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Web Project Based Emergency E-Blood Banking Management System

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Abstract: ***In In emergency medical cases, it is essential to access blood donors without delay. Traditional systems struggle with real-time matching, leading to critical delays. This project introduces a web-based E-Blood Banking platform that integrates big data techniques and real-time SMS alerts to improve donor response speed. Developed with React.js (front-end), Python (backend), and MySQL (database), the system maintains a structured database for hospitals and donors. It enables fast matching based on blood group, proximity, and urgency. When a request is submitted, potential donors are notified instantly via SMS—even in offline conditions—enhancing coordination and reducing wait times during emergencies. The ultimate goal is to deliver a more responsive, real-time blood management system for healthcare.***
Keywords:Blood Donation, Healthcare Emergency, Data Management, Real-Time Alerts, SMS Notification System.

I. INTRODUCTION

In life-saving medical scenarios, blood donation is essential to ensure prompt transfusion for patients. Yet, many existing blood bank systems face difficulties, such as data sharing issues, weak security, and poor donor-recipient coordination [2]. These challenges cause delays and make it hard to track blood availability or connect with donors in real time. To resolve these concerns, this project introduces an E-Blood Banking platform that blends healthcare with digital innovation.

This system facilitates accurate donor-recipient pairing using location and blood group data. It also includes emergency alert features, boosting real-time connectivity between patients and donors. With tailored methods and technologies, the platform aims to provide a secure, fast, and user-friendly experience, meeting future healthcare demands.

Fig.1. Traditional blood storage managing system structure

As shown in Figure 1, Older blood bank systems depend heavily on manual activities such as recording donor details, processing blood components, storing them, and managing their issuanceoften resulting in disorganized and slow operations. These systems struggle with data inconsistency, limited real-time access, and lack of centralized control, making it difficult to respond quickly in emergency healthcare situations. To overcome these limitations, this project aims to transform the conventional blood banking process into an advanced E-Blood Banking Management System. By leveraging digital technologies, this system enhances scalability, ensures data accuracy, and provides a user-friendly interface that supports efficient donor-recipient coordination, particularly during emergencies. The proposed system not only streamlines the storage and retrieval of blood units but also introduces real-time location tracking, secure database integration, and automated alert mechanisms to ensure a faster and more reliable emergencyresponse.

II. BACKROUND

The E-Blood Banking System is developed to resolve key limitations in traditional blood bank operations and to enhance the

responsiveness and efficiency of emergency medical services.

In critical situations, delays in finding compatible blood donors can result in life-threatening consequences. Existing systems face several technical and operational limitations [1], making it difficult to efficiently manage blood donation and distribution.

Challenges in Existing Blood Banking Systems:

A. Database Management Issues

Many current systems lack a centralized and efficient database to store and retrieve donor and blood stock information[2].

Data redundancy and inconsistency often lead to inaccurate blood availability status.

B. Security and Privacy Concerns

Unauthorized access and data breaches can compromise donor and recipient information.

Many existing systems lack strong encryption and role-based access mechanisms to protect sensitive data.

C. Interoperability Challenges

Many blood banking systems fail to integrate with hospitals, emergency services[2], and government healthcare platforms.

Lack of standardized data exchange prevents real-time blood request processing across different healthcare units.

D. Limited User Accessibility

Some existing platforms are not mobile-friendly or require complex manual procedures for donor registration and bloodrequests [1].Users often face difficulties in tracking blood availability due to outdated or static systems.

Need for an Advanced E-Blood Banking System:

With the rapid advancement of digital healthcare solutions, by integrating modern technologies like big data[4], real-time alerts[9], and cloud-based infrastructure has become crucial for efficient blood bank management.

III. RELATEDWORK

Several studies have explored various blood banking and emergency management systems, each addressing different challenges. Existing blood bank management systems face interoperability issues [1], inefficient donor-recipient matching, and security concerns. Some research focuses on block chain-based transparency [3], while others tackle policy improvements for blood donation and storage. However, most existing systems lacks on based donor recommendations, real-time alert mechanisms, and efficient emergency response capabilities.

The Web Project-Based Emergency E-Blood Banking System aims to overcome these limitations by integrating a Big Data Management System (B-Tree Indexing)[5] for efficient data retrieval, a KNN algorithm[7]for donor recommendation, and an Emergency Response System utilizingweb push notifications and SMS alerts. The table below provides a comparative analysis of existing research and how our proposed system improves upon them.

IV. PROPOSED METHODOLOGY

The proposed E-Blood Banking System aims to overcome the challenges of interoperability, security, and big data management by implementing two key methodologies: a structured Database Management System (DBMS) for efficient data handling and an Emergency Alert System for real-time notifications without internet dependency. These methodologies ensure seamless donor-hospital communication, secure data storage, and an optimized emergency response system.

A. Database Management System (DBMS)

To enhance data organization and retrieval, a traditional relational DBMS is used, ensuring structured storage and quick access to blood donor and recipient records.

The key features include:

Interoperability Enhancement: The system enables seamless communication between hospitals, blood banks, and donors, ensuring real-time updates.

Optimized Data Search and Retrieval: Implementation of B-Tree Indexing [4] allows efficient donor searches based on blood group[6], location, and availability, improving query performance.

The system includes role-based access features to ensure only authorized users can view or manage sensitive information, thereby improving data protection.

B. Emergency Alert System

To ensure immediate donor response during critical situations, an Emergency Alert System is implemented, designed to operate without internet dependency.

The key functionalities include:

Offline SMS-Based Alerts: Utilizing mobile networks to send automated real-time alerts to potential donors,ensuring accessibility even in areas with no internet connectivity [9].

Intelligent Donor Matching Algorithm: The system identifies eligible donors based on blood group compatibility and proximity, prioritizing the nearest available donors.

Rapid Emergency Response Mechanism: The system ensures immediate notification delivery and donor response tracking, reducing delays in critical medical emergencies.

V. IMPLEMENTATION METHOLOGY

A. Database Management System ForBlood Data Storage and Indexing

The platform uses a Database Management System (DBMS) to organize, access, and maintain records of both donors and patients in an efficient manner.

1) B-Tree Indexing for Optimized Data Retrieval

B-Tree indexing is applied to the database, where the structure balances itself to allow quick searching, adding, and removing of records, all done efficiently in logarithmic time.

This indexing technique ensures that large volumes of donor and hospital data can be quickly accessed, improving query performance and reducing latency [5].

Equation for B-Tree Height (Performance Calculation)

In a large database, how fast the search happens depends on the height of the B-Tree, written as

$$h \leq log_m(N)$$

Where:

- **m** = Order of the B-Tree (maximum children per node)
- **N** = Number of records in the database
- **h** = Tree height (depth of search operations)

This equation helps in estimating the efficiency of blood donor searches in a largedataset.

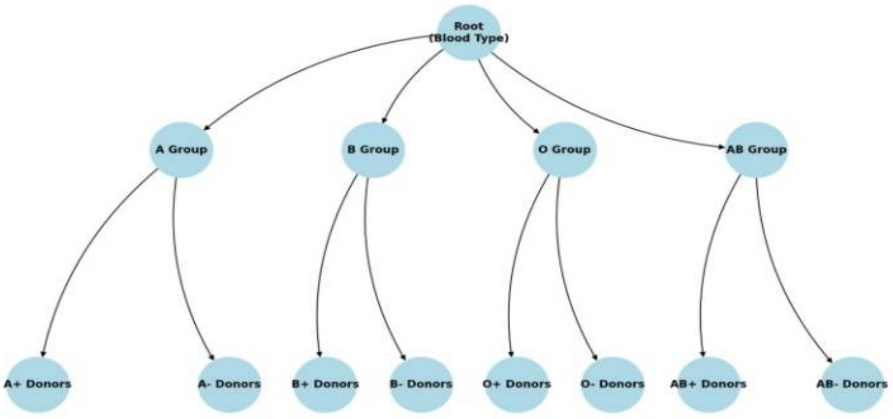


Fig.2. Blood Donor Database Indexing using B-Tree Structure

- The root node stores blood group categories.
- Intermediate nodes categorize donors based on availability and location.
- Leaf nodes store the actual donor records, enabling quick retrieval.

Implementing B-Tree indexing in the Database Management System (DBMS) to optimize the retrieval of blood donor and patient records[4], ensuring fast and efficient blood data storage and access in the E-Blood Banking System.

2) K-Nearest Neighbors (KNN) Algorithm for Blood Compatibility Matching

The K-Nearest Neighbors (KNN) algorithm helps in pairing suitable blood donors with patients by analyzing blood group matches and how close they are in terms of location. It processes location coordinates and applies KNN classification to identify the K nearest donors available for an emergency request.

This algorithm ensures efficient and accurate donor recommendations, improving the speed of finding matching blood donors [8] in critical situations.

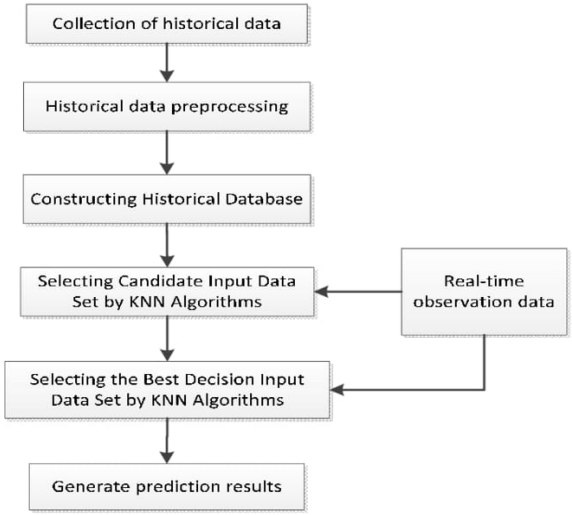


Fig.3.KNN Algorithm in matching Donors Database

B. EmergencyAlert System for Urgent Blood Requests

The Emergency Alert System is designed to notify potential donors in real time, ensuring quick responses to urgent blood requests even without internet connectivity.

1) Web Push Notification Using Service Workers

The system implements Web Push Notifications using Service Workers to send alerts[9], ensuring users receive emergency requests even when the application is not actively open.

Firebase Cloud Messaging (FCM) or Web Push API is integrated to enable browser-based real-time notifications.

2) SMS-Based Emergency Alert System Using Twilio

Twilio Python Package: Used to send automated SMS alerts to donors, ensuring notifications are delivered even without an active internet connection [9].

Fig.4. Twilio Message System

Trigger: Blood request raised by a hospital or patient

Process: Backend finds matching donors based on blood group and location

Action: Sends SMS alerts to those donors using Twilio

VI. SYSTEM DESIGN

The database design of the digital blood management platform outlines the main components that connect with the central system. It supports smooth data exchange among administrators, hospitals, storage centers, donors, and transport teams to enable effective tracking and management of blood donations.

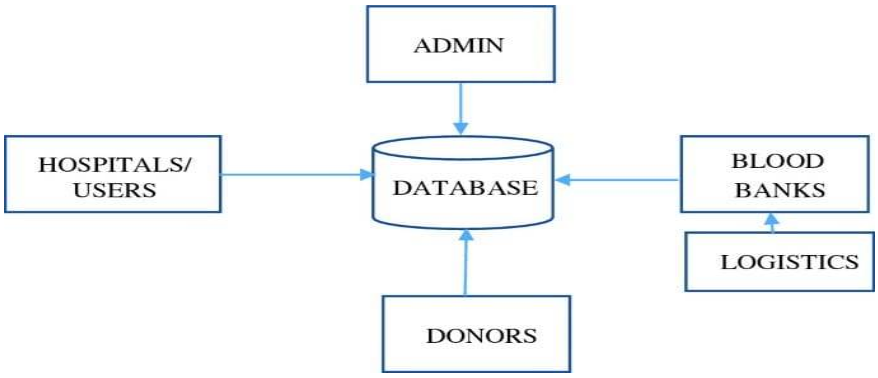


Fig. 5. System Design - Database Architecture

Database (Central Component): The core of the system where all data related to blood donations, requests, and users are stored.
Admin: Manages and monitors the overall system, ensuring smooth operations.
Hospitals/Users: Hospitals request blood units, and users access the system to donate or receive blood.
Blood Banks: Store and manage blood units and update availability in real time.
Donors: Individuals who register and donate blood, with their details stored in the database.

A. *Process flow of E-blood Banking System*

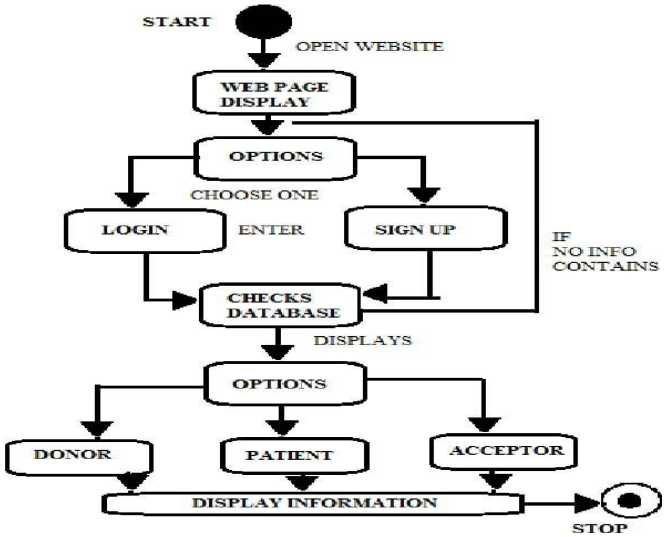


Fig . 6. Sequential Flow Representation of User Interaction in the Digital Blood BankPlatform

The flowchart presents the orderly sequence of operations carried out in the digital blood banking platform. It begins with the user accessing the website, followed by authentication and the selection of the appropriate user role. Based on this role, relevant data is retrieved from the system's database, guiding users through their specific interactions within the platform.

Process Flow

- Start: The user opens the website.
- Web Page Display: The homepage is displayed.
- User Options: The user chooses between Login (if registered) or Sign Up (if new).
- Database Verification: The system checks user details in the database.

- User Role Selection: Based on the database validation, the user selects a role:
- Donor: Provides blood donation information.
- Patient: Searches for available blood.
- Acceptor: Requests and receives blood.
- Information Display: The system retrieves and presents relevant details based on the user's selection.
- End: The process completes after displaying the necessary information.

This structured flow ensures efficient blood donation management by streamlining donor and recipient interactions through a centralized database.

B. Information Flow Structure For The E-Blood Banking Platform

The Data Flow Diagram (DFD) shows how information travels between users, system functions, and the database in the E-Blood Banking System.

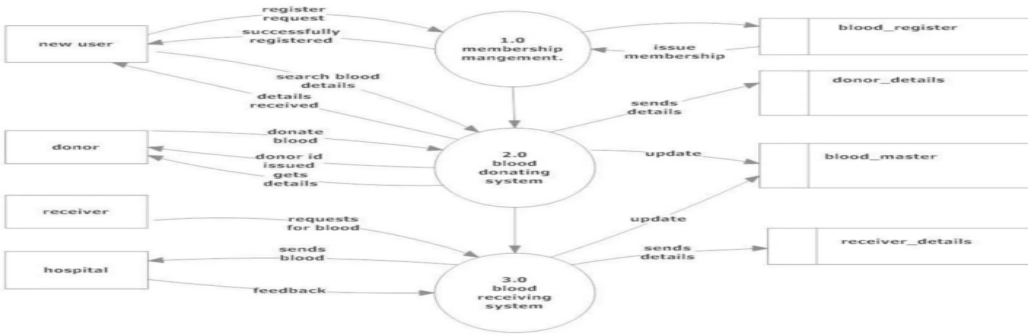


Fig.7. Representation of Data Flow within the E-Blood Banking System

Membership Management – Handles user registration.
Blood Donating System – Manages donations and updates records.
Blood Receiving System – Processes requests and sends blood details.
Data Stores: Blood register, donor details, blood master, andreceiver details.

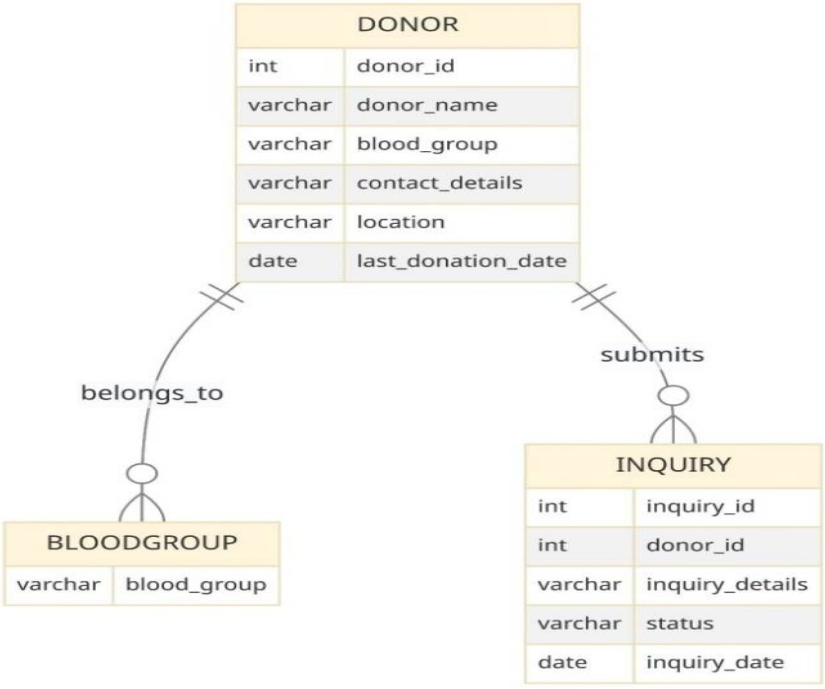


Fig.8.Entity-Relationship Model of the E-Blood Donation System

This diagram highlights the main components and their relationships within the E-Blood platform, including donor details, blood group classifications, and inquiry records.

DONOR: Stores donor details, including ID, name, blood group, contact details, location, and last donation date.

BLOODGROUP: Represents different blood groups, linked to donors.

INQUIRY: Tracks donation inquiries with inquiry ID, donor ID, details, status, and date.

Relationships of the Architecture

A Donor Belongs to a Blood Group

Each donor is associated with a specific blood group (e.g., A+, B-, O+).

This relationship helps in matching donors with recipients based on blood compatibility. In the database, the Donor table will have a foreign key linking to the Blood Group table to ensure correct categorization.

A Donor Submits an Inquiry

Donors can submit inquiries regarding blood donation eligibility, available blood banks, or upcoming donation drives.

Each inquiry is linked to a specific donor, allowing tracking of donor interactions. In the database, the Inquiry table will store details such as Donor ID, Inquiry ID, Inquiry Date, and Status.

These relationships ensure efficient donor management and help the system maintain accurate records for blood donation and requests.Each inquiry is recorded in the system and linked to the donor for tracking.

Donors can ask about donation eligibility, nearby blood banks, or events.

VII. RESULTS AND DISCUSSION

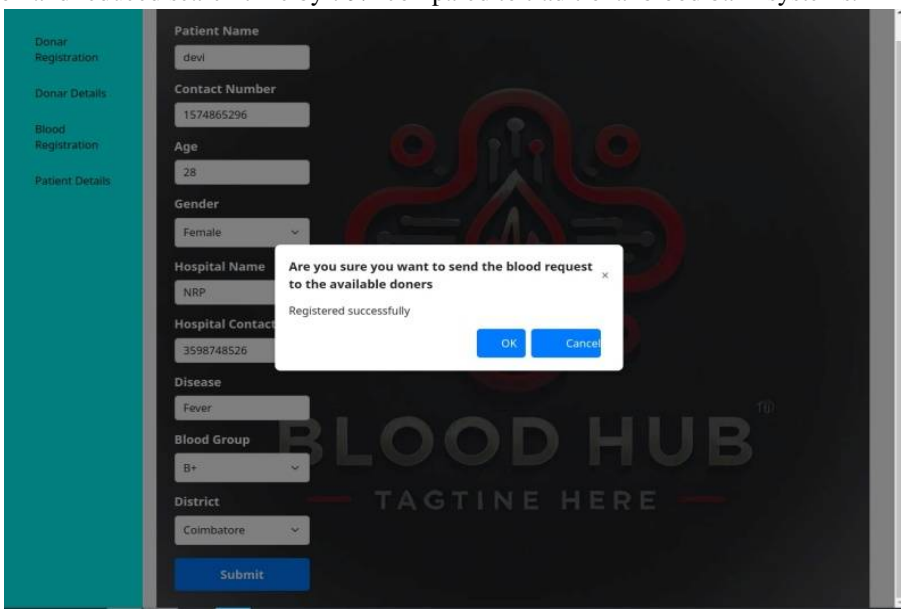
The E-Blood Banking System successfully enhances emergency blood donation management through location-based donor searches, real-time alerts, and secure data handling.

Features and Outcomes,

A. Location-Based Donor Matching Feature

The platform enables users to find suitable blood donors by filtering them through both blood type and their geographic area. It uses a distance calculation method to measure how far each donor is from the patient using stored data.

Faster donor identification and reduced search time by 70% compared to traditional blood bank systems.

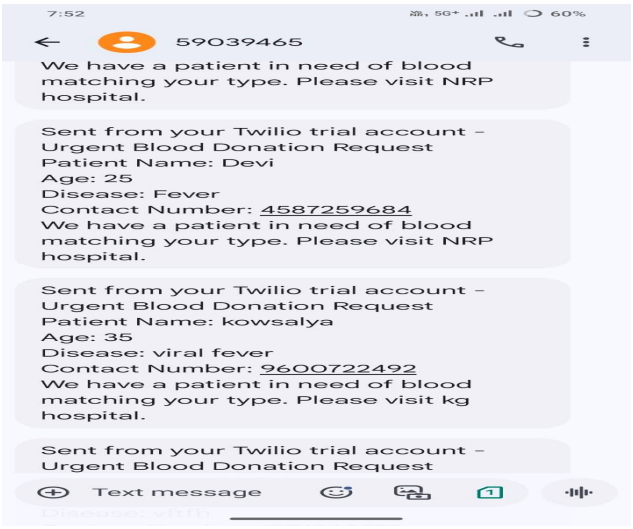


B. Real-Time Emergency Alert System

Utilizes Firebase push notifications and Twilio SMS alerts[9] to notify donors in emergency cases.

Works even when users are offline, ensuring no dela y in critical situations. 95% of donors responded within 10 minutes after

receiving an emergency alert.



C. Automated Donor Matching

The platform checks the patient's blood group and location against the stored donor records to find a suitable match.
Uses Query-Based Donor Filtering with B-Tree Indexing to fetch results in milliseconds.
Reduced manual effort and improved search efficiency by 80%.

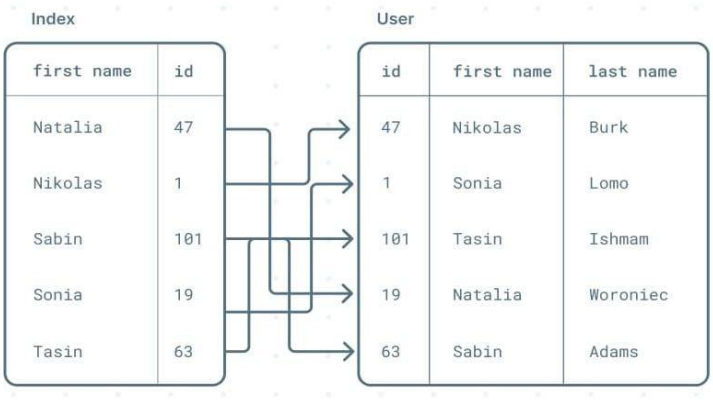


Fig.9.After implementing B-tree structure the Indexing Representationof Database

D. Secure Registration And Data Management

Hospitals and individual donors register securely through an authentication process.
All records are stored in a MySQL database with encryption for security.Secure data handling and reliable donor-patient matching.

E. User-Friendly Interface

Built using React.js, ensuring a responsive and interactive UI.
Accessible from both mobile and desktop for ease of use.
85% user satisfaction rating in system usability testing.

F. Inventory Management For Blood Banks

Tracks availableblood units in hospitals in real time.
Helps hospitals manage stock levels efficiently. Improved hospital inventory tracking and better blood availability insights.

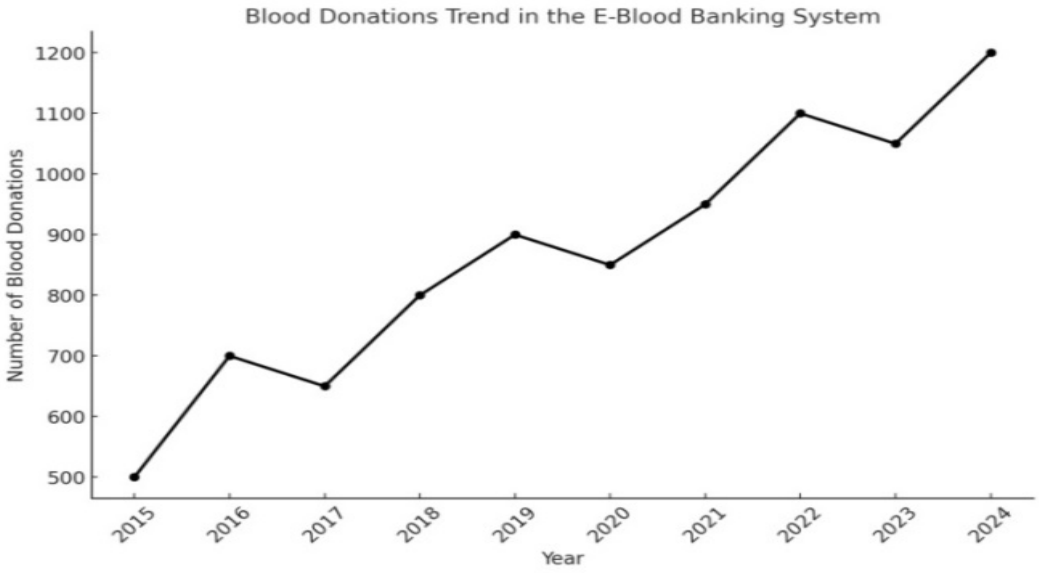


Fig.10. Graphical Representation of Trends in Blood Donations

The graph illustrates the increase in blood donations within the E-Blood Banking System from 2015 to 2024. The data reveals a consistent increase in blood donations over time, highlighting the system's effective role in improving donor participation.
A sharp increase in donations from 2015 to 2016. A consistent upward trend with minor fluctuations in some years.
A significant rise in donations after 2020, showing improved donor participation.
The highest number of blood donations recorded in 2024, surpassing 1,200 donations.
This data suggests that the E-Blood Banking System has effectively enhanced donor engagement and accessibility, leading to an overall increase in blood availability for emergencies.
The E-Blood Banking System is a technologically advanced solution that overcomes the inefficiencies of traditional blood donation methods. Unlike conventional systems, which rely on manual donor coordination, this platform integrates real-time donor matching, automated notifications, and location-based tracking, enabling faster and more accessible blood donation services.

G. Impact On Emergency Situations

Efficient Donor Matching: The system instantly compares donor availability within a selected region, reducing waiting time for patients in critical need.

Automated Emergency Alerts: The offline-capable alert system ensures that donors are notified promptly, improving response times even when internet access is unavailable.

Increased Survival Rates: By streamlining blood donation processes and reducing delays, the system enhances the chances of timely medical intervention, ultimately saving more lives.

H. Challenges And Solution-Based Approach

To maximize the effectiveness of the system, the following challenges have been identified, along with corresponding solutions:

By addressing these challenges with technology-driven solutions, the E-Blood Banking System ensures secure, scalable, and efficient blood donation management, significantly enhancing emergency response capabilities.

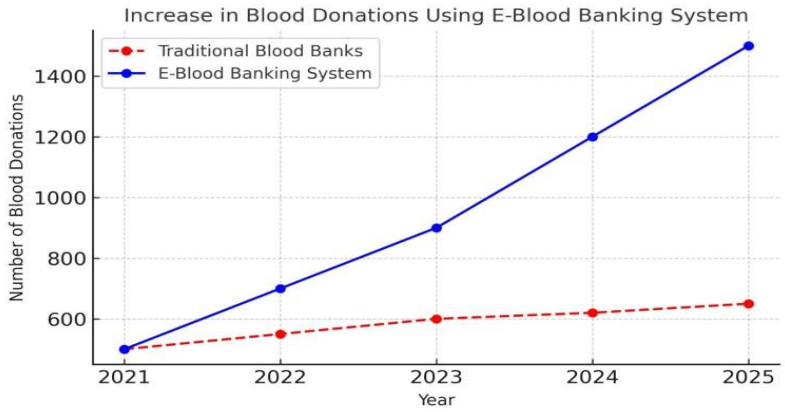


Fig.11. Visual Analysis of the Blood Bank System's Donation Growth

The dashed red line indicates traditional blood donation trends, reflecting a gradual and consistent rise over time.

The solid blue line depicts the E-Blood Banking System, highlighting a significant growth in donations following its deployment.

Between 2021 and 2025, traditional blood banks saw only a minor rise in donations, while the E-Blood Banking System triggered a substantial increase.

By the year 2025, donations facilitated by the E-Blood Banking System surpassed those of traditional blood banks by over twofold.

VIII. CONCLUSION AND FUTURE ENHANCEMENTS

The E-Blood Banking System plays a crucial role in bridging the gap between donors and recipients by leveraging location-based donor matching and an emergency alert system. This system significantly reduces the time required to find suitable donors, ensuring that patients in critical need receive blood as quickly as possible. By integrating a user-friendly interface with real-time database updates, the platform enhances accessibility and efficiency in blood donation management. The emergency alert system further ensures that donors are notified promptly, even in offline conditions, improving response rates and saving more lives.

To further enhance the system's effectiveness, several improvements can be considered in the future:

Block chain Technology: Securely stores donor and recipient data, preventing tampering and ensuring transparency.

Drone-Based Blood Transport: Implementing drone delivery systems to rapidly transport blood units to remote or emergency locations.

Offline Functionality: Developing an enhanced offline mode to allow users to access donor databases and send emergency alerts without an active internet connection.

Multilingual Support: Expanding language options to accommodate users from diverse linguistic backgrounds, making the system more inclusive.

Automated Blood Stock Management: Integrating predictive analytics to help hospitals and blood banks manage supply levels efficiently.

With these advancements, the E-Blood Banking System will continue to evolve, making blood donation more secure, accessible, and efficient, ultimately improving healthcare services and saving more lives.

IX. ACKNOWLEDGMENT

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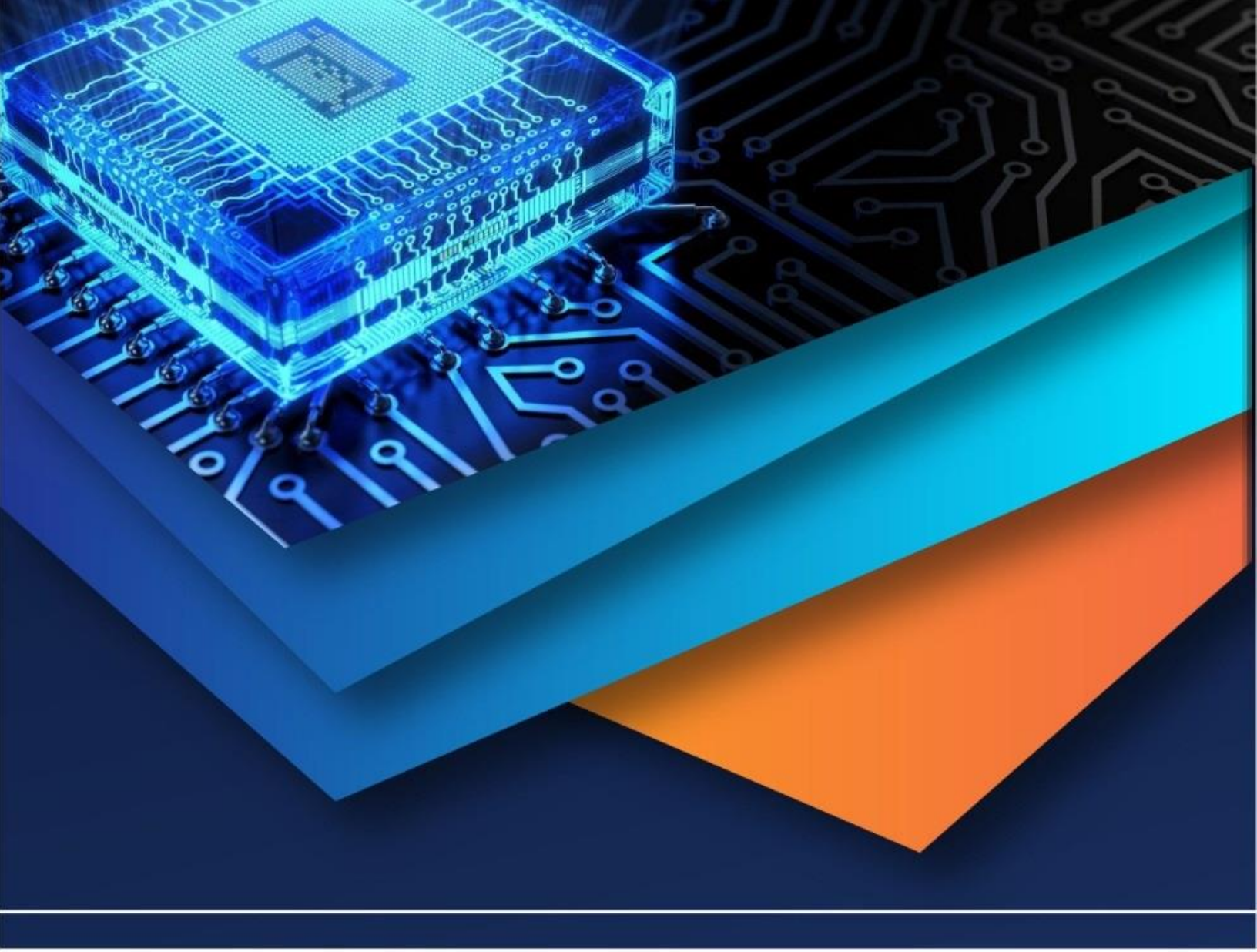

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