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Blood Bank Connect: Streamlining Blood Donation Processes Through a Mobile Application

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Abstract

The growing demand for efficient blood donation systems exposes the limitations of traditional approaches, which suffer by communication breakdowns and manual processes. The goal of this study is to create Blood Bank Connect, a mobile application that will help donors, blood bank administrators, and healthcare providers coordinate donations, manage inventory, and communicate more effectively. Using an Waterfall methodology, the system offers automated notifications, and inventory management. The findings show considerable increases in donor involvement and inventory accuracy, illustrating the power of digital solutions in addressing systemic inefficiencies. Future study should look into scaling the platform for greater use and implementing advanced analytics for predictive demand forecasting.

1. Introduction

Blood donation plays a vital role in healthcare systems worldwide, providing essential support for surgeries, trauma care, and chronic condition management. However, traditional blood donation management methods, which rely heavily on manual or semi-digital systems, often result in inefficiencies. These inefficiencies include communication delays, fragmented inventory systems, and inadequate donor engagement, which collectively hinder the ability to meet urgent blood supply demands. This problem is particularly critical during emergencies, where timely access to blood is essential to save lives [1][2]. Recognizing these challenges, there is an increasing need to modernize the blood donation process by optimizing technology to enhance efficiency and reliability.

The current processes for coordinating blood donations face several significant issues, including outdated inventory management practices, and limited donor retention. Manual communication methods, such as phone calls and in-person visits, often result in inefficiencies and errors, making it difficult to mobilize donors. Additionally, the lack of integrated systems to manage donor data and blood inventories increases the risk of errors and wastage, further straining blood supply chains. These limitations necessitate a more effective approach to ensure a reliable and responsive blood donation system [1].

The scope of this study focuses on developing and testing Blood Bank Connect specifically for Unit Tabung Darah Hospital Sultanah Nora Ismail Batu Pahat. The application is designed to cater to three primary user groups which is blood donors, blood bank administrators, and healthcare providers. By automating processes such as inventory tracking, donor registration, and appointment management, the system aims to address inefficiencies and improve coordination between these stakeholders. Its functionalities are tailored to enhance the reliability and responsiveness of the blood donation process, particularly during critical times [3]. The project aims to provide clear direction for the system:

i. Design a Blood Bank Connect System using an object-oriented approach.
ii. Develop the Blood Bank Connect System utilizing a mobile-based approach.
iii. Test the developed system with User Acceptance Testing.

Blood Bank Connect is expected to bring significant improvements to the current system by reducing inefficiencies, enhancing donor retention, and improving inventory accuracy. Features such as push notifications, centralized data management, and geolocation-based services will ensure timely responses during emergencies and promote a culture of regular blood donations. Ultimately, these advancements will create a more efficient and lifesaving blood donation system, contributing to better patient outcomes and public health [1][2].

2. Related Work

The development of effective blood donation management systems has been an ongoing focus of research, with various applications and systems introduced to address inefficiencies in traditional processes. Existing applications, such as the Life Donor Application, NZ Blood Donor Application, and Blood Donor Mobile Application, offer foundational features like donor registration, appointment scheduling, and geolocation services. For instance, the Life Donor Application facilitates donor and blood bank interactions, allowing users to register and search for donors by blood group and location. However, it lacks advanced functionalities such as push notifications, inventory tracking, and educational resources. Similarly, the NZ Blood Donor Application allows donors to schedule appointments, track donations, and receive urgent notifications about blood type requirements. While it provides valuable features like digital donor IDs and appointment reminders, it does not address broader operational needs, such as inventory management or analytics [4].

Another prominent example is the Blood Donor Mobile Application, which incorporates functionalities like donor registration, appointment management, and geolocation services. It streamlines the donation process by integrating push notifications and features that track donation eligibility and upcoming donation drives. However, it also falls short in providing inventory tracking and reporting capabilities. These gaps in existing systems highlight the need for a more comprehensive approach to managing blood donations, one that integrates donor engagement tools with operational management features such as stock monitoring and analytics [6]. Table 1 shows the system's comparison

Table 1 *System's comparison*

Features/System	System A	System B	System C	Proposed System
Donor Registration	Yes	Yes	Yes	Yes
Appointment Scheduling	No	Yes	Yes	Yes
Push Notifications	No	Yes	Yes	Yes
Inventory Tracking	No	No	No	Yes
Donor History	No	Yes	Yes	Yes
Educational Resources	No	No	No	Yes
Health Tracking	No	No	Yes	Yes
Reporting and Analytics	No	No	No	Yes

System A: Life Donor Application

System B: NZ Blood Donor Application

System C: Blood Donor Mobile Application

Proposed System: Blood Bank Connect

A comparison of these applications reveals that while they address some challenges in donor engagement and scheduling, they fail to provide a holistic solution for managing blood inventories and improving operational efficiency. For example, none of the reviewed systems include inventory updates, robust reporting mechanisms, or health tracking features. These limitations underscore the need for a system like Blood Bank Connect, which not only incorporates the basic functionalities of existing applications but also extends them to include advanced features such as inventory tracking, reporting, and analytics. By addressing these gaps, Blood Bank Connect aims to provide a more efficient and integrated solution for blood donation management, ensuring a reliable and responsive system to meet the growing demands of healthcare [3][5].

3. Methodology

A methodology is a collection of practices, strategies, approaches, processes, guidelines, and procedures [7]. Methodologies in project management are specific, strict, and often involve a sequence of actions and activities for each stage of the project's lifecycle. They are predefined strategies that demonstrate what activities to perform next, why each step is significant, and how a project stage should be finished.

This project is being managed using the Agile methodology. The waterfall model is chosen because the business owner's requirements are clearly understood and the product specification is consistent. Generally, Waterfall model is widely used in different software development companies due to its simplicity and reliability [8]. The waterfall model consists of six phases, which is requirement gathering and analysis, system design, implementation, testing, deployment and maintenance.

System requirements analysis is the process of defining the criteria that a developed system must meet, as well as the outcomes of user expectations for a proposed system. It also focusses on actions that define the system's needs or conditions, such as evaluating, documenting, verifying, and managing system requirements. System requirements are classified as functional and non-functional requirement, and user requirements. Table 2 shows the functional requirements, while Table 3 shows the non-functional requirements.

Table 2 *Functional requirements*

No	Modules	Description
1.	User Registration and Authentication	- The system must allow users to register an account - The system must allow the user to log in using their registered user ID and password. - The system should only allow users with the valid ID and password to access it based on Role-Based Access Control. - The system must be alert to users who enter the system with invalid user IDs and passwords. - Following a successful login, the system should direct the user to the homepage. - The system should allow users to edit and update their profiles.
2.	Appointment Scheduling	- The system must display available time slots for blood donation. - The system must allow users to book or cancel donation appointments. - The system must allow admins to add and delete slot for appointments. - The system must allow admins to manage the users attendance for the booked appointments.
3.	Blood Inventory Management	- The system must display current blood stock levels. - The system should display collection and expiration dates of blood units. - The system must allow admins to add blood stock, update blood details, and remove blood stock.
4.	Blood Request	- The system must allow healthcare providers to request specific blood types and quantities. - The system must record and track the status of each blood request.
5.	Donor Eligibility & History Tracking	- The system must maintain a history of donations for each donor. - The system should calculate the next eligible donation date for each donor. - The system must show donor’s eligibility status.
6.	Push Notification	- The system must send reminders for upcoming appointments
7.	Reporting and Analytics	- The system must generate reports on blood stock levels, donation trends, blood requests and donor demographics including donor blood types. - The system should analyze and visualize all the reports.

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Table 3 *Non-functional requirements*

No	Requirements	Description
1.	Performance	- The system must handle at least 1000 concurrent users without noticeable performance degradation.
2.	Reliability	- The system must ensure 99.9% uptime, especially for critical modules like blood requests and inventory management.
3.	Maintainability	- The system must use modular design to allow for easier updates and debugging. - All code should be documented to enable quick understanding and modifications. - The system should support hotfixes for critical bugs without service interruption.
4.	Portability	- The system must be deployable on multiple platforms, including cloud-based Solutions and on-premise servers. - It should compatible with major browsers and mobile OS platforms.
5.	Stability	- The system must remain stable under high loads. - System crashes must be minimized to less than one per year.
6.	Security	- Implement secure password storage using hashing algorithms - Encrypt sensitive data during transmission and storage.

User requirement analysis are the user's expectations about how the system performs. The description of requirement might the setting that will support the system operation. The user requirements for the proposed system are listed in Table 4.

Table 4 *User requirement*

No	User Requirements
1.	Donor can enter a valid user ID and password to log in to the system.
2.	Donor can schedule, view, and cancel blood donation appointments.
3.	Donor will receive notifications about upcoming appointments.
4.	Donor can track their donation history and eligibility for the next donation.
5.	Donor can update their personal information, including contact details.
6.	Donor can access educational resources or FAQs about blood donation.
7.	Admins can log in to the system with a secure admin account to manage users and system data.
8.	Admins manage all appointment records and ensure compliance with system policies.
9.	Admins can create account for healthcare provider.
10.	Admins can access all donor history for monitoring, analysis, and reporting purposes.
11.	Admins can update health status and donor eligibility.
12.	Admins can manage blood request status.
13.	Healthcare providers can log in to access donor data and manage blood requests.
14.	Healthcare providers can request blood for low stock blood type and set the quantity.
15.	Healthcare providers can view blood requests status.

Fig. 1 shows the use case diagram for Blood Connect System. The Blood Bank Connect System is designed to streamline the blood donation process by integrating the roles of admins, donors, and healthcare providers. The admin is responsible for managing the system, which includes creating healthcare provider accounts, maintaining blood inventory, and generating reports and analytics to ensure operational efficiency. Meanwhile, the donor interacts with the system to log in, schedule, view, and modify appointments, and track donation history. On the other hand, the healthcare provider handles blood requests. This coordinated effort between the stakeholders ensures a seamless and effective blood donation process, enhancing accessibility and efficiency for all users involved..

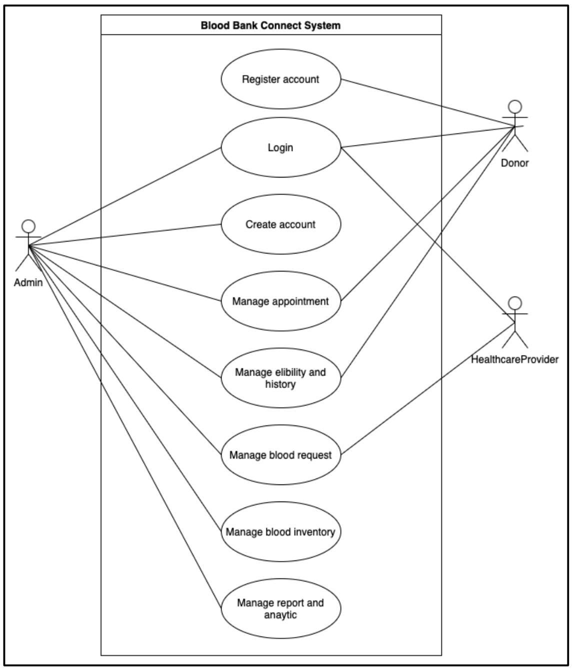

Fig. 1 *Use case diagram for Blood Bank Connect System*

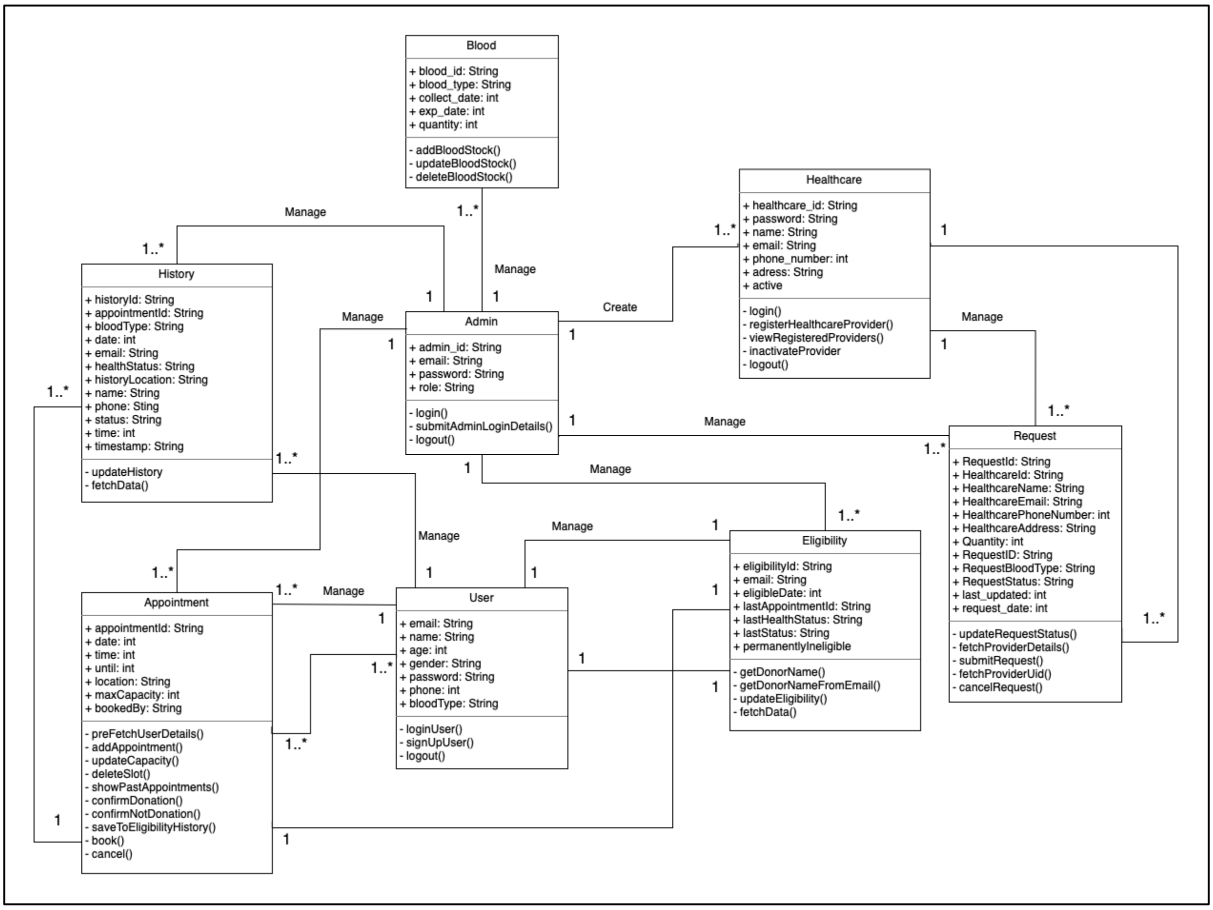

Fig. 2 *Class diagram for Blood Bank Connect System*

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System architecture is the organisation of the system components, their relationships to each other, and to the environment, and the principles guiding its design and evolution [9]. Fig. 3 depicts the system architecture model for the proposed system.

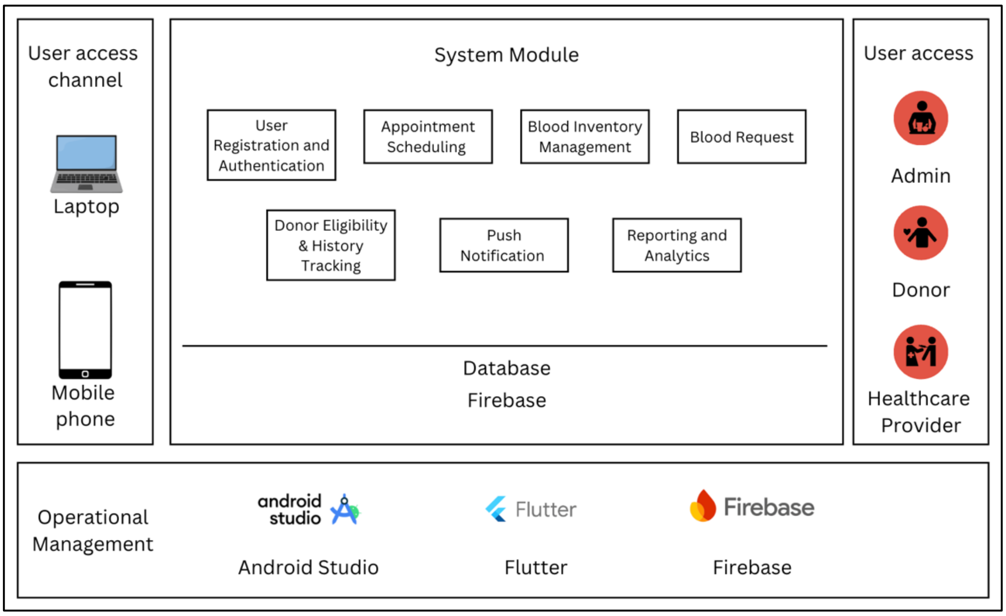
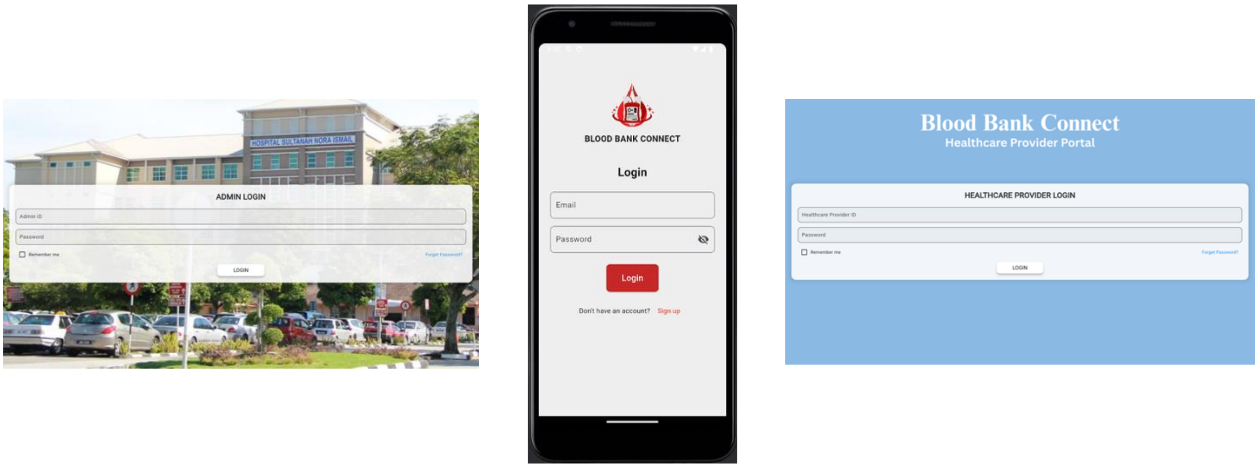


Fig. 3 *System architecture for Blood Bank Connect System*

Database schema is listed in the following:

i. `admins (admin_id, password, email, role)`
ii. `users (email, name, age, gender, password, phone, bloodType)`
iii. `healthcare_providers (healthcare_id, password, name, email, phone_number, address, active)`
iv. `appointments (appointmentId, date, time, until, location, maxCapacity, bookedBy)`
v. `eligibility (eligibilityId, email, eligibleDate, lastAppointmentId, lastHealthStatus, lastStatus, permanentlyIneligible)`
vi. `history (historyId, appointmentId, bloodType, date, email, healthStatus, historyLocation, name, phone, status, time, timestamp, actionStatus)`
vii. `Request (RequestId, HealthcareID, HealthcareName, HealthcareEmail, HealthcarePhoneNumber, HealthcareAddress, Quantity, RequestID, RequestBloodType, RequestStatus, last_updated, request_date)`
viii. `blood_inventory (blood_id, blood_type, collect_date, exp_date, quantity)`

The system provides distinct login mechanisms for admins, donors, and healthcare providers to ensure secure and efficient access. Admins log in via a web portal using their unique admin ID and password to create healthcare provider account and manage appointments, eligibility and history, blood request, blood inventories, and reports. Donors access the system through a mobile application with their email and password, enabling them to book appointments, track donation history, and check eligibility. Healthcare providers use a web-based portal to log in with their provider ID and password, allowing them to request specific blood types and monitor request statuses. Each login process ensures secure access to the user's role while maintaining data integrity. Figure 4(a): login page for admins, Figure 4(b): login page for donors, Figure 4(c): login page for healthcare providers show the login page of each user.



(a) **(b)** **(c)**

Fig. 4 *Login page for (a) admins (b) donors (c) healthcare providers*

To register on the app, donors fill out a form with the following fields which is full name, age, gender, email, phone number, and password. They must also confirm their password to ensure accuracy. Once all the fields are completed and validated, the donor clicks the "Sign up" button to submit their information. The application checks for required fields, validates the email format, and ensures that the passwords match before creating the account. Upon successful registration, the donor receives confirmation and gains access to features like appointment scheduling, donation history tracking, and eligibility updates. Fig. 5 shows the register page for donors.

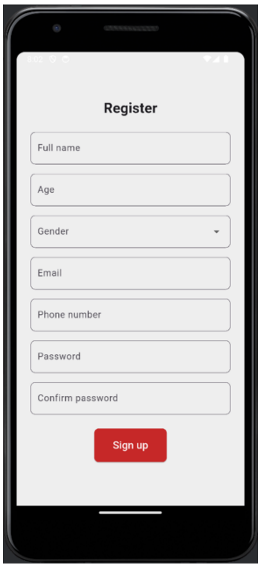


Fig. 5 *Register page for donors*

The admin creates a healthcare provider account through a secure web-based portal. To do this, the admin accesses the create account section and enters the required details for the healthcare provider, including their full name, healthcare provider ID, email address, phone number, and password as shown in Fig. 6. Once all fields are completed, the admin submits the information, and the healthcare provider's account is created. Additionally, the admin can view all registered healthcare provider accounts through a view registered healthcare provider button, which displays their details such as name, ID, email, phone number and password. This functionality allows the admin to manage and monitor healthcare provider account's information efficiently.

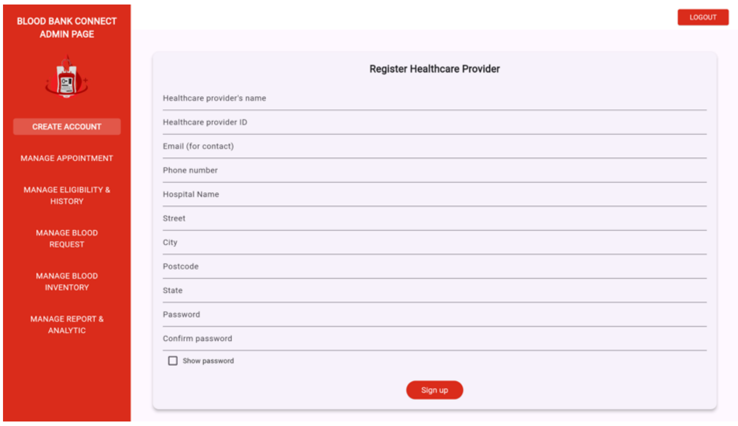


Fig. 6 *Register healthcare provider page for admins*

The admin appointment management interface, as shown in the Fig. 7 is part of the Blood Bank Connect Admin Page and is designed to help administrators efficiently schedule and manage blood donation appointments. Within the Manage Appointment section, admins can add new donation slots by entering the date, start and end times, location, and maximum donor capacity, using user-friendly input fields supported by calendar and clock icons. Once the details are filled, a "Add Slot" button allows for easy creation of the slot. Below the form, existing slots are displayed with details including location, date, time, max capacity, and the number of users booked. Each slot also shows a list of booked users with their names, email addresses, and phone numbers. Admins have the ability to delete slots, or mark donor participation using "Donate" and "Not Donate" buttons, with a disabled "Done" button after an action is taken. This interface promotes organized scheduling, prevents overbooking, and supports smooth coordination between blood banks and donors.

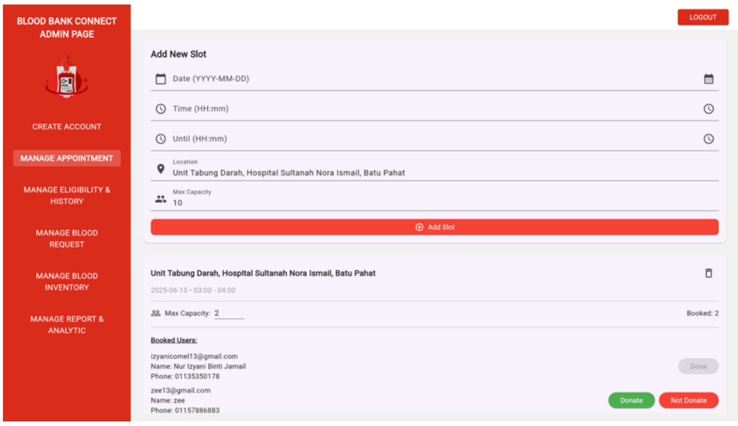


Fig. 7 *Manage appointment page for admins*

The mobile interface for booking blood donation appointments, as shown in Fig. 8, provides donors with a convenient way to select available time slots through a user-friendly application. Displayed under the "Book Appointment" section, each card represents a slot at Unit Tabung Darah, Hospital Sultanah Nora Ismail, Batu Pahat, and includes the date, time range, and current booking status. Available slots feature a “Book” button labelled with the number of spots left, making it easy for users to gauge availability immediately. Once a slot reaches full capacity, the button is automatically disabled and shown as “Full”, indicating that no further bookings are accepted. This interface ensures a smooth booking experience while effectively managing appointment availability and preventing overbooking.

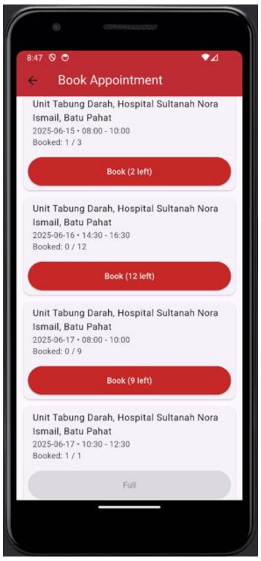


Fig. 8 *Book appointment page for donors*

The admin interface for managing donor eligibility and history, as shown in the Fig. 9, it allows administrators to efficiently access and review individual donor records. Under the Manage Eligibility & History section, the screen is divided into two parts which is Manage Eligibility and Manage History. Each section includes a search bar to quickly locate donors by name. In the eligibility panel, donors are listed by name, and admins can click the "See Details" button next to each name to review their eligibility for donation. The history panel lists donors with both their name and email address, also accompanied by "See Details" buttons for viewing donation records. This interface enables streamlined tracking of donor information, supporting informed decision-making and maintaining accurate donor profiles for the blood bank.

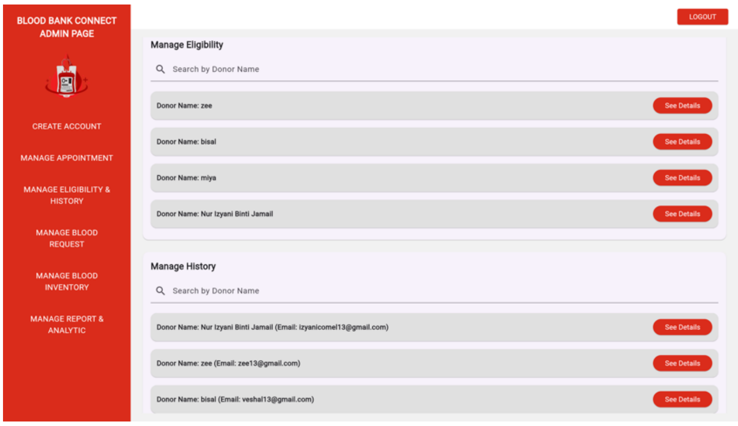


Fig. 9 *Manage eligibility and history page for admins*

The Donation History & Eligibility interface allows donors to view their current eligibility status and past donation records. The screen is divided into two sections which is Eligibility Status and Donation History. The eligibility panel shows if the donor is currently eligible to donate, with the next eligible date automatically calculated as 56 days after the last donation. The history panel displays the date, location, and status of previous donations, providing a clear and organized overview for donor self-monitoring. It also reflects the donor's latest health status for transparency. This user-friendly design helps encourage regular donations while ensuring donor safety and compliance. Fig. 10 shows the donation history and eligibility page for donors.

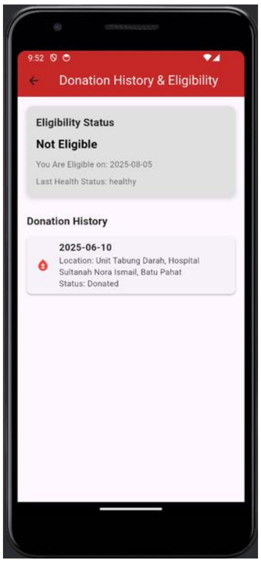


Fig. 10 *Donation history and eligibility page for donors*

The Admin Blood Request Management Interface provides administrators with a centralized view to monitor and manage blood requests submitted by healthcare providers through the provider portal. Each request is displayed with detailed information, including a unique request ID, provider details, hospital address, blood type, quantity requested, status, and timestamps for submission and last update. Admins can approve or reject requests directly from the interface using intuitive action buttons, streamlining decision-making and ensuring timely processing. Pending requests are highlighted for priority handling, promoting responsive coordination between hospitals and blood banks. Fig. 11 shows the manage blood request page for admins.

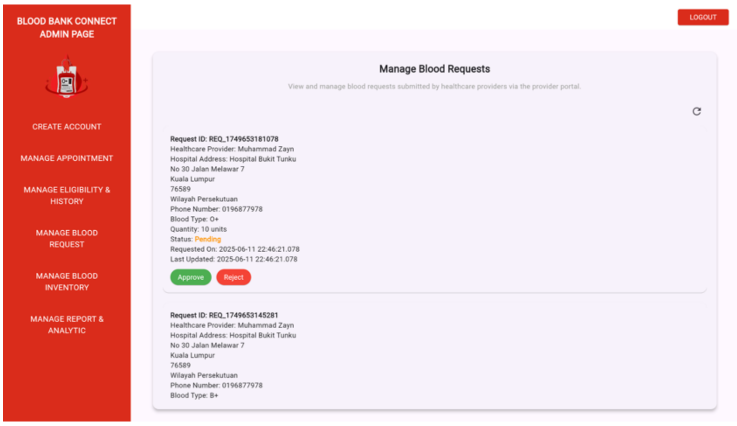


Fig. 11 *Manage blood request page for admins*

The Healthcare Provider Portal is a dedicated interface designed to streamline the blood request process for authorized medical personnel. The portal is divided into two main sections which is Healthcare Provider Details and Blood Request Details, ensuring a clear and organized workflow. In the provider section, essential information such as the name, healthcare ID, hospital address, email, and phone number is displayed to authenticate the requester and maintain traceability of requests. The Blood Request Details section allows healthcare providers to select the required blood type and specify the quantity needed through simple dropdown menus, making the request process quick and efficient. A "Submit Request" button finalizes the action, while a "Back" button allows easy navigation. Fig. 12 shows the request blood page for healthcare providers.

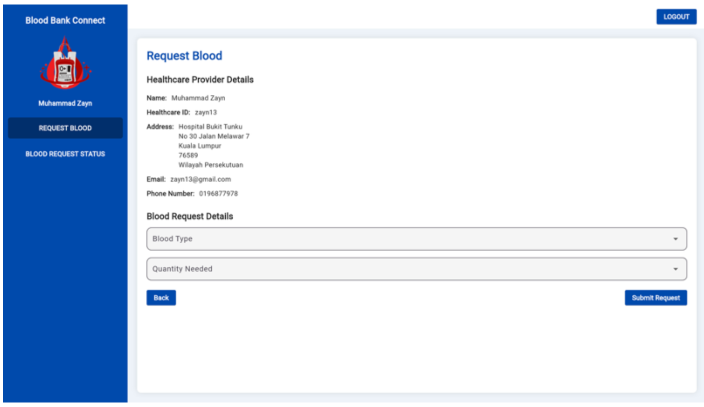


Fig. 12 *Request blood page for healthcare providers*

The blood request status page, as shown in Fig. 13, provides healthcare providers with a clear and organized view of all submitted blood requests. Each request entry displays a unique request ID, blood type, quantity, current status (e.g., Approved or Pending), and timestamps indicating when the request was made and last updated. Providers can also cancel requests that are still pending using the "Cancel Request" button. This interface ensures transparency and allows providers to track the progress of their blood supply needs, improving coordination with the blood bank and ensuring timely responses during critical situations.

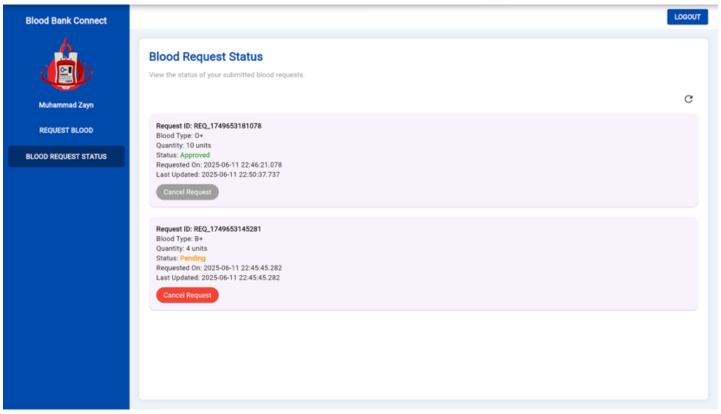


Fig. 13 *Blood request status page for healthcare providers*

The blood inventory management interface, as shown in Fig. 14, enables administrators to efficiently manage the blood stock through options to add, update, or remove blood units. When adding new stock, the admin must input the blood ID, select the blood type, and enter the collection date. The system automatically calculates and autofill the expiration date as 42 days from the collection date, ensuring accuracy and consistency in blood shelf-life tracking. Below the input section, the current inventory is displayed in a table listing each blood unit's ID, type, collection date, and expiry date, allowing for clear oversight of available and expiring blood supplies.

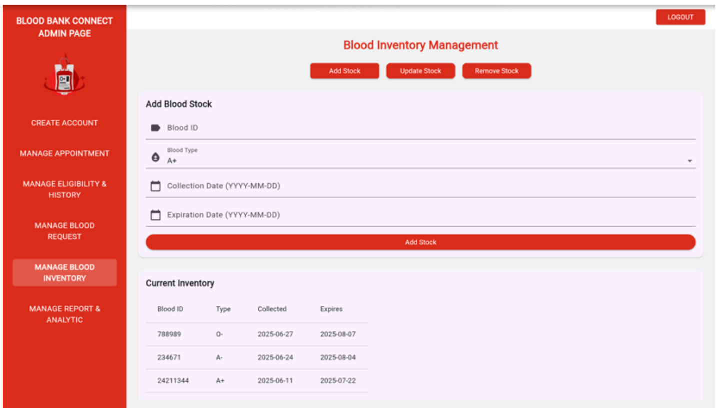


Fig. 14 *Manage blood inventory for admins*

The analytics dashboard in the admin panel provides a visual summary of key metrics for the blood donation system. The "Appointments History" graph displays the number of attended appointments for each day of the

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current month, highlighting peak activity. The "Blood Inventory by Blood Type" bar chart presents the current stock levels for each blood group, allowing admins to quickly identify supply gaps. Additionally, the "Blood Requests by Status" chart gives an overview of request statuses, helping monitor the balance between pending, approved, and fulfilled demands. This centralized overview aids in efficient blood bank management and decision-making. Fig. 15 shows the manage report and analytic page for admins.

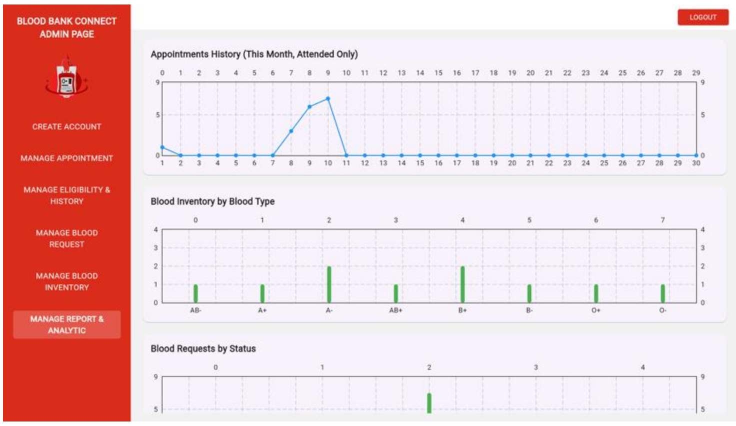

Fig. 15 *Manage report and analytic page for admins*

4. Result and Discussion

Beta testing was conducted by involving targeted users after the completion of the Blood Bank Connect mobile application. This testing aimed to gather feedback from target users based on their experience while using the application. The subjects of testing were limited to blood donors, the primary user group. The testing process was designed to evaluate the app's usability, functionality, and overall user satisfaction in real-world scenarios. A set of questionnaires was prepared on Google Form, enabling the automatic generation of figures and charts to simplify data analysis. There were 19 users in total who participated in the beta testing. The feedback collected during this phase will be instrumental in identifying areas for improvement and ensuring the app meets the needs of donors effectively. The testing period spanned several weeks to allow for diverse usage patterns and thorough evaluation.

Fig. 16 is a bar chart titled "The Blood Bank Connect app is easy to navigate," based on 19 responses from beta testers. The x-axis represents the Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), while the y-axis indicates the number of responses. The chart shows a significant majority of respondents, 13 (68.4%), strongly agreed (5) that the app is easy to navigate, indicating high user satisfaction with the navigation experience. Additionally, 5 respondents (26.3%) agreed (4), contributing to a total of 94.7% positive feedback. Only 1 respondent (5.3%) provided a neutral response (3), with no respondents disagreeing (1 or 2), highlighting the app's intuitive design and effective user interface during the beta testing phase.

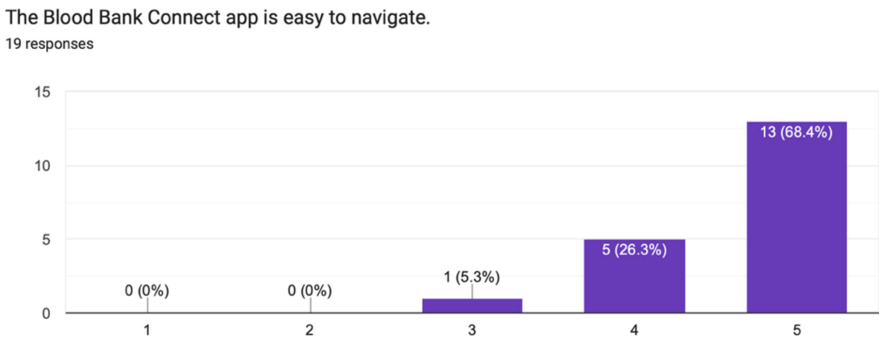

Fig. 16 *Result for question "The Blood Bank Connect app is easy to navigate"*

Fig. 17, labeled "I was able to successfully register or log in to the app," presents feedback from 19 beta testers of the Blood Bank Connect application. The data highlights a predominantly positive outcome, as 16 testers (84.2%) rated their experience with a 5, signifying strong confidence in the app's registration and login features. Two testers (10.5%) gave a rating of 4, adding to the favorable feedback, while a single tester (5.3%) selected 3, indicating neutrality. Notably, no testers chose 1 or 2, suggesting that the authentication process encountered no significant difficulties during testing.

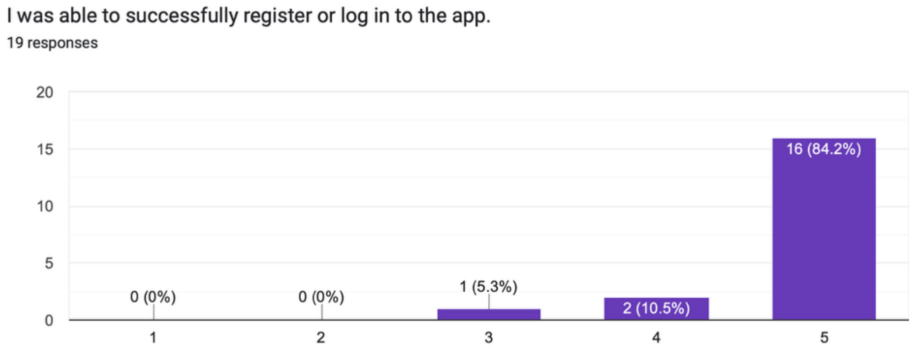

Fig. 17 *Result for question "I was able to successfully register or log in to the app"*

The bar chart in Fig. 18, showcasing the opinions of 19 beta testers for the Blood Bank Connect application, is labelled "The appointment scheduling feature is satisfactory." A clear majority, with 15 users (78.9%), expressed strong satisfaction with the feature, highlighting its efficiency and user-friendliness. Another 3 testers (15.8%) found it satisfactory, adding to the overall positive feedback. A single respondent (5.3%) opted for a neutral stance, while no negative ratings were recorded, indicating a robust and well-received scheduling tool. This feedback emphasizes the feature's success in facilitating a seamless booking experience for donors throughout the testing period.

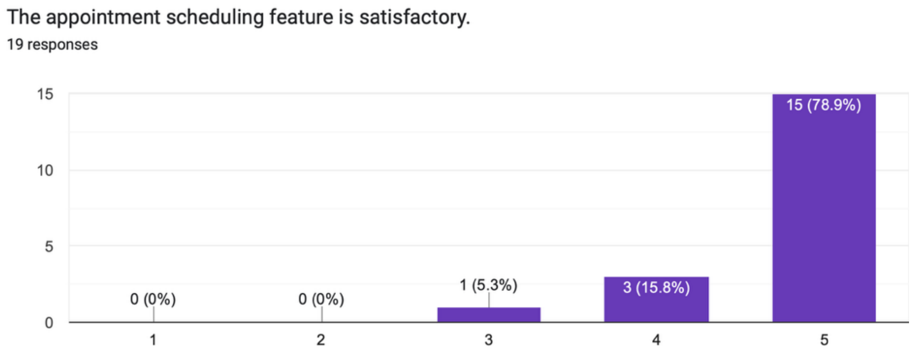

Fig. 18 *Result for question "The appointment scheduling feature is satisfactory"*

Feedback from 19 beta testers of the Blood Bank Connect application is illustrated in the bar chart titled "The push notifications for upcoming appointments worked as expected." The results in Fig. 19 reveal a predominantly positive response, with 12 testers (63.2%) strongly agreeing that the notifications performed reliably. Additionally, 6 respondents (31.6%) agreed, contributing to an overall satisfaction rate of 94.8%. Only 1 tester (5.3%) remained neutral, while no participants reported disagreement, indicating that the notification system was highly effective. This strong approval suggests that the feature successfully met the needs of donors during the testing phase.

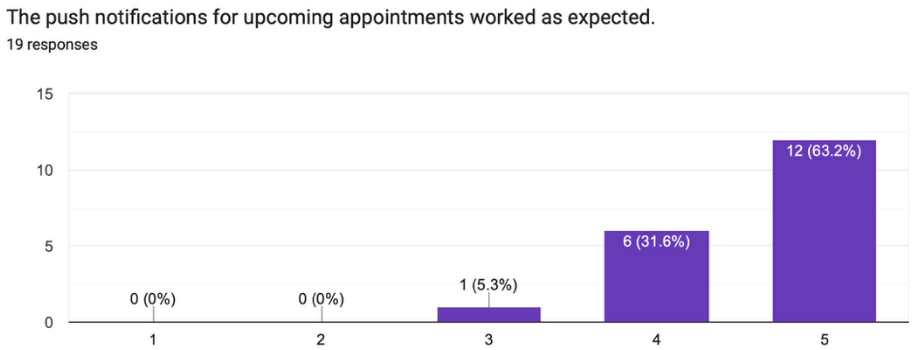

Fig. 19 *Result for question "The push notifications for upcoming appointments worked as expected"*

The bar chart in Fig. 20 titled "The eligibility status information is clear and helpful" captures the views of 19 beta testers of the Blood Bank Connect application. An impressive 16 testers (84.2%) rated the information as highly clear and helpful, reflecting strong approval of this feature. Additionally, 2 respondents (10.5%) agreed with the statement, contributing to a total positive feedback of 94.7%. Only 1 tester (5.3%) remained neutral, with no negative responses recorded, indicating that the eligibility status presentation is well-received and effectively supports donors. This high satisfaction level underscores the feature's success in providing transparent and useful information during the testing period.

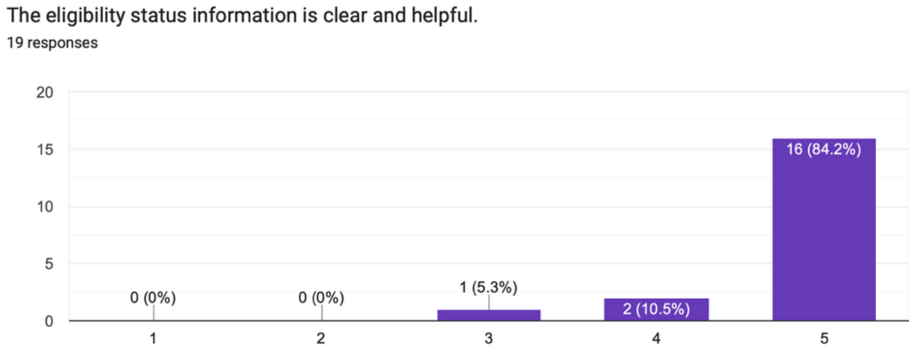

Fig. 20 *Result for question "The eligibility status information is clear and helpful"*

Feedback from 19 beta testers of the Blood Bank Connect application is summarized in the bar chart titled "I could effectively view my donation history." A significant majority, with 16 respondents (84.2%), rated the feature highly, reflecting excellent usability and satisfaction. Another 2 testers (10.5%) also gave positive feedback, pushing the overall approval rate to 94.7%. A single respondent (5.3%) chose a neutral stance, while no testers disagreed, pointing to the feature's reliability. This strong endorsement underscores how well the donation history tool served donors throughout the testing period. Fig. 21 shows the result.

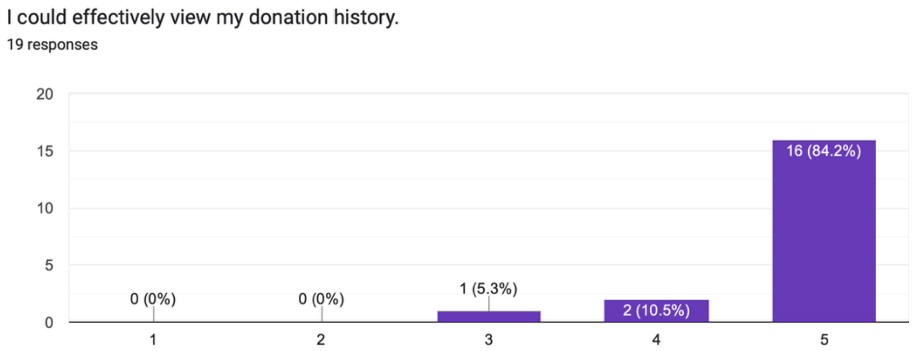

Fig. 21 *Result for question "I could effectively view my donation history"*

The bar chart in Fig. 22, presenting feedback under the title "The app's performance (e.g., loading speed, responsiveness) is reliable," captures insights from 19 beta testers of the Blood Bank Connect application. A notable 12 testers (63.2%) expressed full confidence in the app's dependable operation, underscoring its smooth functionality. Additionally, 6 respondents (31.6%) supported this view, leading to a combined positive rating of 94.8%. One tester (5.3%) opted for a neutral stance, with no dissenting opinions recorded, suggesting the app's responsiveness and speed were well-received. This positive feedback highlights the app's stable performance during the testing phase.

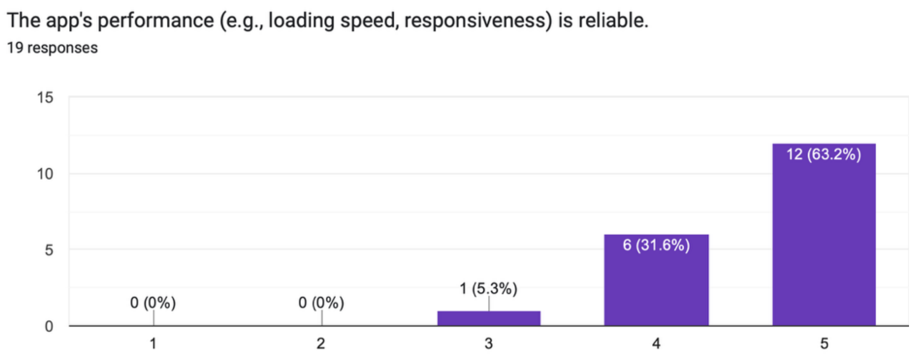

Fig. 22 *Result for question "The app's performance (e.g., loading speed, responsiveness) is reliable"*

Insights from 19 beta testers of the Blood Bank Connect application are displayed in the bar chart titled "I encountered bugs or errors while using the app" as shown in Fig. 23. An impressive 14 participants (73.7%) confirmed a trouble-free experience, pointing to the app's overall reliability. Meanwhile, 4 testers (21.1%) noted occasional glitches, and 1 user (5.3%) faced more significant issues, with no feedback indicating moderate or severe problems. This distribution highlights a predominantly stable performance, despite a small number of technical hiccups observed during the testing period.

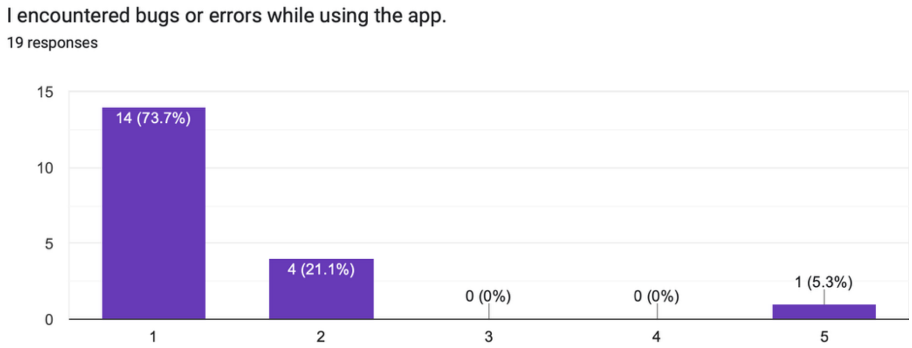

Fig. 23 *Result for question "I encountered bugs or errors while using the app"*

Fig. 24 presents the results of a survey question titled "I would recommend Blood Bank Connect to others," which received a total of 19 responses. The majority of respondents 15 out of 19, or 78.9% gave the highest possible rating of 5, indicating extremely strong satisfaction and willingness to recommend the service. A smaller portion of participants provided lower ratings: 5.3% (1 response) rated it a 4, and 15.8% (3 responses) chose a mid-range rating of 4. Notably, no respondents selected 1, or 2, suggesting that dissatisfaction opinions were rare. These results highlight a high level of user approval for Blood Bank Connect, with the majority of participants expressing strong endorsement. The absence of very low ratings further reinforces the service's positive reception among its users.

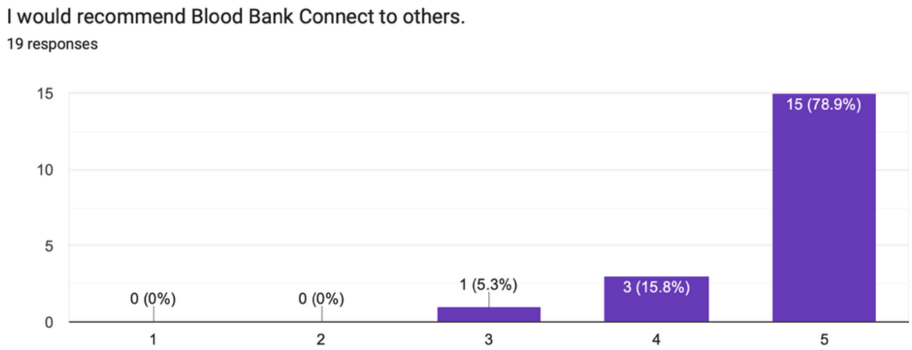

Fig. 24 *Result for question "I would recommend Blood Bank Connect to others"*

Fig. 25 shows qualitative feedback from a survey titled "The app meets my expectations for additional features in future updates," with 19 responses collected. Users provided mixed but generally positive comments, with some praising the app's current functionality—such as "Application is functional" and "All features are functional", while others called for enhancements. Several respondents suggested specific improvements, including live chat support, multi-language support for better accessibility, and a reporting feature. One user expressed concern about regional limitations, hoping the app is not restricted to "Unit Tabung Darah Hospital Sultanah Nora Ismail only." A few participants were highly satisfied, with comments like "nothing to add already perfect" and "Yes good." Overall, the feedback indicates that while many users find the app effective as-is, there is clear demand for additional features to improve usability and inclusivity in future updates. The responses reflect a balance between appreciation for current functionality and constructive suggestions for growth.

The app meets my expectations for additional features in future updates.

19 responses

need more new features like live chat to get support

Application is functional

Adding multi-language support would make it more accessible.

hope it is not just for unit tabung darah hospital sultanah nora ismail only

nothing to add already perfect

Yes good

good

All feature are functional

I hope the app have report function

Fig. 25 *Result for question "The app meets my expectations for additional features in future updates"*

Fig. 26 captures open-ended feedback from a survey prompt asking users to share "any overall feedback or suggestions to improve the app," drawing 19 responses. While some respondents simply noted "nothing", implying no criticisms, others offered specific recommendations for enhancements. For instance, one user proposed including "a tutorial for using the application," while another expressed enthusiasm for future updates, stating, "just add more interesting features, I'm excited for new updates." Several participants praised the app's usability, with remarks like "The app is very user-friendly" and "Overall, it's a fantastic tool for blood donation management," though some suggested practical additions such as "a feature to contact support directly" or "a feedback button within the app itself." Aesthetic improvements were also mentioned, including a request for "a darker mode option." Positive highlights included "very good apps even in its first version" and "the app encourages me to donate again," underscoring its impact. The feedback reveals a strong foundation for the app, with users eager for iterative refinements to functionality and design.

Please provide any overall feedback or suggestions to improve the app.

19 responses

nothing

Tutorial for use the application should be added

just make add more interesting features, im excited for waiting new updates

The app is very user-friendly, but adding a feature to contact support directly would enhance it.

very good apps even it is the first version

the apps encourage me to donate again

Great work! The design is clean, but adding a darker mode option would be nice.

The app is very effective, but I suggest including a feedback button within the app itself.

Overall, it's a fantastic tool for blood donation management.

Fig. 26 *Result for question "any overall feedback or suggestions to improve the app"*

5. Conclusion

The findings of this study highlight the potential of mobile-based solutions to address inefficiencies in the blood donation process, particularly in donor coordination, inventory management, and engagement strategies. The proposed Blood Bank Connect system successfully integrates functionalities such as donor registration, inventory tracking, and push notifications, which streamline operations and enhance responsiveness during emergencies. Trends observed during the study indicate significant improvements in donor engagement, with automated reminders for consistent participation. Furthermore, the centralized data management approach ensures better accuracy in inventory control and minimizes wastage due to expired blood units. Despite these achievements, there remain areas for further exploration. Future research should focus on scaling the application for broader use, integrating advanced analytics for predictive modeling of blood demand, and enhancing user engagement through personalized features. The incorporation of machine learning algorithms for matching donors with specific needs and expanding the platform's capabilities to support multi-language interfaces can also broaden its applicability. By continuing to refine and extend the system's functionalities, Blood Bank Connect can play a crucial role in transforming blood donation management and addressing global challenges in healthcare systems.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Zulfahme Solihan, Mazidah Mat Rejab;* ***data collection:*** *Muhammad Zulfahme Solihan;* ***analysis and interpretation of results:*** *Muhammad Zulfahme Solihan, Mazidah Mat Rejab;* ***draft manuscript preparation:*** *Muhammad Zulfahme Solihan, Mazidah Mat Rejab. All authors reviewed the results and approved the final version of the manuscript.*

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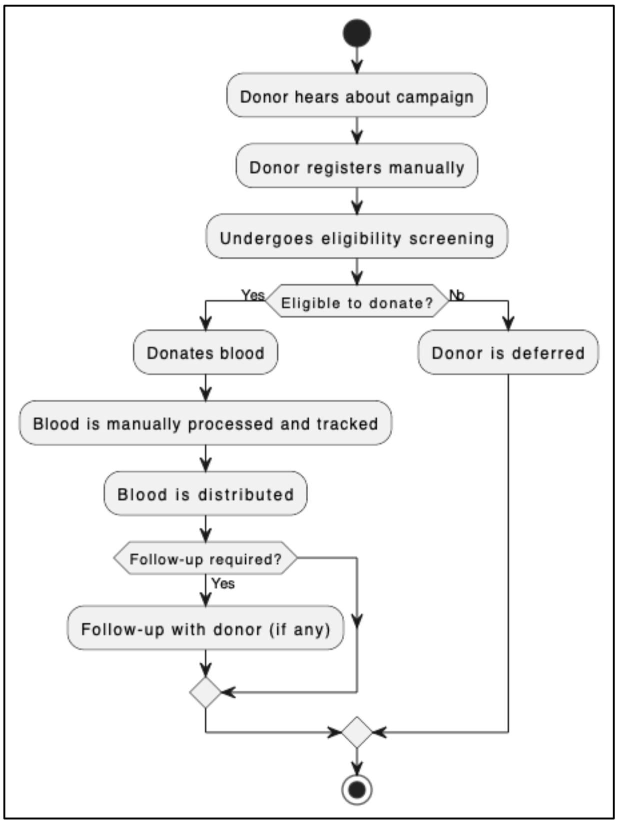
Appendix A: The workflow for current process of Blood Donation Management System



Appendix B: The Waterfall model