

Pure-Blood: Blockchain-Enabled Blood Management in Healthcare System

Chigozie Athanasius Nnadiakwe^{1,*}, Ikechi Saviour Igboanusi², and Dong-Seong Kim¹

¹Department of IT Convergence Engineering, Kumoh National Institute of Technology, South Korea

²ICT Convergence Research Center, Kumoh National Institute of Technology, South Korea

*cnnadiakwe01@gmail.com, chigozie, ikechisaviour, dskim [@kumoh.ac.kr]

Abstract—Managing blood donations in healthcare is essential to maintain a safe and steady patient supply. Despite high demand, the supply remains low, particularly in low and middle-income countries. Ensuring careful handling during donation, storage, and matching processes is critical. Trust, accuracy, and time consumption are the major constraints of existing matching methods. We designed a robust system model that uses Smart contracts to efficiently match donated blood to patients and provide security to the blood in the bank. Our model also considers matching based on first in first out and assures donor and recipient information anonymity to guarantee data security.

Index Terms—Blockchain, Blood Donation, Matching, smart contract and Security.

I. INTRODUCTION

Blood is life; as a lifesaving tissue, it is essential in the healthcare system. Unfortunately, it is not artificially produced, and its supply is limited. It requires careful management to guarantee safe and reliable transfusions as a precious biological resource. Governmental oversight plays a crucial role in achieving this goal [1]. The recent methods that employ blockchain in blood management do not offer a matching process and security of blood in the bank using the smart contract. The traditional blood management system lacks accountability, security, and trust and is prone to human error, especially during matching. The blockchain technological paradigm and trend have enabled secure data in various domains [2]; hence, its integration in the medical sector is steadily gaining momentum, with private companies globally leveraging it to store and exchange medical records [3] securely. The authors of [4] proposed a system for managing blood donations using a private Ethereum blockchain. The proposed system utilized two secure smart contracts to safeguard the safety and security of information stored in Ethereum and the Interplanetary File System (IPFS).

The researchers in the study [5] introduced an integrated blockchain model. Their model facilitates the transfer of medical information from a smart contract-enabled medical record system to an organ matching and donation smart contract. The system collects relevant data such as blood type, age, organ condition, height, and weight, then feeds it into the organ-matching management system. Combining K-Nearest Neighbor (KNN) and traditional blood donation mechanism, [6] utilized blockchain for storing essential blood

donation data. This approach employs Hash files and IPFS to safeguard the donor's details, such as image and signature files, while the KNN algorithm matches the closest blood supply center with a particular blood type. Fig. 1 illustrates the process flow of the proposed approach.

The contributions of this paper are: (i) To design and Implement a smart contract-based blood matching model for blood donation and matching. (ii) To build a trusted system that grants access to the blood bank only through smart contracts, ensuring accountability and security. (iii) To build a smart system that allows clinicians and caregivers to update the blood bank inventories.

II. SYSTEM MODEL

Our proposed system model is a private Ethereum blockchain designed to manage blood donation effectively, the matching process, take inventory, and provide security to blood banks in a healthcare setting. The technique implements a smart contract that stores the data and the matching process. In our system, as shown in Fig. 1, the process starts with a volunteer called the donor visiting a hospital for blood donation purposes. After donor screening and blood collection, a code is generated in the smart contract and attached to the blood bag; the code is stored on the smart contract. All the inputs to the smart contract are made through blockchain addresses to ensure privacy and security. The health caregiver registers the patient through a blockchain address into the smart contract. The smart contract does the matching, and the corresponding code to the matched blood bag is returned to the caregiver. The smart contract removes the data from the already matched code and updates it when new registrations are made. Our system considers the age of the donated blood and starts the matching process from the oldest in the blood bank. As shown in Fig 2, the Result of our system deployment. It shows a successful input and view function that represents our model design.

III. EVALUATION AND RESULTS

The pseudo-code shows the Algorithm of our system model. Our smart contract was able to compare different blood types and match accordingly, update donations, view total blood in the bank, and also keep records of each blood type in the blood bank.

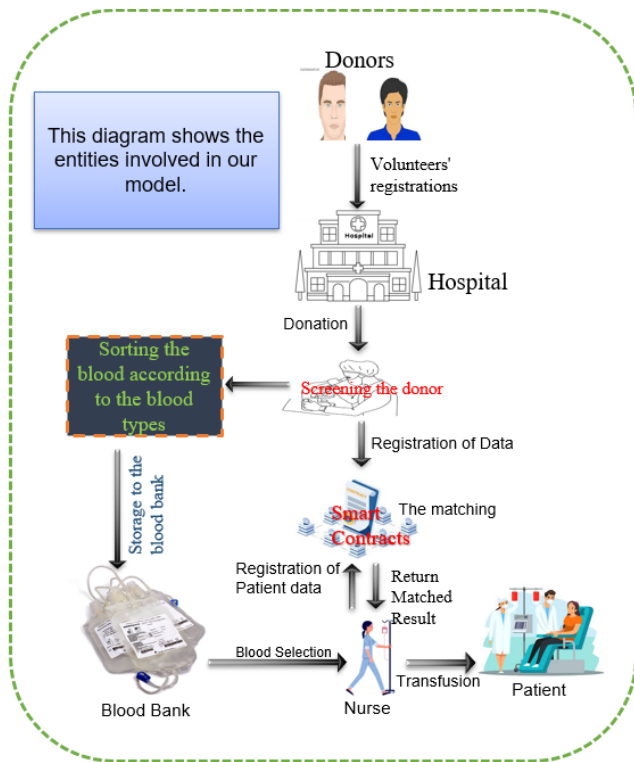


Fig. 1: The Pure Blood System Model: The diagram shows the entire process of Pure-Blood Blockchain-enabled blood management in the health sector.

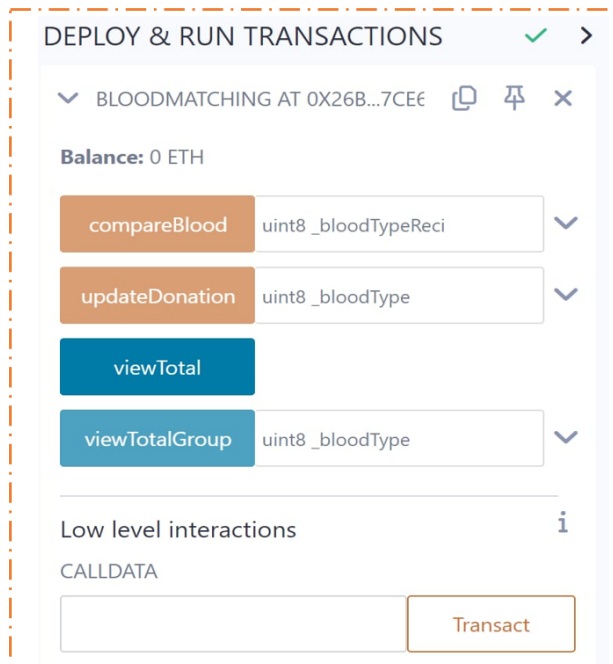


Fig. 2: Smart Contract for Pure Blood: This picture shows the deployment result of our system model, indicating all the input and view functions.

1) **Blood Matching Process:** Algorithm 1. below explains the blood matching process.

Algorithm 1: Blood Matching Process

```

Require: Blood donation is registered
Require: Donated blood is not assigned to any recipient
Require: Recipient data is registered
Require: donor and recipient blood to be compatible
for all recipients do
  score = 0;
  if donated blood and recipient's blood type are compatible then
    if Matching Blood is confirmed then
      check the oldest in the bank
    end if
    if Oldest is find then
      Update the smart contract;
    end if
    return best match;
  if Blood is not compatible then
    No match if found;
  end if
end if
end for
if New Registration then
  Update the smart contract;
end if
Process completed

```

IV. CONCLUSION

In this paper, blood matching was automated using a smart contract. Matching was done on a first-in, first-out basis, and records of different blood types, donors, and recipients were kept anonymously. This approach guarantees trust, security, confidence, and accountability for blood donation and management in the healthcare system.

ACKNOWLEDGMENT

This work was partly supported by Innovative Human Resource Development for Local Intellectualization program through the Institute of IITP grant funded by the Korean government(MSIT) (IITP-2024-2020-0-01612, 50%) and by Priority Research Centers Program through the NRF funded by the MEST(2018R1A6A1A03024003, 50%)

REFERENCES

- [1] H. O. Kim, "Current State of Blood Management Services in Korea," *Korean Society for Laboratory Medicine*, vol. 42, pp. 1–4, 5 2022.
- [2] L. A. C. Ahakonye, C. I. Nwakanma, and D.-S. Kim, "Tides of Blockchain in IoT Cybersecurity," *Sensors*, vol. 24, no. 10, p. 3111, 2024.
- [3] S. Kim, J. Kim, and D. Kim, "Implementation of a Blood Cold Chain System Using Blockchain Technology," *Applied Sciences*, vol. 10, p. 3330, 05 2020.
- [4] D. Hawashin, D. A. J. Mahboobeh, K. Salah, R. Jayaraman, I. Yaqoob, M. Debe, and S. Ellahham, "Blockchain-Based Management of Blood Donation," *Ieee Access*, vol. 9, pp. 163 016–163 032, 2021.
- [5] I. S. Igboanusi and D.-S. Kim, "Blockchain enabled medical record and organmatching integrated system," *KICS*, 2023.
- [6] Y. Luo, G. Lu, and Y. Wu, "Design and Analysis of Blood Donation Model Based on Blockchain and KNN," in *Proceedings of the 2021 3rd Blockchain and Internet of Things Conference*, ser. BIOTC '21. New York, NY, USA: Association for Computing Machinery, 2021, p. 32–37. [Online]. Available: <https://doi.org/10.1145/3475992.3475997>