Volume 9, Issue 12, December – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

Improving Blood Transfusion Services for Better Patient Care: Linking Blood Banks and Hospitals in Nigeria Using Web Technologies

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Abstract:- Nigeria currently faces significant challenges in maintaining an efficient supply of blood products to meet the healthcare needs of its population. Blood transfusions are critical in modern healthcare, saving countless lives, which is far from optimal in Nigeria. This paper investigates the drawbacks and flaws in the current blood transfusion process in Nigeria, where a web-based technology is developed that serves as a bridge between the blood bank & hospitals, allowing for accessible communication and coordination. This research used a cross-sectional survey of medical experts about the current system using Qualtrics. The data obtained was analyzed to understand Nigeria's current technological infrastructure of blood transfusion services. The web-based application was developed using HTML, CSS, JavaScript, PHP, and MySQL with their libraries to meet the gap in the current system. Medical experts tested it, and the result showed that the proposed web-based application could significantly improve the efficiency, accessibility, and quality of blood transfusion service in Nigeria using a simple & easy web interface. This study signifies the importance of exploring modern technology to address critical healthcare challenges and bring innovation and improvement in service delivery. Integrating emerging technologies like Blockchain for enhanced system security application performance and feature optimization can be considered for further research and development.

Keywords:- *Blood Transfusion; Healthcare Systems; Nigeria; Blood Bank; Hospitals; Web Technologies.*

I. INTRODUCTION

Information and communication technology (ICT) has transformed every element of human life. The popularity of IT health systems has boosted applications of ICT to healthcare delivery. In health systems worldwide, blood transfusion is essential for patients experiencing acute blood loss or severe anemia [1]. Globally, whole blood and blood components (blood products) are crucial medicines for blood transfusion. Yet, shortages are a well-described problem, particularly in low-income and middle-income countries (LMICs)[2]. Nigeria is faced with numerous healthcare challenges, including inadequate infrastructure and resources. One of the critical issues is the effective management and distribution of blood and blood products to hospitals across the country [3,4]. Blood transfusions are crucial in modern healthcare, saving countless lives by providing essential components for needy patients. However, in many parts of the world, including Nigeria, the availability and accessibility of blood transfusion services are far from optimal. This shortage of safe and timely blood supply has had a detrimental impact on patient care, leading to increased mortality rates and unnecessary suffering [5].

Blood shortages, delayed responses to urgent blood requests, and suboptimal patient care 3 characterize the current situation in Nigeria. A comprehensive and integrated system is needed to address healthcare delivery. They further stated that Hospitals are often forced to rely on multiple independent blood banks, making it challenging to source blood when needed. This situation creates a heightened risk of patient complications and mortality due to delays in the provision of essential blood components. Ensuring a consistent blood supply remains challenging for blood banks, resulting in shortages during crucial periods. Hospitals encounter obstacles in acquiring timely access to blood, leading to delays in administering life-saving treatments. [6]. Furthermore, a lack of openness in bloodstock information results from the absence of real-time tracking and communication. In addition to affecting patient outcomes, these complications also give rise to concerns about the safety of blood transfusions. [7].

Addressing the challenges outlined involves creating and deploying an integrated web application. This application establishes a connection between blood banks and hospitals, establishing a unified platform for managing blood transfusion services. In this system, real-time communication, tracking of blood availability, and efficient allocation are facilitated, ultimately enhancing the quality of blood transfusion services in Nigeria. This research tackled these fundamental issues by providing a transformative solution to improve healthcare delivery, decrease morbidity

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

and mortality rates, and serve as a model for similar enhancements in healthcare systems globally.

A web application that connects blood banks and hospitals in Nigeria is used as a potential application for this research. This integrated system streamlines the blood request and distribution process, ensuring hospitals have timely access to the blood they need. Real-time monitoring and communication provide efficient allocation of blood stocks, reducing wastage and improving overall blood safety. Additionally, the system can serve as a data collection and analysis platform, helping health authorities make informed decisions on blood collection and distribution strategies.

II. RELATED STUDIES

A new chipless RFID tag based on an L-resonator was introduced by [8] At the 8th Asia-Pacific Conference on Antennas and Propagation (APCAP 2019). The tag is intended for tracking and identification within a blood bank management system. The system utilized an L-resonator and a microstrip transmission line, demonstrating the configuration and easy bit detection for different blood groups. Through simulations, the authors showcased the encoding of blood groups O- and O+, affirming the potential for efficient blood group identification in hospital settings. In conclusion, the study establishes the feasibility of the L-resonator-based chipless RFID tag for practical use in tracking and identifying hospital equipment, particularly blood bags, and as a smart label for blood group identification in donors and patients. The proof of concept provided and experimental results set the stage for future applications and advancements in the field.

Hummady's (2022)[9] Work focuses on developing a mobile application addressing challenges in blood donation systems exacerbated by the COVID-19 pandemic. The application, built using React Native and Firebase, is a cross-platform solution to streamline blood donation processes. It aims to connect donors, oversee blood transfusion services, and compile data on blood supply, facilitating quick responses to emergencies. The application aims to offer a user-friendly interface, ensuring data reliability and providing swift connections between donors and patients in need with compatibility for both iOS and Android. Hummady's [9]Mobile application emerges as a valuable solution to enhance the efficiency of blood donation processes, especially during emergencies.

Awasthi and Sharma (2022)[10] investigated the complexities of the Indian healthcare system, emphasizing its inadequacies in serving all segments, particularly the poor and lower class, due to resource constraints. To propose an innovative solution, the authors introduce the Advanced Blood Management System Community Method, leveraging cutting-edge technologies like cloud computing, wearable tech, and machine learning. The Sustainable Blood Management Solution (SBMS), a contemporary web mobile application, emerges as a key component, comprising donors, patients, hospitals, and blood donation camps. The study concludes by envisioning the future integration of big data analytics and IoT to enhance further the proposed system's efficiency and anticipatory capabilities in blood supply network management. Overall, Awasthi and Sharma's work presents a significant advancement in addressing critical blood donation and management issues in India through technological innovation and system optimization.

The Blood Donor Management System presented by Elakya et al. (2022)[11] Significantly contributes to the field, leveraging mobile technology to bridge the gap between voluntary blood donors and those in urgent need. This Android-based model facilitates user registration, requiring basic details and geographical location through Google Maps. The use of one-time passwords adds an extra layer of authentication during registration. It involves the integration of Android Studio, XML, Java, Google Maps, Firebase, and algorithms like K Nearest Neighbor and Dijkstra's, demonstrating a comprehensive approach to system development. Overall, the Blood Donor Management System offers a practical and innovative solution to streamline blood donation processes, ensuring timely access to blood during emergencies and reducing panic caused by blood unavailability.

Kaur et al. (2023)[12] Introduce "RaktFlow," a mobile application aiming to streamline blood donation processes, enhance the blood supply chain, and address oxygen shortages, especially during the COVID-19 pandemic. The application, developed with React-Native, Django, and RestAPIs, facilitates user registration, blood donation scheduling, and timely reminders. Hospitals and blood banks benefit from dedicated dashboards for efficient resource management. The authors propose a comprehensive technology stack and highlight the system's advantages in reducing manual efforts and providing secure access to critical healthcare resources. The study reiterates the pivotal role of technology, particularly IoT, in fortifying the blood supply chain and advocates for nationwide adoption of platforms like E-raktkosh to promote voluntary blood donation.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

Table 1: Previous Related Works on Blood Transfusion

S/N	Authors and year	Key Focus	Methodologies /Technologies	Main Contributions	Future Work/Enhancements
1	[8]	L-resonator-based chipless RFID tag for blood group identification	L-resonator, microstrip transmission line	Innovative chipless RFID tag for blood group identification, versatility for blood bags, potential for efficient hospital Tracking.	Further applications and advancements in tracking hospital equipment, such as smart labels for blood group identification.
2	[10]	Indian Healthcare Challenges, Blood Management System	Cloud computing, wearable tech, machine learning	Advanced Sustainable Blood Management Solution (SBMS), integration of big data analytics and IoT for future enhancements	Integration of big data analytics and IoT for system efficiency and anticipatory capabilities in blood supply network management
3	[9]	Mobile application for blood donation during COVID-19	React Native, Firebase	Cross-platform solution, streamlined blood donation processes, user-friendly interface, compatibility with iOS and Android	Continued system refinement, optimization, and efficiency in blood donation processes
4	[11]	Blood Donor Management System using Android	Android Studio, XML, Java, Google Maps, Firebase	Android-based model for seamless donor-recipient connection, request-response mechanism with data security through one-time passwords	Biometric validation, encryption, authentication algorithms, system refinement
5	[12]	RaktFlow – Blood Bank Management and Donation System	React-Native, Django, RestAPIs	Mobile application for streamlined blood donation and optimization of the blood supply chain.	Location-based details, network facilities improvement, multilingual support, enhanced ambulance services

III. MATERIALS AND METHODOLOGY

This section presents the software engineering method adopted for designing and implementing the web application and describes some of the steps undertaken while developing the proposed system. This research employs a mixed-methods approach which is chosen because of the need for a comprehensive understanding of the multifaceted issues surrounding blood transfusion services in Nigeria. A survey was administered to a sample of healthcare professionals and blood bank staff, who are the main stakeholders involved in blood transfusion services, to obtain information on the system's current challenges. A total of 5 participants were recruited and interviewed for the qualitative interview, and a structured questionnaire with closed-ended questions to gather quantitative data was developed.

The project employs a Pragmatist research philosophy and an agile model to develop the proposed system. A pragmatic study focuses on an individual decision-maker within an actual real-world situation. The process of pragmatic study first identifies a problem and views it within its broadest context, which leads to research inquiry, which seeks to understand better and ultimately solve the problem (Kaushik, 2019)[13]. This approach was adopted for this research as the application is being constructed based on real-world experiences. The term Agile refers to the frequent reassessment and adaptation of plans and techniques and the dividing of tasks into shorter tasks for efficiency (Waja, 2021)[14]. Compared to other models, agile methodology is variable and more flexible regarding adaptation of needs. It is an iterative and incremental approach, which is conducted with collaboration and the right formalism, which enables the research to generate a high-quality product while considering the changing needs of users. The Agile model (Figure 1) comprises the following stages: collecting data from healthcare professionals, designing, implementing, testing, and maintaining the product.

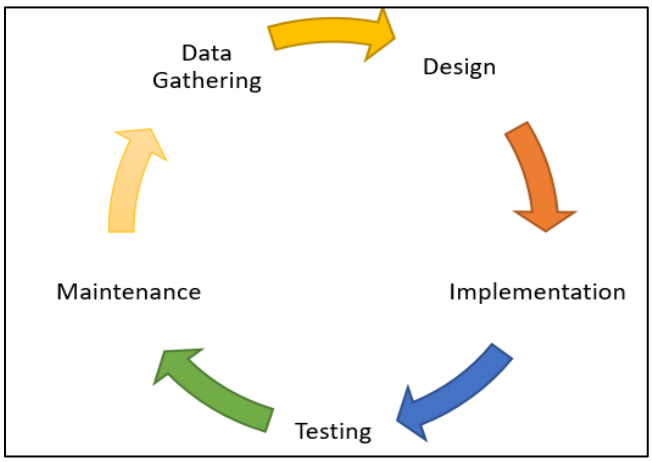

Fig 1: Agile Methodology

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

The web application was successfully designed and implemented using web technologies and tools, including Jira (For Project Management/ Planning), Scrum (for Agile Software Development Framework), Qualtrics (for data and information gathering), Figma (for designing and prototyping); HTML, CSS, Javascript, and PHP (for software development), and MySQL (for database),

The system has a user-friendly interface that is accessible via desktop computers. It also has login and signup features for users, which allow them to check blood inventory details, make blood requests, and use the dashboard to check details. The system was tested and evaluated by 3 health care professionals and 2 blood bank staff and found to be effective provision of blood transfusion service.

IV. RESULT AND DISCUSSION

A. Presentation of Data Result

Table 2: Demography of respondent

Demography	Profile	Frequency	Percent (%)
Profession	Blood Bank Staff	3	60.0
	Healthcare Professionals	2	40
Total		5	100.0
Years of Experience	Less than 2 years	4	80.0
	2-5 years	1	20.0
Total		5	100.0
Type of Healthcare Institution	Blood Bank	2	40.0
	Hospital	3	60.0
Total		5	100.0

The demographics of the study's respondents (Table 2) indicate that they were primarily divided into two professional roles: Blood Bank Staff and Healthcare Professionals. Most participants, constituting 60%, belong to the Blood Bank Staff category, while the remaining 40% are Healthcare Professionals. The respondents' years of experience in the field indicate that 80% have less than 2 years of experience, while 20% have 2-5 years of experience. The results suggest a predominantly early-career profile among the participants. The demographic breakdown based on the type of healthcare institution reveals that 60% of the respondents are affiliated with hospitals, while 40% belong to blood banks. This distribution reflects a slightly higher representation of the hospital sector within the sample.

Table 3: Level of Coordination

Level of Coordination between Blood Banks and Hospitals	Frequency	Percent (%)
2	2	40.0
3	3	60.0
Total	**5**	**100.0**

The respondents' assessment of the coordination level between blood banks and hospitals (Table 3) was rated on a scale of 1 to 5, with 1 indicating poor coordination and 5 representing excellent coordination. The distribution of responses suggests that 40% rated the coordination at level 2, while the majority, comprising 60%, rated it at level 3. The result suggests a moderate perception of coordination effectiveness among the participants, with a higher inclination towards a satisfactory rating. Additionally, mixed feedback about tedious blood delivery processes and insufficient blood issues was noted, impacting the perceived coordination level. These insights provide a nuanced understanding of how communication issues influence participants' perceptions of coordination effectiveness.

Table 4: Communication Channels between Blood Banks and Hospitals

Communication channels between blood banks and hospitals	Frequency	Percent (%)
2	3	60.0
3	2	40.0
Total	**5**	**100.0**

Respondents were asked to rate the clarity of communication channels between blood banks and hospitals on a scale of 1 to 5 (Table 4). The majority (60%) rated it as 2, indicating somewhat unclear communication, while 40% rated it as 3, suggesting room for improvement in achieving clearer communication channels.

Table 5: Communication Protocols

Communication Protocols	Frequency	Percent (%)
Not Available	3	60.0
Available but effective	2	40.0
Total	5	100.0

Respondents were asked about standardized communication protocols, and 60% reported that no such protocols are currently in place (Table 5), while the remaining 40% affirmed their presence. This distribution suggests an opportunity to establish or enhance communication guidelines for more effective coordination between blood banks and hospitals.

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Table 6: Effectiveness of Technology System for Tracking and Managing Blood Supply

Effectiveness of Technology System for Tracking and Managing Blood Supply	Frequency	Percent (%)
Extremely effective	1	20.0
Neither ineffective nor effective	2	40.0
Somewhat ineffective	2	40.0
Total	**5**	**100.0**

The effectiveness of technology systems for tracking and managing blood supply was assessed by respondents (Table 6), with 20% finding these systems extremely effective, 40% rating them as neither ineffective nor effective, and another 40% deeming them somewhat useless. The result suggests a mixed perception of the current technology integration, indicating a need for potential improvements or adaptations to meet the coordination requirements better. Respondents identified various technological barriers to coordination. Notable responses included the need for a platform to contact multiple blood banks, concerns about prior and proper communication, limitations to communication channels to only phone calls, and a general affirmation of technological barriers. This diversity of responses underscores the complexity of technological challenges in coordinating blood banks and hospitals.

Table 7: Level of Collaboration between Blood Bank and Healthcare Staff

Collaboration between Blood Bank and Healthcare Staff	Frequency	Percent (%)
Neither professional nor unprofessional	1	20.0
Somewhat professional	2	40.0
Somewhat unprofessional	2	40.0
Total	**5**	**100.0**

Participants were interviewed to rate the level of collaboration between healthcare professionals and blood bank staff (Table 7). The responses varied, with 40% perceiving the collaboration as somewhat professional and another 40% finding it somewhat unprofessional. Additionally, 20% indicated that collaboration could be more experienced and skilled. These diverse perceptions highlight the need to foster more effective collaboration among stakeholders involved in blood transfusion.

The responses from the respondents indicate key features they desired in a web application for enhancing coordination between blood banks and hospitals in Nigeria. Respondents highlight the need for effective communication tools, real-time information on blood availability (including blood group types and quantities), and an integrated platform for requests, communication, payments, and delivery scheduling. Additionally, there's a clear emphasis on tracking blood supply, communicating with recipient hospitals, and facilitating final fees, costs, and logistics agreements. These insights underscore the importance of streamlined communication and efficient blood supply chain management for improved coordination.

Respondents shared concise insights. One participant had no additional comments. Another stressed the need for public awareness of voluntary blood donation. A third expressed optimism about a coordination platform as a significant breakthrough. The fourth had no further comments. The fifth emphasized the urgency of timely blood access, proposing an emergency request platform for swift responses. These perspectives highlight considerations from public engagement to technological solutions in improving blood transfusion services in Nigeria.

B. Presentation of the Web Application

- *Hospital Signup Page*

The hospital signup page (Figure 2) for healthcare professionals allows users to create an account. Users choose a hospital from the two available options. Then, proceed to the hospital signup page. The application anticipates receiving five signup parameters from the signup page: the user's name, email address, phone number, password, and password confirmation for verification purposes. The first and last names can only consist of alphabetical characters and cannot contain any symbols. The email address must have a valid format, and the database shouldn't have any duplicate email entries. In addition, the passwords must be at least six characters long and match one another. After a successful signup, a validation page displays, allowing the user to be redirected to the profile page. The user's input data ought to be retained in the database. An OTP is generated for the user and sent to the user number required to log in.

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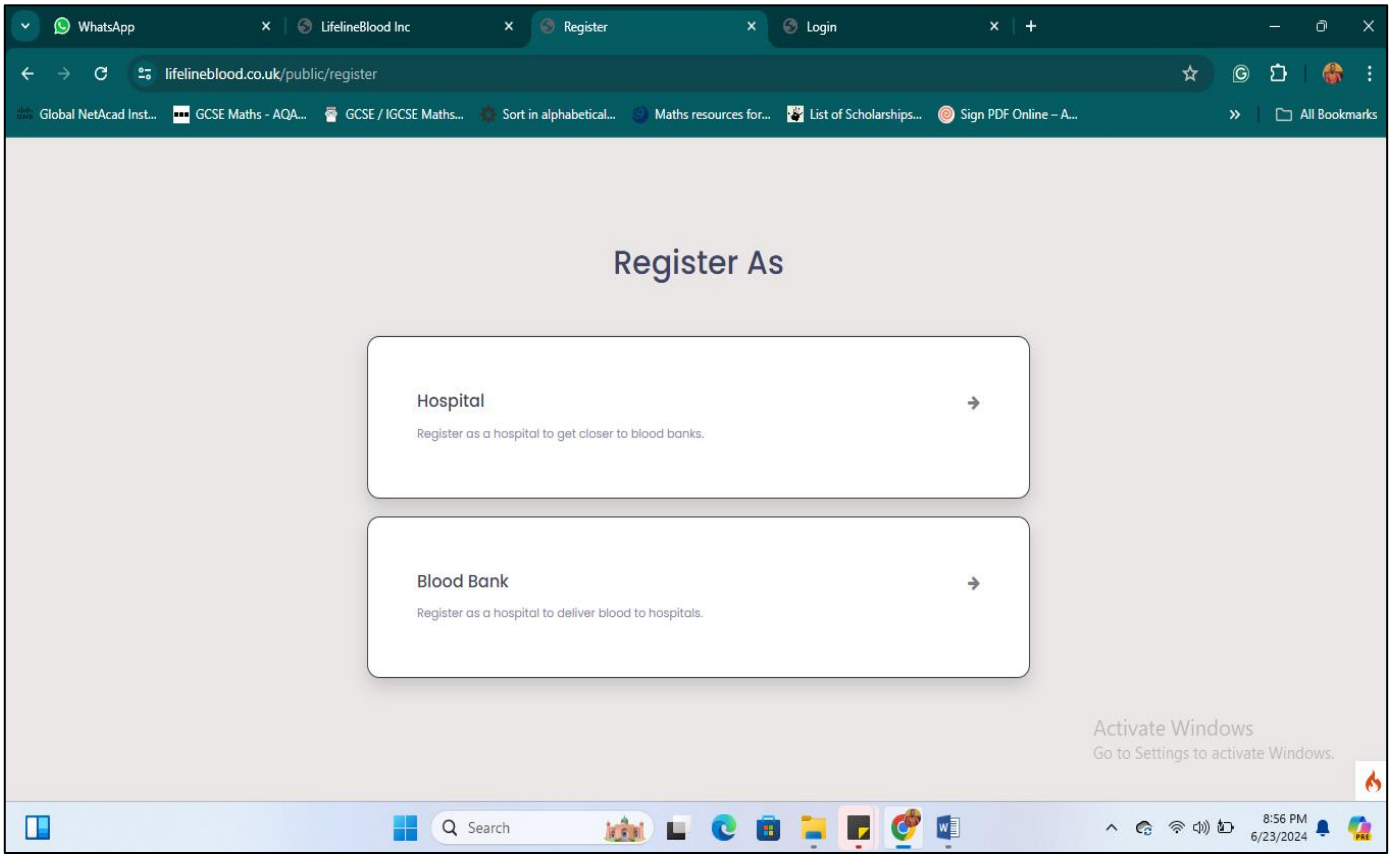

Fig 2: First Dashboard Showing to Select Whether to Register as a Hospital or Blood Bank

After the user clicks on the Hospital button, it takes the user to the hospital registration pages (Figure 3), where users are expected to fill in the details and click the signup button.

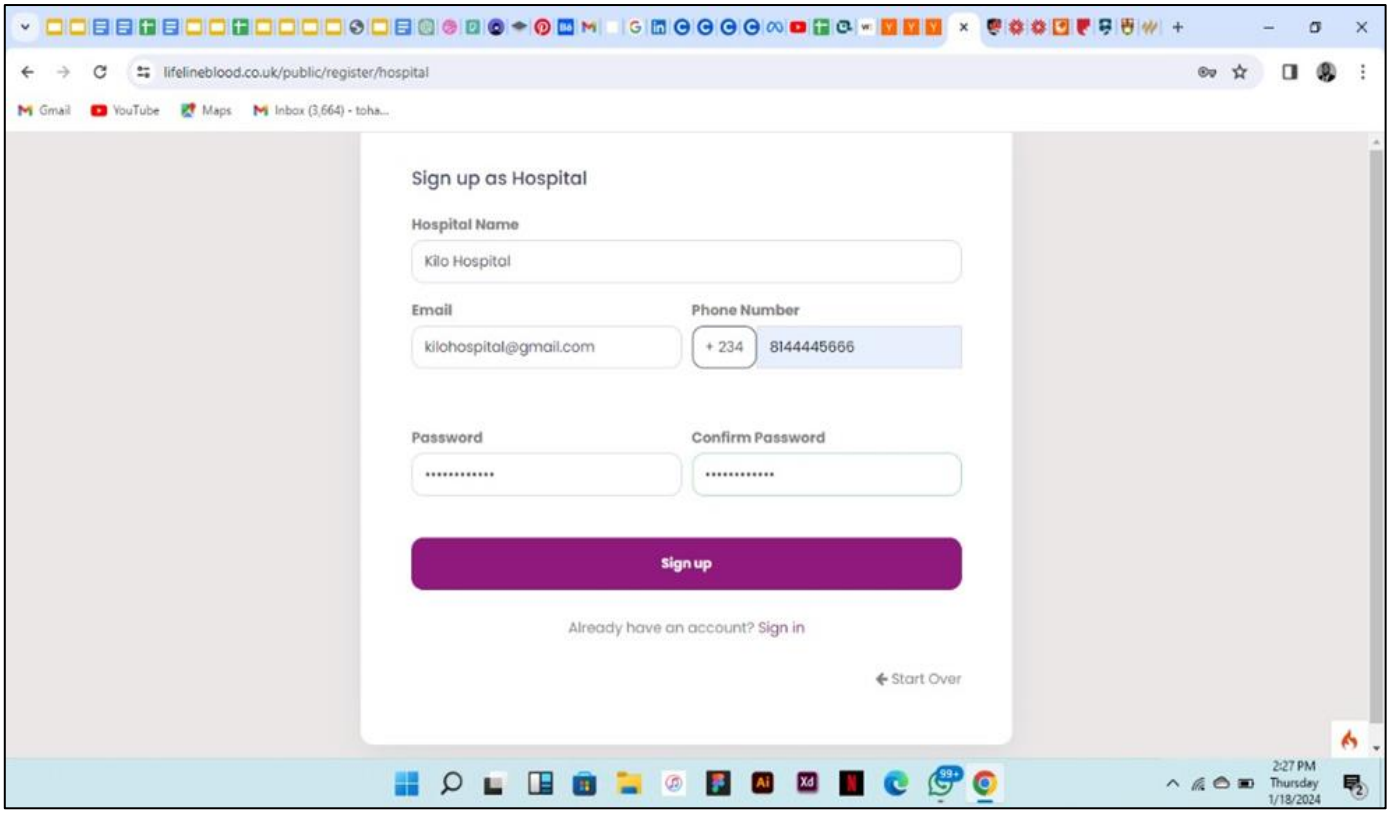

Fig 3: Hospital Sign-in Page

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➢ *Hospital Login Page*

The user should be asked for their password and email address to log in to the hospital login page (Figure 4). For the user to be granted access, these two pieces of information must match a matching record in the database. An error message stating incorrect login information is shown when the credentials do not match. Following login, a cookie is shown for the user in their browser, and a session is created for them that is momentarily held in memory. Because of the cookie, the user won't require further authentication to access private pages.

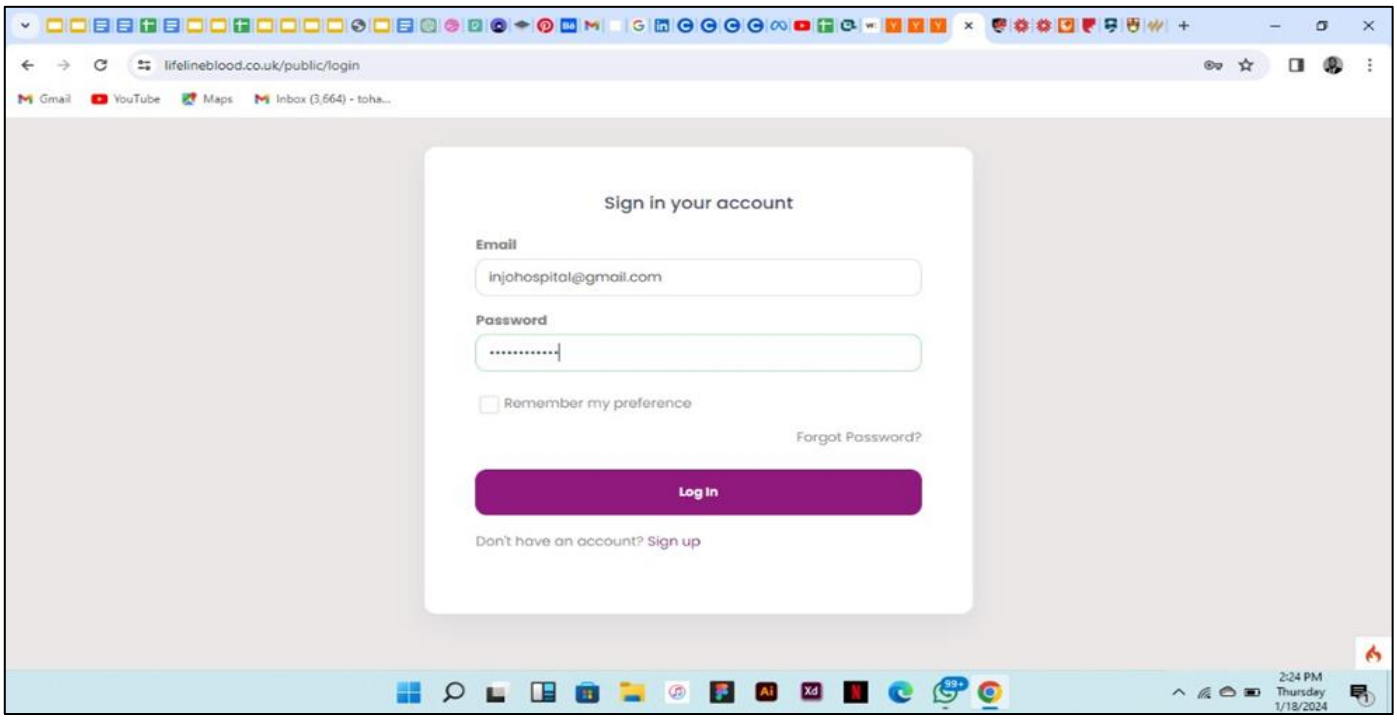

Fig 4: Hospital Login Page

➢ *Hospital Dashboard*

When the user logs in as a hospital, the hospital page contains the dashboard (Figure 5), requests and settings, and other information. The user is meant to update the profile before proceeding and filling in all required details, then click the update profile button after completion.

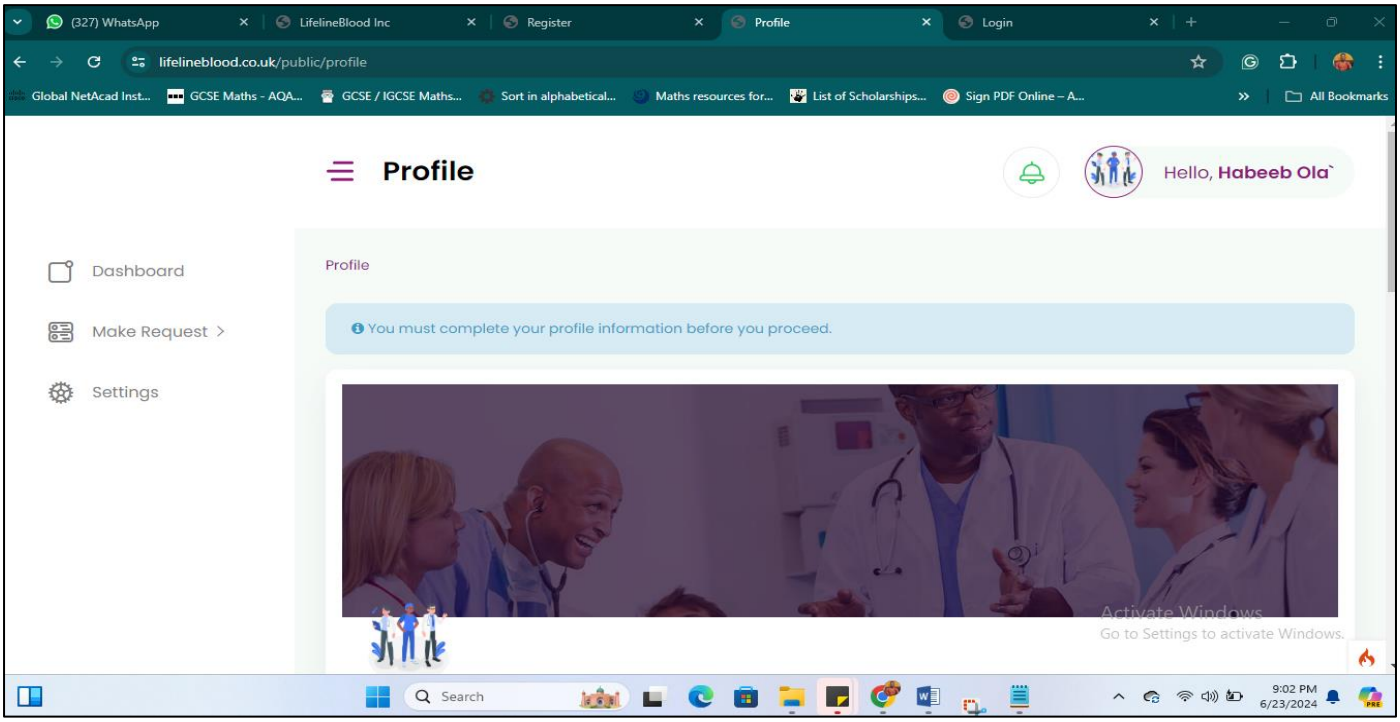

Fig 5: Hospital Dashboard after Logging in Showing all Details and Button

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The user can update their profile by going to the settings page (Figure 6) and filling out the box provided. All information filled in after clicking the update profile button is updated in the database.

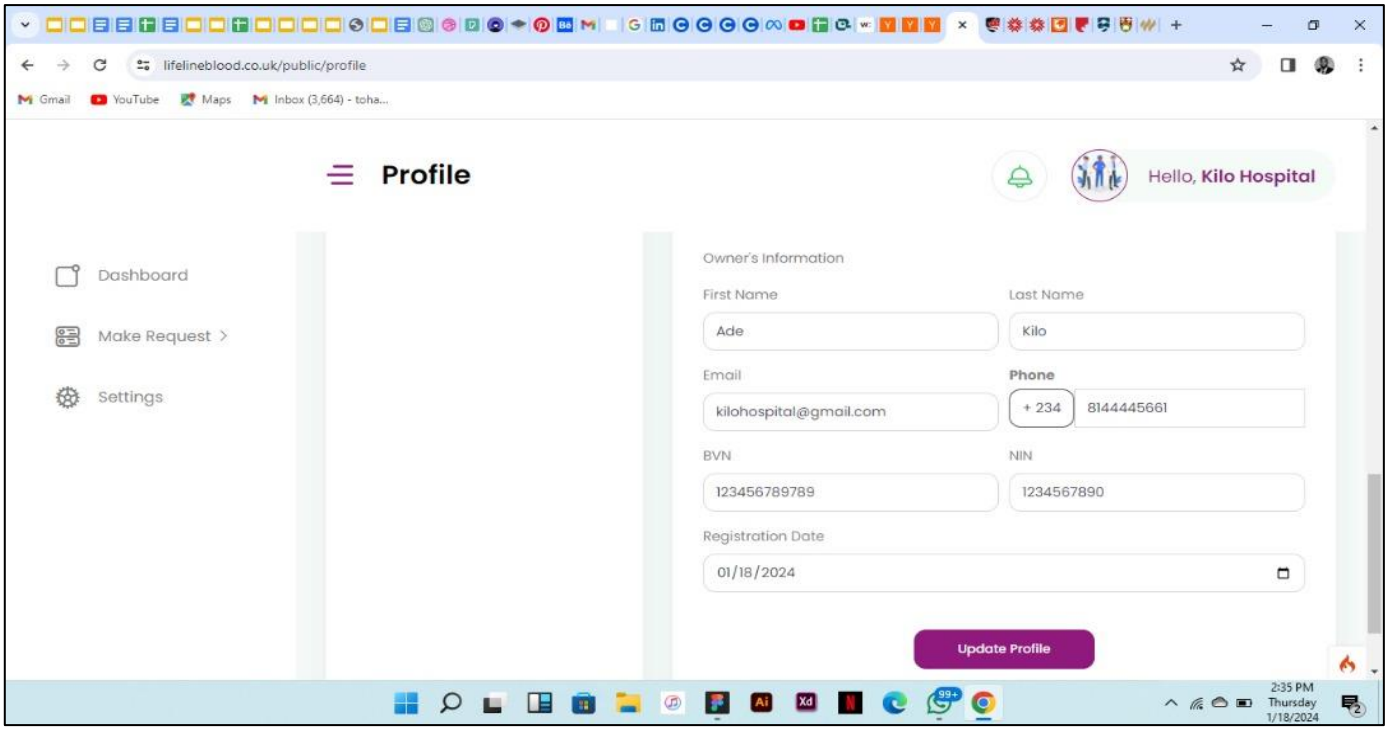

Fig 6: Page Showing How the User Updates the Profile

➢ *Hospital Blood Request Page*

With an easy-to-use form on the blood request page (Figure 7), hospitals can prepare and submit blood requests with all the necessary information, including blood type, quantity, and urgency. Blood banks can simultaneously see and reply to these requests, bringing in a thorough status update system to expedite correspondence. Users can see their request activities and check the status and available blood offers.

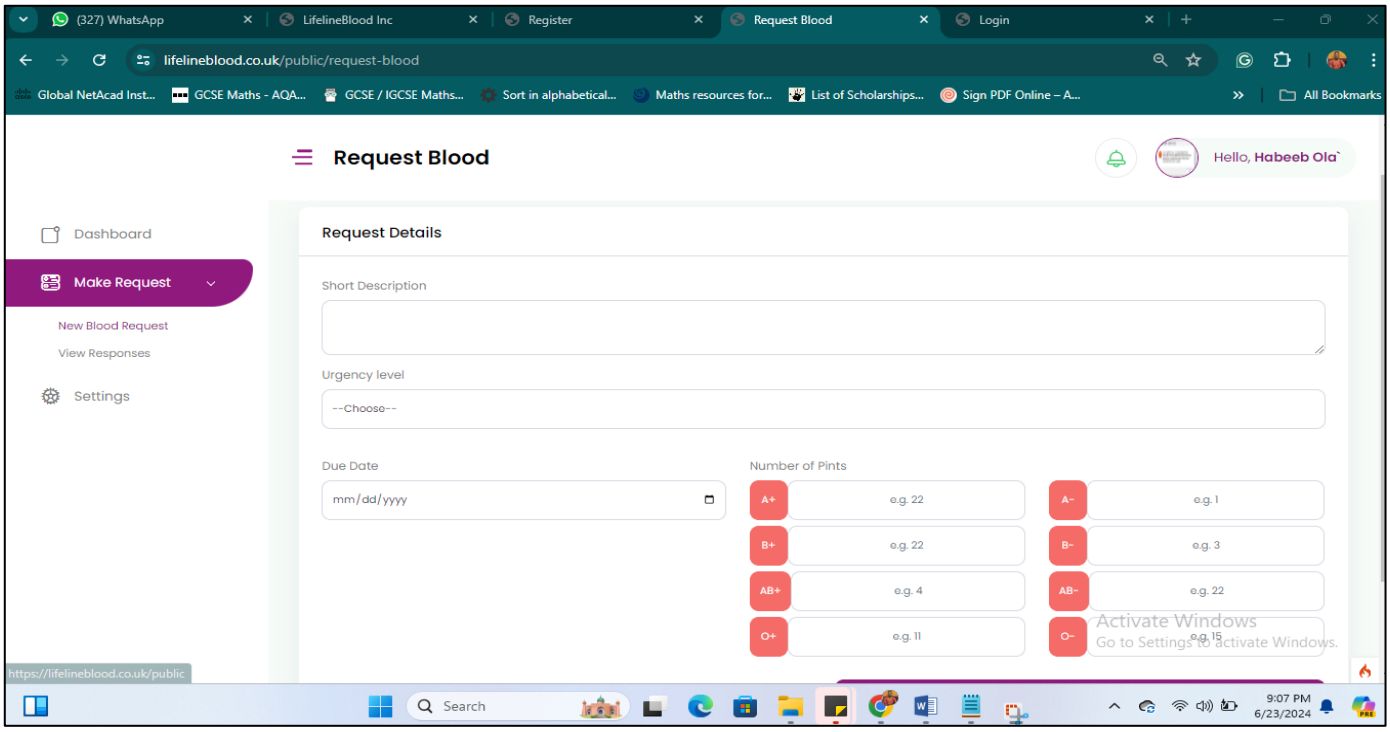

Fig 7: Hospital Blood Request Page

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This page (Figure 8) shows where hospital staff get responses from blood banks after making requests, and also a notification icon at the top to improve communication.

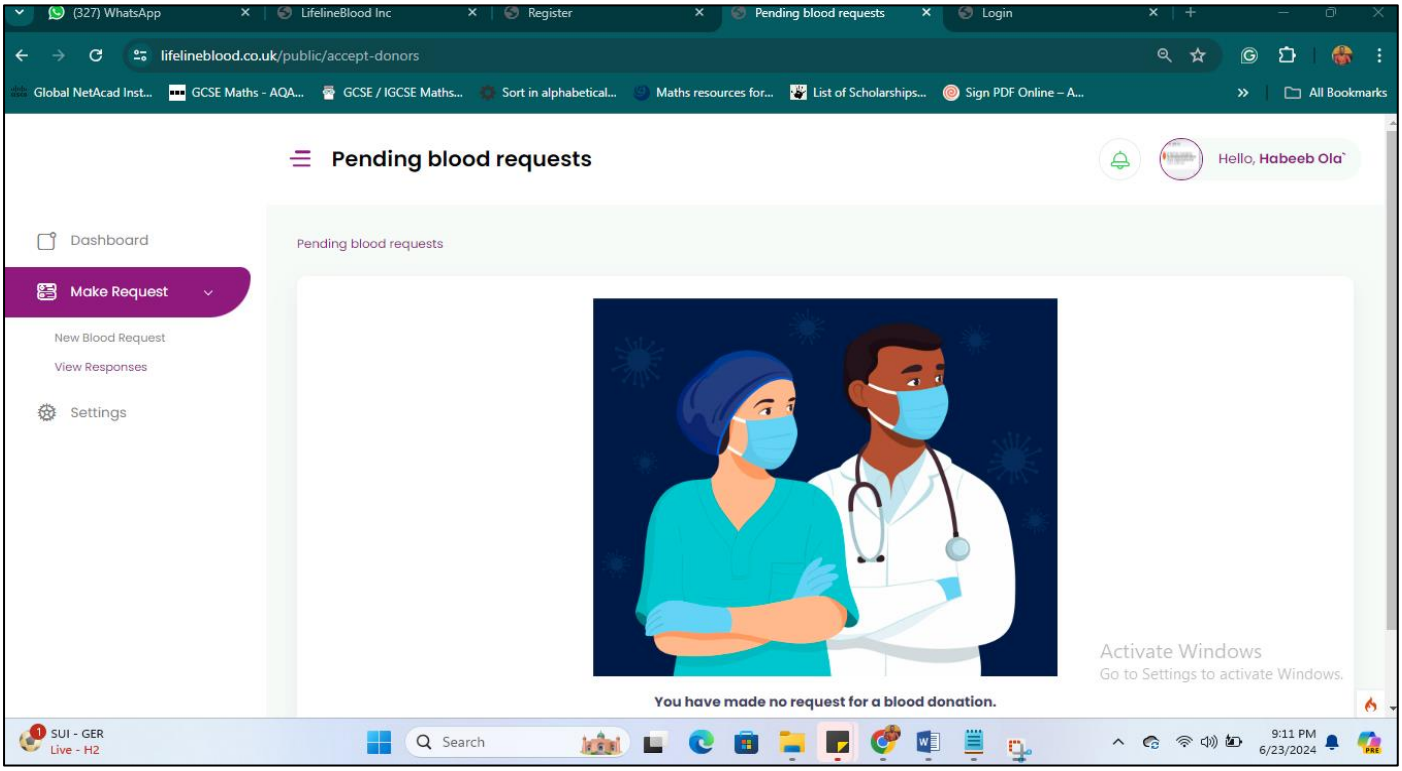

Fig 8: Response from Blood Bank Page Shown to Hospital Users

➢ *Blood Bank Dashboard*

After creating an account, just like hospital users, blood bank staff would be able to log in after a successful account creation. When the user logs in as a blood bank, the page contains the dashboard, blood requests, inventory, settings, and other information. The user can update their profile like the hospital user by going to the settings page and filling out the provided box. All information filled in after clicking the update profile button is updated in the database. The user fills in OTP and arrives at the dashboard (Figure 9).

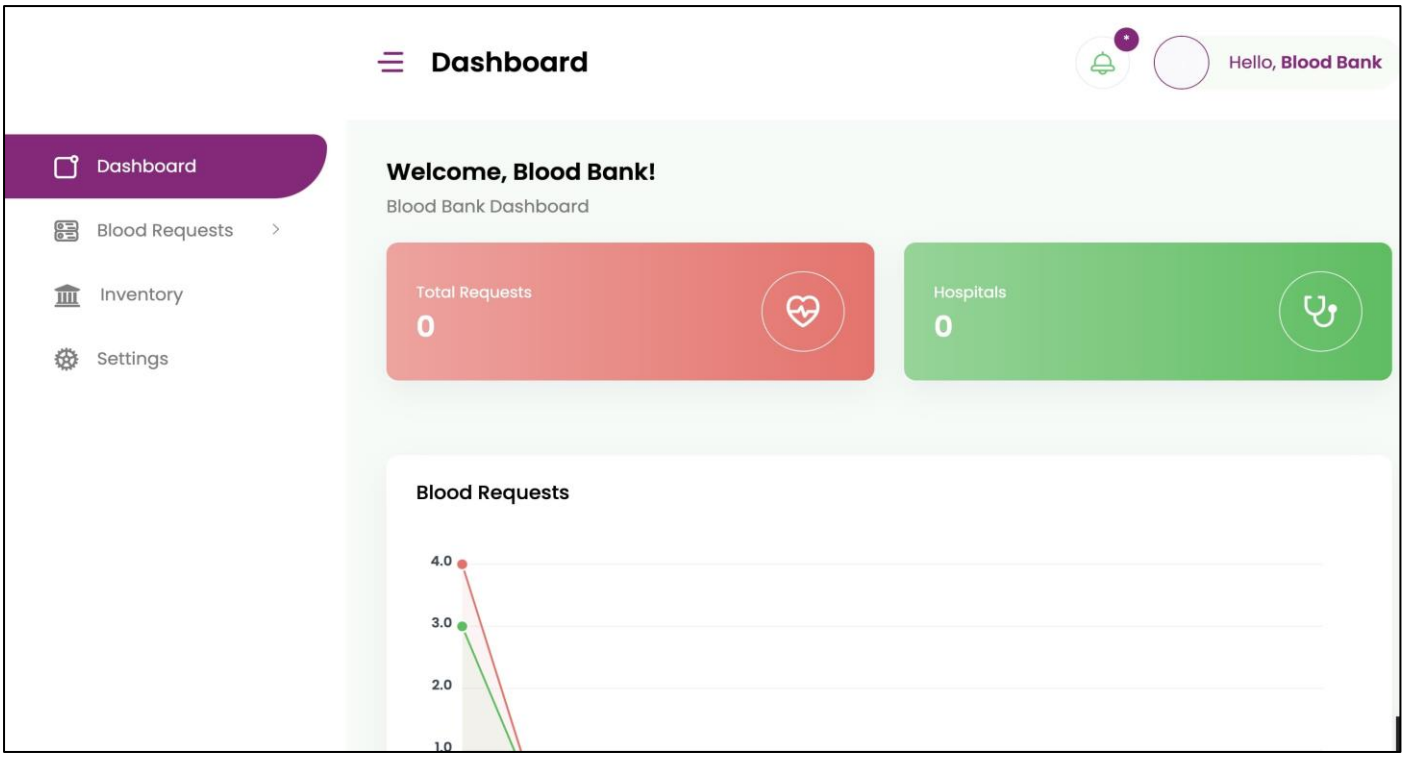

Fig 9: Blood Bank Dashboard

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Blood bank staff can see requests made by different hospitals from the dashboard interview and review activities on the blood bank dashboard (Figure 10, Figure 11), such as pending blood requests and inventory. As a result of this process, the request is made based on the availability of blood. User is also allowed to withdraw offers through the withdraw offer button. After completion of the process, a validation message appears on the dashboard.

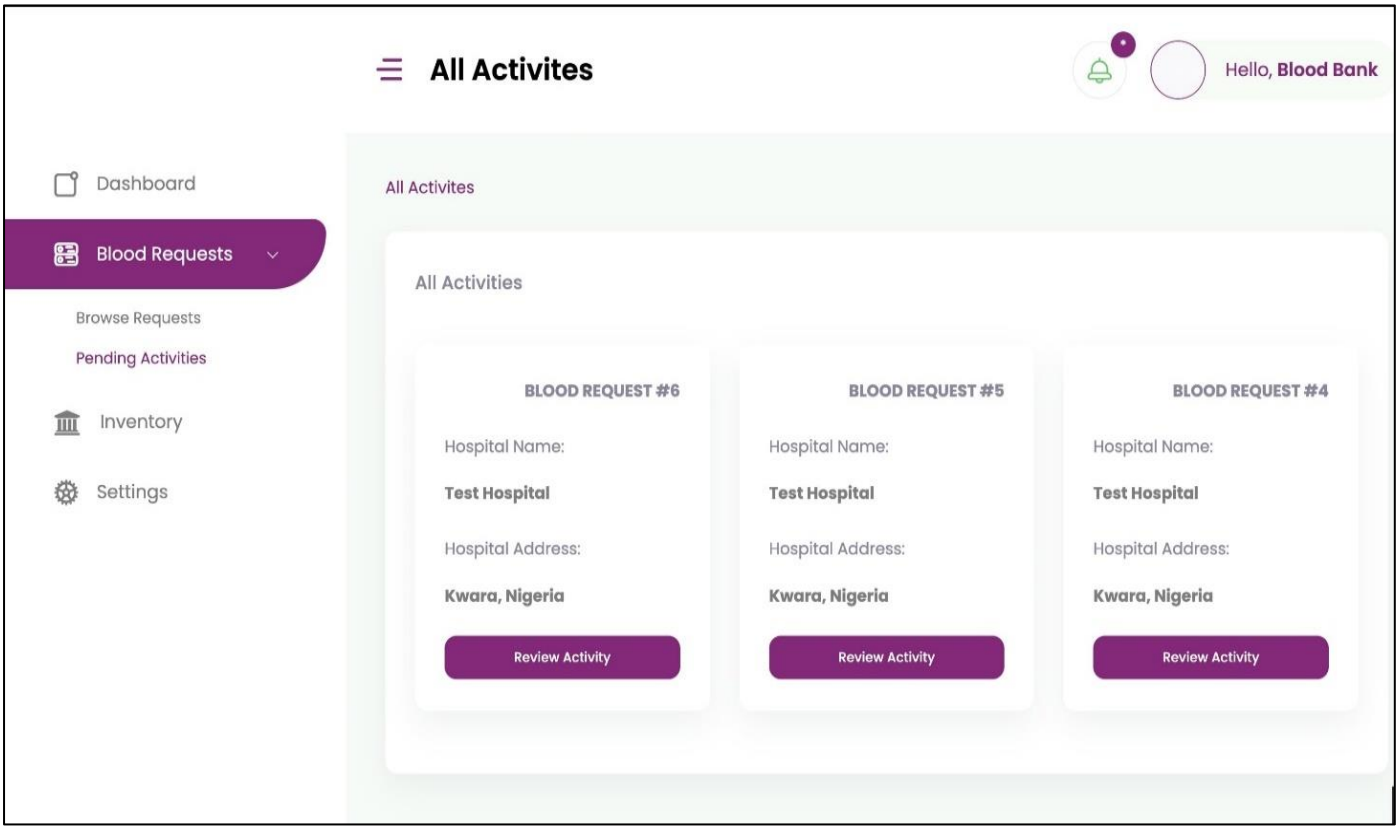

Fig 10: Blood Request Activities Pages for Blood Bank Staff

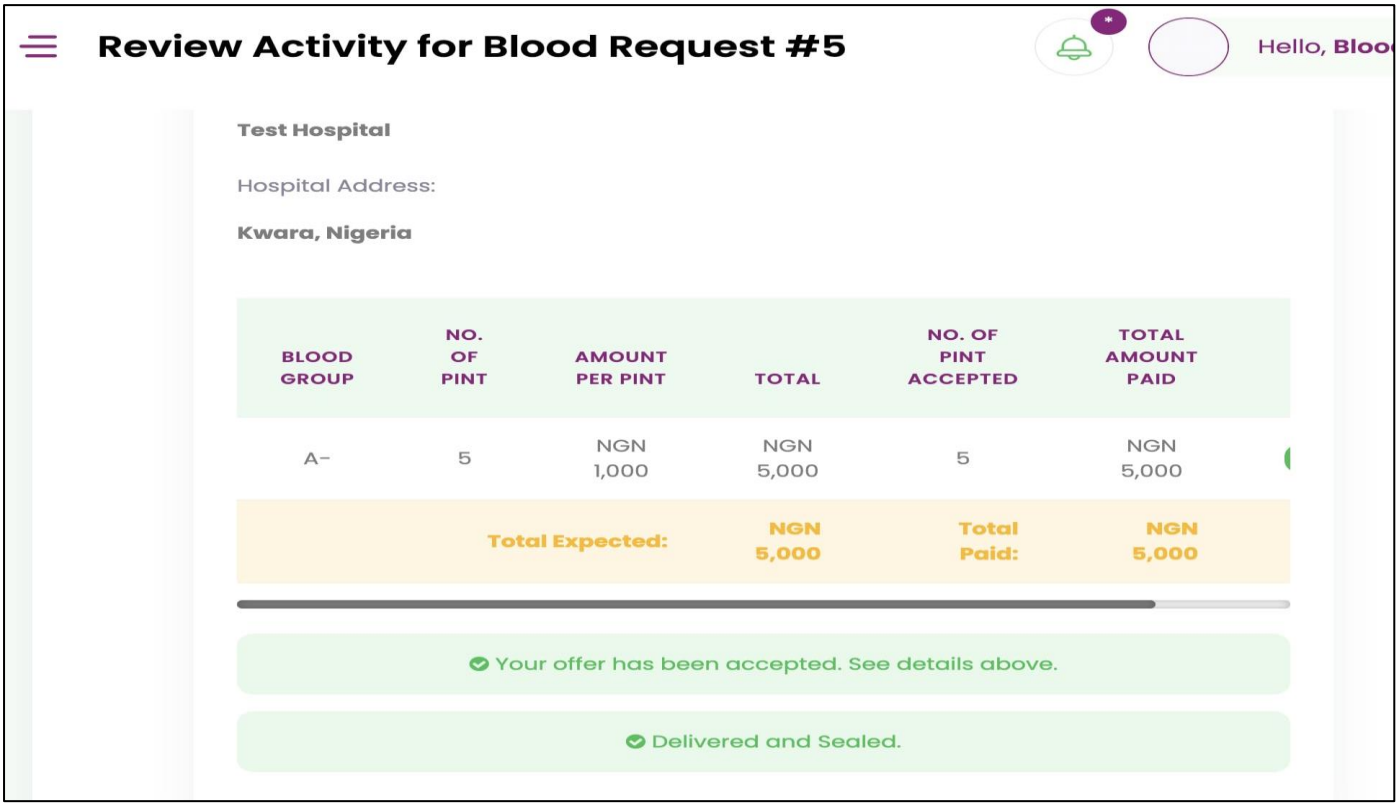

Fig 11: Review Activity for Blood Bank Showing Completion of the Request

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On the Bloodbank account dashboard (Figure 12), Blood Bank staff can set a rate for each blood type per pint, and the user clicks on save after setting rates.

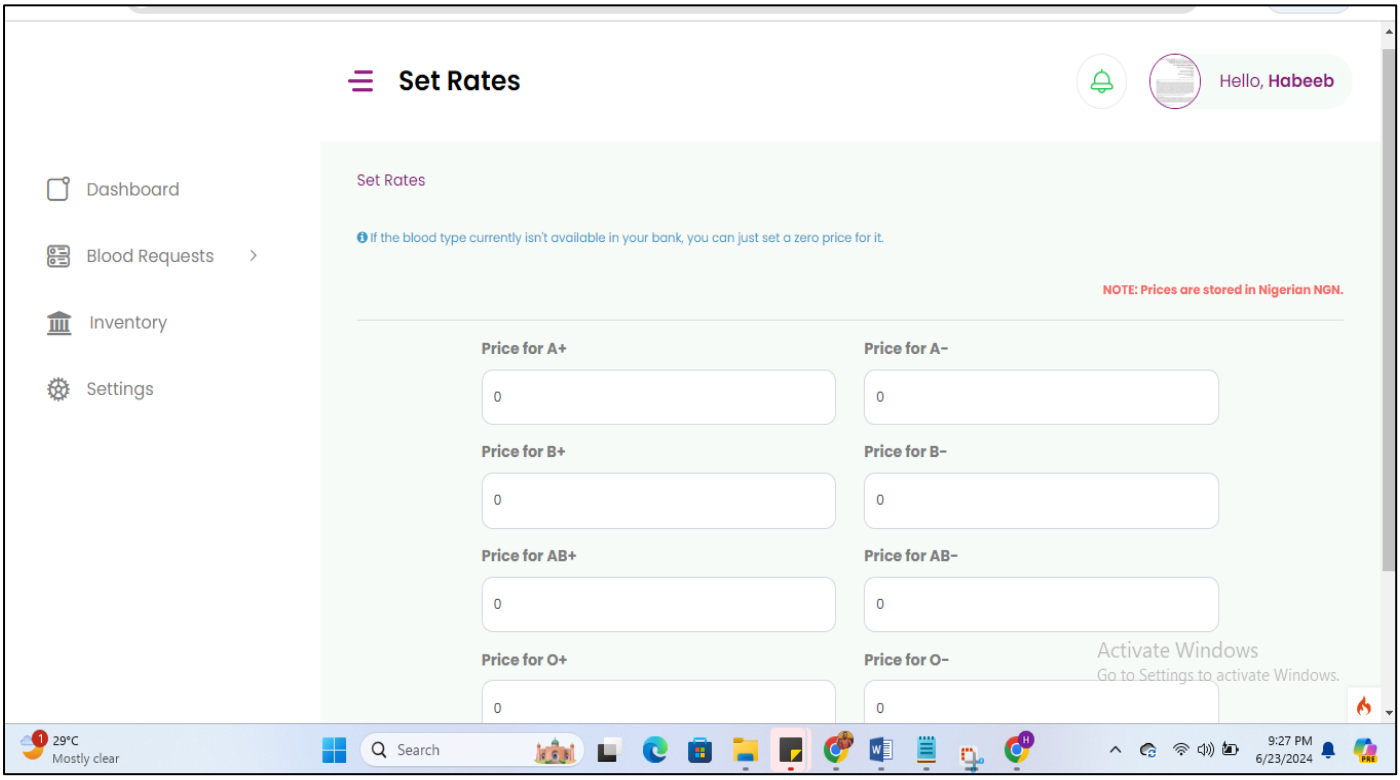

Fig 12: Page for Setting Rate for Blood Bank

The Inventory page (Figure 13) shows where the inventory of the available blood is, and staff can also check the history and add new blood.

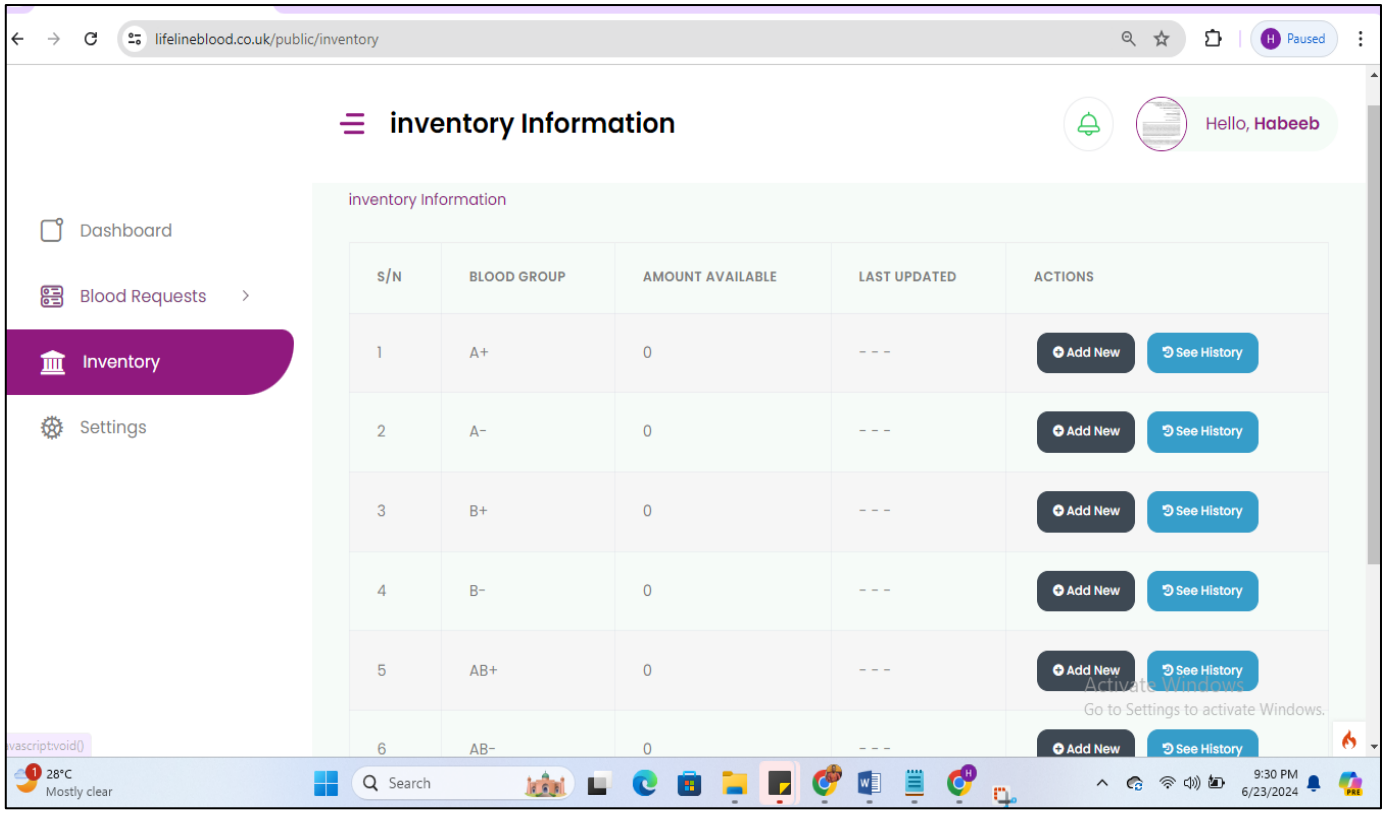

Fig 13: Page for Showing Blood Inventory

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➢ *Testing and Evaluation*

Table 8: Feature Testing of the Developed Web Application

	Requirement	Test Process	Expected Result	Result
1	A user should be able to register through the hospital signup page	Input individual details (name, email, phone, password, password confirmation) in the appropriate frontend form.	The data is collected through this form and saved in the database as a unique entry for each user.	Passed
2	A user should be able to log in through the hospital login page	Enter input details (email, password) on the login form.	After submitting, the user should be redirected to their unique dashboard.	Passed
3	A hospital user should be able to update their profile	Click on the settings page, fill out the provided box, and click the update profile button.	The information filled out is updated in the database.	Passed
4	A hospital user should be able to submit a blood request	Use the blood request form to input blood type, quantity, and urgency, then submit.	The blood request is submitted, and blood banks can view and reply to these requests with a status update.	Passed
5	A hospital user should be able to see request activities and status	Navigate to the request activities page.	The user can see their request activities, check their status, and view different available blood offers.	Passed
6	A user should be able to register through the blood bank signup page	Input individual details (name, email, phone, password, password confirmation) in the appropriate frontend form.	The data is collected through this form and saved in the database as a unique entry for each user.	Passed
7	A user should be able to login through the blood bank login page	Enter input details (email, password) on the login form.	After submitting, the user should be redirected to their unique dashboard.	Passed
8	A blood bank user should be able to update their profile	Click on the settings page, fill out the provided box, and click the update profile button.	The information filled out is updated in the database.	Passed
9	A blood bank user should be able to see and review blood requests	Navigate to the dashboard to see pending blood requests and inventory.	The user can review activities, process requests based on blood availability, and withdraw offers if needed.	Passed
10	A user should be able to logout	Click on the logout button.	The session is terminated, and the user is redirected to the login page.	Passed
11	A user should receive an error message for invalid login details	Enter the incorrect email or password on the login form.	An error message is displayed indicating incorrect login details.	Passed
12	A user should receive validation errors for incorrect signup details	Enter invalid data (e.g., symbols in name, mismatched passwords, invalid email) on the signup form.	Appropriate validation error messages are displayed.	Passed
13	A user should receive a confirmation email upon successful registration	Complete the registration form with valid details.	A confirmation email is sent to the user's email address.	Passed
14	A hospital user should be able to see blood request history	Navigate to the blood request history page.	The user can see a list of all past blood requests and their statuses.	Passed
15	A blood bank user should be able to update blood inventory	Navigate to the inventory page and update bloodstock information.	The blood inventory is updated in the database and reflected on the dashboard.	Passed

➢ *User Testing and Evaluation*

The system was evaluated by five professionals consisting of 3 blood bank staff, which accounts for 60% of the total respondents, and two health care staff, which accounts for 40%. Four respondents have more than 4 years' experience, which accounts for 80% of their profession, while the remaining 1, which accounts for 10%, has 2 years' experience.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

Table 9: Response based on Design and Layout Interface

Response based on design and layout interface	Frequency	Percent (%)
Good	3	60.0
Excellent	2	40.0
Total	5	100.0

Users were asked about the overall design and layout of the web application interface (Table 9). The majority (60%) said it was good, and others (40%) said it was excellent. This result shows that the interface and the layout are good, and users are satisfied.

Table 10: User Response based on Ability to Navigate the System Easily, Responsiveness, and Speed

Ability to navigate the system easily, responsiveness, and speed	Frequency	Percent (%)
Yes	4	80.0
No	1	20.0
Total	5	100.0

Users were asked about their ability to navigate the system easily, responsiveness, and speed. Most respondents (Table 10), which accounts for 80%, indicated that they can navigate the system easily, and speed and responsiveness are okay (Yes). A smaller percentage (20%) reported having difficulty (No). The result suggests that a significant portion of users reported the system navigation to be user-friendly and the responsiveness and speed to be great. However, a minority still faces challenges in this aspect.

Table 11: Managing Blood Bank Information

Managing Blood Bank Information	Frequency	Percent (%)
Yes	4	80.0
No	1	10.0
Total	5	100.0

Users were asked whether they found all the necessary features for managing blood bank information (Table 11). Most respondents (80%) answered "Yes," meaning they found all the necessary features. On the other hand, 20% of respondents answered "No," indicating that some users feel that essential features for managing blood bank information are missing or insufficient. In summary, while most users are satisfied with the available features, a percentage expresses a need for additional features and improvements in the system.

Table 12: Entering New & Retrieving Existing Blood Records

Entering new & retrieving Existing Blood Records	Frequency	Percent (%)
Yes	4	80.0
No	1	20.0
Total	5	100.0

Users evaluated how easy it was to enter new and retrieve existing blood records (Table 12). The results show that 80% of users found it easy (Yes), while 20% reported difficulty (No). The result indicates that most users have a positive experience with the system's functionality for entering new blood records and retrieving existing ones. Users were also asked about the challenges faced during data entry and retrieval, and none were identified.

Table 13: Level of Satisfaction with the Web Application

Level of Satisfaction with the Web Application	Frequency	Percent (%)
8	1	20.0
9	1	20.0
5	1	20.0
7	1	20.0
9	1	40.0
Total	5	100.0

Users were asked to rate their satisfaction with the blood bank management system (Table 13) on a scale of 1 to 10. The responses are as follows: 20% of users rated their satisfaction as 8, another 20% rated it as 7, and another 20% rated it as 5. Furthermore, 40% of users expressed high satisfaction, rating 9. Overall, these responses suggest a varied range of satisfaction levels, with a notable portion of users expressing relatively high satisfaction with the blood bank management system.

Table 14: Likelihood to Recommend the System to Others

Likelihood to recommend the system to others	Frequency	Percent (%)
Most likelihood	3	60.0
Very Likelihood	1	20.0
likelihood	1	20.0
Total	5	100.0

Users were asked about their likelihood to recommend the system to others, and the responses are as follows (Table 14). Most users (60%) expressed the "Most Likelihood" to recommend the system, indicating a strong positive endorsement. Additionally, 20% of users indicated "Very Likelihood" and "Likelihood" to suggest the system, contributing to an overall positive sentiment toward recommending the system to others. In summary, most users are inclined to recommend the system, highlighting a positive perception of its value and functionality.

In Conclusion, Users were invited to share additional thoughts on their experience with the blood bank management system. Feedback highlights a positive user experience with specific areas identified for improvement, such as system responsiveness, feature enhancement, and user-friendly navigation. The input is valuable in shaping future updates further to enhance the system's performance and user satisfaction.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

The paper represents a significant step toward improving blood transfusion services in Nigeria. While challenges remain, the potential for a positive impact on patient care is evident. When compared with the work of Hummad Y. (2022)[9] On a mobile application for blood donation during COVID-19 and the limitation of Sathish et al. (2023) web-based blood donors and blood bank tracking system, the proposed web-based platform has the potential to significantly improve the efficiency, accessibility, and quality of blood transfusion services in Nigeria by strengthening collaboration between blood banks and hospitals, to enhance quality patient outcomes.

This paper encountered several challenges, including data privacy concerns, technical hurdles, and limited resources. These issues were addressed but underscore the complexities of implementing technology in healthcare. While significant progress has been made, it is essential to acknowledge the limitations of this work. One notable limitation is the prototype's scalability and the need for additional resources to implement it across a broader healthcare network.

V. CONCLUSION

This research focused on Improving Blood Transfusion Services for Better Patient Care by Linking Blood Banks and Hospitals in Nigeria using Web Technologies, and it has been an informative discovery of the connection between the health sector and emerging technology. This paper aimed to enhance patient care by creating a meeting point between hospitals requesting blood and blood banks with the custody of blood available for dispatch using web applications. The literature reviews a wide range of cutting-edge transfusion and blood bank technologies, each providing a special solution to problems with blood management and healthcare. Technological innovations and easy-to-navigate user interfaces show how blood transfusion procedures are changing.

The system was tested and successfully passed both the unit and user testing, which means it has enhanced the efficiency of blood supply and ensures more privacy while bridging the communication gap between blood banks and hospitals. User evaluation was conducted to measure the satisfaction of healthcare professionals and blood bank staff with all the application features. Most user feedback was positive, showing that the application's performance was well received. They also commended the application's improved communication and data management. However, a few people raised concerns about how to navigate the application easily. Also, there is a need for additional features and resources to implement it across a more extensive healthcare network. Future researchers should optimize the application's performance and features by bringing the blood donors dashboard to the systems and ensuring compliance with healthcare standards and regulations. Finally, integrating emerging technologies like Blockchain for enhanced system security in blood transfusion services should be considered for further research. They can also explore the impact of such technological improvements on patient outcomes and healthcare efficiency.

AUTHOR CONTRIBUTIONS

All authors contributed equally to the study's conception and design. Material preparation, data collection and analysis were performed by Habeeb Oladimeji Oladipupo and Boluwatife Esther Folorunso. The supervision was done by Pwadubashiyi Coston Pwavodi. The writing and draft of the manuscript were written and reviewed by Pwadubashiyi Coston Pwavodi, Habeeb Oladimeji Oladipupo and Boluwatife Esther Folorunso.

- **Funding:** There is no funding related to this work.
- **Data availability:** The data and code supporting this study's findings are openly available upon request from the corresponding author.

➢ *Declarations:*

- Conflict of Interest: The authors declare that there are no Conflict of interest to this work.
- Consent to participate: The need for informed consent was received from the participants before the data were obtained.

REFERENCES

[1]. Abubakar, N., Mbosso, E., Okonofua, E., & Uchenna, I. (2022). Enhancing blood transfusion services in Nigeria: A case study. Journal of Health Informatics in Developing Countries, 16(3), 1-10.

[2]. Aneke, J. C., & Okocha, C. E. (2017). Blood transfusion safety; current status and challenges in Nigeria. Asian Journal of Transfusion Science, 11(1), 1-5. https://doi.org/10.4103/0973-6247.200781

[3]. Asamoah-Akuoko, L., Hassall, O. W., Bates, I., & Ullum, H. (2017). Blood donors' perceptions, motivators, and deterrents in Sub-Saharan Africa - A scoping review of evidence. British Journal of Haematology, 177(6), 864-877. https://doi.org/10.1111/bjh.14662

[4]. Awasthi, A., & Sharma, A. K. (2022). Advanced blood management system community method based on deep learning. In Proceedings of the 2022 IEEE 11th International Conference on System Modeling & Advancement in Research Trends (SMART) (pp. 16-17). IEEE. https://doi.org/10.1109/SMART55829.2022.9756643

[5]. Barnes, L. S., Stanley, J., Bloch, E. M., Pagano, M. B., Ipe, T. S., Eichbaum, Q., Wendel, S., Indrikovs, A., Cai, W., & Delaney, M. (2022). Status of hospital-based blood transfusion services in low-income and middle-income countries: A cross-sectional international survey. BMJ Open, 12(2), e055017. https://doi.org/10.1136/bmjopen-2021-055017.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14603615

[6]. Elakya, R., Dhanam, M., Hemnaath, B., Dhanalakshmi, R., Gayathri, M., & Begum, H. (2022). Blood donor management system - An android-based model and implementation. In Proceedings of the 2022 Third International Conference on Intelligent Computing, Instrumentation and Control Technologies (ICICICT). IEEE. https://doi.org/10.1109/ICICICT.2022.9956614

[7]. Gammon, K. (2021). Blood banks and transfusion services in Nigeria: An overview. Transfusion Medicine Reviews, 35(1), 1-5.

[8]. Hummady, M. M. (2022). Design mobile application for blood donation system. In Proceedings of the 2022 International Conference on Computer and Applications (ICCA) (pp. 978-1-6654-5294-6). IEEE. https://doi.org/10.1109/ICCA56443.2022.10039544

[9]. Kaushik V, Walsh CA. Pragmatism as a research paradigm and its implications for social work research. Social Sciences. 2019;8(9):255. doi:10.3390/socsci8090255

[10]. Kaur, J., Gupta, A., Tripathi, A., Gupta, A. K., & Srivastava, A. (2023). RaktFlow - Blood bank management and donation system. In Proceedings of the 2022 OPJU International Technology Conference on Emerging Technologies for Sustainable Development (OTCON) (pp. 978-1-6654-9294-2/23/$31.00). IEEE. https://doi.org/10.1109/OTCON56053.2023.10113983

[11]. Roberts, N., James, S., Delaney, M., et al. (2019). The global need and availability of blood products: A modeling study. Lancet Haematology, 6, e606–e615. https://doi.org/10.1016/S2352-3026(19)30200-5

[12]. Solomon, O. P., Oluwafemi, A. D., Busari, O. B., Ogundeji, O. A., Adepoju, O. A., & Esan, F. G. J. (2021). Knowledge, attitude, and perception towards voluntary blood donation among university students in Nigeria. ISBT Science Series, 16, 85-91. https://doi.org/10.1111/voxs.12614

[13]. Vijay, S., & Hashmi, M. (2019). Blood bank management based on chipless RFID. In Proceedings of the 8th Asia-Pacific Conference on Antennas and Propagation (APCAP 2019), August 4–7, 2019, Incheon, Korea. IEEE. https://doi.org/10.23919/APCAP.2019.8870255

[14]. Waja, G., Shah, J., & Nanavati, P. (2021). Agile software development. International Journal of Engineering Applied Sciences and Technology, 5(12), 73–78. http://www.ijeast.com

[15]. World Health Organization. (2019). World Health Organization model list of essential medicines. In Mental and holistic health: Some international perspectives (pp. 119–134).