Organ Transplant Management Using Blockchain Technology

Priya Shelkar[1]; Shraddha Naikare[2]; Gautami Mudhol[3]

[1,2,3] Department of Computer Science and Engineering
Nutan College of Engineering and Research
Pune, India

Abstract: Organ transplantation is a critical medical procedure used to save patients suffering from organ failure. However, traditional organ transplant management systems face several challenges such as lack of transparency, delays in organ allocation, and risks of data manipulation. These issues often reduce trust and efficiency in the organ donation process. This paper proposes a Blockchain Based Organ Transplant Management and Verification System that provides a secure and transparent platform for managing organ donation across multiple hospitals. The proposed system uses blockchain technology to store organ records in an immutable ledger to ensure data integrity and traceability. Smart contracts automate organ registration, verification, and request processing between hospitals. Decentralized document storage is used to securely store donor related medical records, while QR based verification enables quick validation of organ authenticity. The system also supports real time updates and role based access for hospitals and administrators. The results indicate that the proposed system improves transparency, security, and efficiency in organ transplant management compared to traditional systems. The proposed framework can help healthcare institutions build a reliable and tamper resistant organ donation ecosystem.

Keywords: *Blockchain; Organ Transplantation; Smart Contracts; Healthcare Security; IPFS; QR Code Verification; Decentralized Systems.*

How to Cite: Priya Shelkar; Shraddha Naikare; Gautami Mudhol (2026) Organ Transplant Management Using Blockchain Technology. *International Journal of Innovative Science and Research Technology*, 11(3), 1461-1465. https://doi.org/10.38124/ijisrt/26mar778

I. INTRODUCTION

Organ transplantation is one of the most significant advancements in modern medical science, offering a life saving treatment for patients suffering from end stage organ failure. Organs such as kidneys, liver, heart, lungs, pancreas, and cornea can be transplanted from donors to recipients in order to restore essential biological functions and improve patient survival. Over the past few decades, the success rate of organ transplantation has increased due to improvements in surgical techniques, medical research, and post transplant care. Despite these advancements, the management of organ donation and transplantation remains a complex challenge that involves coordination among multiple stakeholders including hospitals, transplant authorities, donors, recipients, and regulatory bodies.

One of the major challenges in organ transplantation is the imbalance between the demand for organs and their limited availability. In many countries, including India, thousands of patients are placed on waiting lists for organ transplants every year, while only a small percentage of these patients receive suitable organs in time. The process of identifying compatible donors, verifying medical records, and allocating organs requires accurate and transparent data management. However, many existing organ transplant management systems rely on centralized databases and manual record keeping processes. These systems often face issues such as lack of interoperability between hospitals, limited transparency, delays in communication, and vulnerability to data manipulation or unauthorized access.

Another significant concern in traditional organ management systems is the difficulty in ensuring the authenticity and traceability of medical records. Since organ transplantation involves highly sensitive patient data and legal regulations, maintaining secure records is extremely important. Any alteration, loss, or unauthorized modification of data can lead to serious consequences, including incorrect organ allocation, delays in transplantation procedures, or ethical concerns. Furthermore, the absence of a unified platform for information sharing between hospitals and transplant authorities can make it difficult to verify donor

eligibility, recipient compatibility, and the overall transplantation process in real time.

In recent years, emerging digital technologies have shown the potential to address many of these challenges. Among them, blockchain technology has gained significant attention for its ability to provide a decentralized, transparent, and tamper resistant data management system. Blockchain is a distributed ledger technology in which transactions are recorded in blocks that are securely linked using cryptographic techniques. Once information is recorded on the blockchain, it becomes extremely difficult to modify or delete the data without the consensus of the network participants. This feature ensures data integrity, transparency, and trust among different stakeholders involved in the system.

The application of blockchain technology in healthcare has been widely explored in areas such as electronic health records, medical supply chain management, clinical trials, and patient data sharing. In the context of organ transplantation, blockchain can provide a reliable platform for securely recording donor and recipient information, tracking organ allocation processes, and ensuring that medical records remain authentic and verifiable. By maintaining an immutable record of all transactions, blockchain enables transparent auditing and traceability of organ donation activities, which can help reduce the risks of illegal organ trading and data manipulation.

In addition to blockchain technology, decentralized storage systems and automated verification mechanisms can further enhance the reliability of healthcare data management systems. Decentralized storage platforms allow large medical documents and reports to be securely stored across distributed networks, reducing the risk of data loss and improving accessibility for authorized users. Automated verification mechanisms, such as smart contracts and digital authentication tools, can also help streamline the organ allocation process and ensure that only verified and authorized data is used in decision making.

Considering these technological advancements, this research proposes a Blockchain Based Organ Transplant Management and Verification System aimed at improving the transparency, security, and efficiency of the organ transplantation process. The proposed system provides a decentralized platform that enables hospitals and healthcare institutions to securely register donor and recipient information, store medical records, and verify organ related data through blockchain transactions. By integrating blockchain technology with decentralized storage and verification mechanisms, the system ensures secure record management and reliable communication between healthcare institutions.

The primary objective of the proposed system is to create a trustworthy and efficient environment for managing organ transplant information while minimizing the risks associated with traditional centralized systems. Through improved traceability, secure data sharing, and automated verification processes, the proposed system has the potential to enhance coordination between hospitals, reduce delays in organ allocation, and increase overall transparency in the organ transplantation ecosystem.

II. LITERATURE REVIEW

Organ transplantation systems have been widely studied in the healthcare domain due to the increasing demand for organs and the challenges associated with organ allocation and verification. Traditional organ management systems mainly rely on centralized databases and manual communication between hospitals, which often results in delays, lack of transparency, and risks of data manipulation.

- Several researchers have explored the use of blockchain technology in healthcare systems to improve security, transparency, and data integrity. Rajesh and Rane (2021) proposed a blockchain-based framework for managing medical supply chains, demonstrating how decentralized ledgers can ensure secure and tamper resistant record keeping. Their work highlights the potential of blockchain technology in managing sensitive healthcare information.

- Panigrahi et al. (2025) studied the adoption of blockchain in healthcare supply chains and emphasized the importance of secure data sharing and interoperability among healthcare institutions. Their findings suggest that blockchain can improve trust and coordination among hospitals involved in organ donation and transplantation processes.

- Decentralized storage technologies such as the InterPlanetary File System (IPFS) have also been used to securely store medical records and documents. By storing data in a distributed network, IPFS ensures that medical files remain tamper proof and accessible only to authorized users. Additionally, QR code based verification systems have been implemented in healthcare applications to quickly verify the authenticity of medical data and reduce the chances of fraud.

- Despite these advancements, many existing systems focus on individual components such as blockchain storage or document verification, but fail to integrate all functionalities into a unified platform. Therefore, there is a need for a comprehensive system that combines blockchain technology, decentralized storage, and verification mechanisms to improve transparency, security, and efficiency in organ transplant management.

III. PROPOSED SYSTEM

The proposed Blockchain Based Organ Transplant Management and Verification System aims to create a secure, transparent, and decentralized platform for managing organ donation and transplantation activities among multiple hospitals and healthcare institutions. The system addresses the major challenges of traditional organ transplant management systems such as lack of transparency, data manipulation risks, inefficient communication between hospitals, and difficulties in verifying the authenticity of organ related information.

The proposed architecture is designed using blockchain technology combined with decentralized storage and verification mechanisms. In this system, hospitals, transplant authorities, donors, and recipients are connected through a

secure network where organ related information can be shared and verified in real time. Blockchain technology acts as a distributed ledger that records every transaction related to organ donation and transplantation in a secure and immutable manner. Once a transaction is recorded on the blockchain, it cannot be altered or deleted, ensuring high data integrity and accountability.

The system allows hospitals to register patients who require organ transplants by providing necessary medical information such as patient identity, blood group, organ type required, medical condition, and hospital details. Similarly, donor information is registered in the system, including donor identification, available organs, compatibility details, and verification by medical authorities. These records are securely stored and linked through blockchain transactions, enabling hospitals to access accurate and verified information when needed.

To manage medical documents and reports efficiently, the system integrates decentralized storage using the InterPlanetary File System (IPFS). Instead of storing large medical documents directly on the blockchain, the files are uploaded to the IPFS network, which generates a unique cryptographic hash for each file. This hash value is then stored on the blockchain as a reference to the original file. This approach ensures that medical records remain tamper proof while reducing the storage burden on the blockchain network.

Smart contracts play an important role in automating the organ allocation and verification process. Smart contracts are self executing programs deployed on the blockchain that automatically enforce predefined rules and conditions. When a donor organ becomes available, the smart contract checks the list of registered recipients and identifies suitable matches based on compatibility factors such as blood group, organ type, and urgency level. This automated matching process reduces manual intervention and speeds up the decision making process in critical medical situations.

The system also incorporates a QR code based verification mechanism to ensure the authenticity of organ information and medical documents. Each organ record or medical report stored in the system is associated with a unique QR code generated from the blockchain transaction details. Authorized hospital staff can scan this QR code to instantly verify the authenticity and origin of the organ data. This feature helps prevent fraudulent activities and ensures that only verified information is used during the transplantation process.

Additionally, the system provides role based access control to ensure data privacy and security. Different stakeholders such as hospitals, doctors, administrators, and regulatory authorities are assigned specific permissions to access or modify certain types of data. Sensitive patient information is protected through encryption techniques to maintain confidentiality while still allowing necessary verification through blockchain records.

By integrating blockchain technology, decentralized file storage, smart contracts, and QR code verification, the proposed system provides a reliable and efficient solution for managing organ transplantation processes. The system improves transparency, enhances data security, reduces the risk of manipulation, and enables better coordination among hospitals involved in organ donation and transplantation activities.

IV. METHODOLOGY

The proposed Blockchain Based Organ Transplant Management and Verification System follows a systematic methodology designed to improve transparency, security, and efficiency in the organ transplantation process. The methodology integrates blockchain technology, decentralized storage, smart contracts, and verification mechanisms to ensure secure data sharing among healthcare institutions.

The first stage of the methodology involves system registration and authentication. Hospitals and authorized medical staff register on the platform by providing their institutional credentials and identification details. Each registered entity is assigned a unique digital identity within the system. This authentication mechanism ensures that only verified and authorized healthcare institutions can access or update the organ transplant records stored on the platform. Role based access control is implemented so that different stakeholders such as doctors, administrators, and hospital authorities have different access permissions based on their responsibilities.

The second stage involves donor and recipient data registration. Hospitals upload patient information such as patient identification number, blood group, organ type required, medical history, and urgency level. Similarly, donor information including donor identity, available organs, medical compatibility reports, and hospital verification details are recorded in the system. These records are digitally signed and then stored as blockchain transactions. Since blockchain maintains an immutable ledger, once the data is recorded it cannot be altered or deleted, ensuring the integrity of the organ transplant records.

The third stage of the methodology focuses on secure storage of medical documents. Medical reports such as laboratory test results, donor verification documents, transplantation approvals, and patient medical history are often large in size and therefore cannot be efficiently stored directly on the blockchain. To address this challenge, the system integrates the InterPlanetary File System (IPFS), which is a decentralized file storage system. When a medical document is uploaded, IPFS generates a unique cryptographic hash that represents the file. This hash value is then stored on the blockchain while the actual file remains stored in the distributed IPFS network. This method ensures secure storage while maintaining efficient use of blockchain resources.

The fourth stage involves smart contract based organ matching and allocation. Smart contracts are self executing programs deployed on the blockchain that automatically enforce predefined rules. When a donor organ becomes available, the smart contract compares the donor details with the list of registered recipients based on compatibility parameters such as blood group, organ type, medical urgency, and waiting time. Once a compatible match is identified, the system automatically generates a notification to the respective hospital and authorized medical staff for further verification and transplantation procedures.

The fifth stage focuses on verification and validation of organ information. To ensure authenticity and prevent fraudulent activities, the system generates a unique QR code for each organ record stored on the blockchain. This QR code contains encoded information related to the blockchain transaction and organ identification details. Authorized hospital personnel can scan the QR code using the system interface to verify the authenticity of the organ data stored in the blockchain. This mechanism provides an additional layer of security and transparency in the organ transplantation process.

The final stage of the methodology involves monitoring and transaction recording. Every activity in the system such as donor registration, recipient registration, organ allocation, document verification, and transplantation confirmation is recorded as a transaction on the blockchain network. These transactions create a transparent audit trail that allows regulatory authorities and healthcare institutions to track the entire lifecycle of organ transplantation activities. This traceability helps in preventing illegal organ trading and ensures compliance with healthcare regulations.

Through this multi stage methodology, the proposed system provides a secure, transparent, and decentralized platform for managing organ transplant data across multiple hospitals. The integration of blockchain technology with decentralized storage and automated verification mechanisms enhances data integrity, improves coordination between healthcare institutions, and increases trust in the organ transplantation process.

V. RESULTS AND ANALYSIS

The proposed Blockchain Based Organ Transplant Management and Verification System was evaluated to analyze its effectiveness in improving transparency, security, and efficiency in organ transplant management. The system was implemented using a blockchain framework integrated with decentralized storage and verification mechanisms. The evaluation focused on parameters such as data security, transparency, processing time, and system reliability.

To analyze the performance of the proposed system, a simulated dataset representing donor and recipient information from multiple hospitals was used. The dataset included patient identification details, blood groups, organ types, compatibility parameters, and medical records. These records were securely stored and processed through the blockchain network.

The experimental analysis showed that the use of blockchain significantly improved the security and integrity of organ transplant records. Since each transaction is recorded in a decentralized ledger, the possibility of data tampering or unauthorized modification is minimized. Additionally, the use of smart contracts automated the organ matching process, reducing the time required to identify suitable recipients.

The integration of IPFS for storing medical documents also improved system efficiency by reducing the storage load on the blockchain network. Medical files such as donor verification reports and laboratory test results were stored in decentralized storage, while their cryptographic hash values were recorded in the blockchain ledger for verification purposes.

Table 1 presents a comparison between the traditional organ management system and the proposed blockchain based system based on different performance parameters.

Table 1: Comparison of Existing System and Proposed System

Parameter	Traditional System	Proposed Blockchain System
Data Security	Moderate	High
Transparency	Limited	High
Data Tampering Risk	Possible	Very Low
Record Traceability	Difficult	Easy
Verification Time	High	Reduced

The results demonstrate that the proposed blockchain based organ transplant management system provides improved transparency, secure data management, and efficient verification mechanisms compared to conventional systems. The system ensures reliable coordination between hospitals and reduces the chances of fraudulent activities in the organ transplantation process.

VI. CONCLUSION

This research proposed a Blockchain Based Organ Transplant Management and Verification System designed to improve transparency, security, and efficiency in the organ transplantation process. Traditional organ management systems often suffer from issues such as lack of transparency, risk of data manipulation, and inefficient coordination

between hospitals. The proposed system addresses these challenges by integrating blockchain technology, decentralized storage, and automated verification mechanisms.

The system utilizes blockchain to maintain an immutable and transparent ledger of organ donation and transplantation records. Medical documents are securely stored using decentralized storage systems, while smart contracts are used to automate organ matching and allocation based on compatibility parameters. Additionally, QR code based verification allows authorized healthcare professionals to quickly validate organ related information and ensure its authenticity.

The experimental evaluation demonstrates that the proposed system improves data integrity, reduces the possibility of fraudulent activities, and enhances coordination between healthcare institutions. By providing secure and traceable records of organ transplantation activities, the system contributes to building trust among hospitals, regulatory authorities, and patients.

In the future, the system can be extended by integrating real time hospital networks, advanced medical compatibility algorithms, and government healthcare databases. Such improvements can further enhance the efficiency of organ allocation and support large scale deployment of secure organ transplant management systems.

ACKNOWLEDGMENT

REFERENCES

[1]. M. Swan, "Blockchain: Blueprint for a New Economy," O'Reilly Media, 2015.

[2]. S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," 2008.

[3]. A. Ekblaw, A. Azaria, J. Halamka, and A. Lippman, "A Case Study for Blockchain in Healthcare: MedRec Prototype for Electronic Health Records," IEEE Open & Big Data Conference, 2016.

[4]. A. Zhang, X. Lin, and P. Khan, "Blockchain-Based Healthcare Systems: Architecture and Applications," IEEE Access, vol. 6, pp. 23045–23054, 2018.

[5]. M. Mettler, "Blockchain Technology in Healthcare: The Revolution Starts Here," IEEE International Conference on e-Health Networking, Applications and Services, 2016.

[6]. S. Rouhani and R. Deters, "Blockchain Based Access Control Systems for Healthcare," IEEE International Conference on Collaboration and Internet Computing, 2017.

[7]. K. Kuo, H. Kim, and L. Ohno-Machado, "Blockchain Distributed Ledger Technologies for Biomedical and Healthcare Applications," Journal of the American Medical Informatics Association, vol. 24, no. 6, pp. 1211–1220, 2017.

[8]. A. Yue, H. Wang, D. Jin, M. Li, and W. Jiang, "Healthcare Data Gateways: Found Healthcare Intelligence on Blockchain with Novel Privacy Risk Control," Journal of Medical Systems, vol. 40, no. 10, 2016.

[9]. P. Zhang and M. Walker, "Blockchain-Based Organ Donation and Transplant Management System," International Journal of Healthcare Information Systems, vol. 12, no. 3, pp. 45–52, 2020.

[10]. A. Gupta and S. Gupta, "Secure Healthcare Data Management Using Blockchain Technology," International Journal of Advanced Computer Science and Applications, vol. 11, no. 5, pp. 123–130, 2020.