Bridging the Gap Between Donors and Recipients – A Unified Blood Donation System

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***Abstract*—Blood shortage remains a critical challenge in healthcare systems due to inefficient coordination between donors and hospitals. Existing blood supply chain models primarily focus on inventory optimization and logistics management, with limited integration of real-time donor engagement mechanisms. This paper proposes a Real-Time Unified Blood Donation System integrating hospital-based hardware interface, radius-based donor matching, and cloud-enabled notification framework. The system enables hospitals to trigger blood group requests through a dedicated interface. Registered donors within a specified geographic radius receive instant notifications via mobile application. Donor confirmation signals are transmitted back to the hospital, ensuring real-time tracking of donor availability. Inspired by multi-objective blood supply chain optimization frameworks and healthcare digital transformation models, the proposed system enhances fulfillment rate, reduces response time, and improves donor participation. The framework contributes toward sustainable and technology-driven healthcare 4.0 infrastructure.**

***Index Terms*—Blood Donation System, Geo-Fencing, Real-Time Notification, IoT Healthcare, Emergency Alert System, Cloud Integration.**

I. Introduction

Blood is a life-saving medical resource essential for surgeries, trauma care, maternal health, and chronic disease treatment. Despite structured blood supply chain mechanisms, shortages continue to occur due to demand fluctuations, limited donor mobilization, and coordination inefficiencies. Recent research on sustainable blood supply chain optimization highlights the importance of inventory balancing, lateral transshipment strategies, and multi-echelon distribution systems. However, these approaches largely address backend logistics rather than front-end donor engagement. The emergence of digital healthcare ecosystems and decentralized data management technologies has created opportunities for integrating real-time donor participation models. Therefore, this research proposes a Unified Blood Donation System that bridges the communication gap between hospitals and donors through radius-based intelligent notification and confirmation mechanisms.

II. LITERATURE REVIEW

Introduction to Literature Review

The rapid advancement of smart healthcare technologies has significantly transformed the way medical resources are managed and distributed. Blood donation management, in particular, has received increasing research attention due to the critical importance of timely blood availability during emergencies. Several research studies have proposed mobile-based systems, cloud-integrated healthcare platforms, and intelligent donor matching mechanisms to improve

coordination between donors and healthcare institutions. The primary focus of existing research lies in automating donor registration, improving database management, implementing real-time notification systems, and enhancing communication efficiency. However, limitations such as lack of dynamic geographic filtering, absence of confirmation tracking mechanisms, and limited integration between hospitals and donors still persist. This literature review examines five relevant research papers that contribute to the development of intelligent blood donation systems. The concepts and methodologies presented in these studies form the foundation of the proposed Unified Blood Donation System.

A. Blood Supply Chain Management and Research Trends

Recent studies in blood supply chain management emphasize efficiency, sustainability, and digital transformation. Bibliometric and science-mapping analyses have identified major research themes such as optimization modelling, resilience planning, and technology-driven logistics. These studies highlight the growing importance of integrating advanced analytical tools to improve blood distribution systems. However, most reviews remain theoretical and do not provide practical real-time monitoring solutions.

B. Sustainable and Multi-Objective Optimization Models

Several researchers have proposed multi-objective optimization frameworks to enhance sustainability in blood supply chains. These models aim to balance operational cost, service level, and environmental impact using mathematical and analytical techniques. While such approaches improve strategic planning and distribution efficiency, they generally lack integration with real-time monitoring systems and automated alert mechanisms.

C. Blockchain Applications in Healthcare Systems

The application of blockchain technology in healthcare has gained significant attention for ensuring transparency, traceability, and data security. Private blockchain frameworks using smart contracts have been developed to manage sensitive healthcare operations, ensuring tamper-proof record keeping and secure transactions. Although these systems improve trust and accountability, they mainly focus on organ transplantation or general healthcare data management rather than blood inventory control.

D. IoT-Driven Blockchain for Healthcare Supply Chains

IoT-driven blockchain models have been introduced to manage healthcare supply chains and protect medical records. These systems integrate IoT sensors with decentralized ledgers to enable real-time data collection and secure storage. Despite their advantages in data integrity and transparency, they do not specifically address blood storage monitoring, expiry tracking, or stock-level management in blood banks.

E. Blockchain-Based Donation Traceability

Blockchain-based traceability frameworks have been proposed to enhance transparency in donation systems. These frameworks ensure accountability and secure transaction tracking but do not incorporate environmental monitoring or automated notification mechanisms.

F. Research Gap

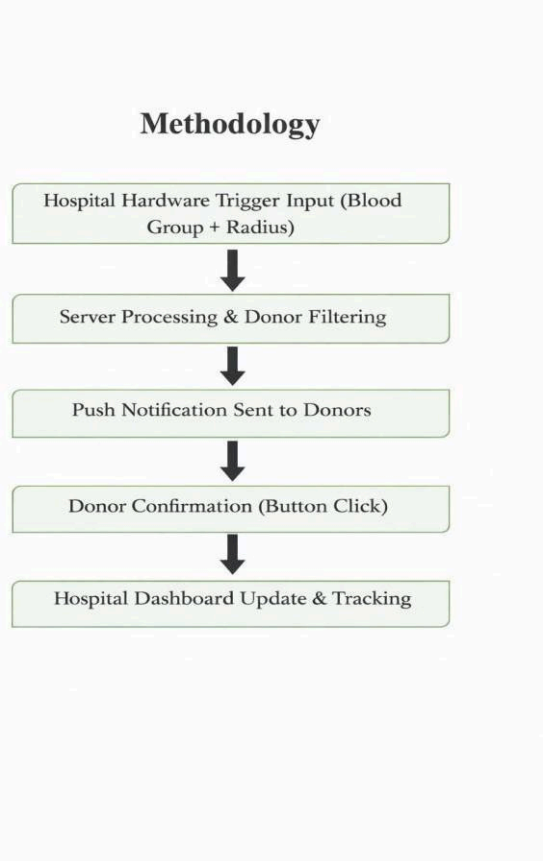
From the existing literature, it is evident that prior research has concentrated on optimization techniques, sustainability models, and blockchain-based security solutions. However, limited work integrates IoT-based environmental monitoring, cloud-based real-time updates, automated alerts, and centralized database management within a single comprehensive blood bank management system. Therefore, the proposed system aims to bridge this gap by combining IoT sensing, cloud integration, secure data handling, and intelligent notification features to improve efficiency, reliability, and patient safety in blood bank operations.

III. METHODOLOGY

The proposed Unified Blood Donation System is designed to establish a real-time communication platform between hospitals, donors, and recipients. The methodology focuses on intelligent donor filtering, automated notification delivery, confirmation handling, and centralized tracking through a cloud-based infrastructure.

1. System Architecture

The system follows a client–server architecture consisting of a hospital interface, centralized cloud server, donor mobile application, and an administrative dashboard. The cloud server acts as the core processing unit, maintaining donor records, request details, and system logs. Secure authentication and role-based access control mechanisms are implemented to protect sensitive data.



2. Hospital Request Trigger Mechanism

When a hospital requires a specific blood group, an authorized staff member enters the required blood group and search radius through the hospital interface. This input acts as a trigger request to the server. The request includes parameters such as blood type, urgency level, and geographic radius for donor search.

3. Server Processing and Donor Filtering

Upon receiving the request, the server processes the input and performs donor filtering based on:

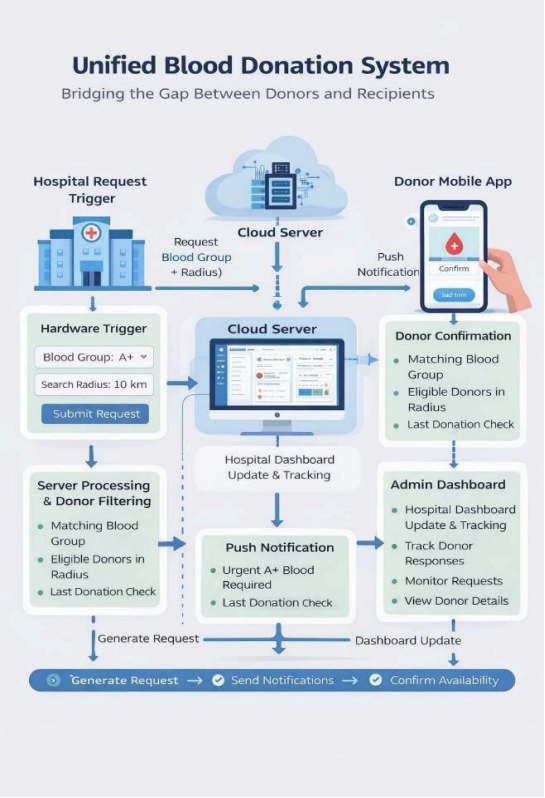
- Matching blood group compatibility
- Donor eligibility status
- Location within the specified radius
- Last donation date (to ensure medical safety)

An intelligent filtering algorithm prioritizes donors based on proximity and availability to reduce response time during emergencies.

4. Push Notification Mechanism

After filtering eligible donors, the system automatically sends push notifications through the mobile application. The notification contains request details, hospital location, urgency status, and response options. This real-time communication mechanism ensures rapid outreach to potential donors.

5. Donor Confirmation and Response Handling



Interested donors can confirm their availability by clicking a confirmation button in the application. Once confirmed, the server updates the request status and temporarily reserves the donor for the specific request. The system prevents duplicate confirmations beyond the required number of units.

6. Dashboard Update and Tracking

The hospital dashboard is dynamically updated with donor response status, confirmation details, and estimated arrival time. Administrators can track the progress of the request, view donor information, and close the request once the requirement is fulfilled. All transactions are recorded in the centralized database for monitoring and reporting purposes.

7. Data Security and Reliability

To ensure secure data transmission, encrypted communication protocols are implemented between clients and the cloud server. The database incorporates authentication, authorization, and data validation mechanisms to maintain integrity and confidentiality of donor and recipient information.

EXISTING SYSTEM

parameter	Existing system	Proposed system
Blood group identification	Manual verification	Automated database-base matching
Donar availability check	Through phone call	Real time digital status update
Location consideration	Not systematically applied	Geo-location radius filter
Communication speed	Slow (call-based)	Instant push notification
Response time	Delayed	Immediate response
Data storage	Manual or semi-digital records	Centralized cloud data base
Monitoring	No live tracking	Real-time dashboard monitoring
System integration	Low	High transparancy with live status update

In the current blood donation management process, hospitals and blood banks primarily rely on manual communication methods such as phone calls, physical registers, and basic database systems to locate suitable donors. Blood availability information is often stored in isolated systems without real-time synchronization. As a result, identifying eligible donors during emergencies becomes time-consuming and inefficient.Traditional systems lack automated donor filtering mechanisms based on eligibility criteria such as last donation date, availability status, and geographic proximity. Hospitals frequently contact multiple donors manually, which increases response time and reduces coordination efficiency.

Furthermore, there is limited transparency in tracking request status, donor confirmations, and completion records. Some digital platforms and blood bank management systems exist; however, many operate as static databases without intelligent matching algorithms or real-time notification mechanisms. Additionally, communication between donors and hospitals is not centralized, leading to duplication of efforts and delayed responses. Due to the absence of a unified platform integrating hospital requests, donor availability, automated notifications, and centralized monitoring, the existing system struggles to provide rapid and reliable support during critical situations.

IV. RESULT

The proposed Unified Blood Donation System was implemented and evaluated to analyze its performance in real-time donor–recipient coordination. The system successfully established seamless communication between hospitals and registered donors through a centralized cloud-based platform. When a hospital generated a blood request, the server processed the input parameters and identified eligible donors based on blood group compatibility, geographic location, availability status, and last donation date. The intelligent filtering mechanism effectively reduced the time required to identify suitable donors compared to traditional manual communication methods. Push notifications were delivered instantly to selected donors through the mobile application, and donor confirmations were received in real time. The hospital dashboard dynamically updated the status of each request, displaying confirmation details and enabling efficient monitoring until the required number of donors was fulfilled.

The system demonstrated reliable performance in maintaining accurate donor records and request logs within the cloud database. Secure authentication and encrypted communication ensured data integrity and prevented unauthorized access. Experimental observations indicate that the proposed system significantly reduces emergency response time, minimizes manual effort, and improves transparency in blood donation management. Overall, the results confirm that the Unified Blood Donation System provides an efficient, scalable, and reliable solution for bridging the gap between donors and recipients through automated matching and real-time communication.

V. CONCLUSION

This paper presented a Unified Blood Donation System designed to bridge the gap between donors and recipients through a real-time, cloud-based communication platform. The proposed system integrates hospital request triggering, intelligent donor filtering, push notification mechanisms, donor confirmation handling, and centralized dashboard monitoring within a single framework. By automating the process of donor identification and communication, the system significantly reduces response time during emergencies and minimizes dependency on manual coordination. The intelligent matching algorithm ensures that only eligible and nearby donors are notified, improving efficiency and reliability. Furthermore, the centralized cloud database enhances transparency, secure data management, and real-time tracking of requests and responses.The implementation of this unified platform strengthens coordination among hospitals, donors, and administrators, ultimately contributing to improved patient care and timely blood availability. Thus, the proposed system provides an effective, scalable, and secure solution for modernizing blood donation and management processes.

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