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Application of blockchain technology in decentralized medical data security and privacy systems

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ABSTRACT

In a time when both the quantity and number of medical records are growing, protecting medical information has taken on particular significance. Medical data security and privacy are still compromised by the current system, which leaves room for manipulation and data leaks. Prior research has suggested techniques to safeguard medical data using encrypted algorithms like Blowfish and Vigenere. Nonetheless, this study suggests blockchain technology as a remedy for medical data security and decentralized data protection solutions this work, we implement decentralized data protection and medical information security using smart contracts. Smart contracts are blockchain-encoded agreements that, under specific circumstances, guarantee the contract's execution. In medical information management, smart contracts are used to control how patients, physicians, and healthcare organizations may utilize information. By doing this, patients can consent to the secure and encrypted use of their medical data, guaranteeing that only individuals with the proper authorization can access the information. In this work, we leverage smart contracts and blockchain technology to enhance the security of medical data stored in hospitals or outpatient clinics. The study's findings demonstrate that the data held in blockchains is distributed among several nodes, making them resistant to malware attacks and making the technology hard to alter.

Keywords: blockchain; medical data; security; privacy; smart contracts.

1. INTRODUCTION

The system in place still has numerous flaws in terms of protecting the security and privacy of medical data, including the possibility of data tampering and leakage, given the annual growth in the number of patients and medical information. Therefore, a way to build a better system for handling and preserving this data must be found.

A method for safeguarding medical data in image format through the use of the Vigenere Cipher cryptographic algorithm was developed the earlier study [1] The Blowfish algorithm was also utilized in the previous study [2] as an encoding strategy to protect patient data confidentially; however because the algorithm is symmetric and only employs one key for file encryption and decryption, the level of security will be poor [3].

The usage of blockchain technology in a decentralized medical data security and privacy system is the approach we suggest in this research. Blockchain technology can be used to build databases that can store and retrieve data [4]. This technology functions without the need for a centralized data storage management system or administrator [5]. Data is dispersed among several nodes, and encryption and replication are used to preserve data quality [6], Accessing or manipulating data stored on a blockchain network will require authorization.

It has been determined that blockchain technology is better suited for cloud-based healthcare record management while protecting privacy and data security [7]. Blockchain technology has the

potential to avoid data falsification and reduce losses by securing ledgers, which is crucial for research handling healthcare records [8].

In this study, smart contracts are used to construct a decentralized system for the security and privacy of medical data. An agreement between two or more parties that is coded so that the blockchain ensures the proper execution process is known as a smart contract [9]. If specific conditions are met by contracts embedded in the blockchain system, smart contracts ensure that agreements between parties are carried out [10].

Smart contracts can be used in medical data management systems to control access to medical data that has been granted permission by physicians, patients, or approved healthcare organizations. In addition to guaranteeing the security and privacy of medical data by making sure that only allowed parties may access the medical data, smart contracts can allow patients to securely encrypt, and permit designated parties to access their medical data.

Smart contracts are an integral part of blockchain development and cannot be isolated. The first person to propose the idea of smart contracts was computer specialist Nick Szabo, who also holds degrees in cryptography and law. Digital transactions are made possible via smart contracts, which restrict access to users of the same network. Smart contracts in the Ethereum system are built with the Solidity programming language. Solidity employs Contract Oriented Programming [11]. As opposed to other programming languages that embrace Object Oriented Programming (PBO). The Ethereum platform is an open-source blockchain development environment that enables programmers to design and develop smart contract-based decentralized applications [12].

2. METHOD

2.1 Blockchain and smart contract

Blockchain

With public blockchains, users can view the blockchain's content and take part in the consensus-building process in a decentralized network. There are two recognized categories of public blockchains: the Ethereum blockchain and the Bitcoin blockchain [13]. Anyone can construct smart contracts and decentralized apps (dApps) using Ethereum, a comprehensive programming language that enables the creation of arbitrary ownership rules, transaction formats, and government transfer features.

Blockchain technology was first intended for use in cryptocurrency and economics, but it is already finding usage in a several other industries, including the biomedical industry [14]. Because blockchain technology has mechanisms that stabilize and protect data sets that users may interact with through multiple means, it has the potential to be applied in a variety of sectors, including medicine, genomics, telemedicine, telemonitoring, e-health, neuroscience, and personalized healthcare applications.

Blockchain Architecture

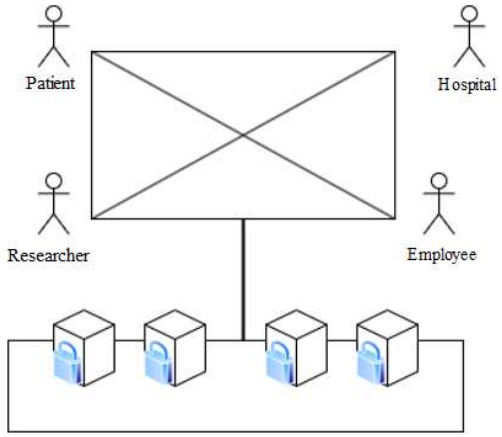

Figure 1. Decentralization in Blockchain

Blockchain is a type of database that holds certain information and is genuinely and securely arranged in a peer-to-peer network. Every member of the distributed, decentralized blockchain can maintain, authorize, and update new entries. The participants are in charge of the entire system. To enable data validation and data security, participants make sure that all databases are properly organized.

Decentralization in blockchain refers to the movement of power and decision-making from a centralized body to a dispersed network, as discussed in Figure *1*. Databases can therefore be kept in several places (nodes) within a single network thanks to decentralized blockchain technology. Consequently, any attempt to modify a record in a single database instance will not affect the other nodes. Furthermore, since all transactions are visible to everyone and can be tracked, blockchain decentralization significantly improves data transparency [15].

Talk The blockchain-based patient data storage plan, which uses cloud storage technology to guarantee patient data security, accessibility, and efficiency, is described in Figure *2*. Figure *2* depicts the medication data storage blockchain architecture. The primary parties involved in transactions on the blockchain are patients, medical facilities, and third parties (such as governments, health insurance companies, and information service platforms). Medical facilities are in charge of patient diagnosis, treatment, and record-keeping. Several services, including suggestions for healthcare facilities and verification of the veracity of medical records, can be offered by third-party institutions.

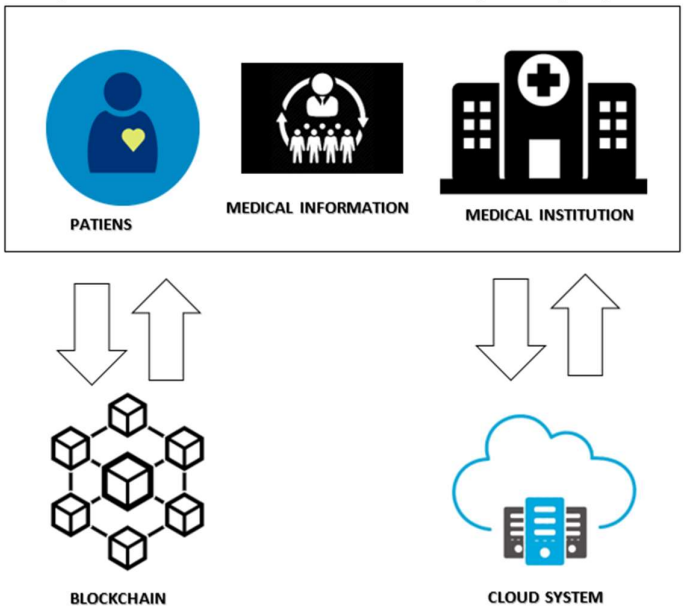

Figure 2**.** Blockchain architecture using the cloud

Implementation

At this point, we utilize the React.Js framework to construct a UI/UX display, and we use the Solidity programming language to generate Smart Contracts that allow us to interface with the blockchain. The phases of the study and implementation of blockchain technology and smart contracts for medical data are as follows in Figure *3*.

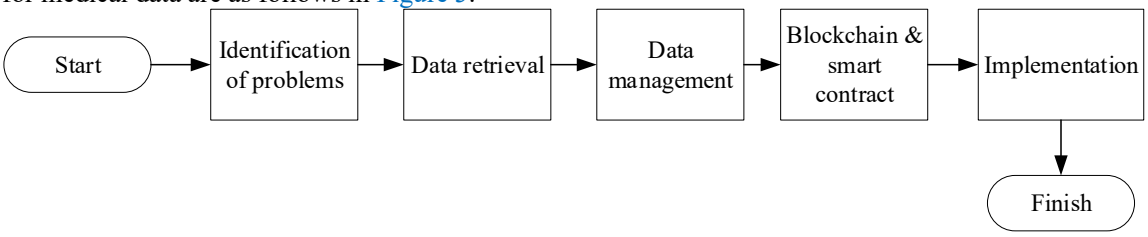

Figure 3**.** Flow research

3. RESULTS AND DISCUSSION

In this study, we employ medical data from hospitals that we have gathered through data extraction from earlier journals. We then process the data before entering it into the blockchain to be stored there. The following is the data that we have processed in Table *1* and Table *2*.

a. Patient data

Table 1. Patient data

No.	Patient's name	Place of birth	Date of birth	Gender	Address	Status	Work	Religion	No. Telephone
1	Burhanudin	Jayapura	12-12-1995	Male	New road	Not married yet	Employee	Islam	085267927 xxx
2	Dina	Jayapura	22-01-1996	Female	Old road	Married	Housewife	Islam	082367877 xxx
3	Aisyah	Jayapura	10-03-1998	Female	New road	Not married yet	Trader	Islam	081254874 xxx
4	Budi	Jayapura	17-09-1999	Male	Old road	Not married yet	Chicken farmer	Kristen	085254874 xxx
5	Agus	Jayapura	22-08-1994	Male	New road	Married	Lawyer	Kristen	082358774 xxx

b. Medical record data

Table 2. Medical record data

No	Patient's name	Place of birth	Date of birth	Gender	Gender	Outpatient Poly	Diagnosis	Doctor	Treatment Date
1	Burhanudin	Jayapura	12-12-1995	Male	12a1928sde	Internal disease	Out of breath	Dr. Bayu	12-03-2022
2	Dina	Jayapura	22-01-1996	Female	2193qe02o1	Child	Out of breath	Dr. Rita	16-04-2022
3	Aisyah	Jayapura	10-03-1998	Female	so10qo2210	Eye	Nearsighted	Dr. Brian	17-07-2022
4	Budi	Jayapura	17-09-1999	Male	ow0219qi82	Tooth	Tartar	Dr. Andre	27-09-2022
5	Agus	Jayapura	22-08-1994	Male	as19o2oq01	Tooth	Malnutrition	Dr. Sinta	12-02-2023

c. Login design

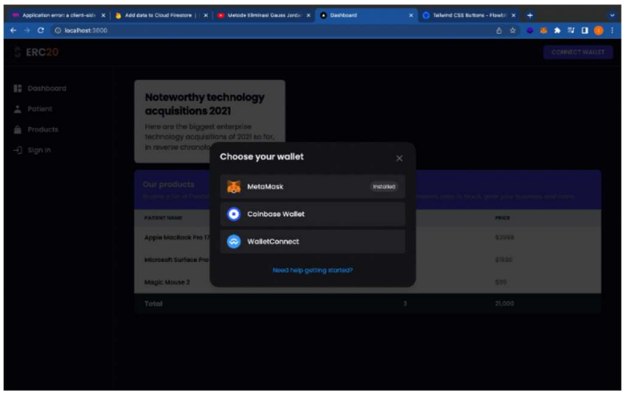

Figure 4. Login page design

Talk The wallet selection page or data security method about blockchain and smart contract mechanisms is explained in Figure 4.

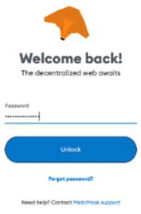

Figure 5. Login page design

d. Added design

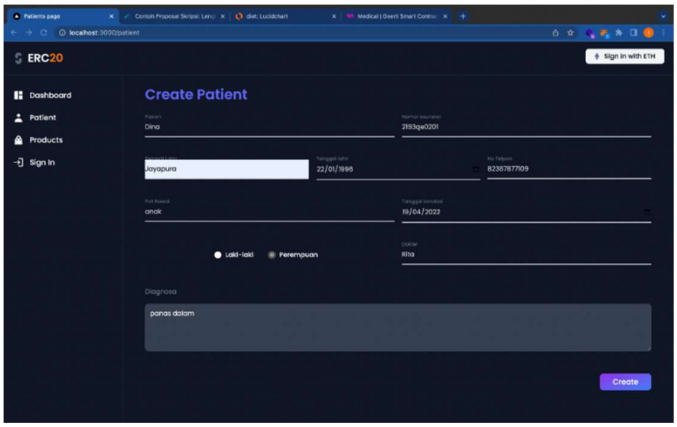

Figure 6. Create/add design

The page design for adding new patient data is shown in Figure 6. The page design that verifies the addition of data is as follows.

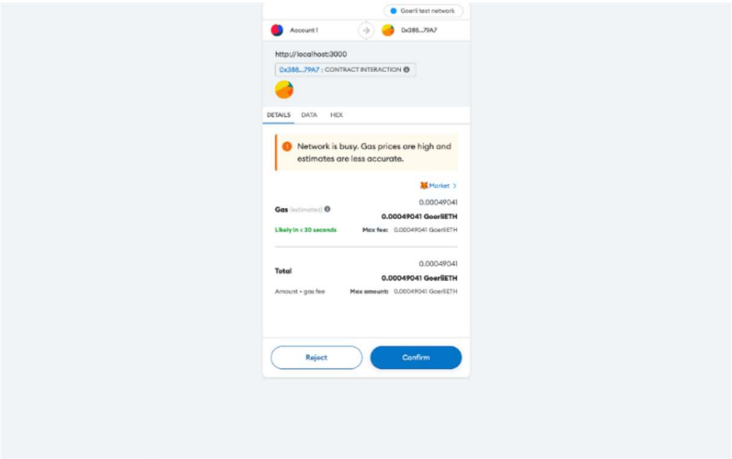

Figure 7. Create confirmation page

Discussion Figure 7 explains what the page design looks like to confirm newly added patient data.

e. Dashboard design

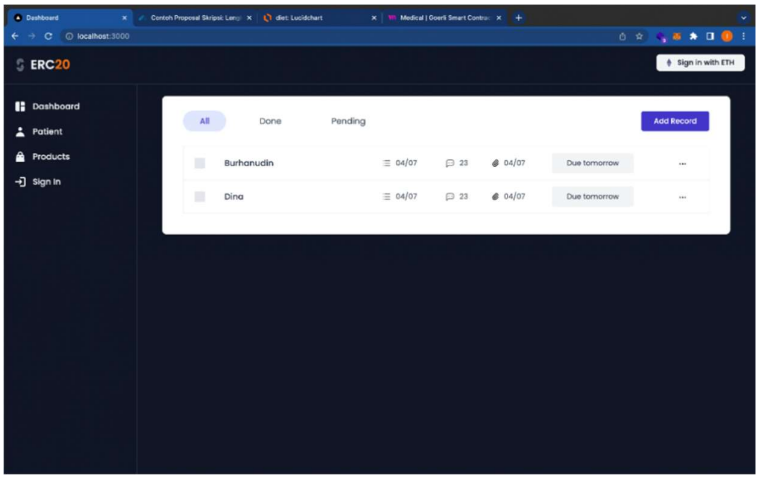

Figure 8. Dashboard/main page

4. CONCLUSION

In this study, we use blockchain technology to create a secure and private medical data system, specifically for patient information from hospitals or health centers. Our findings indicate that the data held on the blockchain is distributed among multiple nodes, making it challenging to manipulate because altering one node will not affect the data stored on the other nodes. To protect blockchain data from any malware threats. Our goal is for this research to contribute to the advancement of current patient data security and privacy solutions.

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