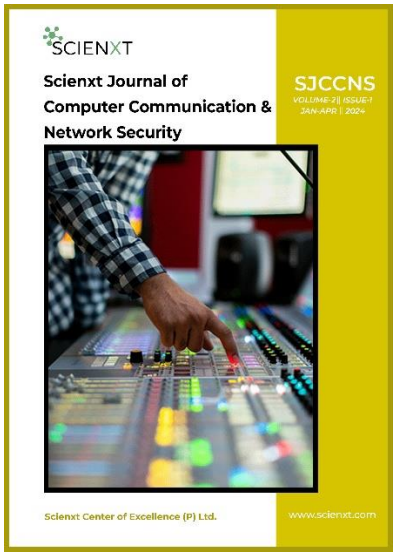

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Optimizing organ donor matching and enhancing transparency through blockchain technology

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Abstract:

Over countless lives have been saved worldwide through the diversionary healing process of organ transplantation. All the same, the process of allocating resources and making gifts has been irritated by certain obstacles, a dearth of clarity, inefficiencies, and worries about the integrity and autonomy of the dossier. By utilizing blockchain electronics' efficiencies to create a safe and comprehensible platform for tool gifting, this project offers a unique solution. Providing a transparent and safe framework for tool distribution and tracking, the project intends to design and develop a way to use blockchain technology. It will be the responsibility of a permissioned blockchain network to ensure privacy and regulate access to sensitive data. It will also speed up the process of recording and listening to gifts of organs, which is one of the most important aspects of benefactor registration, giving donors the best chance, and scheduling transplants. Smart contracts will automate and execute various aspects of the organ distribution process, ensuring fairness and openness, along with corresponding pre- established rules and conditions. Transaction traceability and immutable records provided by blockchain electronics will improve dossier security. Secret dosages and medical records will be kept in an encrypted plan accessible only to those with the proper encryption key and accompanying authorization. This strategy will protect donors' and recipients' privacy by reducing the possibility of data breaches and illegitimate actions. This project's positive exercise has the potential to significantly progress our tool transplantation, conditioning more lives in the process and raising the bar for healthcare as a whole.

Keywords:

Blockchain, Ethereum, Organ donation, Organ transplantation, smart contracts, Traceability.

1. Introduction:

Organ decline happening from injury or affliction, maybe a life-threatening condition, frequently needing means transplants for survival. While money tool is a commendable act, the demand for money exceeds the convenient supply, resulting in an increasing relocation waiting list. Successful transplants mean believing in compatible benefactors and achieving safe replacement processes. Blockchain electronics, a secure and immutable account book joint across a network, has the potential to enhance the adeptness of means transplantation processes. It can guarantee data honor, halt unauthorized approaches, and further obvious transactions in the donation process, discussing a few of the challenges that guide the current system.

2. Literature:

It proposes a blockchain-based website to enhance and secure the organ donation process within the medical field, focusing on organ donations, hospitals, patients, and maintaining the integrity of sensitive medical records. The system is designed to automate processes, ensure security, and eliminate the possibility of manipulation, while also providing a solution for maintaining the anonymity of medical records [1]. The proposed system employs blockchain and decentralized technologies to enhance the organ donation process. It establishes a secure, automated workflow involving hospitals, donors, and recipients, leveraging technologies such as IPFS, Ethereum blockchain, and smart contracts for data integrity and transparency. The algorithm and table provide comprehensive details of the system's functionality [2]. Organ donation process begins with identifying eligible donors, obtaining consent, and utilizing a computerized system for matching donors to recipients. Coordination and communication between transplant centers, Organ Procurement Organizations, and surgical teams are crucial. The recovery of organs is conducted with respect, and transplantation occurs promptly to ensure organ viability. Anonymity is maintained, with the option for individuals to share their identities if they wish [3]. The proposed "Life Share" system is a web-based platform designed to bridge the gap between blood donors, recipients, and blood banks in Sri Lanka's healthcare sector. The system consists of four main components:

1) Blockchain-Based Smart Identity
2) Automated Blood Group Matching with Location Tracking
3) Predicting Future Blood Supply and Demand
4) Evaluating Organ Donation Failures and Finding Solutions
5) Dataset and System Analysis

6) Tools and Technologies

In summary, the "Life Share" system integrates blockchain, machine learning, and predictive modeling to enhance blood and organ donation processes, promote transparency, and address healthcare challenges in Sri Lanka. The technology stack includes React JS, Node JS, Java, and Python for a comprehensive and innovative solution [6]. The study examines the centralized and potentially opaque nature of the United States' organ donation system, specifically focusing on the Organ Procurement and Transplant Network (OPTN) managed by the United Network for Organ Sharing (UNOS). To address concerns about transparency and data integrity, the paper explores the feasibility of a blockchain-based OPTN. A prototype using the Hyperledger Fabric framework was developed, considering factors such as max batch time out, max block size, endorsement policy, and transaction rate. Two variants of blockchain chain code were tested, revealing that performing organ-candidate matching on the blockchain (Scheme A) outperformed an external approach (Scheme B) in write operations, with a recommendation to adopt Scheme A with a max batch time out close to the transaction rate.

The study underscores the potential of blockchain technology to enhance the transparency and efficiency of the organ donation system, offering insights into the optimal configuration for organ-candidate matching on the blockchain to address existing concerns in the field [7]. It focuses on leveraging blockchain technology, specifically Hyperledger Fabric (HLF) and smart contracts (SCs), to enhance transparency, accountability, and security in the sharing of medical data for multi-stakeholder involvement. The rapid digitalization in the health domain has prompted the need for advanced technologies like virtual reality, artificial intelligence, and blockchain. The proposed model, based on blockchain, aims to address challenges such as accountability, transparency, security, cost, and time efficiency. The framework, designed for organ/tissue transplantation, utilizes blockchain to offer increased visibility, security, and cost-effective data storage. By implementing smart contracts on Hyperledger Fabric, the system ensures transparency and accountability in managing shared medical data[9]. It outlines the evolution of organ donation and transplantation since the first successful kidney transplant in 1954. The complexity of kidney allocation arises from a persistent disparity between organ supply and demand. To address this, various allocation algorithms have been employed, with some proposals incorporating blockchain technology. The global push for collaboration among organ donation organizations highlights the need for international regulations, especially given the significant variations in organ allocation policies between countries.

The paper's primary focus is on kidney allocation algorithms, acknowledging the high demand for kidney transplants. The survey explores existing organ allocation systems, emphasizing

blockchain-based decentralized solutions as potential remedies for current limitations in the field of organ donation [10].

3. Proposed approach:

A secure method for organ donation is proposed through a decentralized platform facilitated by a web portal connecting organ donors, recipients, and hospitals. The objective is to eliminate third-party interference, safeguard patient data integrity, and protect organ identification. This is attained with the help of smart contracts. Smart contracts will contain the protocols that will govern our organ transaction process and facilitate smooth transactions without intermediaries. These smart contracts will be deployed on a blockchain-based distributed computing platform, Ethereum. All transaction-related information and patient data will be bundled into a smart contract and pushed into the blockchain platform called Ganache.

Designing a system architecture for organ donation using blockchain involves leveraging the decentralized nature and immutability of blockchain technology to enhance transparency, security, and traceability in the organ donation process. The system should have a user- friendly interface for organ donors, recipients, healthcare professionals, and administrators to interact with the platform. This interface can be developed as a web application. Utilize smart contracts on the blockchain to define the rules and conditions for organ donation transactions. Smart contracts can automate and enforce various aspects, such as consent verification, organ matching algorithms, and the transfer of ownership. Set up a permissioned blockchain network that allows authorized participants, such as hospitals, organ procurement organizations, and regulatory bodies, to join the network as nodes.

This can be achieved using blockchain frameworks like Hyperledger Fabric or Ethereum with private chains. Store organ donation-related data on the blockchain. This includes information about donors, recipients, medical records, consent forms, and organ availability. Ensure data privacy and confidentiality by encrypting sensitive information. Validators on the network verify and validate transactions using the predefined smart contracts. This process ensures that only authorized and valid transactions are added to the blockchain. Consider legal and regulatory aspects of organ donation, such as privacy laws (e.g., General Data Protection Regulation), consent requirements, and compliance with local organ allocation policies. Implement auditing mechanisms to track and monitor the organ donation process, ensuring transparency, accountability, and fraud prevention.

4. Algorithm:

This is an application for managing medical pledges, donors, and patients on a blockchain network using web3.js and a smart contract deployed on a local Ethereum network (likely Ganache). Below is an algorithmic breakdown of the main functionalities:

4.1. Initialization and Setup:

InitializeApp:

Initialize web3.js with local Ethereum node connection.

Retrieve accounts from the local Ethereum node.

Instantiate contract instance with contract ABI and address.

4.2. Registration:

Register(user):

Get user input for personal information Validate input values for correctness and completeness

If input values are valid:

Check if medical ID already exists in the smart contract

If medical ID does not exist:

Call respective smart contract function to store registration data

Display registration success message

Else:

Display warning message indicating medical ID already exists

4.3. Search

Search (user):

Get medical ID input from user

If medical ID input is not empty:

Check if medical ID exists in the smart contract

If medical ID exists:

Fetch user information from the smart contract

Display userinformation

Else:

Display message indicating medical

ID does not exist

Transplant Matching

TransplantMatch():

Retrieve all patients and donors from the smart contract

For each patient:

For each organ needed by the patient:

Find potential donors matching blood type and organ availability

If match is found:

Display patient-donor match information

Viewing Data

ViewPledges():

Fetch and display list of pledges from the smart contract

ViewDonors():

Fetch and display list of donors from the smart contract

ViewPatients():

Fetch and display list of patients from the smart contract

UI Interactions

ShowWarning(user, message, color):

Display warning message for user with specified message and color

CloseAlert():

Close warning alert

Utility Functions

GenerateTableHead(table, data):

Generate table header based on provided data

GenerateTable(table, data):

Generate table rows based on provided data

SelectRow():

Highlight selected row in table ClearSearchValues(user):

Clear search result values from UI CheckInputValues(user, fullname, age, gender, medical_id, organ, weight, height):

Validate input values for registration

Event Listeners

OnLoad():

Call InitializeApp() when page loads Set event listeners for various UI interactions

Asynchronous Operations

Asynchronous operations for fetching data from smart contract and interacting with Ethereum blockchain

5. Implementation details:

Blockchain technology ensures the security and immutability of data, mitigating the risk of unauthorized access or manipulation. Each entry in the patients' and donors' lists is cryptographically linked, creating a transparent and unalterable chain of information. This not only safeguards the integrity of the records but also builds trust among stakeholders involved in the organ donation process. Smart contracts embedded in the blockchain can automate certain aspects of the matching process, ensuring that the criteria for compatibility, such as blood type and other medical factors, are met.

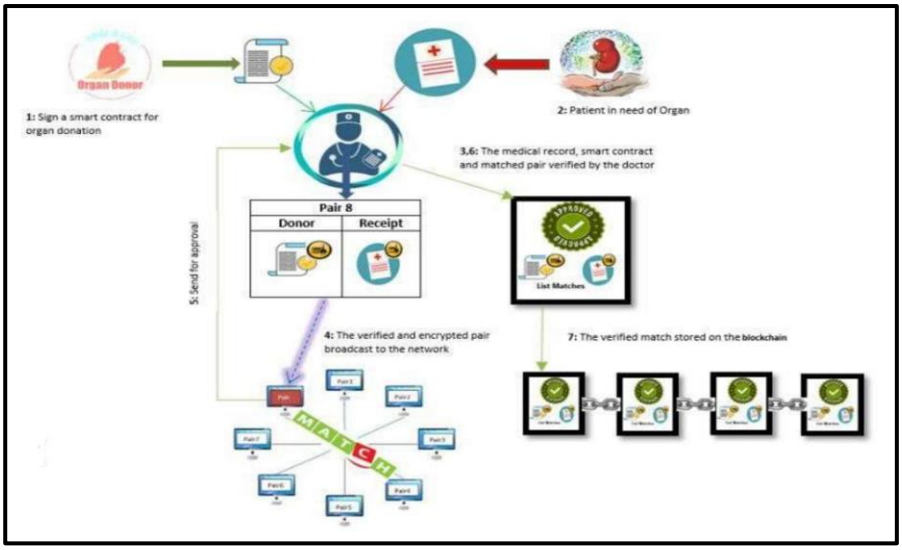

Figure. 1: Organ donation and transplantation flow chart

6. Results and discussion:

Implementing a blockchain-based organ donation platform involves complex technical aspects, regulatory considerations, and collaboration with healthcare institutions. Engaging experts in blockchain development, healthcare regulations, and legal frameworks is recommended to ensure the success and compliance of your platform.

7. Security analysis:

7.1. Integrity:

The suggested method for managing organ donations is event-based and records every transaction on an unchangeable ledger, enabling users to follow the donation and transplantation procedures step-by-step. To ensure that the recipient with the highest priority receives the donated organ, any ranked list of receivers who have been matched with potential donors, for instance, is documented as an event.

7.2. Authorization and accountability:

In the suggested solution, Ethereum smart contracts are written in Solidity and make use of the "Modifier" feature. This feature enables specified users to carry out certain tasks. As a result, everyone involved takes responsibility for their activities, and any unlawful activity is recorded as an event in an unchangeable ledger. Consequently, errors and unlawful activity can be tracked down to determine their origins. For example, the matching function where the matched

list is saved and may be obtained later by the DApp can only be executed by the organ matching organizer. Furthermore, the organ transplantation function can only be performed by a transplant surgeon. As such, these participants have responsibility for their conduct and will be held liable for any manipulation or errors made during these two procedures.

8. Generalization:

Our suggested blockchain-based system demonstrates how blockchain technology can help with the tracking and management of the transplantation of donated organs during the stages of transplantation, transit, matching, removal, and registration.

It is possible to adapt the created smart contracts, which depict the many stages of the donated organ transplantation management system, to other systems involving extremely sensitive materials that need accountability, tracing, and tracking. Delivery functions, for instance, have numerous uses in the healthcare sector as well as other fields and businesses.

Similarly, blood donation programs, medical equipment donations, and even industry products might benefit from the concept of comparison and auto-matching between the donor and the registered patients.

9. Comparison with the existing solutions:

Features	Our solution	Dajim [1]	Jain [7]	Holbi [12]
Blockchain Platform	Ethereum	NA	Ethereum	NA
Smart Contract	Yes	No	No	No
Tracing	Yes	Yes	Yes	Yes
Ganache	Yes	No	No	No

Features	***Our solution***	***Dajim [1]***	***Jain [7]***	***Holbi [12]***
Blockchain platform	Ethereum	NA	Ethereum	NA
Smart contract	Yes	No	No	No
Tracing	Yes	Yes	Yes	Yes
Ganache	Yes	No	No	No

10. Conclusion and future work:

Regulatory considerations, cooperation with healthcare institutions, and intricate technical elements are all involved in the implementation of a blockchain-based organ donation platform.

It is advisable to consult with specialists in blockchain development, healthcare regulations, and legal frameworks to guarantee the prosperity and adherence of your platform.

Enhancing the record-keeping system through the addition of more metadata, the ability to securely share records with authorized healthcare providers, and the investigation of possibilities for interoperability with other healthcare systems are some examples of how the project could boost the efficacy and accuracy of the matching algorithms and broaden the compatibility criteria.

Enhancements to the application could include putting strongsecurity measures in place to safeguard user data, investigatingblockchain data encryption methods, and adhering to privacylaws. In order to improve organ donation procedures, boost participation, and save more lives, the future work for a blockchain-based organ donation application primarily consists of system enhancements, addressing technological, ethical, and regulatory challenges, and broadening the application's reach.

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