

BloodBridge: A Real-Time Emergency Blood Donation Coordination Platform

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ABSTRACT

Blood availability during emergency situations remains a major challenge in healthcare systems, where delays in finding compatible donors can lead to critical consequences. Traditional methods of blood request management often depend on manual communication, fragmented donor records, and slow response mechanisms. This paper presents **BloodBridge**, a real-time emergency blood donation coordination platform designed to improve communication between hospitals and potential donors through a mobile-based ecosystem. The proposed system enables hospitals to generate urgent blood requests by specifying blood group, quantity, and priority level, while nearby eligible donors receive instant notifications and can respond instantly through the application.

The platform is developed using **React Native** for cross-platform mobile deployment, **Firebase** for authentication and real-time database synchronization, and **Map Libre** for location-based visualization services. A dual-interface model is implemented, consisting of a donor module and a hospital module, allowing efficient coordination between both stakeholders. Additional features such as emergency availability status, request prioritization, and contribution recognition are incorporated to encourage donor participation and reduce response delays.

A functional prototype demonstrates the feasibility of the proposed framework in managing urgent requests, improving workflow transparency, and supporting faster donor-hospital interaction. Unlike conventional donor directory systems, BloodBridge focuses on reducing search-to-action time during emergencies through automated and real-time coordination. The proposed platform offers a scalable and practical solution that can be extended with predictive analytics, live tracking, and broader healthcare integration in future implementations.

Keywords: Blood Donation, Emergency Healthcare, React Native, Firebase, Real-Time Coordination, Mobile Application

1. Introduction

Blood donation is an essential part of modern healthcare systems, as it supports patients during surgeries, accidents, childbirth complications, cancer treatments, and various emergency medical conditions. Every year, hospitals and blood banks face challenges in maintaining an adequate supply of compatible blood units. In many emergency situations, the major issue is not only the shortage of blood, but also the delay in locating suitable donors within the required time. Rapid coordination between hospitals and donors can significantly improve survival chances and treatment efficiency.

Traditional blood request methods often rely on phone calls, personal contacts, hospital notice boards, or manually maintained donor records. These approaches are time-consuming, inefficient, and difficult to manage during urgent situations. In many cases, donor databases are outdated, donor availability is unknown, and communication lacks real-time response capability. As a result, patients and hospitals may experience unnecessary delays while searching for compatible donors. With the growth of smartphones, cloud computing, and location-based services, mobile technology offers a practical solution to improve emergency blood donation systems. Real-time digital platforms can instantly connect hospitals with nearby eligible donors, automate request notifications, and streamline communication between all stakeholders. Such systems can reduce manual effort, improve transparency, and increase response speed during critical medical events.

To address these challenges, this paper proposes **BloodBridge**, a real-time emergency blood donation coordination platform designed as a mobile-based ecosystem for hospitals and donors. The platform enables hospitals to create urgent blood requests by specifying blood group, quantity, and priority level, while registered donors receive instant alerts and can respond directly through the application. The system integrates React Native for cross-platform development, Firebase for real-time backend services, and MapLibre for location visualization.

The main objective of the proposed system is to minimize search-to-action time, improve donor-hospital coordination, and create a scalable model for emergency blood supply management. A functional prototype has been developed to demonstrate the feasibility and practical implementation of the proposed solution.

2. Literature Review

The global magnitude of blood shortages is well documented: the World Health Organization (WHO) reports that despite collecting over 112 million donations worldwide in the period covered by its 2016 global report, substantial disparities persist across income groups, with low- and middle-income countries disproportionately burdened by insufficient and unsafe supplies [1]. The report highlights that inadequate supply combined with delays in transfusion-transmitted infection screening creates compounding risks for patients in developing nations, underscoring the urgent need for digital interventions targeting donor recruitment and real-time coordination.

A broad body of research has explored smart approaches to improving blood donation, encompassing data mining for donor behavior prediction, mobile application-based recruitment, and social media-driven

emergency requests [2]. These strategies reflect a wider shift toward technology-mediated solutions for increasing donor engagement and operational efficiency. Among the most promising design directions, gamification has emerged as an effective tool for motivating and retaining donors: the G-Blood application integrates leaderboards and badges through User-Centered Design (UCD), demonstrating that gamified features significantly improve engagement and retention, particularly among younger populations [3].

Systematic reviews of mobile blood donation applications confirm that while many platforms exist, critical functional gaps remain. Li et al. conducted a systematic review and case study of mobile apps for blood donation and found that most existing applications focus primarily on donor recruitment, with limited evidence of dynamic real-time interaction, location-based filtering, or structured emergency workflows [4]. This analysis establishes a clear benchmark: modern platforms must go beyond static donor listings to provide genuinely responsive, interactive features. Real-world evidence from a deployed blood donation app developed by an Austrian Red Cross blood center reinforces this direction: within 18 months of launch, the app attracted 45,000 users, and its digital health questionnaire reduced donor deferrals by 31.9% compared to the conventional paper-based process [5]. These outcomes demonstrate that thoughtfully implemented digital tools can produce measurable improvements across both donor engagement and operational quality.

Donor motivation and behavioral readiness are equally critical. Guglielmetti Mugion et al. analyzed both donors and non-donors using the Theory of Planned Behaviour and found that attitudes, communication quality, and perceived service quality are the primary antecedents of blood donation intention and the willingness to encourage others to donate [6]. Their findings highlight that platforms must actively support a positive donor experience — not just facilitate logistics — to foster long-term commitment. From a digital platform perspective, Torrent-Sellens et al. surveyed 389 participants across Latin America and Spain and found that trust in digital communities and positive associations with a modern lifestyle were strong predictors of the intention to donate through digital platforms [7]. These motivational pathways indicate that well-designed mobile platforms can tap into altruistic and social identity-driven motivations to build sustained engagement.

The practical readiness of donor populations for mobile-based participation has also been assessed directly. Potgieter and Rensleigh surveyed 2,154 South African blood donors and found that the majority already owned smart devices and regularly used mobile applications; 41% believed a dedicated blood donation app would encourage younger South Africans to donate more regularly [8]. These findings confirm that the technological and attitudinal conditions for mobile adoption are already in place, provided platforms are designed to align with user expectations and address concerns around privacy and usability.

Collectively, the literature shows that existing solutions often address isolated components — donor discovery, gamification, or basic notification delivery — while the global scale of blood shortages demands more integrated approaches [1]. Systematic evidence confirms that real-time coordination and interactive functionality remain largely absent from current apps [4], yet donor populations are demonstrably ready to embrace well-designed platforms [8], and real deployments show that digital transformation produces measurable gains [5]. The motivational literature further affirms that effective

platforms must address the full service experience and the social dimensions of donation [7], [6]. These collective gaps motivate the development of the proposed platform, which aims to unify hospitals, donors, alerts, and workflow transparency within a single, real-time mobile ecosystem.

3. System Analysis and Design

The proposed **BloodBridge** platform is designed to provide a fast and reliable solution for emergency blood request management by connecting hospitals and eligible donors through a mobile-based ecosystem. The system focuses on minimizing delays, improving communication, and enabling real-time coordination during urgent medical situations. This section describes the system requirements, functional design, and data flow structure of the proposed platform.

3.1 Requirement Analysis

The need for the proposed system arises from the limitations of traditional blood request methods, which often depend on manual communication, outdated donor records, and delayed responses. In emergency situations, hospitals require a quick mechanism to locate suitable donors and notify them instantly.

The major requirements of the system are:

- Donors should be able to register and manage their profile.
- Hospitals should be able to create emergency blood requests.
- The system should notify nearby eligible donors instantly.
- Donors should be able to accept or reject requests easily.
- Request status should update in real time.
- The application should be easy to use and accessible.

3.2 Functional Requirements

The core functions supported by the platform are:

- User registration and login authentication.
- Donor profile management.
- Hospital request generation with blood group and urgency level.
- Real-time notifications to donors.
- Request acceptance and rejection workflow.
- Status monitoring for hospitals.
- Display of active requests and donor participation history.

3.3 Non-Functional Requirements

The system must also satisfy quality and performance requirements:

- Fast response during emergencies.
- Secure storage of user data.

- Reliable synchronization between modules.
- Scalable backend for multiple users.
- Cross-platform mobile support.
- User-friendly and responsive interface.

3.4 Data Flow Diagram

The BloodBridge platform processes emergency blood requests through structured communication between hospitals, donors, and the backend database. Hospitals create requests, which are stored in the database and forwarded to eligible donors through notifications. Donors respond through the application, and the system updates the request status for hospitals in real time.

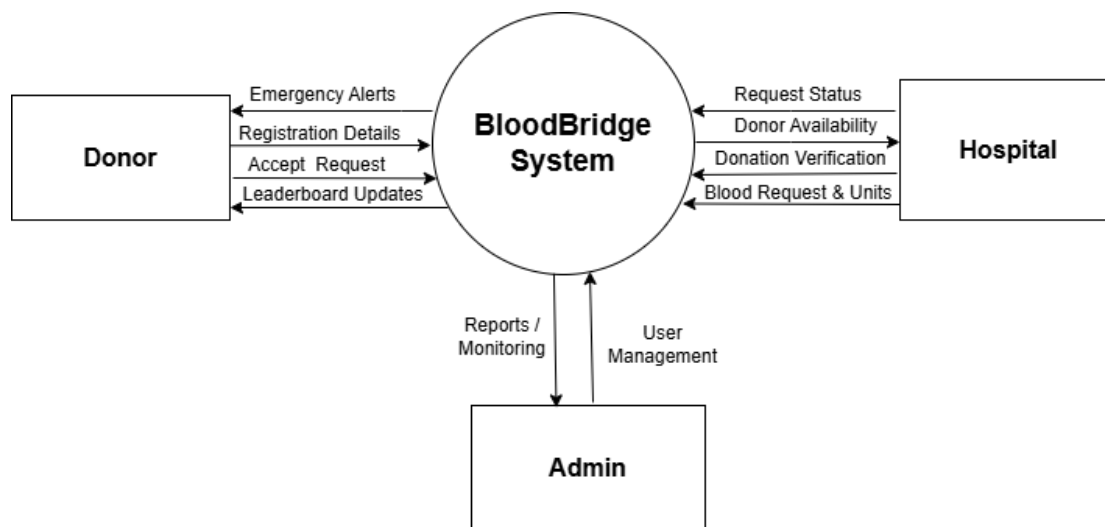


Fig. 1 DFD Level 0 – Context Diagram

3.5 Activity Diagram

The activity diagram of the BloodBridge platform represents the sequence of actions involved in the emergency blood donation workflow. The process begins when a donor, hospital, or admin user logs into the system. If a hospital user creates an emergency blood request, the system checks the required blood group and filters eligible donors based on availability and proximity. Notifications are then sent to the selected donors.

After receiving the alert, a donor can either accept or reject the request. If the donor accepts, the system generates a verification code and updates the request status in real time. The donor then visits the hospital and provides the verification code for confirmation. Once the hospital verifies the donation, the system updates the donor history and reward points accordingly. If the donor rejects the request or does not respond, the system continues to search for other eligible donors until the request is fulfilled or closed.

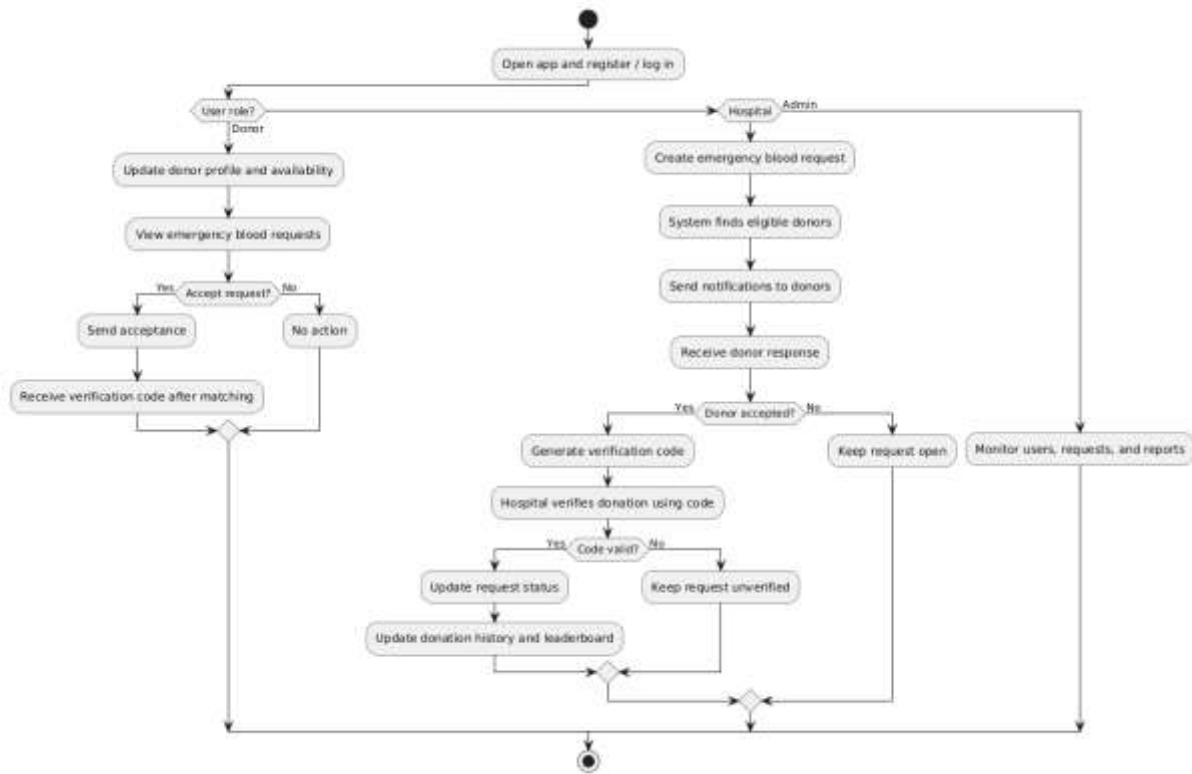


Fig. 2 Activity Diagram

3.6 System Architecture

The platform follows a dual-module mobile architecture consisting of a **Donor Module** and a **Hospital Module** connected through a cloud backend. Firebase services are used for authentication, database synchronization, and notifications, while MapLibre provides location-based map support.

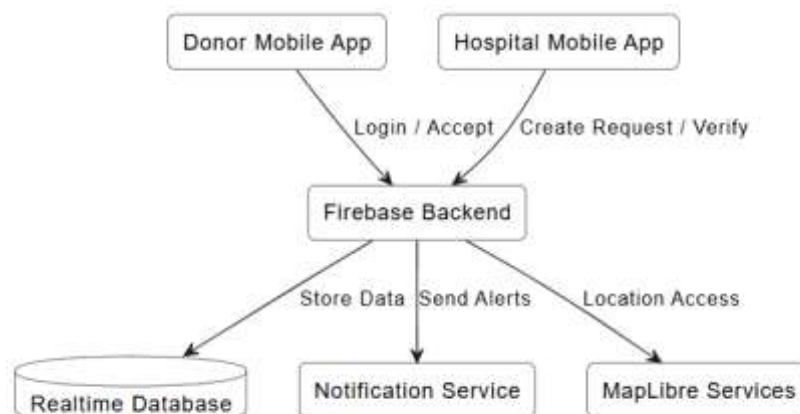


Fig. 3 System Architecture

3.7 Summary of Design

The proposed system design ensures that emergency blood requests are handled efficiently through real-time communication and mobile accessibility. The integration of cloud services and role-based modules provides a scalable framework for improving donor-hospital coordination during critical situations.

4. Proposed Work

4.1 Overview

The proposed system, **BloodBridge**, is a real-time emergency blood donation coordination platform developed to minimize delays in finding compatible blood donors during urgent medical situations. The platform creates a digital bridge between hospitals and registered donors through a mobile-based ecosystem. It enables faster communication, secure verification, and efficient coordination during emergencies.

Unlike traditional donor directory systems, BloodBridge focuses on active emergency response rather than passive donor listing. Hospitals can instantly raise blood requests, while eligible donors receive alerts and respond through the application. The platform also improves trust and transparency by integrating a verification code mechanism and reward-based participation model.

4.2 Workflow of Proposed System

The complete workflow of the proposed BloodBridge platform is explained below:

1. Donor, hospital, and admin users complete registration and login.
2. Hospital creates an emergency blood request by entering blood group, quantity, and urgency level.
3. The system filters compatible eligible donors from the database.
4. Notifications or email alerts are sent to selected donors.
5. Donors can accept or reject the request through the mobile application.
6. If a donor accepts the request, a unique verification code is generated.
7. The donor visits the hospital and provides the verification code.
8. Hospital verifies successful donation through the system.
9. Reward points and leaderboard rankings are updated automatically.

4.3 Key Modules

The BloodBridge platform is divided into three major modules:

Donor Portal

The donor portal allows users to register, log in, view active blood requests, accept or reject requests, receive verification codes, and monitor leaderboard rankings based on donation activity.

Hospital Portal

The hospital portal enables healthcare institutions to register, create emergency blood requests, specify urgency level, verify donor codes after donation, and monitor donor response status.

Admin Portal

The admin portal is responsible for managing users, monitoring request activity, maintaining system records, and generating analytical reports for platform supervision.

4.4 Use Case Diagram

The use case diagram of the proposed BloodBridge system represents the interaction between the three major actors: **Donor**, **Hospital**, and **Admin**. Each actor performs specific tasks according to their role. Donors interact with request-related features, hospitals manage emergency requests and verification, while the admin supervises overall system operations.

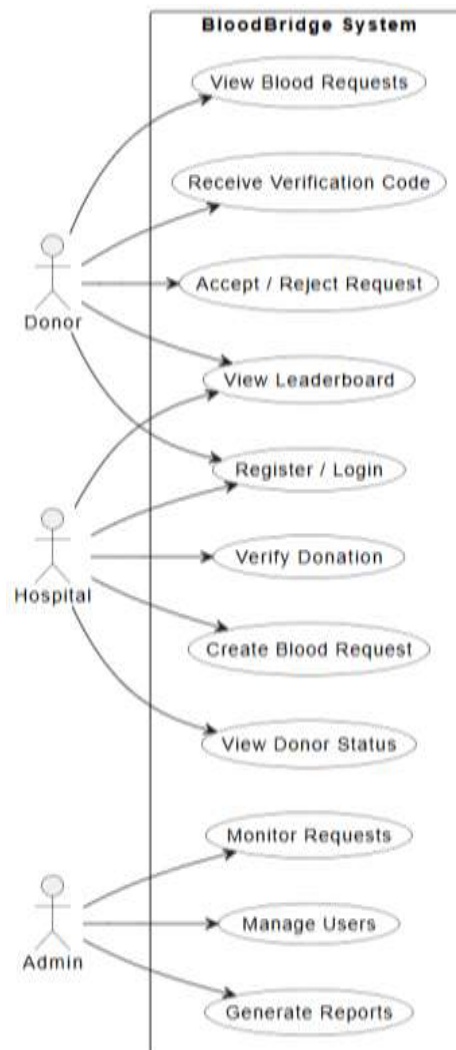


Fig. 4 Use Case Diagram

5. Implementation

5.1 Technologies Used

Technology	Purpose
React Native	Cross-platform mobile development and deployment.
Firebase	User authentication, real-time database synchronization, and backend services.
MapLibre	Location-based visualization and map services.

5.2 Interface

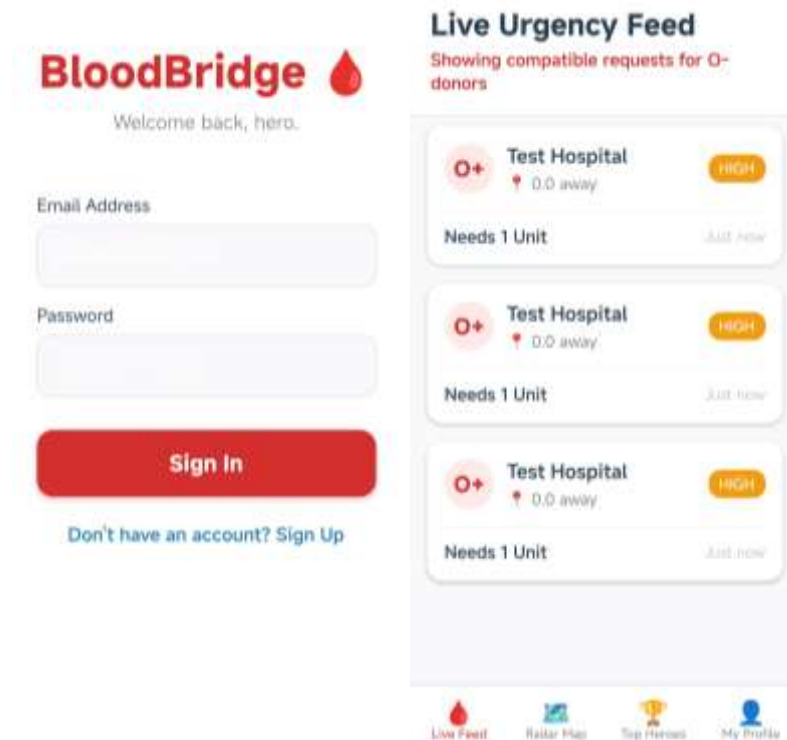


Fig. 5 Login Screen (Left) and Donor Dashboard (Right) of BloodBridge Application

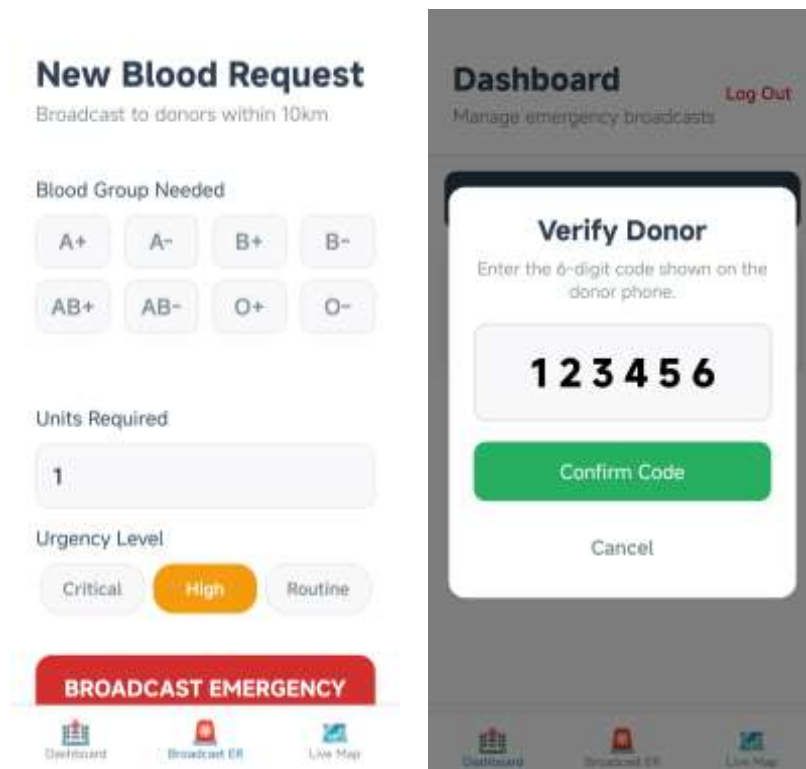


Fig. 6 Hospital Request Form (Left) and Verification Code Screen (Right) of BloodBridge Application



Fig. 7 Leaderboard Screen of BloodBridge Application

5.3 Working Process

The operational workflow begins when a hospital generates an emergency blood request specifying the required

blood group, quantity, and priority level. The system's backend immediately filters eligible donors based on proximity and availability, sending them instant alerts. Upon a donor accepting the request, a unique verification code is generated, which the hospital uses to confirm the donation upon arrival.

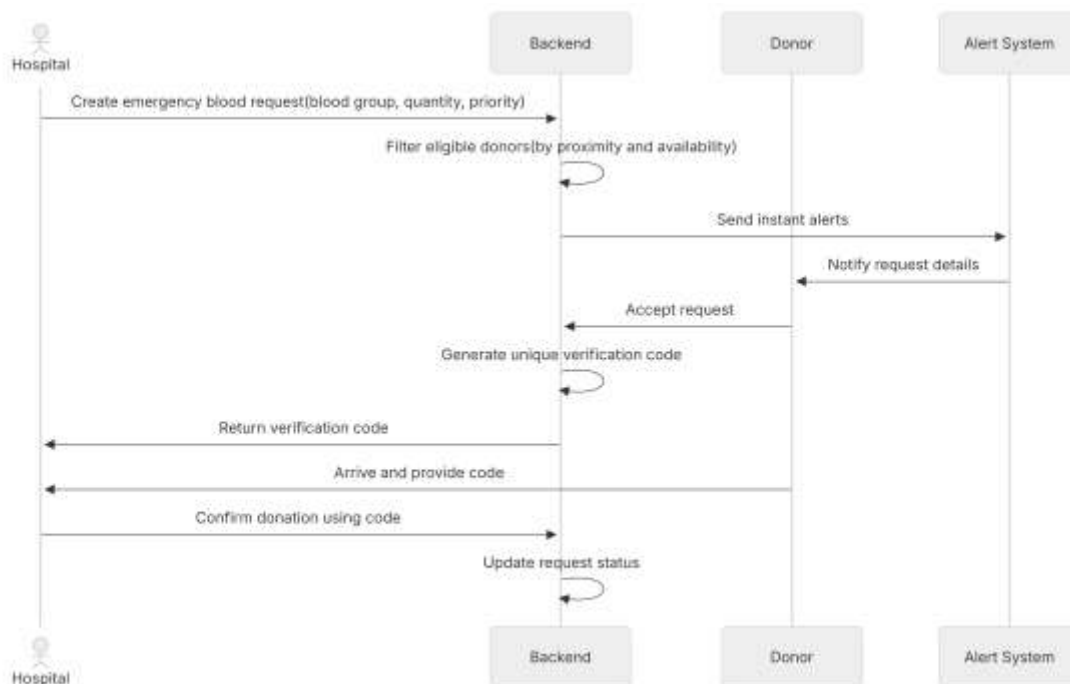


Fig. 8 Sequence Diagram of BloodBridge Workflow

6. Results and Discussion

A functional prototype of *BloodBridge* demonstrates feasibility in managing urgent requests and facilitating faster donor-hospital interactions. The platform successfully reduces search-to-action time and improves workflow transparency compared to traditional directory systems. By automating notifications and request tracking, the system effectively mitigates the delays inherent in manual coordination.

Parameter	Existing System	Proposed System (BloodBridge)
Coordination Method	Manual phone calls and personal contacts	Real-time digital platform and automated alerts
Donor Discovery	Outdated records and unknown availability	Location-based filtering of eligible/available donors
Processing Speed	Time-consuming with critical delays	Minimized search-to-action time

7. Conclusion

BloodBridge provides a practical, scalable mobile ecosystem designed to bridge the gap between hospitals and potential blood donors during emergencies. By replacing manual, fragmented processes with a centralized, real-time coordination platform, the system significantly reduces response delays and improves overall workflow transparency. Ultimately, this streamlined approach ensures a faster, more reliable supply of compatible blood units for critical medical situations.

8. Future Scope

- Integration of predictive analytics to forecast donor behavior and blood demand.
- Implementation of live GPS tracking for real-time monitoring of requests.
- Broader healthcare integration with existing medical infrastructure.
- Wearable integration for continuous donor health monitoring.
- Multi-language support to increase accessibility across diverse demographics.

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