



Exploring challenges using Smart Contract in Healthcare Industry

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ABSTRACT

During the Industrial Revolution 4.0 era, the block chain was used as a digital record of transactions that is simultaneously used and shared within a large decentralized, publicly accessible network. In order to maintain the healthcare sector in Industrial Revolution 4.0, smart contracts are used to provide those addresses which provide transparent ways to do transactions among entities. In the other hand, the adoption has challenges, such as the adoption curve, the complexity of the business ecosystems and standardization, data privacy, and people expectations in the healthcare industry.

Key words : Smart Contract, Block chain, Healthcare

1. INTRODUCTION

The development of technology for digital-based health services is now increasingly widespread. Within Industrial Revolution 4.0, it implements automatization concept which is done by machine without people's involvement in its application. It is a vital necessity that is needed by current industries for the time efficiency, manpower, and cost which can do the data retrieval and data exchange on time. The one of innovation of Industrial Revolution 4.0 is Block chain, which is a combination of Big Data and Internet of Thing (IoT) [1].

Big Data is a component provider on a computer system that contains a large enough data set beyond the capabilities of database software, but big data uses the main memory capacity, local disks and even remote disks. Big data is useful for capturing, storing, managing, and analyzing existing data on a computer system [2]. Data Mining is the process of extracting data from large data sets that have not been known before, but can be understood and analyzed hidden data patterns with different perspectives to group or categorize the

data into useful information in making decisions [3]. One technique that is in the data mining process is classification. This classification technique involves the process of finding a series of models or functions that explain and distinguish data classes and concepts that aim to predict classes from objects whose class labels are unknown.

Block chain is a database that contains information that can be used and shared simultaneously in a large decentralized network and can be accessed digitally by the public. It includes records of digital-based transactions, therefore transactions added to the block chain will be validated by many computers on the internet.

This technology that can reduce risk, prevent fraud, and present transparency in a way that can be measured for a variety of uses. This is used almost in various industries. Block chain is a ledger technology which is applied in various ways to track fraud in finance, share medical records between health professionals safely, and track intellectual property in business. It is list of blocks consisting of cryptographic hashes to previous blocks, time stamps, and recorded transaction data that are interconnected and growing, where the block list cannot be changed and cannot be modified [4].

One part of the block chain is the smart contract. On the block chain, smart contracts are line of code and automatically execute where predetermined terms and conditions. Smart contracts can assist various industries in the process of exchanging money, property, shares, etc. in a transparent manner, without going through intermediaries. By using smart contracts, anyone can enter bitcoin into ledgers and important documents to enter into the block chain account. Smart contract not only serves to define the rules and penalties that apply to an agreement, but also enforce these obligations automatically. Therefore, smart contracts can be

used in various industries, including industries in the health sector [5].

Healthcare 4.0 refers to the change from traditional hospital care to more virtual hospitals and hospital care data can be distributed by utilizing the latest technology, such as the use of artificial intelligence (AI), in-depth learning, data analysis, genomics, household health care, robotics, and 3D printing of tissues and implants. When the technology is integrated into the health care system, healthcare 4.0 makes it possible to adjust health service time for patients, professionals and caregivers [6]. The health sector consists of all businesses involved in the supply and coordination of related medical goods and services [7]. Healthcare has evolved because it is driven by data that are connected to one another. On the other hand, these developments make healthcare very easy to manage, compact, and have significant educational requirements for those who participate. As a result, health services are slower but can change more quickly in the future.

In order to maintain healthcare sector in Industrial Revolution 4.0, smart contracts are used to provide to address those issues which gives transparent way to do transactions among entities. In the other hand, the adoption has challenges. In this paper, we would discuss about the challenges in healthcare industry.

2. LITERATURE REVIEW

A. Block chain

Block chain is known as a digital ledger that stores transactions publicly and can be verified automatically by node [8]. On the block chain, there are added and connected blocks consisting of cryptographic hashes on the previous block, timestamp, and transaction data recorded [9]. There are three types of block chain, namely: public, private, and consortium. Public block chain is used to decentralize networks and offer secure transparency. Meanwhile, private block chain and consortium (semi-private) are used to control and delegate privacy.

Block chain technology offers transactions that cannot be changed thanks to a Proof-of-Work (POW) system and also provides security based on a lack of trust in the use of the system by utilizing node agreements to authorize new chains that are added to act as a transaction ledger. Therefore, this platform can reduce a single centralized authority while supporting secure transactions on entities that interact directly [10] without interference from third parties or central administration. This has the potential to reduce costs and the intermediaries involved in maintaining trust in the transaction. In addition, this provides the basis for several

application domains, one of which is a smart contract that acts as a decentralized ledger to record transactions [11].

As a centralized technology, it is useful in various fields one of which is the healthcare industry [12-14]. Block chain nodes are used to store information and medical knowledge. Even so, there are major problems in the healthcare industry in terms of building end-to-end networks that can be maintained to protect the role of health professionals with a certain level of privacy [15].

Figure 1 explains the block chain architecture. New transactions sent by users for producing new blocks in its network. on the block chain functions to store transactions and distribute them to interconnected nodes on the block chain network. All nodes have a copy of transaction data which can help in the verification process. After all blocks have been added to the block chain, validation will be performed. Validation will be performed by the connected node to verify the transaction and ensure that the user sending the transaction to the block chain network is part of network authentication. When the node has successfully verified, the node will be given a cryptocurrency. This validation process is also called mining. After the validation process has been completed, the block will be produced to the block chain. If all processes have been validated, the transaction is successful [16].

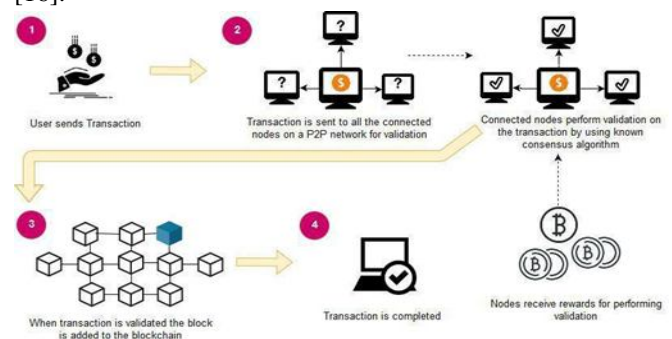


Figure 1: An Overview of Blockchain Architecture [16]

B. Smart Contract

The Smart Contract contains executable code that has the functions to facilitate, execute and enforce the provisions contained in the agreement to parties not trusted [17]. It stores data objects and determines data operations that allow decentralized applications (DApps) to interact with the Block chain to provide unlimited service [15]. In addition, smart contracts expand the block chain to build protocols to support peer-to-peer collaboration arrangements [4]. Figure 2 illustrates the smart contract system. Users make transactions at the contract address to be executed by each node or can be called a miner in the network to reach consensus on the output where the transaction received will be read / write to private storage. With this process, activities that can be carried out in smart contracts are storing personal data, depositing money

in account balances, sending / receiving messages or money, or making new contracts [17].

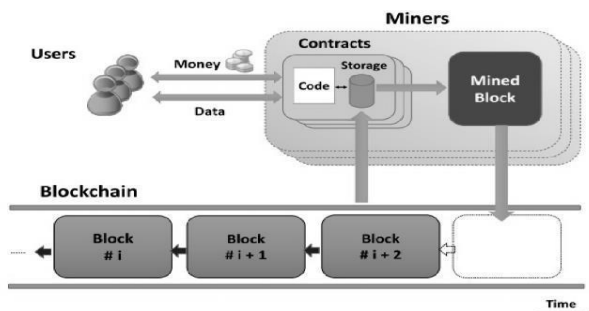


Figure 2: Smart Contract System [17]

Therefore, integrating block chain technology and smart contracts provides the benefit of flexibility in development and design and reduces costs and less time without involving a third person. This is a focus area because it provides peer-to-peer transactions and the data base can be maintained safely and publicly in an environment that is trustworthy.

Smart contract has the characteristics as part of a distributed application program that is able to be driven autonomously. Based on these characteristics, smart contracts support rapid and real-time renewal, level of accuracy, reduced risk of execution, reduction of third parties involved, low cost and less, implementing new business processes or operations [17]. Of course, smart contracts can be implemented in various fields, such as smart properties, music rights, e-commerce, etc. Even so, there must still be problems such as performance, security, codification, and privacy issues [8].

C. Block chain in Healthcare Industry

Block chain has been used in various fields, one of which is health service with the following sections [18]:

1) Clinical Data Sharing

In improving the quality of health services, medical information must be stored and provided regularly to patients, doctors, health care providers, pharmacies, insurance companies, and researchers. This is crucial data sharing that requires steps for transparency and accountability when conducting data transactions. Thanks to the block chain, this process can be implemented to maintain the ledgers distributed to all entities in the network.

2) Global Data Sharing

With the block chain approach, medical information is easily obtained and shared with different entities. Patients will give consent at the same time have control over the data held. To receive medical treatment elsewhere, the medical history of the patient must be known to find out what type of illness must be treated.

3) Maintaining Medical History

Patients who have stopped visiting the hospital makes the entire medical history may have been deleted because it was

not available or well maintained. By using a block chain, a patient's medical history can be stored and maintained. Therefore, the block chain is useful in maintaining historical medical records for each visit to any hospital. Not only that, but also always connecting data related to medical / laboratory reports.

4) Research and Clinical Trials

The trials phase consumes resources because of the coordination and the need for great trust between the entities involved. This is a crucial process in the health sector that requires proper monitoring at every trail. Therefore, the block chain can face trial research that helps in the tracking process at each phase is carried out correctly, then the data can be processed and analyzed without a lot of waste of resources.

5) Healthcare Data Access Control

Patients have the right to control their own data. However, it becomes weak because of the privacy issues considered. In addition, the majority of patients do not know the entity that accesses their medical data and for what purpose and whether they are authorized to access it. With the help of the block chain, this process is realized due to the promised privacy as well as distributing it to trustworthy entities.

6) Drug Supply Chain Management

The process of managing medical supplies is no less crucial in the healthcare industry. However, until now still involved problems in complexity and losses that can be caused by counterfeiting and theft. Block chain helps in verifying the authenticity of drugs and their supply chains to the authorities. Therefore, the role of the block chain is important especially in monitoring phases in the management of complex drug supply chains and providing access to valid entities.

7) Billing/Payers

Patient payment systems are complex and can be fraudulent. Not only that, but also requires a lot of resources and time to receive bills. With block chain, the payment process will be easier by sharing information to the entities involved while providing security for payment data. So that payments will be more valid, effective and efficient in terms of time and cost.

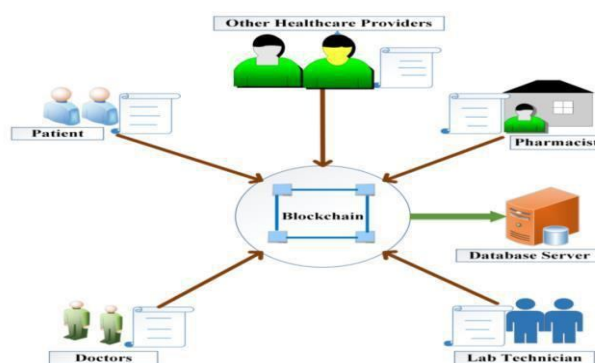


Figure 3: Blockchain Utilization in Various Healthcare Application [18]

In the figure 3, it explains the entities that are involved in the healthcare industry. They share their distributed ledger in a block chain that is entered into the database server.

D. Smart Contract in Healthcare Industry

Smart Contract deals with stakeholders whose signature is in the legal agreement. This can reduce costs, use less resources, eliminate additional costs. The use of smart contracts can be used in the health care system that allows the parties involved to work collaboratively and efficiently to be better.

Figure 4 illustrates the use of block chain-based smart contracts where parties and providers are involved in operating the health care system. After the appointment between the patient, the health care provider, and the pharmacist specified in the contract will take place and make a transaction that contains information about the data up to the smart contract address. Furthermore, the virtual machine that is distributed from the block chain executes the code process based on programming.

Some basic elements of smart contracts for health services consist of addresses to determine patient data in the database and will be stored in the block chain, and access codes to indicate the authority that gives permission to access the information of the third parties involved to determine the agreement of the party that signed it and other functions to do. After the statement has been approved, the transaction details are recorded in the system and the entity involved is entitled to receive transaction information [22].

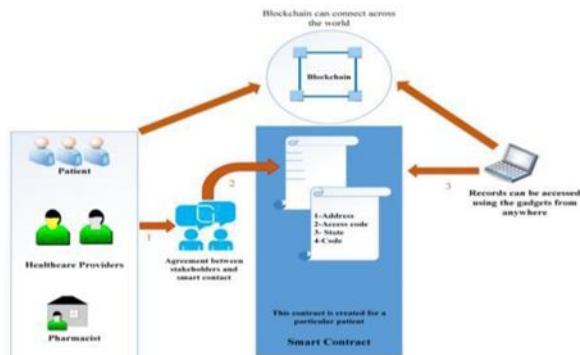


Figure 4: Smart Contract for Healthcare Scenario [18]

By owning a property without a party that can modify patient data without patient permission and encrypt the protocol automatically, this system is worthy of trust. However, the use of smart contracts is needed by overcoming several challenges for the success of the health care system such as code with incorrect writing rules, problems with the legal framework because it is not fully validated by the government [18].

3. RESEARCH METHODOLOGY

The method that have been used to do the Systematic Literature Review for Designing Smart Contract in Healthcare Industry are:

1. Creating a systematic searching method, by defining key words from the topic that will be going to be reviewed in order to minimize unnecessary search.
2. Source collection method by searching related healthcare journals and topics from Internet to gain information and theories that related to Designing Smart Contract in Healthcare Industry.

4. DISCUSSION

One application of the block chain is in the smart contracts system. Its security and safety of block chain technology makes smart contracts and their digital agreements suitable for any domain, including healthcare.

The smart contract in healthcare is supporting ability to increased interoperability and reconciliation. Smart contracts act as health records and patient information in the ledger to maintain facilities and regulate regulations in the field of healthcare.

Patients can move from one hospital to another without having to fill numerous forms since they can allow preferred physicians to view their health records on the block chain network. Tracking of patients’ treatment activities for purposes of insurance payments will also be increasingly streamlined using smart contracts. Ones the network is notified of a consultation or operation it immediately releases payments to the appropriate entities.

Hospitals and health care companies rely on a data base that contains patient information. Without block chain and smart contracts, information is given in a long time to reach the recipient and has the potential to be hacked. Therefore, with the help of smart contracts, health record information will be available to hospitals and research institutions. With adequate adoption, a person can enter a hospital that has a smart contract and block chain system. Hospitals and research institutions have their information in real time.

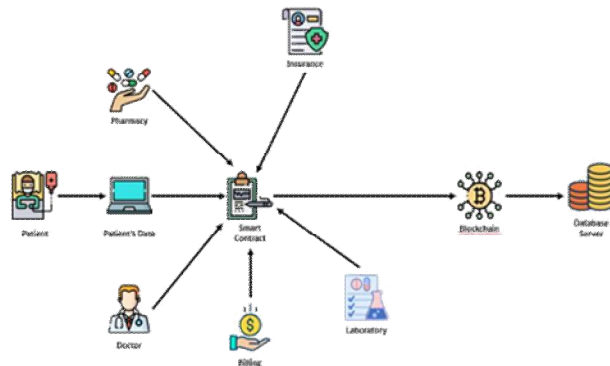


Figure 5: Smart Contract in Healthcare Industry

Figure 5 explains the smart contract in the healthcare industry. Patient data in the hospital, pharmacy data, patient insurance data, payment data, laboratory results data, and doctor or other medical personnel data will be in the smart contract which is automatically be in the block chain. After that, data that has been entered into the block chain cannot be changed or deleted. By using smart contracts, there are no operational costs and will save human resources. Smart contracts in the healthcare industry will increase speed in business transactions.

However, there are challenges that be faced in healthcare when using smart contracts, such as the adoption curve, cost that needs to be spent, the complexity of the business ecosystems and standardization, data privacy, people expectations, and the government regulation in the healthcare industry. For the adoption of smart contract surely takes time to do it, because it is quite complex to do the business procedure and its standardization so it would be risky. Due to the adoption and standardization to gain success for using smart contract, the cost for implementing and maintaining smart contract absolutely high. Not only that, but also the people also have high or low expectation, including the way of people concern the data privacy's using block chain. They're might be optimism or pessimism for using the smart contract in their environment, including the government, who is giving the permissions or regulations for using the smart contract whether they can accept nor reject the considerations.

5. CONCLUSION

Smart contracts are used in the health department to improve interoperability and reconciliation by storing patient data and helping to facilitate data standards and completeness. In addition, the smart contract can track patient's treatments for insurance purposes. Therefore, information will be available in the scope of hospitals with sufficient adoption. However, there are challenges that are faced in healthcare when using smart contracts, such as the adoption curve, the complexity of the business ecosystems and standardization, data privacy, and people expectations in the healthcare industry. Therefore, the adoption of smart contracts must be considered in the healthcare industry.

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