



## Blockchain-Based Organ Donation Platform: Defeating Trafficking and Ensuring Transparency

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### Abstract

Organ donation and organ trafficking are significant global health issues that pose ethical and legal challenges. There is a significant shortage of available organs for transplantation compared to the demand, resulting in the emergence of an illegal market for organs. This black market exploits and takes advantage of vulnerable individuals, who are coerced into selling their organs for transplant purposes. To address these issues, this research proposes using blockchain technology as a tool for improving transparency and traceability in the organ donation and transplantation process. The platform is built on top of the Polygon blockchain, using smart contracts to automate various aspects of the process, such as verifying donor and recipient identities, managing organ matching, and releasing organ donation records. Patient information is securely stored using MongoDB, while decentralized digital identities ensure data security and privacy. An administrative dashboard provides a user-friendly interface for managing the system, and regular data analytics and monitoring track key metrics. The use of blockchain technology has the potential to improve the safety and ethical integrity of the organ transplantation process, combat organ trafficking, and improve the availability of lifesaving organ transplants.

### 1. Introduction

Organ donation and organ trafficking are major global health issues that pose significant ethical and legal challenges. Organ trafficking involves the illegal trade of organs for transplantation, often involving the exploitation and coercion of vulnerable individuals. To address these issues, researchers and policymakers have proposed using blockchain technology as a tool for improving transparency and traceability in the organ donation and transplantation process.

Blockchain is a type of ledger that is distributed

and decentralized, which means that it can securely record and store transactions in a transparent manner. When it comes to organ donation and transplantation, blockchain technology could be utilized to create an unalterable and tamper-proof record of organ donations, transplant recipients, and surgeons involved in the process. This would help ensure the transparency and security of the information. This would help to prevent the use of illegally obtained organs and ensure that organs are allocated fairly and ethically.

One potential approach is to use blockchain to

create a registry of organ donors and recipients, with each transaction verified by multiple parties. This could help to ensure the authenticity of organ donations and reduce the risk of fraud or corruption. Furthermore, blockchain has the potential to monitor and trace the transportation of organs from the donor to the recipient, by generating a transparent and verifiable record of the entire transplantation process. This would enable the monitoring of the organ's journey, from its initial point of donation to its final destination, ensuring the integrity and security of the process.

Overall, the use of blockchain in organ donation and organ trafficking prevention has the potential to improve the safety and ethical integrity of the organ transplantation process. Blockchain could be an important tool in global efforts to combat organ trafficking and improve the availability of lifesaving organ transplants.

## 2. Background

Organ donation is a crucial aspect of modern healthcare, with millions of people around the world benefiting from lifesaving organ transplants each year. However, the demand for organs far outweighs the supply, leading to long waiting lists and a high risk of mortality for those in need of transplants. This has given rise to a global black market for organs, in which vulnerable individuals are exploited and coerced into selling their organs for transplantation.

Organ trafficking is a serious global health issue that poses significant ethical and legal challenges. The World Health Organization (WHO) estimates that around 10% of all organ transplants worldwide involve organs obtained through illegal means. The trade in illegal organs involves the exploitation and coercion of vulnerable individuals, including impoverished people, refugees, and victims of human trafficking.

To address these issues, researchers and policymakers have proposed using blockchain technology as a tool for improving transparency and traceability in the organ donation and transplantation process. Blockchain is a decentralized, distributed ledger that allows for the secure and transparent recording of transactions. Blockchain technology could be employed to establish an immutable and secure record of organ donations, transplant recipients, and the surgeons involved in the transplantation process,

within the context of organ donation and transplantation. This would help guarantee the authenticity and transparency of the information recorded. This would help to prevent the use of illegally obtained organs and ensure that organs are allocated fairly and ethically.

### 2.1. Objectives

To address global health issues of organ donation and organ trafficking by using blockchain technology as a tool for improving transparency and traceability in the organ donation and transplantation process.

To develop a secure and transparent platform for recording and tracking organ donation and transplantation using blockchain technology. This will help ensure that organs are properly matched with recipients and prevent illegal organ trafficking.

The development of an unalterable system for the safekeeping and exchange of medical records and donor information is essential to enhance the effectiveness of the organ donation process and minimize the possibility of fraudulent activities. This system would enable the reliable and secure storage and sharing of information.

To improve communication and coordination among hospitals, organ donation organizations, and government agencies involved in the organ donation and transplantation process using blockchain technology.

To empower individuals to control and share their medical information, including their organ donation status, using blockchain-based self-sovereign identity systems.

To use blockchain-based smart contracts to automate the process of organ donation and transplantation, making it easier for donors and recipients to find each other and facilitating the exchange of organs safely and efficiently.

## 3. Literature Review

Rawat et al in the year 2022 has stated that illegal trade of organ transplantation is on the rise, mainly due to the shortage and difficulty of safeguarding transplantable organs (Rawat et al.). Criminals use advanced methods of technology and the dark web to coordinate organ transplants and collect payments, often using cryptocurrency to avoid detection. The use of the internet has made it easier for criminals to exchange organs and launder money

at international locations. Patients in need of vital organs often have to wait for a long time to find a matching organ. To overcome this, they resort to illegal methods of organ trading, which is often coordinated by agents and conducted at secret locations. The trade of organs is not only illegal but also morally wrong as it often exploits vulnerable people and exposes them to social disgrace. There is a need for a system to evaluate the risk of organ trafficking on the online platform and to identify the online presence and channels of communication used by criminals.

The need for blockchain in supply chain management is showcased by Howson et al proposed in the year 2020, the paper explores how blockchain technology is being used to enhance both marine conservation efforts and supply chain management practices within the fishing industry is essential (Howson). Blockchain is a digital database that allows for secure and transparent tracking of transactions and data, reducing the risk of data corruption. It's increasingly being utilized in various industries, such as marine conservation, reducing pollution and slavery at sea, and sustainable fisheries management. The paper also highlights the challenges of building trust and equity for various stakeholders and how it's important that coastal communities and artisanal fishers are included in order for the technology to be successful. The goal is to ensure that these communities are able to benefit from the technology and that the conservation operations are transparent and trustworthy.

A decentralized organ donation system using blockchain technology is proposed by Dajil et al in 2019 (Dajim et al.). The authors discuss the problem of a lack of transparency and security in current organ donation systems, as well as a growing gap between patients on waiting lists and actual donors. They argue that implementing blockchain technology can address these issues by creating a decentralized and distributed system with a permanent ledger for recording transactions. The advantages of using blockchain technology for organ donation include increased transparency and security, efficient and cost-effective processing, and the potential to speed up the donation process. However, the authors also note that implementing the technology would require addressing legal, ethical, and financial issues. The authors also referenced the Saudi

center for transplantation, as well as other sources to discuss the general scenario of organ donation, explaining the types of donors, the importance of organ donation, and the related laws and regulations. They also mentioned the importance of maintaining the integrity of the data in the system and the fact that security breaches are a problem in modern systems.

Ranjan et al proposed a system for organ donation in 2019 that uses a FIFO approach and a web-based application to connect potential organ donors with those who need them (Ranjan et al.). The system utilizes blockchain technology as its underlying technology to provide security and immutability to the records. It also uses digital documents that are digitally signed and timestamped, as well as smart contracts and RSA algorithms to ensure authenticity. The proposed system includes 4 active participants: an administrator, hospital/doctors, donors, and receivers. The administrator is responsible for registering and managing hospitals, doctors, and donation centers, as well as managing the patient's waiting list and organ allocation. Hospitals and doctors are responsible for maintaining patient's medical records and identifying potential donors. The donors register and update their organ donation status, and the receivers seek organ donation and are matched with appropriate donors. (Giannoutakis et al.)

The use of Blockchain technology in organ donation can increase efficiency, security and privacy in the organ matching and transplant process is highlighted and justified in the paper proposed by Alandjani et al in the year 2019 (Alandjani). By creating a global database secured with cryptographic tools, the matching process can be prompt and secure. Confidentiality and privacy can be maintained by using encryption and digital certificates issued by authorized healthcare bodies. The process, as illustrated in a sequence diagram, starts with the donor signing a smart contract for organ donation, the patient/recipient filing a request for transplant, and both documents being verified and hashed by an authorized healthcare doctor. If a match is found, it is sent for approval by the doctor, and once approved, the verified matched pair is added to the Blockchain, becoming immutable and providing all parties with integrity, security, and conformance of information.

The study done by Khan et al in the year 2021 shows that machine learning and network science methods can accurately predict organ donation consent outcomes (Khan and Tutun). The study identifies several factors related to organ donation that can help OPOs and hospital staff develop better ways of approaching family members to obtain consent for donation. The proposed model can be used as an expert system to increase the consent rate for organ donation, thereby saving more lives. The study's comparison of different prediction models can guide OPOs in developing effective strategies to optimize the consent rate for organ donation. The findings of this study can be useful for policymakers, medical professionals, and researchers working to improve the organ donation process.

(Raj et al.) proposes an intelligent organ transplant system that utilizes k-anonymity and rank search algorithms to match donors with the right recipients. The system aims to reduce the time taken in searching for an organ and provide a secure organ transplant by considering medical parameters, critical requirements, and location. The study's use of a k-anonymity algorithm preserves the privacy of donors and recipients, making it a secure and efficient organ transplant system. The proposed system can be beneficial for organ donation organizations worldwide in increasing the number of successful transplants, ultimately helping more patients in need. (Hawashin et al.)

## 4. Methodology

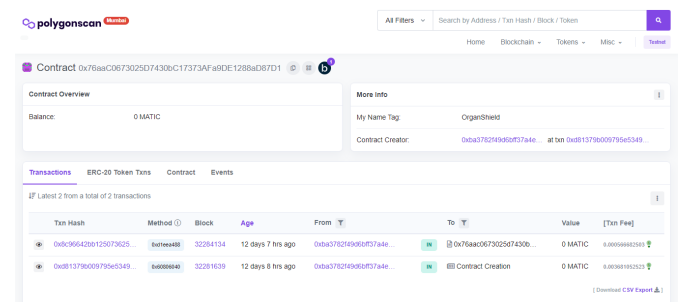
The paper shows the implementation of a secure and transparent platform for organ donation and transplantation using blockchain technology. The proposed methodology includes the following components:

### 4.1. Blockchain Platform

The proposed platform is built on top of the Polygon blockchain platform, which is a layer 2 solution for Ethereum, which provides the infrastructure for creating and executing smart contracts, as well as a tamper-proof, decentralized ledger for storing patient information and organ donation records. The use of Polygon ensures that the platform is scalable, permissioned, and secure, making it ideal for the application. (Soni and Kumar) (Reid and Fox)

### 4.2. Smart Contracts

Smart contracts are used to automate various aspects of the organ donation and transplantation process. This includes verifying the identity of donors and recipients, recording the matching of organs to recipients, and managing the release of organ donation records. The smart contracts are implemented using Solidity, a contract-oriented programming language that is specifically designed for writing smart contracts on the Ethereum blockchain and its layer 2 solutions like Polygon.



**FIGURE 1. Deployed smart contract on polygon test net**

### 4.3. Patient Information Database

MongoDB is used as a centralized database to store patient information such as medical history, current medical status, and contact information. The database is secured using AES-256 encryption and access controls, and is integrated with the blockchain platform using APIs to ensure that the records are tamper-proof and transparent. The purpose of using databases is to ensure that only vital information is stored on blockchain and rest of the information is stored off-chain storages like databases to avoid unnecessary load and clutter on the blockchain.

### 4.4. Identity Management

The proposed platform includes a robust identity management component that ensures only authorized users have access to patient information and organ donation records. This is achieved using digital identities that are built on top of blockchain-based self-sovereign identity solutions such as uPort. The use of decentralized digital identities ensures that patient data is secure, private, and cannot be tampered with.

### 4.5. Administrative Dashboard

An administrative dashboard provides a user-friendly interface for hospital staff and government officials to manage the system. The dashboard allows them to view patient information, organ donation records, and other relevant data. It also allows them to perform tasks such as matching donors and recipients, releasing organ donation records, and managing user access.

### 4.6. Analytics

Regular data analytics and monitoring are in place to track key metrics such as the number of organ transplants, the success rate of transplants, and organ trafficking cases reported. With the help of this data, the platform can be improved for better performance and increased impact.

### 4.7. Uniqueness

The proposed platform offers several unique features that set it apart from existing systems.

### 4.8. Automated Organ Compatibility Testing

The platform automates the compatibility testing procedure, which is used to determine if an organ is a match for a potential recipient. This is achieved using neural networks, to predict the compatibility of organs and recipients based on historical data. However, it is important to note that the use of machine learning algorithms alone is not enough to automate the process of organ-matching. Medical experts should evaluate the results generated by the algorithms, taking into account other factors such as the donor and recipient’s overall health, and ethical and legal considerations, before deciding which organ to transplant. (Merrill et al. Soni and Kumar)

### 4.9. Defeating Organ Trafficking

Organ trafficking is a serious concern that has led to the exploitation of vulnerable individuals and the illegal trade of organs. The proposed system aims to address this issue by creating a tamper-proof record of every step in the organ donation and transplantation process. This record would be secured on the blockchain, making it difficult to modify or manipulate.

Additionally, the use of smart contracts and identity management ensures that only authorized individuals have access to patient information and organ donation records. This helps to prevent unautho-

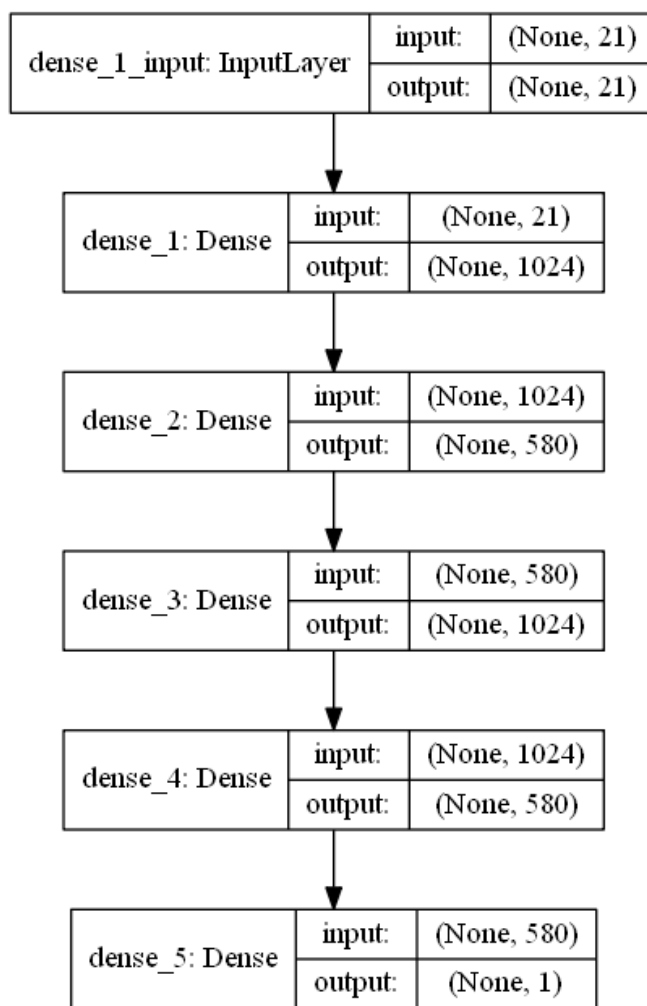


FIGURE 2. Layers of neural network

riized access and potential exploitation by individuals involved in organ trafficking.

## 5. Dataset

The model for automated organ capability is trained on a dataset that has been generated by web scraping data present on Organ Procurement and Transplant Network (OPTN) using Selenium of previous transplants, with information about the donors, recipients, and the outcomes of the transplants. By analyzing this data, the model can learn to identify patterns that are associated with successful transplants and use these patterns to predict the likelihood of success for new organ-recipient pairs.

## 6. Results and Discussion

The proposed platform successfully demonstrated the feasibility of using blockchain technology to improve the transparency and traceability of the organ donation and transplantation process. The platform was tested using a simulated organ dona-

	A	B	C	D	E	F	G	H	I	J	
1	id	dr	age	blood	gender	organ	ethnicity	bmi	lod	acceptance	
2	0	D		44	A	F	Liver	White	25.20566	TRUE	n/a
3	1	R		22	O	F	Kidney	Hispanic	27.85643	n/a	1
4	2	R		44	A	M	Liver	White	32.3209	n/a	0
5	3	R		53	A	F	Liver	White	22.34425	n/a	1
6	4	R		57	O	M	Liver	White	33.27274	n/a	1
7	5	R		92	B	F	Liver	White	26.93741	n/a	1
8	6	R		55	A	F	Heart	White	27.82959	n/a	0
9	7	R		50	A	M	Kidney	White	28.36213	n/a	1
10	8	R		43	AB	M	Kidney	White	26.3768	n/a	0
11	9	R		56	O	M	Kidney	White	25.5097	n/a	1
12	10	D		22	O	M	Kidney	White	28.54062	FALSE	n/a
13	11	R		42	O	F	Kidney	White	25.83375	n/a	0
14	12	R		52	AB	M	Liver	White	25.69446	n/a	1
15	13	R		6	A	M	Liver	Black	27.8498	n/a	0
16	14	R		54	O	M	Liver	Multiracial	36.94479	n/a	1
17	15	R		50	O	M	Kidney	White	34.24449	n/a	1
18	16	R		43	O	M	Kidney	White	29.49904	n/a	0
19	17	R		55	AB	F	Kidney	White	25.44668	n/a	1
20	18	R		60	B	F	Kidney	Black	25.92591	n/a	0
21	19	R		9	O	M	Kidney	White	25.04957	n/a	1
22	20	D		30	O	M	Kidney	White	29.48894	FALSE	n/a
23	21	R		48	O	M	Kidney	White	31.36637	n/a	0
24	22	R		50	O	M	Kidney	White	35.53483	n/a	1
25	23	R		58	A	M	Heart	Black	27.146	n/a	1
26	24	R		56	A	F	Kidney	White	25.92375	n/a	1
27	25	R		50	O	F	Kidney	White	28.21004	n/a	0

FIGURE 3. CSV File of Scrapped Data

tion and transplantation process.

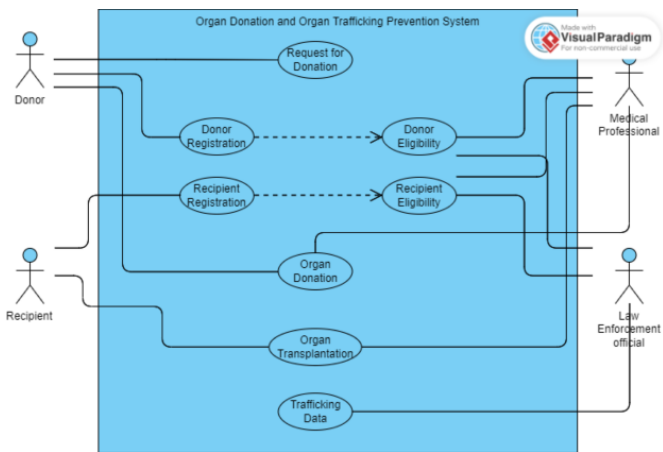


FIGURE 4. Use Case Diagram

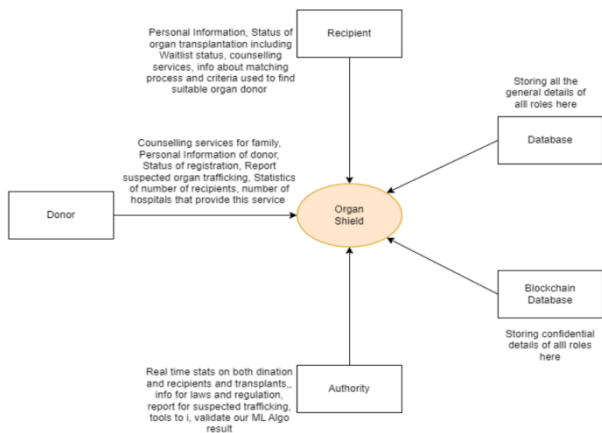


FIGURE 5. Context Diagram

Comparative study of proposed work

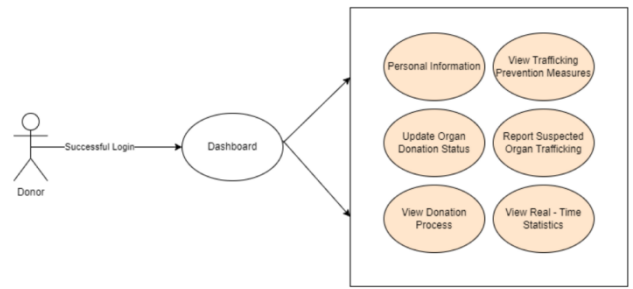


FIGURE 6. Features associated to donor

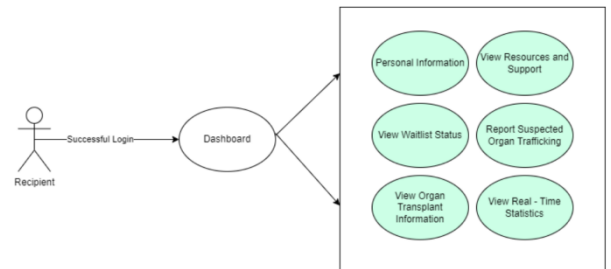


FIGURE 7. Features associated to recipient

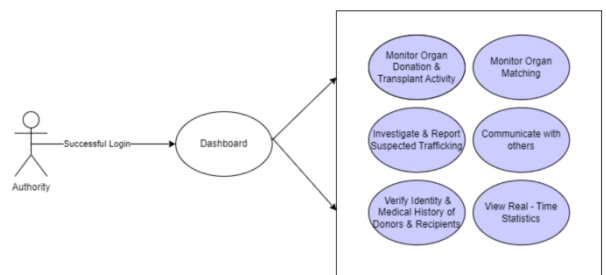


FIGURE 8. Features associated to authority

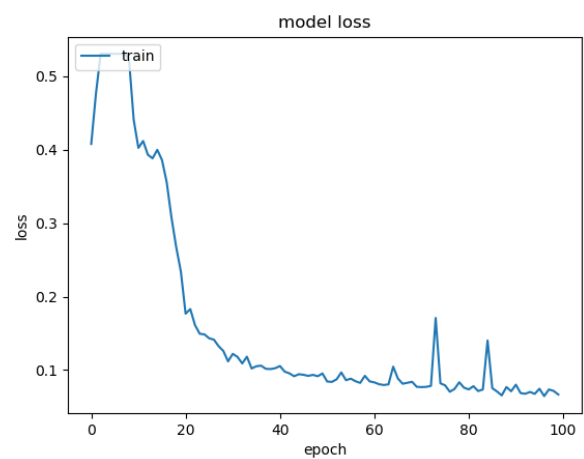
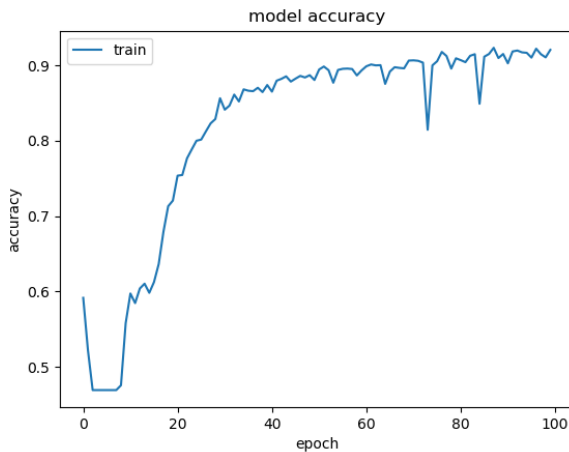


FIGURE 9. Loss associated to model

Currently the organ donation and transplantation process is mostly centralized and relies on government agencies and non-governmental organiza-



**FIGURE 10.** Accuracy associated to the model

tions to manage the donation and allocation process. Organ donation and transplantation process is often paper-based and thus open to fraud and errors. Mismatches between donors and recipients and low availability of organs for transplantation due to lack of information sharing. Limited transparency and traceability of organs during the donation process can lead to the illegal trade of organs.

Proposed methodology uses Blockchain technology that allows for the decentralization of the process, creating a transparent and secure system where all parties involved have access to the same information and any changes are recorded immutably. Blockchain technology allows for the digitization of records which makes the process more efficient and less susceptible to errors. Allowing for real-time monitoring and transparency, Blockchain technology allows for the sharing of information among all parties involved, increasing the chances of successful match between donors and recipients and making more organs available for transplantation. Blockchain technology allows for the tracking of organs from the point of donation to the point of transplantation, increasing transparency and making it more difficult for traffickers to operate.

## 7. Conclusion and Future Scope

The use of blockchain technology in organ donation and transplantation has the potential to revolutionize the field in several ways such as incorporating more advanced technologies, such as AI and machine learning, into blockchain-based organ donation systems to further improve the matching of donors and recipients and the overall efficiency of the trans-

plantation process. Developing new, decentralized forms of organ procurement organizations (OPOs) that operates on blockchain to help ensure organs are properly matched with recipients and prevent illegal organ trafficking. And to better ensure the traceability of organs from donors to recipients, which will help to prevent the sale of counterfeit or substandard organs. Exploring the use of blockchain-based micropayments and incentive systems to encourage more people to become organ donors and motivate hospitals and other organizations to participate in organ donation and transplantation programs.

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### Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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