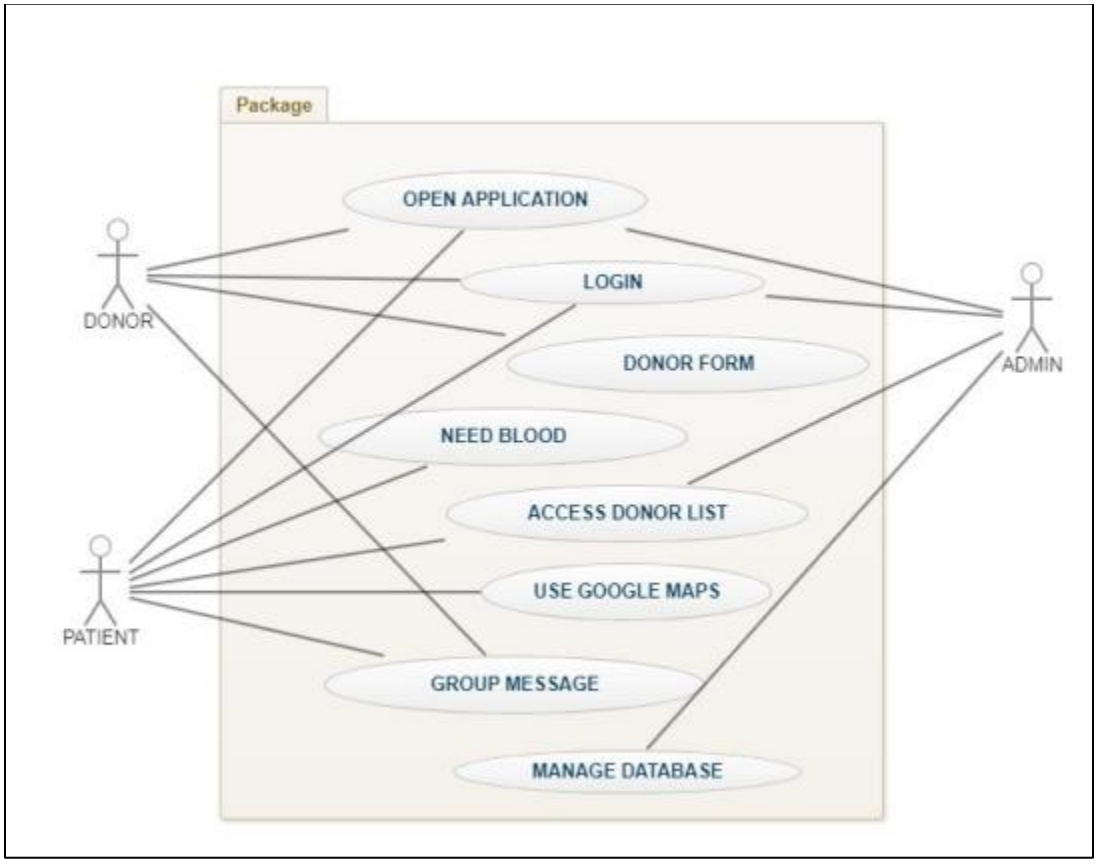

Figure 4. 3: User Case Diagram

A user case diagram was drawn to explain the relationship between attributes as well as the requirement for the system.

4.4.2 Activity Diagram

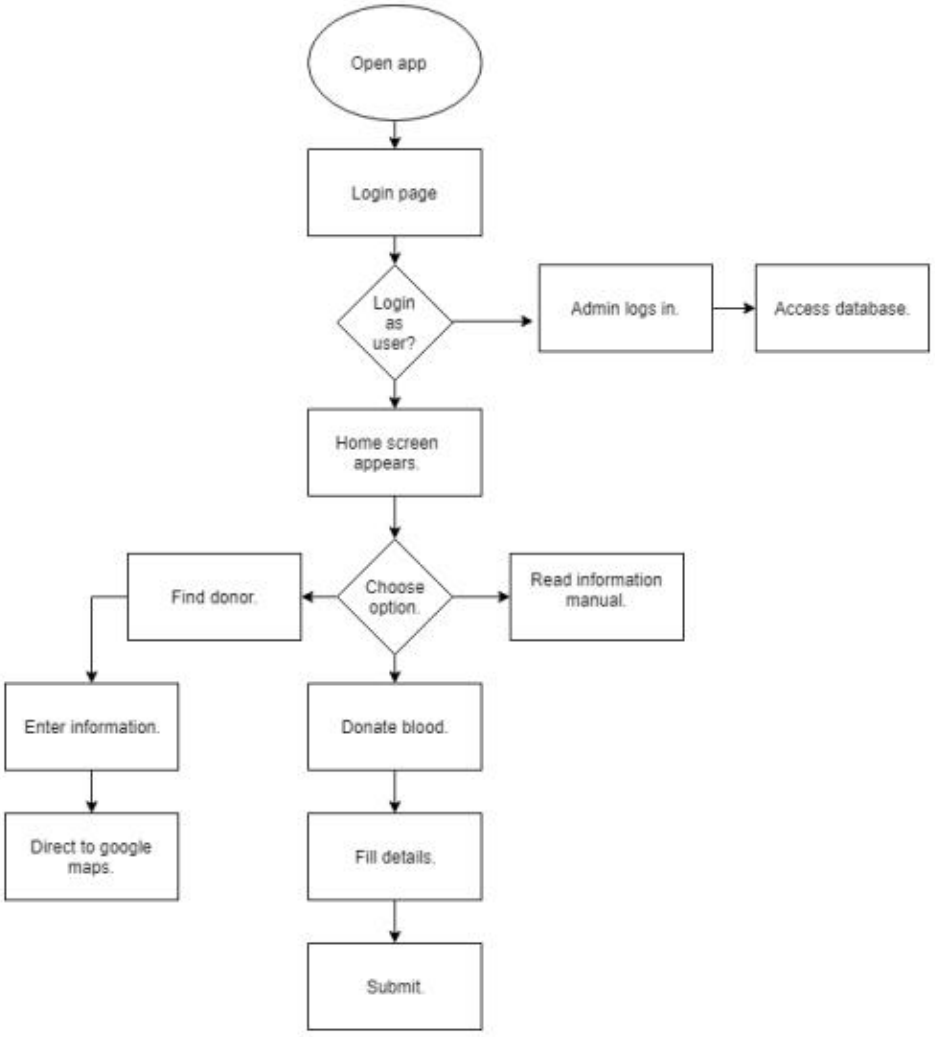

Figure4. 4: Activity Diagram

An Activity Diagram was drawn to identify essential steps and simultaneously offer a big picture of the process.

4.5 Physical Database Design

Google Firebase which is an RDBMS, was used to create a physical database design to show the field names, data types, length, and comments describing each field.

4.5.1 User Interface Design

The user interface is a critical part of any software product. To increase the chances of success when creating user interfaces, the researcher followed the interface design principles. Interface design principles represent high-level concepts that are used to guide software design as shown below;

I. Place users in control of the interface. The system has an easy-to-navigate interface that will allow the users to know exactly which page they are on.

II. Make it comfortable for a user to interact with a product. The system provides relevant data to a specific user to increase the visibility of items needed.

III. Reduce cognitive load. The system has good visual clarity by designing layouts that organize the contents into grouping similar items, numbering items, and using headings and prompt text.

IV. Make user interfaces consistent. The same colors, fonts, and icons will be present throughout the system to enhance usability and learnability.

CHAPTER FIVE

SYSTEM IMPLEMENTATION AND TESTING

5.0 Introduction

In this chapter, the researcher documents how the earlier designs both conceptual and logical were implemented to form a working system. In addition, the implementation of the graphical user interface is shown. In this phase, the real coding was done and a feasible system was implemented.

5.1 System Implementation

When the design was completed, major decisions about the system were made and what was left for this stage was to translate the designs of the system into code and scripts in a given programming language to implement the design in the best possible manner. During this phase, the main focus was on developing programs that were easy to write, simple, clear, and documented to avoid high costs of maintenance and testing. The researcher implemented the system designs using the model view controller ease for editing parts of the system and the following technologies;-

Flutter. Google created the robust open-source Flutter UI framework to enable developers to build natively built apps for mobile, web, and desktop platforms using a single codebase.

Dart. The programming language that works with Flutter is called Dart. It is made for creating server, web, and mobile apps. The frontend and backend parts of the system were easier to create because to Dart seamless interface with Flutter.

Microsoft Visual Studio Code. The system source code was written and edited using Visual Studio Code, a well-known code editor. By providing functions like code completion, debugging, and version control, its Flutter and Dart extensions increased productivity.

Firebase. A complete development platform called Firebase offered the system core functions. To manage user authentication and provide safe system access, Firebase Authentication was employed. The real-time database, Firebase Cloud Fire store, was used to store appointment data, user information, and other pertinent information.

5.2 Implementation Plan

Before proceeding with the system testing, a detailed implementation plan was formulated to guide the development process. The plan encompassed the following key aspects**,**

Requirements Analysis

A comprehensive analysis of the requirements was conducted by collaborating with healthcare experts, stakeholders, and potential end-users. The gathered requirements served as the foundation for the system's design and development.

Technology Stack

After evaluating various technologies, we selected a robust technology stack. The mobile application was built using Flutter framework for cross-platform compatibility, while the backend was developed using Node.js for handling API requests and MongoDB as the database.

5.3 System Testing and Validation

During system design, a system prototype was used. This prototype was not an executable file therefore there was a need for testing the system before deployment so that any errors can be uncovered and corrected. System testing was done against technical system requirements to see if all functional and nonfunctional requirements were met. The system underwent the following software testing hierarchy.

Unit testing - testing was performed on each module or block of code during development.

I. **Integration testing – this** testing was done before, during and after integration of a new module into the main software package.

II. **System testing –** System testing was done against technical system requirements to see if all functional and non-functional requirements were met

III. **Compatibility testing –** The system developed was installed on different phones and computers..

5.4 Milestone Definition

The project was divided into four major milestones: Requirements Gathering, Design and Development, System Testing, and Deployment. Each milestone had specific deliverables and deadlines.

5.6 Database Implementation

The database for the blood bank and donor management system was designed and implemented to store and manage essential data. Firebase ensured robust data management through its NoSQL databases, such as Fire store and Real-time Database. It upheld data integrity by organizing data hierarchically, using transactions for atomic updates, and applying Security Rules to validate and control data access. Data security was reinforced through Firebase Authentication for user verification, Security Rules for precise access control, and automatic encryption of data both in transit and at rest. For efficient retrieval, Firebase enhanced performance with indexes to speed up queries, real-time updates to provide instant data synchronization, and built-in caching to quickly access frequently used information.

5.7 System Implementation

The implementation phase involved developing both the graphical user interface (GUI) and the backend components of the system.

5.8 Graphical User Interface Implementation

The mobile application's GUI was designed following the principles of Material Design for a consistent and modern look. The app provides separate interfaces for donors, blood bank staff, and administrators, each tailored to their specific needs.

Donor Interface. Donors can register, update their profiles, view donation history, and access notifications about blood drives and urgent requirements.

Blood Bank Staff Interface.

Administrator Interface Administrators have access to system-wide controls, including managing user roles, viewing system analytics, and generating reports.

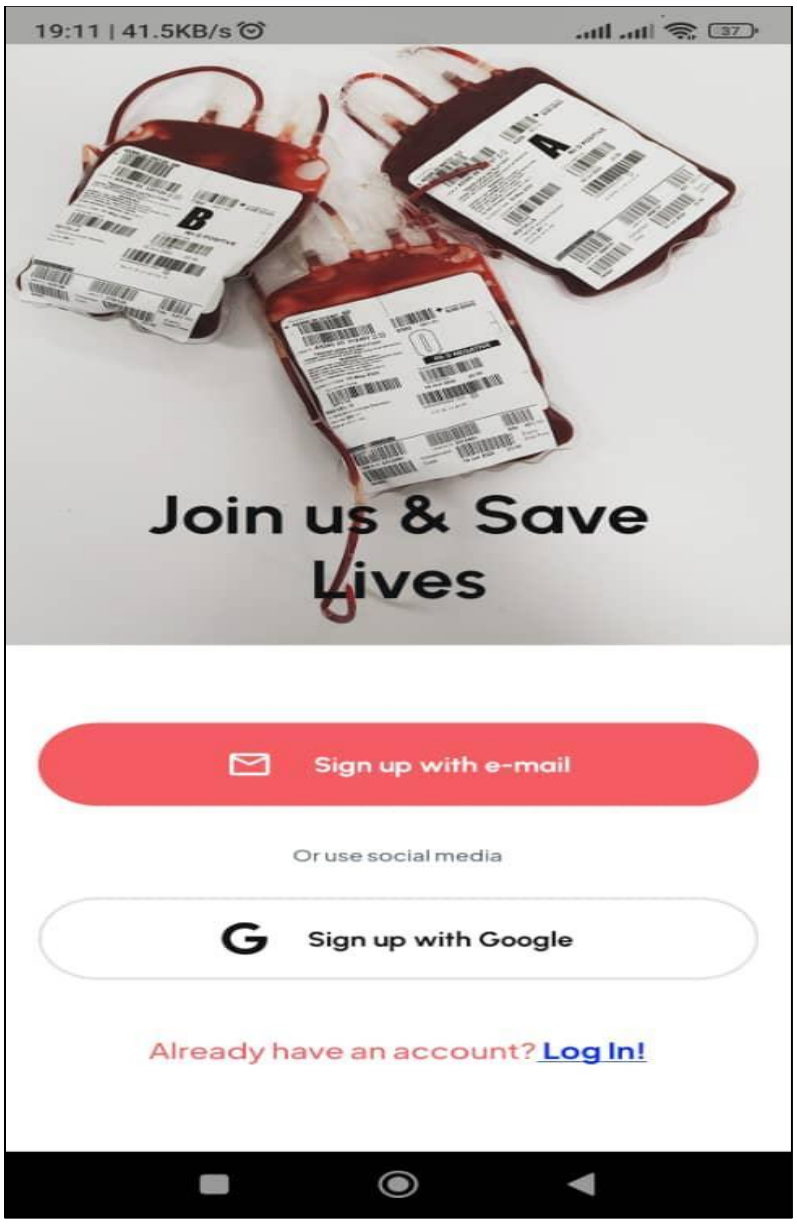

Figure 5.5 :The interface provides access to the system to registered users.

Figure 5.6: The interface shown above allows a user to enter their username and password.

Figure 5. 7: This page allows an authenticated user to schedule an appointment on when he or she is going to donate blood.

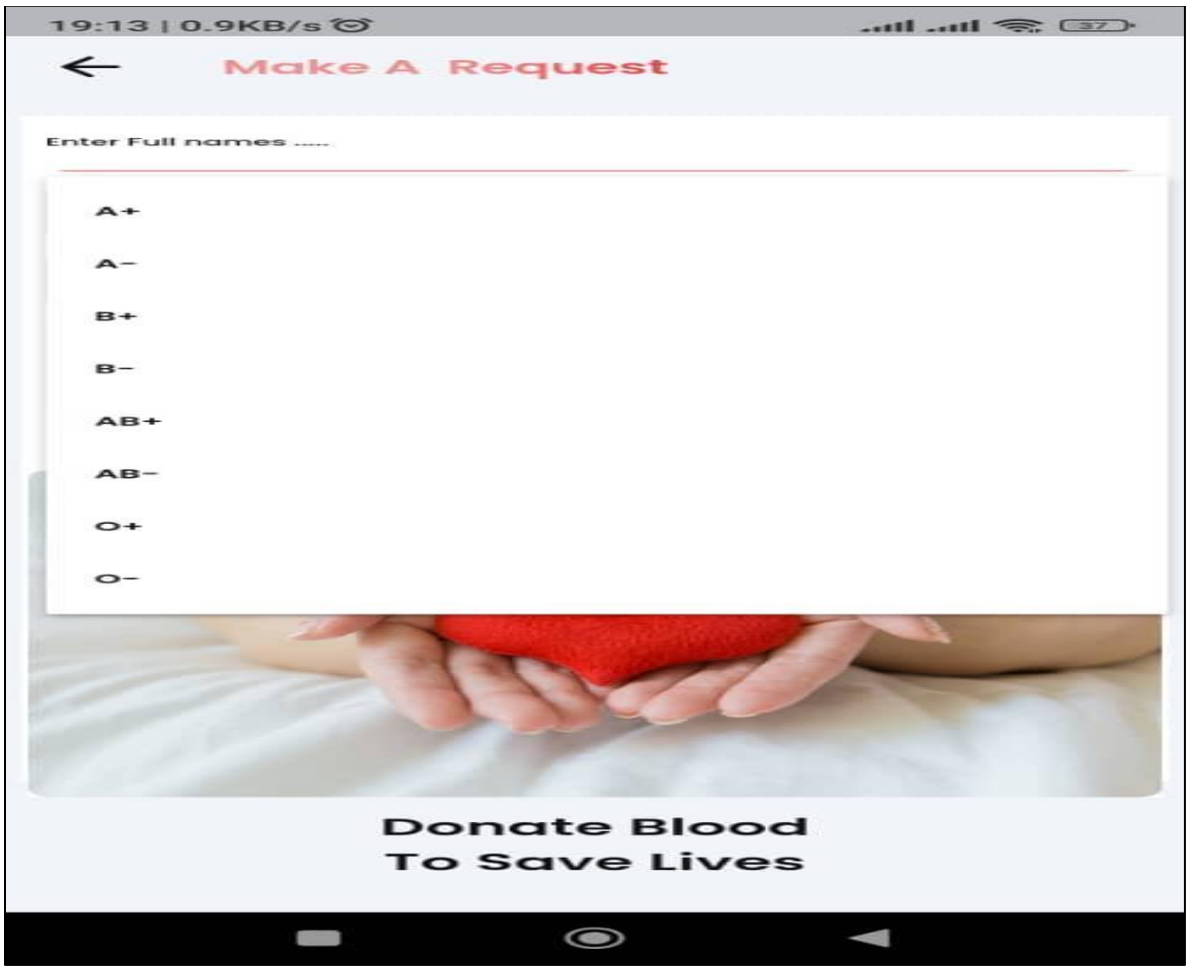

Figure 5.8: allows a user or the hospital to make a request of the blood types needed after filling in a request form, then a request form is submitted to the administrator.

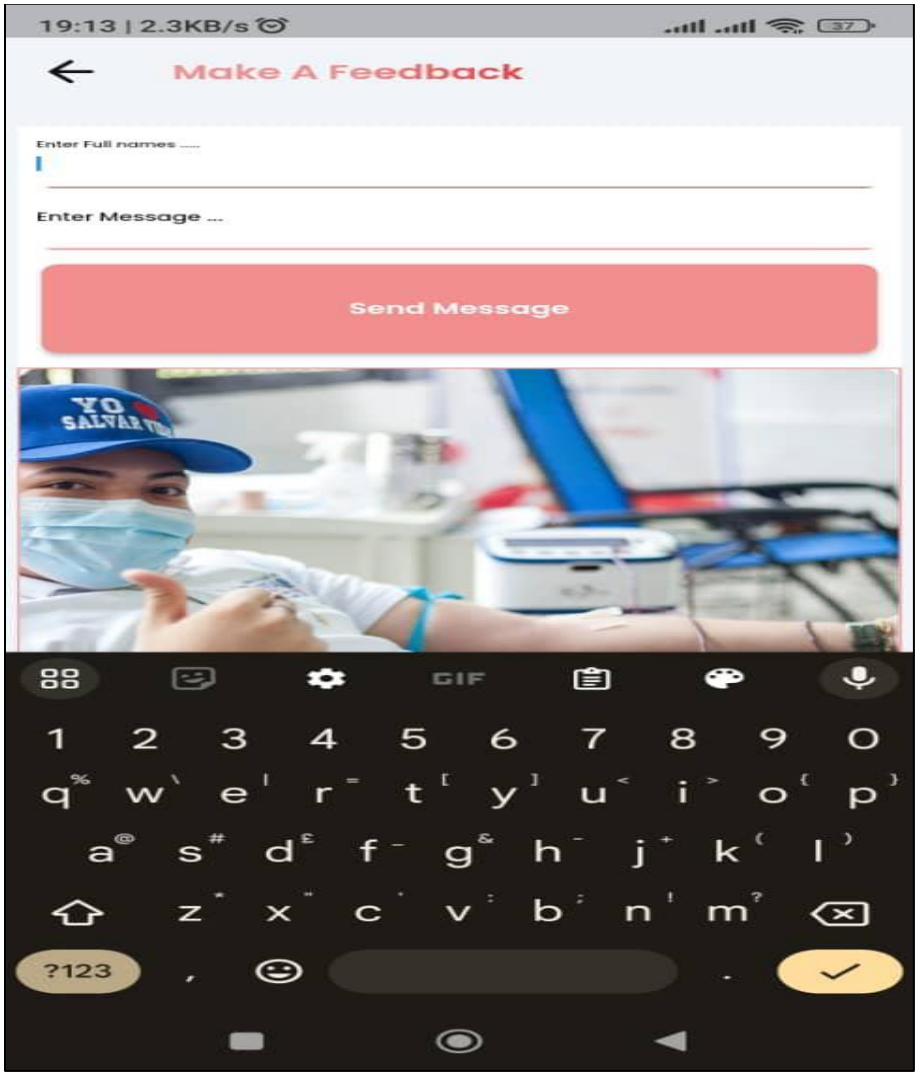

Figure 5. 9: allows a user to send feedback and an email message of the feedback is directly sent to the administrator.

5.4 System Testing

Comprehensive testing was conducted to verify the system's correctness, identify defects, and validate its compliance with the specified requirements.

5.4.1 System Test Results

Various testing methodologies were employed to evaluate the system's performance;

i. Unit Testing

Individual components and functionalities were tested in isolation using automated testing frameworks. This ensured that each module worked as expected.

ii. Integration Testing

The integration of different modules and components was validated to assess their compatibility and interactions. Stress tests were conducted to analyze the system's performance under peak loads.

User Acceptance Testing (UAT) A group of representative users, including donors and blood bank staff, participated in the UAT phase. Their feedback was invaluable in identifying usability issues and validating the system's overall functionality.

5.5 System Validation

The system was validated to determine its usefulness and effectiveness in fulfilling its intended purpose.

5.5.1 Usefulness

Feedback was collected from end-users through surveys and interviews. Donors appreciated the ease of registration and notifications about blood drives, while blood bank staff found the inventory management and scheduling features highly beneficial. The system received positive feedback for streamlining the blood donation process.

5.6 Discussion of Results

The discussion of results involves an analysis of the outcomes from the testing and validation phases. It includes a comparison of the system's performance against the initial requirements and objectives. Furthermore, it highlights the strengths, weaknesses, and areas of improvement identified during the testing process.

Strengths

The system demonstrated robustness and stability during testing. The GUI received positive feedback for its intuitive design, enhancing user engagement.

Weaknesses

Some minor issues were identified during UAT, such as UI inconsistencies and occasional delays in notification delivery.

CHAPTER SIX
DISCUSSION, CONCLUSION AND RECOMMENDATION

6.0 Introduction

This section presents the comparison of the project's findings. An overview of the project is given in this chapter, having gone through all the stages of information system planning, analysis, design and implementation. A brief discussion is made to make recommendations and conclusions.

6.1 Summary

The purpose of this study was to develop a MBBBDMS that enables blood donors to register and donate blood easily and conveniently. To achieve this objective, the researcher had to study other existing and related systems through extensive document review as well as field work that involved interviewing the target audience directly, questionnaires among others appeared in chapter 2. This helped the researcher to understand the study very well and what others had done to try to solve the problem.

The researcher then thought of a prototype methodology and as a result, collecting data and information about the current system, requirements for the new system were delivered as seen in chapter 3 and its designs are elaborated in chapter four.

The implementation was then done in chapter five based on the guidance obtained from chapter three and four. Testing and validation was done based on chapter three. This chapter provides a summary of the report and challenges that were encountered during research. It also provides recommendations of how to improve blood bank management systems and areas for further research.

6.2 Challenges

The following are the challenges encountered by the researcher when undertaking research as seen below;

I. Collecting data from the blood bank administrators was a challenge because they were always busy and the researcher had difficulty in interviewing them.
II. The expenditure incurred for printing the report since the researcher had to look for money.

6.3 Recommendations

There is a great need to educate the blood bank administrators on the need for a mobile based blood bank and donor management system using current technologies since they will cut down their workload.

6.3.1 Future Work

future researchers are argued to do more research about blood banks so as to improve the developed system.

6.3.2 Conclusion

In Conclusion, from a proper analysis and assessment of the developed system, it can be safely concluded that the system is efficient, usable and reliable. It is working properly and adequately meets the minimum expectations that were set for it initially. The study did not cover all blood bank activities but concentrated on donor records management, register and donate blood easily.

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Appendices I: Questionnaire

UGANDA MARTYRS UNIVERSITY MASAKA CAMPUS

INTERVIEW GUIDE

Dear respondent, I am Nassaazi Jovia a student pursuing a Bachelor's Degree in Information Systems of Uganda Martyrs University. Currently I am undertaking research which will lead to the development of a Mobile Based Blood Bank and Donor Management System enhanced with short message services for Kaboyo Health Centre iii Blood Bank. In order to successfully conduct this research, I will need to gather some information from you. You are hereby humbly requested to provide me with the responses to questions herein. The purpose of this research is purely academic and all information collected from you will be used for this research only and will remain confidential. Thank you for your assistance. Please I kindly request your feedback in two days' time.

QUESTIONNAIRE

Instructions

To answer the questions, you must write a ☑ in the box best reflecting your opinion

1. Do you know how to use a computer?

☐ Yes

☐ No

2. Do you have access to the internet?

☐ Yes

☐ No

3. Does the system give notification to donors about the release of their blood results?

☐ Yes

☐ No

4. What is your level of computer skill? :

☐ Good

☐ Fair ☐ Armature

5. Are you content with the current system?

☐ Yes

☐ No

6. How can you describe your experience with the current system?

☐ Tiresome

☐ Tire consuming ☐ I don't know

7. Do you think publishing blood results online is good?

Yes

☐ Yes No

☐ 8. If we are to develop a Blood management System, how would you want it to work?

a) Should the system be computerized?

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither disagree nor agree

☐ Somewhat agree ☐ strongly agree

b) Should the system make statistical reports for the blood storage statuses?

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither disagree nor agree

☐ Somewhat agree ☐ strongly agree

c) Should the system provide user authentication?

☐ Strongly disagree

☐ Somewhat disagree

☐ Neither disagree nor agree

☐ Somewhat agree ☐ strongly agree

9. **Optional, in case of anything you want to supplement, pleases write it in the space provided below.**

_____

_____

The questionnaire is finished!

Make sure you have answered all the questions.

WE THANK YOU FOR YOUR PRECIOUS COLLABORATION

Please return this to Nassaazi Jovia, 0776169064

Appendixes II: Interview Guide

UGANDA MARTYRS UNIVERSITY MASAKA CAMPUS

INTERVIEW GUIDE

Dear respondent, I am Nassaazi Jovia a student pursuing a Bachelor's Degree in Information Systems of Uganda Martyrs University. Currently I am undertaking research which will lead to the development of a Mobile Based Blood Bank and Donor Management System enhanced with short message services for Kaboyo Health Centre iii Blood Bank. In order to successfully conduct this research, I will need to gather some information from you. You are hereby humbly requested to provide me with the responses to questions herein. The purpose of this research is purely academic and all information collected from you will be used for this research only and will remain confidential. Thank you for your assistance.

1. Why should people donate blood?
2. Who can give blood, and how often?
3. Which sites do you use for blood collection?
4. What are the common conditions that need blood?
5. What blood group is consumed most?
6. Can't people sell blood?
7. Do you pay for blood?
8. Who is eligible to donate blood?
9. Which tasks do you perform as a blood bank?
10. Who are the most blood consumers in the hospitals?
11. How do you handle emergency cases of blood groups?
12. Experience on blood collection, donation and recipients. (Blood group that is easily got and one which is not easy to get)

13. What limits people from donating blood?

14. If we are to develop a Blood management System, how would you want it to work?

15. What can motivate donors to donate blood?

16. What are the cases that mostly require blood transfusion?

Any other information

Interviewers

Name: …… Sign…….

Name:…… Sign……

Interviewee (Respondent)

Title:…….

Name:……. Sign:……

Contact:……..

Appendixes III: code

Home page

```
import '/auth/firebase_auth/auth_util.dart';
import '/flutter_flow/flutter_flow_animations.dart';
import '/flutter_flow/flutter_flow_calendar.dart';
import '/flutter_flow/flutter_flow_theme.dart';
import '/flutter_flow/flutter_flow_util.dart';
import '/flutter_flow/flutter_flow_widgets.dart';
import 'dart:math';
import 'home_widget.dart' show HomeWidget;
import 'package:cached_network_image/cached_network_image.dart';
import 'package:flutter/foundation.dart';
import 'package:flutter/material.dart';
import 'package:flutter/scheduler.dart';
import 'package:flutter_animate/flutter_animate.dart';
import 'package:flutter_rating_bar/flutter_rating_bar.dart';
import 'package:google_fonts/google_fonts.dart';
import 'package:provider/provider.dart';

class HomeModel extends FlutterFlowModel<HomeWidget> {
  /// State fields for stateful widgets in this page.
```

```
  final unfocusNode = FocusNode();
  // State field(s) for Calendar widget.
  DateTimeRange? calendarSelectedDay;
  DateTime? datePicked;
  // State field(s) for RatingBar widget.
  double? ratingBarValue;

  @override
  void initState(BuildContext context) {
    calendarSelectedDay = DateTimeRange(
      start: DateTime.now().startOfDay,
      end: DateTime.now().endOfDay,
    );
  }

  @override
  void dispose() {
    unfocusNode.dispose();
  }
}
```

Create account page

```
  import '/auth/firebase_auth/auth_util.dart';
```

```
import '/flutter_flow/flutter_flow_theme.dart';
import '/flutter_flow/flutter_flow_util.dart';
import '/flutter_flow/flutter_flow_widgets.dart';
import 'create_account_page_widget.dart' show CreateAccountPageWidget;
import 'package:cached_network_image/cached_network_image.dart';
import 'package:flutter/material.dart';
import 'package:font_awesome_flutter/font_awesome_flutter.dart';
import 'package:google_fonts/google_fonts.dart';
import 'package:provider/provider.dart';

class CreateAccountPageModel extends FlutterFlowModel<CreateAccountPageWidget> {
  ///  State fields for stateful widgets in this page.

  final unfocusNode = FocusNode();
  // State field(s) for emailAddress widget.
  FocusNode? emailAddressFocusNode;
  TextEditingController? emailAddressTextController;
  String? Function(BuildContext, String?)? emailAddressTextControllerValidator;
  // State field(s) for password widget.
  FocusNode? passwordFocusNode;
  TextEditingController? passwordTextController;
  late bool passwordVisibility;
  String? Function(BuildContext, String?)? passwordTextControllerValidator;
  // State field(s) for passwordConfirm widget.
  FocusNode? passwordConfirmFocusNode;
```

```
  TextEditingController? passwordConfirmTextController;
  late bool passwordConfirmVisibility;
  String? Function(BuildContext, String?)?
      passwordConfirmTextControllerValidator;

  @override
  void initState(BuildContext context) {
    passwordVisibility = false;
    passwordConfirmVisibility = false;
  }

  @override
  void dispose() {
    unfocusNode.dispose();
    emailAddressFocusNode?.dispose();
    emailAddressTextController?.dispose();

    passwordFocusNode?.dispose();
    passwordTextController?.dispose();

    passwordConfirmFocusNode?.dispose();
    passwordConfirmTextController?.dispose();
  }
}
```

Request blood

```
import '/flutter_flow/flutter_flow_drop_down.dart';
import '/flutter_flow/flutter_flow_icon_button.dart';
import '/flutter_flow/flutter_flow_theme.dart';
import '/flutter_flow/flutter_flow_util.dart';
import '/flutter_flow/flutter_flow_widgets.dart';
import '/flutter_flow/form_field_controller.dart';
import 'request_blood_page_widget.dart' show RequestBloodPageWidget;
import 'package:flutter/material.dart';
import 'package:flutter_rating_bar/flutter_rating_bar.dart';
import 'package:google_fonts/google_fonts.dart';
import 'package:provider/provider.dart';
import 'package:simple_gradient_text/simple_gradient_text.dart';

class RequestBloodPageModel extends FlutterFlowModel<RequestBloodPageWidget> {
  ///  State fields for stateful widgets in this page.

  final unfocusNode = FocusNode();
  final formKey = GlobalKey<FormState>();
  // State field(s) for Name widget.
  FocusNode? nameFocusNode;
  TextEditingController? nameTextController;
  String? Function(BuildContext, String?)? nameTextControllerValidator;
  String? _nameTextControllerValidator(BuildContext context, String? val) {
```

```
  if (val == null || val.isEmpty) {
    return 'Enter your names';
  }

  if (val.length < 5) {
    return 'Atleast Type Your first name';
  }
  if (val.length > 25) {
    return 'name is too long';
  }

  return null;
}

// State field(s) for DropDown widget.
String? dropDownValue1;
FormFieldController<String>? dropDownValueController1;
// State field(s) for DropDown widget.
String? dropDownValue2;
FormFieldController<String>? dropDownValueController2;
// State field(s) for RatingBar widget.
double? ratingBarValue;

@override
void initState(BuildContext context) {
```

```
    nameTextControllerValidator = _nameTextControllerValidator;
  }

  @override
  void dispose() {
    unfocusNode.dispose();
    nameFocusNode?.dispose();
    nameTextController?.dispose();
  }
}
```

Appendix iv

Database connection

```
rules_version = '2';
service cloud.firestore {
  match /databases/{database}/documents {
    match /users/{document} {
      allow create: if true;
      allow read: if true;
      allow write: if false;
      allow delete: if false;
    }

    match /blood_Types/{document} {
      allow create: if true;
      allow read: if true;
      allow write: if false;
      allow delete: if false;
    }

    match /request_blood/{document} {
      allow create: if true;
      allow read: if true;
```

```
  allow write: if false;
  allow delete: if false;
}

match /feedback/{document} {
  allow create: if true;
  allow read: if true;
  allow write: if false;
  allow delete: if false;
}

match /book/{document} {
  allow create: if true;
  allow read: if true;
  allow write: if false;
  allow delete: if false;
}

match /Donor_Register/{document} {
  allow create: if true;
  allow read: if true;
  allow write: if false;
  allow delete: if false;
}
```

```
    match /Request_Register/{document} {
      allow create: if true;
      allow read: if true;
      allow write: if false;
      allow delete: if false;
    }
  }
}
```