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Blood Donation Security System Using Block Chain

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Abstract

We propose a private Ethereum blockchain-based solution to automate blood donation management processes in a manner that is fully decentralized, traceable, transparent, auditable, private, secure, and trustworthy.

We integrate the private Ethereum blockchain with the decentralized storage of the Interplanetary File System (IPFS) to overcome the storage limitations. We develop two smart contracts along with algorithms to implement functionalities and define rules regarding blood donation management.

We evaluate the proposed blockchain-based blood donation management solution and the developed smart contracts using the security analyses. Also, we compare our proposed approach with the existing solutions.

Our proposed blockchain-based blood donation management solution is generic and can be customized to meet the needs of other industrial applications with minimal modifications and efforts.

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1. INTRODUCTION

1.1 Introduction

Blood is one of the most crucial fluids in the human body. It contributes in aiding the organs with the essential and valuable substances required for living. Since the demand for blood surpasses all other medical necessities, governments often educate their citizens on the importance of blood donation through organizing awareness programs. The number of donors in the years 2018-2019 were estimated to be 136,908 donors, contributing to a total of 216,639 donations. In general, every 56 days, mostly healthy individuals give blood donations. The World Health Organization (WHO) estimates that the annual amount of blood donations collected is 112.5 million units which is approximately 50 million liters per year. Yet, the shortage of blood donors has risen with the emergence of new diseases, raising the need to enable reliable and efficient blood donation management. Patient Blood Management (PBM) is a vast and challenging task. The restrictions and gaps occurring with the current blood management system limit the efficient performance of the supply chain. Hannon et. al reported that the blood component wastage rates usually run from 1% to 5%, and that the amount of disposal is not shared or visible to clarify the reason behind it. Thus, any improvement or development is a significant factor in providing effective healthcare worldwide. Figure 1 illustrates a typical flow process of blood donation. First, donors have three options to donate blood. Option 1, through healthcare centers where blood units are transported to the nearest blood bank. Option 2, through mobile blood collection units. Option 3, directly through blood banks. After that, separation, testing, and storage are operated on each donated blood in the blood bank. The separation process is based on separating whole blood units into components of red cells, platelets, and plasma through centrifuges. Next, testing is performed to verify the blood type and indicate any infectious diseases. When test results are established, units proper for transfusion are then labeled and stored either in refrigerators and freezer lockers or in walk-in cool and freeze rooms. According to the Food and Drug Administration (FDA) and the American Association of Blood Banks (AABB) standards, red blood cells are stored in refrigerators at 6ºC and have an expiration date of 42 days. As per the FDA requirements, plasma is frozen in freezers for up to one year, and platelets are stored for up to five days at room temperature. Subsequently, blood units are packaged and loaded to transporters based on doctors' orders

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2. Literature Survey

For their patients' treatment. Finally, after healthcare centers receive blood units, they further transfuse to patients. Blood-related information might range from blood type to blood state, to the donor's health record, when the donor donated the blood, and other related readings. Despite the benefit of inter blood bank transfers, hospitals commonly fear the chance of receiving the wrong blood, or even worse, blood infected with hepatitis, HIV, or other similar diseases. Several risks are associated with carrying infective donated blood in the supply chain. An epidemic in the late 80s occurred because polluted blood infected with HIV was carried out in the supply chain. Nonetheless, counterfeiting and forgery of medicinal products are considered as another concern in the supply chain, where a falsified illegal copy of an original product can be replaced with the original product itself. This results in the possibility of replacing the blood with another type or attaching a false label to cover up the existing effective blood. These are major obstacles in the supply chain management system which caught the attention of researchers and other interested parties. Blockchain-based technology in the blood supply chain can assist in reducing the aforementioned risks. The emerging technology possesses several solutions for the verification of the origin of the donated blood. This can be made possible by tracing the source information of the donors in a trusted manner throughout the stages of the supply chain. Several countries across the world have emphasized the importance of traceability and mandated its existence in healthcare supply chains. The Drug Supply Chain Security Act (DSCSA) in the United States, has obligated pharmaceutical industries to inherent electronic systems that will identify prescriptive drugs while being distributed across the country. Similarly, China requires all stakeholders in healthcare supply chains to use a specialized IT system to be able to record the information of products whenever they are sent to or from their warehouses. Subsequently, several supply chains integrated traceability as an important part of establishing authenticity across their chains.

3. OVERVIEW OF THESYSTEM

3.1 Existing System

Many traceability solutions use a central server to handle the visibility and traceability problems. One popular solution for tracking and monitoring blood bags is using the radio frequency identification (RFID) technology. The RFID is a standing-out technology because of its high significance in supply chain management. In industrial applications, this technology is used to transfer data utilizing radio frequency waves and further identifies tagged items. Davis et al. proposed the RFID-based dynamic blood information management system to track blood products in blood centers.

3.1.1 Disadvantages of Existing System

- The system is not implemented blockchain based Blood donation and one popular solution for tracking and monitoring blood bags is using the radio frequency identification (RFID) technology which is low accuracy.
- The system is not generic and can't be customized to meet the needs of other industrial applications with minimal modifications and efforts.

3.2 Proposed System

The proposed system, Online Blood Bank site overcomes the drawbacks of the present system using block chain technology. The Blood Bank helps the people who are in need of a blood by giving them overall details regarding the donors with the same blood group and within their city. Provide security to these data using block chain technology. The advantages of the proposed system are listed below.

3.3 Methodology

Collecting blood units

Delivery process

Creating component blood units

Requesting order

Approving order

Collectwholebloodunit: In this function, it was tested whether or not the owner of the smart contract was able to add the donor ID. Successful execution of the function and its corresponding events and logs are displayed.

Createbloodunit: The Createbloodunit function is the most important key function in this contract. It notifies the details of the produced blood component units. As we mentioned in the previous section, the enumerated variable "BloodcomponentType" takes inputs in the form of uint8 where "0" represents "redelete", "1" represents "plasma type", and "2" represents "platelets type". Thus, a successful execution of creating a platelet unit is given in Figure 7.

BloodunitRequested: The doctor sends a blood component unit request to the smart contract. This is done using the BloodunitRequested () function. The logs after the doctor have sent the request. The request includes blood component unit type, quantity, and requested date.

BloodUnitPrescription: In this function, it was tested whether or not the doctor is able to insert the details of the prescription. Successful execution of the function and its corresponding events and logs are shown.

BloodUnitTransfusion: As a final step in this process, the nurse administrates the blood component unit to the patient, and this is done using BloodUnitTransfusion function.

4. Architecture

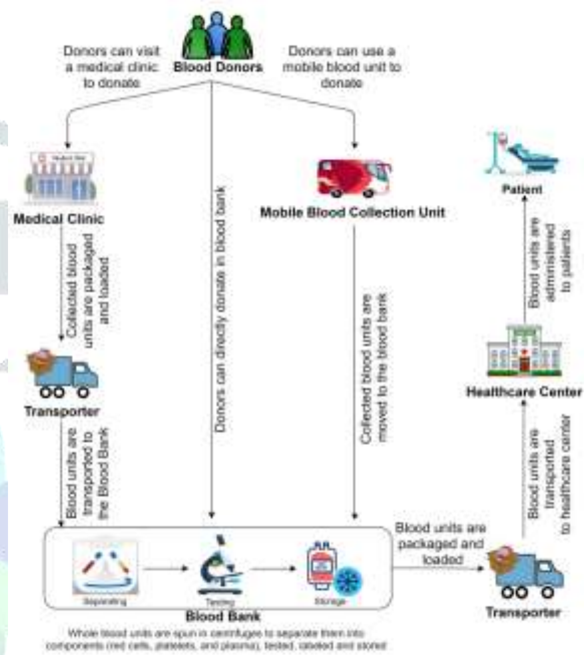
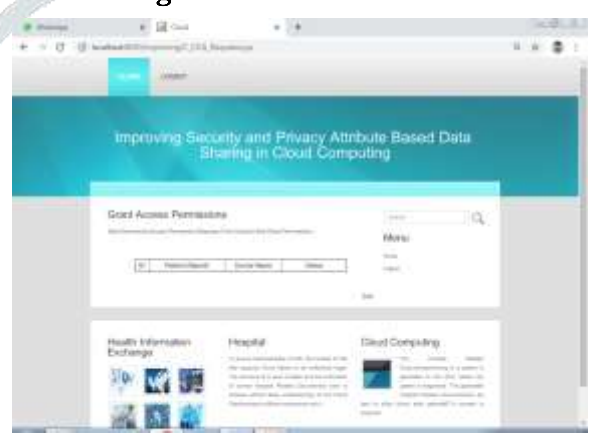


Fig 1: Frame work of proposed method

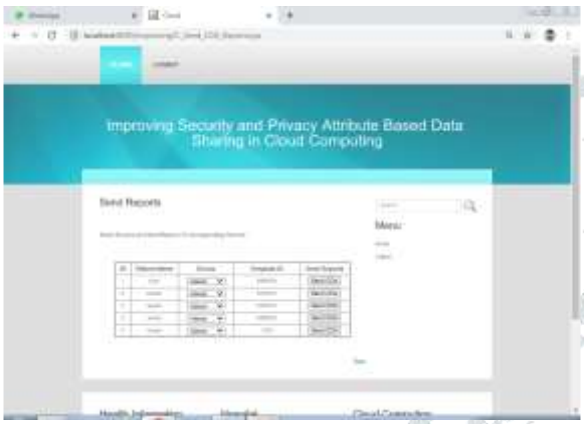
5. RESULTS SCREEN SHOTS

Home Page:

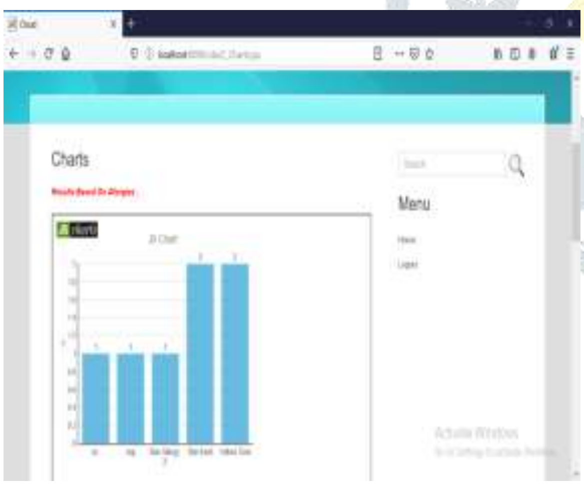


Upload Data:

Choose options:



Predict Result:



6. CONCLUSION

In this paper, we have proposed a blockchain-based blood donation management system that traces the origin of the blood in a transparent, private, secure, trustworthy, auditable, and decentralized manner. The proposed solution employed the smart contract feature of the private Ethereum blockchain to record and log events automatically. We integrated the private Ethereum blockchain with the IPFS to deal with the limited storage issue. We tested and validated the functionality of our solution using the Remix IDE. Our developed smart contracts' code has been made available on the GitHub repository. We conducted the security analysis to show that the proposed blood donation management solution is robust and secure enough against major security vulnerabilities and attacks. In addition, we compared our proposed approach with the existing solutions.

Future Enhancement

- ✓ In the future, we aim to deploy and test our solution on the real Ethereum network and build an end-to-end Dapp. Furthermore, violation monitoring will be added to further enhance the security of the blood cold supply chain.
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