

LifeLink: Online Blood Donation Network

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Abstract—The LifeLink: Online Blood Donation Network is a web-based platform designed to efficiently connect blood donors, hospitals, blood banks, and patients through a centralized system. The system enables users to register, search for available blood types, record donations, and manage blood distribution. A Machine Learning model, specifically the Random Forest algorithm, is used to forecast future blood demand based on parameters such as blood type, date, and time. The platform also includes an optimization module to determine donor eligibility based on previous donations and other criteria. By integrating database management, predictive analytics, and user-friendly interfaces, the system helps ensure timely availability of blood and improves coordination between donors and healthcare institutions.

Index Terms—Blood Donation Network, Random Forest Algorithm, Blood Demand Forecasting, Donor Management System, Healthcare Information System, Machine Learning, Web Application, Blood Bank Management

I. INTRODUCTION

A. Aim

The main aim of the LifeLink: Online Blood Donation Network is to develop a web-based system that connects blood donors, blood banks, hospitals, and patients through a centralized platform. The system aims to simplify the process of searching, managing, and distributing blood during emergencies. It also integrates Machine Learning techniques to forecast blood demand and optimize donor engagement, ensuring that blood resources are efficiently managed and available when required.

B. Objectives

To develop an online platform that connects blood donors, hospitals, blood banks, and patients. To provide an easy registration and login system for all users of the platform. To allow blood banks to record blood donation details and manage blood stock effectively. To enable hospitals and patients to search for required blood types from nearby blood banks. To maintain a database of donors and their previous donation history. To ensure safe blood donation by checking donor eligibility based on donation intervals. To forecast blood demand using a Machine Learning algorithm such as Random Forest. To optimize donor engagement by identifying eligible donors for future donation drives. To improve communication and coordination between blood banks and hospitals. To reduce the time required to find blood during emergency situations. To provide a transparent and efficient blood management system. To encourage voluntary blood donation through a well-organized digital platform.

C. Scope

The scope of the LifeLink system is to provide a digital platform for managing blood donation and distribution activities efficiently. The system supports multiple users including donors, hospitals, blood banks, and patients. It allows users to register, search for available blood types, record blood donations, and track blood inventory. The integration of Machine Learning helps in predicting future blood demand and improving planning for blood collection. The system can be used by hospitals and blood banks to quickly locate available blood during emergencies. In the future, the system can be expanded by integrating mobile applications, GPS-based location tracking, and real-time notifications to further enhance accessibility and effectiveness.

D. Overview

Blood is one of the most essential components required for saving human lives, especially during medical emergencies, surgeries, accidents, and treatment of serious diseases. Every year, millions of patients depend on blood transfusions to survive. However, one of the major challenges faced by healthcare systems worldwide is the shortage of blood and the difficulty in locating the required blood type at the right time. Traditional blood donation systems mainly rely on manual records and limited communication between blood banks and hospitals, which often leads to delays and inefficiencies in blood

distribution.

With the advancement of information technology, digital platforms can play a crucial role in improving healthcare services. Online blood donation systems help in connecting donors, blood banks, hospitals, and patients in a single network, allowing them to easily share information about blood availability. Such systems help reduce the time required to find blood during emergencies and ensure that patients receive the required blood type without unnecessary delays.

The LifeLink: Online Blood Donation Network is designed to address these challenges by providing an efficient and user-friendly web-based platform. The system allows different users such as blood banks, donors, hospitals, and patients to register and interact with the system according to their roles. Blood banks can manage blood collection and distribution, hospitals can search for available blood, donors can view their donation history, and patients can locate nearby blood banks that have the required blood type.

A key feature of the proposed system is the integration of Machine Learning techniques to forecast future blood demand. By analyzing historical data and other parameters such as blood type, date, and time, the system can predict the quantity of blood required in the future. This helps blood banks plan donation drives more effectively and maintain adequate blood inventory. In addition to demand forecasting, the system also includes an optimization module that determines donor eligibility based on previous donation records and other criteria. This ensures that donors follow safe donation intervals and helps blood banks identify suitable donors for upcoming blood donation drives. Such intelligent features improve the overall efficiency of the blood management process.

The LifeLink system also improves transparency and accessibility in blood donation services. Hospitals and patients can easily search for available blood types and obtain contact information for nearby blood banks. This reduces the dependency on manual communication and speeds up the process of blood procurement during critical situations.

Overall, the development of an online blood donation network can significantly improve the coordination between donors, hospitals, and blood banks. By integrating modern technologies such as web applications, databases, and machine learning, the LifeLink system aims to create a reliable and efficient platform that supports timely blood availability and ultimately helps save more lives.

Blood is one of the most critical resources in modern healthcare systems, as it plays an essential role in saving human lives during emergencies, surgeries, accidents, and the treatment of various medical conditions. Every year, millions of patients require blood transfusions, and the demand for blood continues to increase due to population growth, medical advancements, and the rise in chronic diseases. However, the availability of blood is often limited because blood donation depends entirely on voluntary donors. Managing blood supply and demand efficiently is therefore a major challenge for hospitals and blood banks worldwide. Traditional blood management systems rely heavily on manual record keeping and physical communication between hospitals and blood banks, which can lead to delays and inefficiencies in blood distribution during critical situations. Recent studies have highlighted the importance of integrating digital technologies into healthcare systems to improve blood supply chain management and ensure timely access to blood resources [1].

With the rapid advancement of information technology, web-based and mobile-based platforms have emerged as effective solutions for improving communication and coordination between donors, hospitals, and blood banks. Online blood donation management systems provide a centralized platform where donors can register, hospitals can search for available blood types, and blood banks can manage their inventory more efficiently. Such digital systems reduce the time required to locate suitable donors and available blood units during emergencies. Research has shown that mobile and web applications for blood donation significantly improve donor engagement and accessibility, encouraging more people to participate in voluntary blood donation activities [3]. These platforms also help maintain donor records, track donation history, and ensure safe donation intervals.

Another important development in blood donation management is the use of machine learning and artificial intelligence techniques to analyze and predict blood demand patterns. Machine learning algorithms can analyze historical blood donation data and identify patterns that help forecast future blood requirements. Accurate demand forecasting allows blood banks to plan donation drives more effectively and maintain sufficient blood inventory to meet emergency needs. Various studies have demonstrated that machine learning models such as Random Forest, decision trees, and other predictive techniques can be used to identify potential donors and predict blood demand with high accuracy [2, 10]. These predictive systems play a significant role in reducing blood shortages and minimizing wastage.

In addition to demand forecasting, modern blood donation systems also focus on optimizing donor engagement and eligibility management. By analyzing donor data, including previous donations, health status, and donation intervals, machine learning models can identify donors who are eligible to donate blood at a given time. This approach ensures that donation practices

remain safe and compliant with medical guidelines. Research has shown that data-driven models can effectively support blood banks in selecting suitable donors and organizing targeted blood donation campaigns [7, 9]. Such intelligent systems also help improve the efficiency of blood collection and reduce unnecessary communication with ineligible donors.

Recent advancements in digital healthcare technologies have further improved blood donation management through the integration of advanced analytics, blockchain, and artificial intelligence. These technologies enhance transparency, data security, and traceability within the blood supply chain. For example, blockchain-based blood donation systems ensure secure data sharing among hospitals, blood banks, and donors while preventing data manipulation [4]. Similarly, AI-driven analytics can improve decision-making by providing insights into blood demand trends, donor behavior, and inventory management.

These innovations contribute to a more reliable and efficient blood management infrastructure.

The LifeLink: Online Blood Donation Network is developed to address the challenges associated with traditional blood management systems. The system provides a centralized web-based platform that connects four main users: blood banks, hospitals, donors, and patients. Each user can interact with the system according to their specific role. Blood banks can record

blood donations and manage blood inventory, hospitals can search for available blood types, donors can track their donation history, and patients can locate nearby blood banks that have the required blood. By integrating machine learning algorithms for demand forecasting and donor optimization, the system enhances the overall efficiency of blood donation management.

In addition, the system provides an organized database that stores detailed information about blood donations, donor eligibility, and blood availability. Hospitals and patients can quickly search for required blood types and obtain contact details of nearby blood banks. This reduces the time required to locate blood during emergencies and improves coordination among healthcare institutions. Similar digital systems have been proposed in recent research to enhance blood bank operations and improve healthcare service delivery through intelligent data-driven solutions [6, 12].

Overall, the integration of web technologies, database management systems, and machine learning techniques in blood donation platforms has the potential to transform traditional blood bank operations. These systems not only improve the efficiency of blood collection and distribution but also encourage voluntary blood donation by providing a convenient and accessible platform for donors. As healthcare systems continue to adopt digital transformation strategies, intelligent blood donation networks such as LifeLink can play a significant role in ensuring timely availability of blood and ultimately saving more lives [5, 8].

II. LITERATURE SURVEY

Mahadevan et al. studied the application of machine learning techniques in the blood donation supply chain. The research focused on analyzing donor datasets to identify patterns that influence blood donation behavior and supply management. Various machine learning models were explored to predict donor participation and blood demand patterns. The study highlighted that predictive analytics can help blood banks plan donation drives more efficiently and reduce shortages. It also emphasized the importance of digital systems for managing blood inventory and donor databases. The authors concluded that integrating machine learning with healthcare systems improves the efficiency of blood collection and distribution processes. Their work provides a strong foundation for developing intelligent blood management platforms that support data-driven decision making in healthcare systems [1].

Shashikala and Pushpalatha proposed a machine learning approach to identify potential blood donors using historical donor data. The study analyzed several parameters such as recency of donation, frequency of donation, and volume of blood donated. Different classification algorithms including decision trees, random forest, and support vector machines were evaluated. The results demonstrated that machine learning models can effectively identify potential donors and improve donor recruitment strategies. This approach helps blood banks target suitable donors and organize more efficient donation campaigns. The study also highlighted the importance of maintaining accurate donor databases for better prediction accuracy. Their findings demonstrate the usefulness of machine learning techniques in improving blood donation management systems [2].

Thakker et al. developed an Android-based blood donation application designed to connect donors, patients, and hospitals in a centralized platform. The application allows users to search for blood donors based on blood group and location. It also provides features such as donor registration, emergency blood requests, and communication between donors and patients. The research highlighted the advantages of mobile applications in increasing accessibility and participation in blood donation programs. The system also helps reduce the time required to locate suitable donors during emergency situations. The study concluded that mobile technologies can significantly enhance the efficiency of blood donation networks and improve healthcare service delivery [3].

Suvarna et al. proposed a blockchain-based blood management system to improve transparency and security in blood donation networks. The system uses blockchain technology to store and manage donor information, blood inventory, and transaction records securely. This approach ensures that data cannot be altered or manipulated, which increases trust in the system. The study also emphasized the importance of decentralized systems in managing healthcare data securely. By integrating blockchain with blood bank management systems, the authors aimed to create a more reliable and transparent blood supply chain. Their research highlights the potential of emerging technologies to enhance healthcare management systems [4].

Raj et al. presented a cloud-based blood banking system integrated with machine learning for real-time donor tracking. The system allows blood banks to monitor blood availability, track donors, and manage donation records through a cloud platform. Machine learning algorithms are used to analyze donor behavior and predict blood demand patterns. The proposed system improves accessibility and scalability by allowing users to access the platform from multiple locations. It also helps healthcare institutions manage blood resources more efficiently. The research demonstrated that cloud computing combined with predictive analytics can significantly improve blood bank management operations [5].

Bawankar et al. conducted a study on the development of a blood management system using machine learning techniques. The proposed system focuses on managing blood donor records, blood inventory, and demand forecasting. The research emphasized that accurate prediction of blood demand can help hospitals prepare for emergency situations. Machine learning algorithms were used to analyze historical data and identify trends in blood donation patterns. The system also provides features such as donor registration and inventory tracking. The study concluded that intelligent blood management systems can significantly improve coordination between hospitals and blood banks [6].

Singh et al. proposed a machine learning framework for optimizing blood bank inventory and predicting shortages. The study used big data analytics to analyze hospital demand and donor behavior patterns. The predictive model was designed to identify seasonal trends and forecast blood demand more accurately. By using predictive analytics, the system can ensure that blood banks maintain sufficient inventory levels. The research demonstrated that data-driven approaches are more efficient than traditional manual methods in managing blood supply chains. This work highlights the importance of predictive analytics in

modern healthcare logistics [7].

Yeh et al. investigated the use of machine learning models to predict blood donor return behavior. The research analyzed behavioral and demographic data to identify factors that influence donor participation. Models such as XGBoost, LightGBM, and CatBoost were used to analyze donor data and predict the likelihood of donors returning for future donations. The results showed that machine learning models can significantly improve donor recruitment strategies. By predicting donor return behavior, blood banks can design targeted campaigns to encourage regular donations. This research contributes to improving donor retention and long-term blood supply management [8].

Mahajan et al. developed a machine learning-based blood donation application to enhance donor and patient interaction. The system includes predictive models that analyze blood demand and donor availability. It also provides features such as donor registration, emergency alerts, and blood availability tracking. The application was designed to reduce delays in locating blood during emergency situations. The authors demonstrated that integrating predictive analytics with digital platforms improves blood donation management. Their work emphasizes the importance of intelligent healthcare applications in modern medical systems [9].

Ali and Ilyas proposed a web-based blood donation platform that connects donors, patients, and administrators through a centralized system. The platform enables donors to register their details and allows patients to search for blood donors based on location and blood group. The system architecture was designed using UML diagrams such as use case, class, and sequence diagrams. The platform was developed using modern web technologies including PHP, MySQL, and Bootstrap. The study demonstrated that web-based systems can significantly improve communication and coordination among stakeholders in blood donation networks. Their research provides a framework for designing efficient blood donation management platforms [10].

Shelake et al. proposed a machine learning approach for improving donor eligibility screening in blood donation systems. The study analyzed donor data such as donation frequency, previous donation date, and health parameters. Machine learning algorithms including Random Forest, KNN, and Support Vector Machines were applied to classify donors based on eligibility criteria. The results indicated that data-driven donor screening methods can improve the efficiency of blood donation programs. The study also highlighted the importance of predictive analytics in identifying eligible donors for upcoming blood donation drives. This approach helps blood banks maintain safe and effective donation practices [11].

Another study explored predictive models for blood donation recruitment using large donor datasets. The research used machine learning techniques to analyze SMS recruitment records and donor responses. By analyzing donor behavior, the system was able to predict which donors were most likely to participate in future donation campaigns. The results demonstrated that predictive models can significantly increase donor participation rates. The study also highlighted the role of data analytics in designing targeted recruitment strategies. These findings show how machine learning can improve donor engagement and strengthen blood donation programs [12].

Belfarsi et al. proposed an optimization model for blood transfusion management in resource-constrained environments. The system uses machine learning algorithms and heuristic matching techniques to allocate blood resources efficiently. The model considers factors such as blood type compatibility, donor location, and blood expiration dates. Simulation results showed significant improvements in blood request acceptance and resource utilization. The research emphasizes the importance of intelligent resource allocation in healthcare systems. Such models can help hospitals manage blood supplies more effectively during emergencies [13].

Another research study proposed an AI-driven blood bank management framework that integrates predictive analytics, donor matching, and inventory optimization. The system analyzes large datasets to identify donor trends and predict blood demand patterns. It also provides automated decision support for blood banks and hospitals. The authors demonstrated that AI-based systems can reduce blood wastage and improve emergency response times. The research highlights the growing role of artificial intelligence in transforming healthcare infrastructure and improving patient care [14].

Recent studies have also emphasized the role of intelligent analytics in optimizing blood supply chains. Researchers have shown that machine learning models can analyze large healthcare datasets to predict shortages and optimize blood collection strategies. These predictive models enable hospitals to maintain adequate blood inventory while minimizing wastage due to expiration. The integration of advanced analytics with healthcare information systems has the potential to transform blood bank management and improve patient outcomes. Such technologies are expected to play a crucial role in future healthcare systems [15].

III. PROPOSED METHOD

The proposed system LifeLink: Online Blood Donation Network is designed to create an efficient platform that connects blood donors, hospitals, blood banks, and patients through a centralized web-based application. The system aims to improve blood availability, manage donor information, and forecast future blood demand using machine learning techniques. The proposed methodology consists of several stages including user registration, blood donation management, blood search, demand forecasting, and donor eligibility optimization.

Initially, the system allows four different types of users to access the platform: blood banks, hospitals, donors, and patients. Each user must complete the registration process by providing necessary details such as name, contact information, location, and blood group. After successful registration, the users receive login credentials which allow them to securely access the system and perform operations based on their roles. The authentication mechanism ensures that only authorized users can access the system modules.

Once logged in, the blood bank module plays a central role in the system. Blood banks are responsible for managing blood donation drives, collecting blood from donors, and maintaining blood inventory records. When a donor participates in a donation drive, the blood bank records important details such as donor name, blood type, quantity of blood collected, and expiry date. These details are stored in the database to maintain accurate blood stock information. Blood banks can also release blood to hospitals or patients when a request is received.

The hospital module allows hospitals to search for available blood types across different blood banks. Hospitals can select the required blood group and the system retrieves a list of blood banks that currently have the required blood available. The system also provides contact information and location details of the blood banks so that hospitals can quickly collect the required blood units during emergencies.

The Map module will be taking the request from the hospitals, then it will locate the blood banks closest to their location. It will use GPS coordinates and show the nearest blood banks with their distance and contact information.

The patient module provides similar functionality where patients can search for blood availability in nearby blood banks. By entering the required blood type, the system displays a list of blood banks that have the requested blood group in stock. This feature helps patients and their families quickly locate blood resources without manually contacting multiple blood banks.

The donor module enables donors to track their previous blood donation history. Donors can view details such as donation date, blood volume donated, and the blood bank where the donation was made. This module helps maintain transparency and encourages donors to participate regularly in blood donation programs.

A key component of the proposed system is the blood demand forecasting module, which uses the Random Forest Machine Learning algorithm. This module analyzes historical blood donation data and other parameters such as blood type, date, and time to predict the amount of blood that may be required in the future. The prediction results help blood banks plan donation drives more effectively and maintain adequate blood inventory.

Another important feature of the system is the donor eligibility optimization module. This module evaluates whether a donor is eligible to donate blood based on factors such as previous donation date and mandatory waiting periods between donations. If a donor has recently donated blood, the system marks them as temporarily ineligible. Once the required waiting period has passed, the donor becomes eligible again. This ensures that blood donation practices remain safe and follow medical guidelines.

The system is implemented using Python for backend processing, MySQL database for storing records, and web technologies such as HTML and JavaScript for the user interface. The machine learning model is integrated into the system to provide accurate blood demand predictions and improve decision making.

Overall, the proposed methodology combines web-based technologies, database management, and machine learning techniques to develop an intelligent blood donation network. The system improves coordination between donors, hospitals, and blood banks while ensuring efficient blood supply management. By providing real-time access to blood availability and predictive insights, the system aims to reduce blood shortages and enhance healthcare services.

IV. RESULTS

In the proposed work, as per given requirements, we have added 4 different users to manage the Blood Donation Network. Each user module is described below.

New User Sign Up: A page is provided for different users such as Hospitals, Donors, Blood Banks, and Patients to sign up with the application to get login credentials. **Blood Bank Login:** This user can log in to the system and then conduct donation drives. If any donor arrives, the blood bank will collect blood and feed the records to the database. In the next module, if any hospital requires blood, the bank will release blood to them. They can also forecast the required blood using the ML algorithm and run the Optimization module which will analyse each donor's eligibility for donation and also monitor the Blood Expiry Tracker. **Hospital Login:** The hospital can log in to the system and then search for blood using GPS and the current location of the hospital, and can visit the nearest blood bank to collect blood. Hospitals will also send notifications to donors of the required blood group through email. **Donor Login:** The donor can log in to the system and then view a list of all past donations. **Patient Login:** The patient can log in to the system and then search for required blood across different blood banks. All the above module executions are shown in the screens below.

To run the project, install Python 3.7.2 and then install all packages given in the `requirements.txt` file, then install the MySQL database and copy content from the `database.txt` file and paste it in the MySQL console to create the database.

V. SYSTEM IMPLEMENTATION AND SCREENSHOTS

This section presents the implementation of the LifeLink system through various user interface screens. Each module of the system is demonstrated with corresponding screenshots and descriptions.

A. Home Page and Performance Metrics



Figure 1: Fig. 1. Home Page Showing ML Performance Metrics

The home page displays the Random Forest model performance metrics including R^2 Score, Root Mean Square Error (RMSE), and Mean Absolute Error (MAE). The R^2 score indicates the accuracy of the model, where values closer to 1 represent better performance. RMSE and MAE represent the error between predicted and actual values, where lower values indicate better accuracy.

B. User Registration Page



Figure 2: Fig. 2. User Registration Page

This page allows different users such as blood banks, hospitals, donors, and patients to register into the system by entering their details.

C. Blood Bank Dashboard

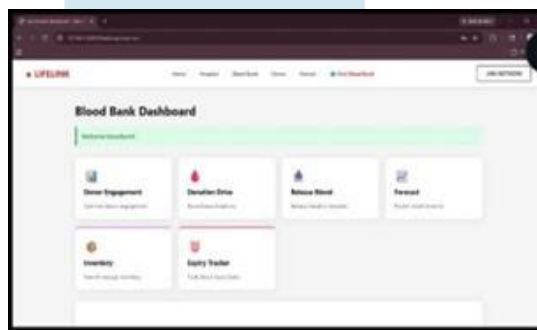


Figure 3: Fig. 3. Blood Bank Dashboard

The blood bank dashboard allows management of donation drives, blood inventory, donor engagement, and forecasting blood demand using machine learning.

D. Donor Information Module

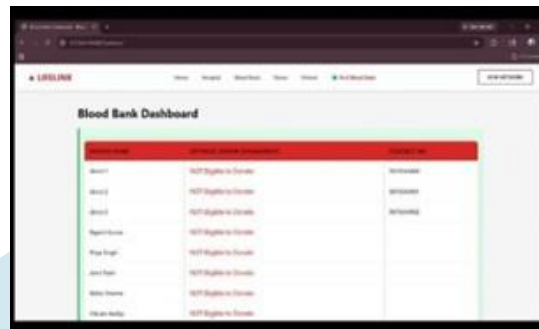


Figure 4: Fig. 4. Donor Information

This module displays detailed donor records including previous donation history, which helps in managing donor engagement and eligibility.

E. Blood Inventory Management



Figure 5: Fig. 5. Blood Inventory

The inventory module helps blood banks track available blood units, update stock, and monitor expiry dates.

F. Hospital Search Module

Hospitals can search for available blood using GPS-based location tracking, which helps in identifying the nearest blood banks.

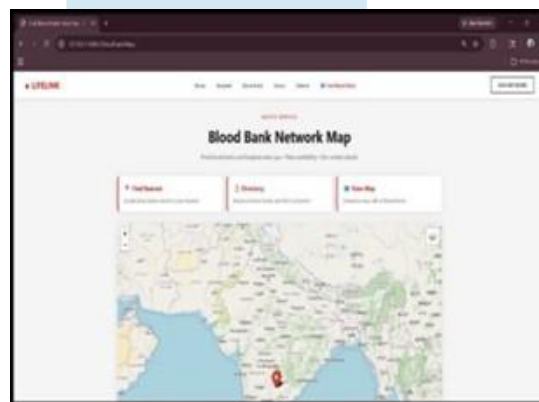


Figure 6: Fig. 6. Hospital Blood Search using GPS

G. Map Location System



Figure 7: Fig. 7. Nearest Blood Banks Location

This module displays nearby blood banks based on current location along with distance and contact details.

H. Donor Dashboard

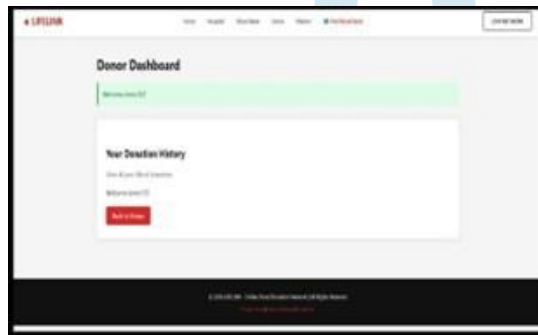


Figure 8: Fig. 8. Donor Dashboard

The donor dashboard shows past donation history and helps donors track their contributions.

I. Hospital to Donor Email Notification Processing

In the above screen, all donors will receive the above notification from the hospital according to the location of the hospital. If there is a requirement for blood, hospitals will select the "Request Blood" option from the hospital dashboard.

VI. CONCLUSION

The LifeLink system provides an efficient digital solution for managing blood donation and distribution activities. The platform successfully integrates multiple users such as blood banks, hospitals, donors, and patients within a single system,



Figure 9: Fig. 9. Hospital to Donor Email Notification Processing

enabling easy access to blood availability information. The use of machine learning for blood demand forecasting improves planning and helps blood banks maintain sufficient inventory. Additionally, the donor eligibility optimization module ensures safe donation practices by tracking donation history. Overall, the system enhances transparency, reduces delays in locating blood, and supports better coordination in emergency situations.

A. Future Scope

In the future, the system can be enhanced by integrating features to automatically identify the nearest blood banks and donors. A mobile application version can be developed to improve accessibility and user engagement. Advanced AI models could be implemented to improve the accuracy of blood demand forecasting. Integration with government health databases and hospital management systems can further expand the system's reach and reliability. Additionally, features such as a donor reward program can be incorporated to encourage more voluntary blood donations and improve healthcare response efficiency.

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