International Journal of Scientific Research and Engineering Development-– Volume 9 Issue 2, Mar-Apr 2026
Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

A Real Time Blood Availability and Donor Management System

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Abstract:

The increasing need for immediate access to blood during emergencies underscores the importance of having an effective and dependable blood management system. This paper introduces a Real-Time Blood Availability and Donor Management System that is designed to make the processes of blood donation, storage, and distribution more efficient. The system features a centralized database that keeps accurate records of blood donors, blood banks, and the availability of blood units in various locations. It allows for real-time monitoring of blood stock and helps in quickly identifying compatible donors based on factors such as blood group, location, and availability.

The system includes easy-to-use interfaces for donors, hospitals, and blood banks, facilitating smooth registration, request processing, and communication.
It uses automated notifications and alerts to keep donors informed about urgent needs and future donation chances. The system also improves transparency and cuts down on delays by reducing reliance on manual procedures and enhancing collaboration between different stakeholders.

By utilizing modern web and mobile technologies, this system seeks to boost the efficiency, accessibility, and speed of blood donation services.
In the end, it plays a key role in saving lives by making sure that essential blood supplies are available exactly when and where they are needed

Keywords — Blood Bank Information System ,Healthcare Information Systems , Emergency Blood Supply , Database Management Systems , Web-Based Application.

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I. INTRODUCTION

Blood is an essential resource for sustaining human life, and its timely availability is often crucial in medical emergencies. Although medical science has advanced significantly, there is currently no alternative to human blood. As a result, the efficient handling of blood donation, storage, and distribution is vital for any healthcare system. "LifeFlow" is a comprehensive Blood Bank Management System intended to connect blood donors, hospitals, and blood banks. It is a dual-platform solution with a Web Application tailored for organizations such as hospitals, blood banks, and administrators, and a Mobile Application designed for donors. The system uses modern web technologies (MERN Stack) and mobile frameworks (React Native) to ensure real-time data accessibility
LifeFlow aims to modernize traditional manual procedures involved in managing blood inventory, registering donors, and handling emergency blood requests, establishing a centralized network that saves time and lives.
The existing manual or semi-automated blood management systems face several important challenges:
* Lack of Real-time Information: During emergencies, hospitals often struggle to identify the nearest blood bank with the required blood group in stock. This delay can be life-threatening.

* Communication Gap: There is no direct way to inform potential donors about urgent blood needs. Appeals on social media are often unstructured and unreliable.

* Inventory Mismanagement: Manual record-keeping leads to errors such as expired blood units being overlooked or stock discrepancies occurring.

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* Donor Inconvenience: Donors often lack information about nearby donation centers or events, resulting in lower voluntary donation rates

LifeFlow tackles these issues by automating and integrating the entire blood supply chain.

* For Hospitals: A dedicated dashboard to submit "Emergency Blood Requests" that quickly alerts relevant donors.

* For Blood Banks: A digital inventory system to monitor blood units, expiry dates, and manage donation camps.

* For Donors: A GPS-enabled mobile app that helps users find nearby blood centers, see upcoming donation events, and book appointments.

* For Admins: A centralized control panel to oversee system activity and verify users to prevent fraudulent activities.

By offering a unified platform, LifeFlow ensures that the correct blood reaches the right patient at the right time.

The main goals of the LifeFlow project are:

* To create a centralized database of donors, hospitals, and blood banks for quick data retrieval.

* To implement a real-time mapping system (Google Maps) that assists donors in finding the nearest blood banks and hospitals.

* To simplify the blood request process by allowing hospitals to raise digital requests that are immediately visible to donors and blood banks.

To manage blood inventory effectively by tracking the quantity and expiration date of blood units to minimize waste.

* To encourage voluntary blood donation by making it easier for people to book appointments and view upcoming donation events.

* To promote voluntary blood donation by simplifying the appointment booking process and displaying upcoming donation camps.

The scope of LifeFlow includes various stakeholders in the healthcare system:

* Administrators: Responsible for verifying organizations and maintaining the system's integrity.

* Hospitals: Can search for needed blood, request supplies during emergencies, and track the status of their requests.

* Blood Banks: Can manage their inventory, organize donation camps, and update stock levels.

* Donors: The general public who can register, check their eligibility, locate centers, and keep a digital record of their donations.

Although the current version is designed for city-wide implementation, the system's scalable architecture allows for expansion to the state or national level in the future..

II. LITERATURE REVIEW

Blood donation and management have been critical areas of healthcare for decades. Over the years, several systems have been developed to manage blood inventories and donor databases. These can be broadly categorized into three types:

1) Manual Record-Keeping Systems:

In many local hospitals and smaller blood banks, records are still maintained manually using registers and spreadsheets. Staff members manually update stock levels, donor details, and expiry dates. When a request for blood arises, staff must physically check the ledger or make phone calls to other centers to locate the required blood group.

2) Static Directory Websites:

Several web-based platforms exist that act as directories. They provide a list of donors with their contact numbers and locations. Examples include simple government portals or NGO-run websites. These platforms essentially function as a "phonebook" for blood donors but lack interactive features.

3) Organization-Specific Apps (e.g., Red Cross App):

Larger organizations like the Red Cross have their own mobile applications. These apps allow donors to schedule appointments and view their donation history. However, they are often limited to the specific ecosystem of that organization and do not aggregate data from multiple private hospitals or independent blood banks.

Despite the existence of these systems, significant gaps remain in the efficient management of blood supply chains:

4) Lack of Real-Time Data: Manual systems and static directories do not reflect the current availability of blood. A directory might list a donor who is currently ineligible or a blood bank that has just run out of stock, leading to wasted time during emergencies.

5)Geographical Disconnect: Most existing platforms do not utilize geolocation services effectively. In an emergency, a user needs to find the nearest available facility or donor. Text-based lists require users to manually filter addresses, which is slow and inefficient.

6)Absence of Emergency Alerts: Traditional systems rely on passive communication (waiting for a donor to check a website). They lack a "push" mechanism to actively notify eligible donors when a critical need arises in their vicinity.

III. PROBLEM STATEMENT

The availability of blood in emergency situations remains a critical challenge in healthcare systems. Traditional blood bank management methods are often manual, fragmented, and lack

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real-time coordination, leading to delays in locating and supplying the required blood. Patients and hospitals frequently struggle to find compatible donors quickly, especially during emergencies, accidents, or rare blood group requirements.

Existing systems do not provide a centralized platform to track blood inventory across multiple blood banks or to connect donors and recipients efficiently. Additionally, there is limited awareness among donors regarding urgent blood requirements, resulting in underutilization of potential donors. Communication gaps, outdated records, and lack of real-time updates further complicate the process.
Therefore, there is a need for a robust, real-time blood availability and donor management system that can efficiently manage donor information, track blood inventory, and facilitate quick and reliable communication between donors, blood banks, and recipients. Such a system should aim to reduce response time, improve accessibility, and ensure timely availability of blood to save lives.

IV. METHODOLOGY

System Development Life Cycle (SDLC). The development of the LifeFlow system followed the Agile Software Development Methodology. This iterative approach was chosen to allow continuous refinement of features based on testing and feedback. The project was divided into systematic phases: Requirements Elicitation, System Design, Implementation (Coding), Integration, Testing, and Deployment.

Agile allowed the parallel development of the web backend and the mobile frontend, ensuring the API endpoints were consumed and tested in real-time.
System Architecture and Design Methodology
LifeFlow employs a sophisticated Service-Oriented Architecture (SOA) based on the Client-Server model.

1)The Client Layer: This is bifurcated into a React.js web application tailored for desktop environments (used by administrative staff in hospitals and blood banks) and a React Native mobile application designed for touch-interfaces (used by donors).

2)The API Layer: An Express.js and Node.js backend serves as the central nervous system. It processes all incoming HTTP RESTful requests, enforces business logic (e.g., verifying if a donor is eligible based on their last donation date), and handles data routing.

3)The Data Layer: MySQL was chosen over NoSQL alternatives due to the highly relational nature of healthcare data. The Prisma Object-Relational Mapper (ORM) was utilized to provide type-safe database queries, ensuring strict data integrity between linked entities like Users, Appointments, and Blood Requests.

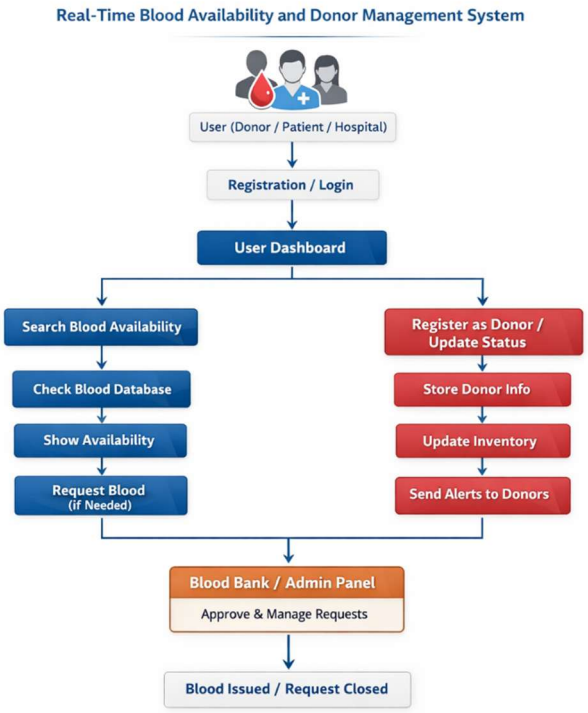

Fig. system flow chart

V. RESULT AND DISCUSSION

The implementation of the *Real-Time Blood Availability and Donor Management System* demonstrates significant improvements over traditional blood management approaches. The system was tested with multiple user roles, including donors, patients, and blood bank administrators, to evaluate its efficiency, usability, and responsiveness.

The results show that the system successfully provides real-time access to blood availability across different blood banks. Users were able to search for required blood groups quickly, reducing the time required to locate compatible blood units. The donor management module effectively maintained updated records of donors, including their availability status and location, which improved the accuracy of donor matching.

The automated notification feature played a crucial role in enhancing communication. Donors received instant alerts during emergencies, increasing participation and reducing delays in critical situations. Additionally, the centralized database minimized data redundancy and ensured better coordination among blood banks and healthcare institutions.

From a performance perspective, the system handled multiple requests efficiently with minimal response time. The user-friendly interface made it easy for non-technical users to

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navigate and perform actions such as registration, searching, and requesting blood.

However, certain challenges were identified. The system's effectiveness depends on regular updates from donors and blood banks. Limited internet access in rural areas and lack of user awareness may affect its adoption. Future improvements can include mobile application integration, GPS-based donor tracking, and enhanced security features for data protection.

Overall, the proposed system proves to be a reliable and efficient solution for improving blood availability and donor management. It has the potential to save lives by ensuring timely access to critical blood resources and strengthening the healthcare support system.

VI . CONCLUSION

The "LifeFlow" Blood Bank Management System was developed with the primary objective of bridging the critical gap between blood donors, hospitals, and blood banks. In the current healthcare landscape, the delay in procuring blood during emergencies often leads to fatal consequences. LifeFlow addresses this issue by digitizing the entire blood supply chain, making information accessible in real-time.

Through the successful implementation of a Web Application for hospitals and a Mobile Application for donors, the project has achieved the following milestones:

1) Centralized Information: We successfully created a unified database where donor details, blood inventory levels, and hospital requests are stored and retrieved instantly. This eliminates the need for manual record-keeping and phone-based searching.

2) Geolocation Integration: The integration of Google Maps API proved to be a game-changer. Donors can now visually locate the nearest blood banks and hospitals, significantly reducing the time taken to reach a donation center.

3)Efficient Inventory Management: The system allows blood banks to track stock levels and expiry dates digitally. This feature helps in reducing the wastage of blood units, which is a major concern in traditional systems.

4) Streamlined Appointments: The digital appointment booking system brings order to the donation process, preventing overcrowding at blood banks and providing convenience to voluntary donors.

In conclusion, LifeFlow is not just a software application but a life-saving tool. By leveraging modern technologies like the MERN Stack and React Native, the system ensures scalability, security, and cross-platform accessibility. It successfully demonstrates how technology can be used to solve real-world healthcare challenges.

VII. FUTURE SCOPE

The modular architecture of LifeFlow allows for significant expansion. The following features are proposed for future development to make the system more robust and intelligent:

1) AI-Driven Demand Prediction:

By integrating Machine Learning (ML) algorithms, the system could analyze historical data to predict blood shortages before they happen. For example, predicting higher demand for specific blood groups during dengue season or festivals and alerting blood banks to stock up in advance.

2)Chatbot Integration:

An AI-powered Chatbot can be integrated into the mobile app to answer donor queries instantly (e.g., "Am I eligible to donate if I took antibiotics yesterday?"). This would reduce the workload on hospital support staff.

3)Blockchain for Transparency:

To prevent the black marketing of blood units, Blockchain technology could be implemented. This would create an immutable ledger tracking every blood packet from the donor's arm to the patient's transfusion, ensuring complete transparency in the supply chain.

4)Social Gamification:

To encourage voluntary donations, a "Gamification" module can be added. Donors could earn digital badges (e.g., "Super Saver," "Hero Donor") and points for every donation, which could be redeemed for certificates or recognition on a leaderboard.

5) Live Blood Van Tracking:

Blood banks often deploy mobile donation vans. Integrating a live tracking feature would allow donors to see exactly where the donation van is currently parked in the city, increasing participation in mobile drives.

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