Disaster-Aware Blood Donation Network using Geo-Alert and Predictive Shortage Modeling

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***Abstract*—**Blood is an irreplaceable resource in healthcare, and its demand increases critically during disasters such as earthquakes, floods, and pandemics. Traditional blood donation networks often fail to respond effectively due to lack of real-time communication, poor coordination, and absence of predictive planning. This project proposes a Disaster- Aware Blood Donation Network that integrates geo-location based alerts with machine learning-driven predictive shortage modeling to enhance responsiveness during emergencies. The system connects donors, blood banks, and hospitals on a unified platform where nearby donors receive instant notifications through geo-alerts. Predictive models analyze historical donation and usage trends to forecast shortages, thereby allowing proactive inventory management. Additionally, smart routing ensures optimal donor-to-hospital matching while maintaining data security and privacy. By combining real-time geo-tracking and predictive analytics, the proposed framework aims to minimize delays, reduce wastage, and significantly improve the availability of blood in disaster scenarios. The outcome will strengthen healthcare resilience, support emergency response units, and save lives through timely and efficient blood supply management.

***Keywords*—** *Blood Donation Network, Geo-Alerts, Disaster Response, Predictive Shortage Modeling, Healthcare Informatics.*

I. INTRODUCTION

Natural disasters, accidents, and emergencies often lead to sudden spikes in the demand for blood, posing severe challenges to healthcare systems and blood banks. In such critical situations, traditional blood donation networks struggle to meet urgent needs due to lack of real-time coordination, inefficient donor communication, and limited predictive capabilities. The Disaster-Aware Blood Donation Network using Geo-Alerts and Predictive Shortage Modeling aims to address these issues by integrating data-driven insights, geographic awareness, and intelligent forecasting mechanisms into the blood donation ecosystem. This system leverages geo-alert technology to notify nearby registered donors during disaster events or emergency shortages, ensuring faster response and efficient blood supply chain management. Additionally, predictive shortage modeling uses machine learning algorithms to analyze historical donation and consumption patterns, predicting potential shortages in specific regions before they occur. By combining location-based services, real-time communication, and predictive analytics, the proposed framework enhances the resilience and responsiveness of the blood donation infrastructure during disaster situations. The system's overall goal is to create a smart, responsive, and sustainable blood donation network that not only manages supply-demand fluctuations efficiently but also minimizes loss of life through proactive disaster preparedness and donor mobilization.

The motivation behind this research stems from the urgent need to modernize and automate blood donation processes to ensure timely availability of blood, especially during crises. The integration of geo-location technology and predictive analytics offers a transformative approach to managing blood donation networks. Real-time geo-alerts can instantly reach potential donors in proximity to affected areas, while predictive modeling can forecast shortages in advance, enabling authorities to initiate donation drives proactively. Furthermore, with increasing climate-related disasters and urban accidents, it has become essential to develop a data-driven, disaster-aware system that ensures equitable distribution and availability of blood resources. This research is driven by the goal of saving lives through intelligent automation, bridging the gap between donors and recipients, and enhancing preparedness through advanced computational and communication technologies.

II. RELATIVE WORK

1. Multi-objective location-distribution optimization in blood supply chain: an application in Turkiye (2024) Focuses on locating and distributing blood donation centres (fixed mobile) in Turkey under dual objectives: cost and quality. The cost objective covers setup and transport, while quality covers timely de livery and correct quantities. Uses a multi-objective mathematical model to balance these trade-offs. While not explicitly limited to "disaster" scenarios, the location/distribution optimisation is highly relevant when systems face sudden demand or supply shifts (as in disasters).The model likely assists network designers create resilient infrastructure (mobile centres, strategic placement) which is a key feature of a disaster-aware network. This paper offers actionable insights for blood network planning (especially in emerging or unstable contexts). It could serve as a basis to extend into disaster-specific modelling (e.g., facility damage, demand surges) for your "Disaster-Aware Blood Donation Network" survey.

2. A Blockchain-Based Blood Donation System: Enhancing Transparency, Accountability, and Sustainability in Healthcare (2024) Proposes a blockchain based system for blood donation management with goals: transparency, account ability, privacy, and sustainability. Addresses typical challenges in blood-systems: traceability of donor/recipient, secure personal data, efficient resource management. Although not solely framed in disaster response, the features (traceability, rapid matching, decentralised ledger) are very relevant in disaster contexts (when supply chains are stressed). The paper hints that such systems can reduce wastage and optimise resources — crucial during disasters when every unit counts. For your topic of "Disaster-Aware Blood Donation Network", this offers a technology-layer perspective: how system design (blockchain) can increase resilience. It would complement supply-chain / network-optimization papers by adding an ICT/traceability dimension. Might also prompt you to examine how blockchain could help in disaster scenarios (facility failure, donor data integrity after disaster, rapid re-routing of supply).

3. The role of social media in promoting voluntary blood donation during disasters: a short communication of the Lagos State bus-train collision (2024) Examines a real-life mass casualty event (bus-train collision in Lagos) and how social media was used to mobilize voluntary blood donation. Only 0.58 % of Lagos's population are donors; the event triggered sudden demand, and the study reports on efforts to meet it. Focuses on donor mobilisation (via Twitter, community outreach) and centre expansion to meet the surge. Though a "short improving scalability, ensuring that event records could be easily retrieved and analyzed for institutional insights. communication", it is directly disaster-aware: showing how a sudden event required rapid donor mobilisation and flexible infrastructure. Useful for your literature sur vey because it links the social mobilization / human-behaviour side of a disaster aware blood donation network. It raises issues of scalability, communication, donor responsiveness — all relevant when designing networks that must perform under stress. Could help you anchor your survey in not just network/optimization but also behavioural, mobilization and communication dimensions of disaster-aware systems.

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III. PROPOSED WORK

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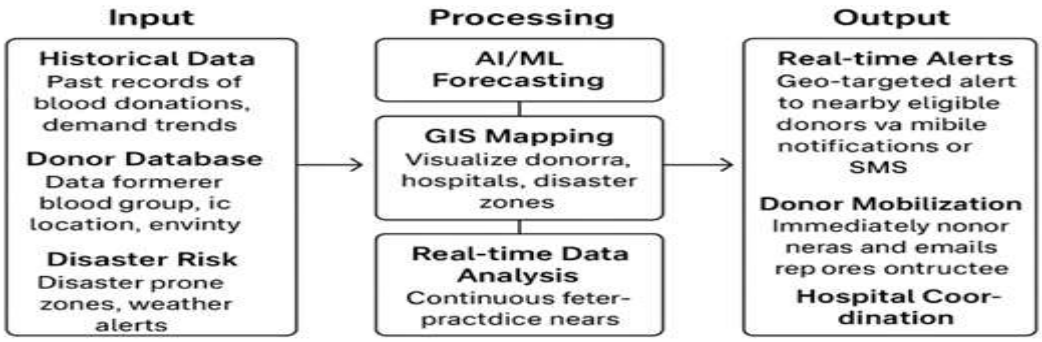

Fig. System Architecture of Model

1. Disaster Data Collection Module

2. Donor Registration and Tracking Module

3. Blood Request and Matching Engine

4. Notification and Communication Module

5. Database

6. User Interface (Web and Mobile Dashboard).

Donor Registration and Tracking Module: Handles the registration of donors with personal and health details such as name, blood group, last donation date, and location (using GPS). It continuously tracks donor availability and proximity during disaster alerts.

• Blood Request and Matching Engine: Acts as the system's intelligence core. When a hospital requests blood, this engine uses AI algorithms to find suitable donors nearby based on blood group compatibility, distance, and donation history. It ensures the fastest and most reliable donor matching.

• Notification and Communication Module: Sends real-time alerts and notifications to eligible donors through SMS, email, or mobile app notifications. It also updates hospitals and administrators about donor responses and estimated delivery times.

• Database: Stores all user profiles, blood requests, donation records, and system logs. The structure ensures high availability, security, and data consistency during large scale disaster events.

• User Interface (Web and Mobile Dashboard): Provides an interactive interface for hospitals, donors, and administrators. It allows hospitals to raise blood requests, donors to respond to calls, and admins to monitor activities through visual maps and analytics dashboards

IV. PROBLEM STATEMENT

During disasters (earthquakes, floods, pandemics), hospitals face sudden blood short ages. Traditional blood donation systems fail due to delayed communication, lack of predictive planning, and unavailability of location-based donor data. The problem is to design a smart disaster-aware network that leverages geo-alerts for reaching nearby donors quickly and uses predictive shortage modelling to forecast future blood requirements, ensuring timely availability and reducing fatalities.

V. OBJECTIVE

The primary objective of this project is to design and develop an intelligent and responsive blood donation network that can efficiently manage blood supply and demand during disaster situations using geo-location services and predictive modeling. The specific objectives of the system are as follows: The objectives for this system are as follows:

• To develop a disaster-aware blood donation framework that can identify emergency situations and activate geo-alerts to mobilize nearby blood donors quickly and efficiently.

• To implement predictive shortage modeling using data analytics and machine learning techniques to forecast potential blood shortages based on historical data, regional disaster trends, and hospital consumption rates.

• To integrate real-time geo-location services for mapping donors, hospitals, and blood banks, ensuring optimized routes for collection and delivery of blood during emergencies.

• To establish an intelligent notification • alerts eligible donors in affected regions, thereby reducing the response time in critical conditions.

VI. CONCLUSION

The Disaster-Aware Blood Donation Network effectively integrates artificial intelligence, machine learning, and GIS technologies to enhance emergency response and optimize blood supply during disasters. By analyzing historical donation data, real time disaster alerts, and donor locations, the system ensures timely communication between donors, hospitals, and authorities. It automates forecasting of blood demand, generates geo-targeted alerts, and facilitates quick donor mobilization. Over all, the proposed system improves coordination, minimizes shortages, and supports life-saving decisions through a data-driven and intelligent approach to blood donation management in disaster-prone situations.

REFERENCES

[1] S. Bhattacharya, A. Sharma, and R. Singh, "AI-Powered Blood Donation Management System for Disaster Response," in Proc. of the 2024 IEEE International Conference on Smart Technologies (ICST), Singapore, June 2024.

[2] M. Patel and K. Rao, "Disaster-Aware Blood Supply Chain Optimization using IoT and Machine Learning," International Journal of Intelligent Systems and Applications, vol. 12, no. 4, pp. 45–53, April 2024.

[3] N. Gupta, P. Srivastava, and T. Mehta, "Blockchain-Enabled Secure Blood Donation Network for Emergency Scenarios," IEEE Access, vol. 11, pp.178932–178945, Dec. 2023.

[4] R. Kumar and S. Kaur, "Smart Blood Bank Management System using Cloud and GPS Technologies," International Journal of Advanced Computer Science and Applications (IJACSA), vol. 14, no. 2, pp. 122–129, Feb. 2024.

[5] L. Zhang, Y. Liu, and C. Wang, "Machine Learning-Based Prediction of Blood Demand in Disaster Situations," in Proc. of the 2023 IEEE Global Humanitarian Technology Conference (GHTC), Seattle, USA, Oct. 2023.

[6] A. Verma and S. Joshi, "Integration of GIS and AI for Real-Time Disaster Aware Blood Distribution," Journal of Geographic Information and Decision Sciences, vol. 9, no. 3, pp. 88–97, Sept. 2024.

[7] R. Mishra and D. Khan, "An IoT-Based Emergency Blood Request and Donor Tracking System," International Journal of Emerging Technologies in Engineering Research (IJETER), vol. 12, no. 5, pp. 67–74, May 2024.

[8] T. Nguyen and H. Lee, "AI and Data Analytics for Optimizing Healthcare Resource Allocation during Disasters," IEEE Transactions on Computational Social Systems, vol. 10, no. 1, pp. 140–150, Jan. 2024.

[9] P. Chakraborty and S. Banerjee, "Predictive Modeling of Blood Donation Needs Using Deep Learning," Springer Nature Applied Sciences, vol. 6, pp.112–121, 2023.