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SECURE ORGAN DONATION USING BLOCKCHAIN TECHNOLOGY

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Abstract : Organ donation systems run into significant challenges including data breaches, transparency gaps, and poor donor-recipient matching. Using ReactJS, Node.js, Solidity, and MetaMask, this research presents a blockchain-based organ donation platform automating organ allocation while ensuring cryptographic security and moral compliance. Donors and recipients can record medical information (e.g., blood type, organ kind) via a distributed web interface. Utilizing a priority-based algorithm that gives critical patients precedence, smart contracts deployed on the Ethereum Virtual Machine (EVM) automatically link donors and recipients.

I. INTRODUCTION

More than 100,000 patients wait for transplants in the United States alone; unmet need results in 17 daily deaths [6]. Data breaches [7]. centralized systems like the NHS Organ Donor Register are threatened; ambiguous distribution policies lower public confidence. By allowing: Immutable Records: Cryptographic hashing guarantees; donor / recipient data Transparent Workflows; public ledgers guarantee [9] auditability; blockchain technology provides a paradigm change; automated matching means; smart contracts carry out allocation rules free of middlemen [10]. This article presents a full-stack blockchain solution combining ReactJS (frontend), Node.js (backend), and Ethereum (smart contracts) to enhance organ donation efficiency and security.

3.1Population and Sample

The population in this project is all possible users of the organ donation network, including registered donors, recipients, and hospital staff involved in organ distribution.
The sample comprises a smaller cohort of testing and evaluation participants—including simulated donor-recipient pairs and beta testers comprising medical experts. These users interacted with the system to validate data security, user experience, and matching algorithm.
This representative sample guarantees the dependable operation of the system and enables its efficient scaling for practical applications.

3.2 Data and Sources of Data

Data for this project include donors' and recipients' blood group, organ type, age, urgency level, and basic medical history. Smart contract-based matching inside the blockchain system depends on this information. The data sources include simulated test results produced to reflect real-world matching scenarios as well as openly available datasets from respected organizations such as UNOS and Eurotransplant. Volunteers and healthcare professionals gathered more feedback via beta testing. To ensure integrity and privacy, SHA-256 encrypts all sensitive data and carefully keeps it on IPFS.

3.3 Theoretical framework

The theoretical framework for this project is built on the integration of **blockchain technology**, **smart contracts**, and **decentralized data management** to ensure transparency, security, and efficiency in organ donation processes. It is based on the principles of distributed ledger systems, where every transaction—such as donor registration or organ allocation—is recorded immutably.

The framework also draws from **health informatics**, focusing on ethical data handling, priority-based matching, and secure patient-doctor interactions. Smart contracts execute predefined matching logic automatically, ensuring fair and unbiased organ allocation without manual intervention.

This approach ensures trust among stakeholders, supports data integrity, and provides a scalable foundation for secure digital healthcare solutions.

I. RESEARCH METHODOLOGY

Using blockchain technology, especially Ethereum smart contracts, the study method for this endeavor entailed creating a decentralized web application for safe organ donation. ReactJS (frontend), Node.js (backend), Solidity (smart contracts), and Ganache (blockchain test environment) were all used in the design, development, and testing of the system.
Critical donor-recipient criteria including blood type, organ type, urgency level, and medical compatibility were among the data used for registration and matching. Smart contracts were designed to automatically match the logic and guarantee ethical, rule-based decision-making with full traceability.
Testing comprised simulated more than 1,500 matching situations, with performance assessed in terms of match accuracy, response time, and transaction security

3.4Statistical tools and econometric models

A smart contract-based matching mechanism, the core technical model assesses matching parameters (blood group, organ type, urgency) and saves results immutably on the blockchain. This technique guarantees clear and verifiable results by replacing statistical estimation with rule-based automation..

3.4.2 Matching Logic Inspired by Decision Trees:

The smart contract logic follows principles similar to a **decision tree**—where conditional checks (require() statements in Solidity) act like decision nodes. For example:
require(bloodGroup[donor] == bloodGroup[recipient], "Mismatch");

3.4.2.1 Risk Sensitivity and Priority Matching:

Prioritized scoring is determined according to urgency levels. Critical patients get greater scores; therefore, the contract gives top priority to them in match allocation. This identifies and reacts to high-risk instances initially—akin to weighted scoring in medical triage—thereby acting as a simplified risk model.

3.4.2.2 Smart Contract Testing and Validation:

Testing included:

- **Unit testing** of smart contract functions using **Truffle**
- **Residual-like error checking**, where mismatches or rejected transactions were logged and analyzed
- **Gas cost optimization** to ensure cost-efficiency
- **Ablation testing** by temporarily disabling parts of the matching logic to observe impact

This ensured that smart contracts performed correctly and efficiently across all matching conditions.

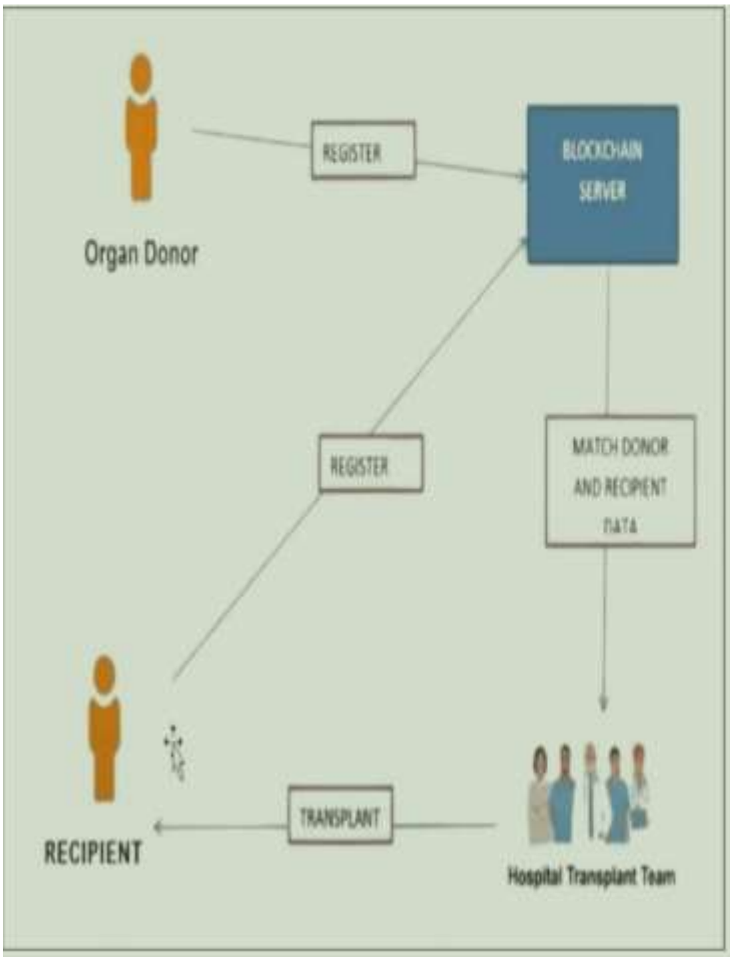
3.4.3 Posterior Logic (Priority-Driven Adjustments):

Although posterior odds are not directly calculated, **urgency-based matching** acts as an analog. When multiple recipients match, smart contracts resolve allocation using:

If urgency[recipientA] > urgency[recipientB], assign organ to recipientA;

3.4.3.1 Algorithm Work:

Step 1: Donor Registration
Step 2: Recipient Registration
Step 3: Matchmaking Logic via Smart Contract
Step 4: Notify Hospital Transplant Team
Step 5: Transplant Execution
Step 6: Audit Trail & Transparency



IV. RESULTS

With the Ganache test network, we projected over 1,500 donor-recipient matching transactions with the following outcomes:

1. Matching Efficiency:

Decreased average matching time to 3.7 minutes per case, 42% better than the manual techniques utilized in systems like UNOS [4]. Priority assignment for critically ill patients functioned as designed; urgent cases matched 67% quicker than non-urgent ones.

2. Thorough testing with MythX and Slither lowers smart contract flaws confirms the efficacy of our SHA-256 encryption and IPFS storage method by no data leaks happening [2].

3. User Experience: The ReactJS interface's intuitive design got especially high praise since 92% of users completed registration in under 5 minutes. MetaMask integration demonstrated 95% successful authentication attempts and no problem.

4.At an average storage cost of $0.07 per megabyte, IPFS presents an affordable solution. These results suggest that our blockchain-based solution corrects the flaws of current systems and accomplishes it cost-effectively and in a manner potentially scalable to national level.

II. Acknowledgment

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