

A Smart Healthcare Management System Using Blockchain Technology

Mrs. Kala Chandrashekhar L.
Asst. Professor

Department of Computer Science & Engineering
SJB Institute of Technology

Aarya Choudhary

Department of Computer Science & Engineering
SJB Institute of Technology

Gaurav Ashish

Department of Computer Science & Engineering
SJB Institute of Technology

Hardik

Department of Computer Science & Engineering
SJB Institute of Technology

Harsh Kumar

Department of Computer Science & Engineering
SJB Institute of Technology

Abstract — *The features of blockchain technology, such as its decentralized data network, immutability, transparency, and crypto-security, make it applicable in practically every field. A smart healthcare system with a blockchain data network today offers transparency, simple and quick access, security, efficiency, etc. The purpose of this effort is to develop a smart healthcare system, and it has been shown that this is feasible by integrating and utilizing Blockchain while taking healthcare ground realities into account. The Ethereum network implements the blockchain together with related programming languages, tools, and methodologies including solidity, web3.js, Athena, etc. Additionally, a comparative and thorough analysis of modern blockchain-based smart healthcare systems is prepared in this paper. The thorough survey contains the methodology, applications, specifications, results, and future directions, among other things. Those who work primarily with electronic health records (EHR), electronic medical records (EMR), or electronic personal records (EPR) are listed, along with their groups, organizations, and businesses, and a comparison is made regarding whether or not they should implement blockchain technology into their workflows. This effort tries to enhance the functionality of decentralized blockchain-based healthcare apps. For the proposed system, smart contracts and their designs are also ready to speed up the payment and trust-building processes. To validate the suggested technique, simulation and implementation were taken into consideration in this work.*

Keywords – *Block, blockchain, healthcare systems, mining optimization, smart solution, transaction.*

I. INTRODUCTION

The research community has begun to see blockchain's possibilities outside of financial applications. Numerous beneficial applications, including those in healthcare, logistics, supply chain management, and the Internet of Things (IoT)s, can make use of blockchain as a decentralized technology. Blockchain offers safe distributed databases that may function independently of outside parties or centralized management. When several important parties want to access the same information, it is quite helpful. Blockchain-based systems therefore have enormous potential to reduce the expense

and resources of existing intermediaries. Blockchain often makes use of cryptographic techniques to maintain trust amongst stakeholders while they interact.

To improve the overall quality and services of healthcare systems, the storage and exchange of medical data is a crucial component. The patient's private and sensitive information may leak if data records are shared insecurely across several institutions. Inadequate user control over their personal information can also have negative effects, such as allowing unwanted parties access to private medical data. Information on the patient may not be shared uniformly across healthcare systems, which poses several problems.

Maintaining interoperability across the numerous stakeholders engaged in electronic health/medical records (EHR/EMR) is one of the key problems with current EHR/EMR. This problem could create barriers between data transfers. Information about healthcare may get dispersed if there is not a coordinated data management and sharing method across the many institutions. In addition to interoperability, data security and privacy are a major issue with how data is currently stored and shared through EHR/EMR systems. Due to data leakage and potential security system flaws, most patients are reluctant to share and save their private medical information. Therefore, a distributed method of data sharing and keeping is clearly required so that patients may be more confident in the confidentiality and privacy of their personal information and so that all parties involved can have a comprehensive understanding of all transactions and interactions.

Therefore, it is crucial to make use of the potential blockchain technology in the healthcare industry given these issues with the present healthcare systems. Numerous healthcare applications can benefit from the use of blockchain technology. The usage of smart contracts in blockchain for healthcare also allows features that reduce the need for trust between different system participants. Smart contracts are composed of computer programs that display the agreements and guiding principles that all parties engaged in the network agree upon, negating the need for a trustworthy third party. The suggested blockchain-based healthcare system is also designed to accommodate the system's interoperability function.

As a result, the primary goal of this effort is to introduce and investigate blockchain technology for use in healthcare-related

applications. The possible requirements and difficulties of developing healthcare systems based on blockchain are also covered in this article. Additionally, the necessity of smart contracts for blockchain based healthcare systems will be covered.

II. BLOCKCHAIN APPLICATION IN HEALTHCARE INDUSTRY

The decentralized and distributed blockchain technology has several applications in the healthcare sector. Although blockchain was first created for the financial services sector, it is now being used to give safer ways for providers, funders, and patients to share data in the healthcare system. Researchers have begun to investigate possible use cases for blockchain in the healthcare business due to the technology's enormous potential and practical usability.

A. Clinical Data Sharing

The exchange of medical data among multiple system entities is an essential and fundamental application of blockchain in healthcare. EHRs and EMRs include extremely important and private medical data about the patient that must be shared, processed, and accessed in a safe manner. Therefore, in order to enhance and raise the standard of healthcare services, medical information must be kept and often disseminated to multiple important parties, including patients, physicians, healthcare service providers, pharmaceuticals, insurance firms, and researchers, among others. In general, rigorous mechanisms for accountability and openness during data transactions are needed for this sort of crucial data sharing. Since blockchain maintains a distributed ledger across all participating organizations inside the network, it increases transparency in such situations. The blockchain offers a dependable and secure process of information exchange and management processes where all participants are aware of transactions.

B. Global Data Sharing

Patients occasionally travel outside of their own nation for business, pleasure, or for any other reason. There are other circumstances in which they might need to see a doctor for the treatment of any condition. In that instance, the appropriate hospitals/doctors from the other nation should be aware of the patient healthcare information in order to give better health services. Through blockchain-based methods, it is simple to communicate medical information with the necessary parties located in another nation, with the patient's consent and ownership over the data. The medical history of the relevant patient should be known in order to obtain better medical care outside of the nation, such as whether the patient has any type of medication allergy or is aware of his or her most recent treatment. The service provider must thus securely access the medical history.

C. Maintaining Medical History

The patient's medical history may be stored and maintained using blockchain technology. When patients visit distant hospitals, for instance, the complete chain of their medical history may not be accessible or maintained. Blockchain can be helpful in retaining the history of data of patient for each visit to any hospital to address such problems. Additionally, the patients must repeat the same medical tests because some unconnected data pertaining to laboratory and medical reports is not available. Repeating a laboratory test will not only cost more money but performing some tests with high radiation levels again might also be harmful.

D. Research and Clinical Trials

Another important and beneficial procedure in the healthcare industry is the conduct of clinical trials, which must be properly monitored at every stage. As an illustration, consider data collection, trial design, and trial monitoring and data administration.

As many parties must collaborate during these testing stages, a lot of resources will be used. These trial phases also needed a great deal of confidence amongst the many parties involved. In light of this, the blockchain may be an essential tool for managing such research trials, where each stage can be precisely monitored, and data can be maintained and evaluated without any resource waste.

III. KEY REQUIREMENTS

The main goal of this section is to emphasize the crucial conditions necessary for the proposed blockchain-based healthcare system.

A. Nationwide Interoperability

One of the main prerequisites for blockchain based healthcare systems is this. One of the biggest challenges facing the existing healthcare management systems is the absence of national interoperability in the healthcare system. The absence of global standards for interoperability is one of the main causes of this. The present healthcare systems' EHR interoperability is predicted to be strengthened by blockchain.

B. Data Security

Securing the sensitive patient data is a crucial necessity while creating such blockchain healthcare systems. Security should be the top priority because there are several organizations participating in blockchain-based healthcare processes. Comparing blockchain to conventional healthcare systems, increased security, privacy, and trust are anticipated. The fact that all parties involved are aware of every data exchange within the system is one of the main factors contributing to greater privacy and trust.

C. Data consistency/Integrity/Immutability

The fragmentation and inconsistent nature of the medical data is one of the problems with the existing healthcare management systems. Data discrepancy might result in delays and increased expenditures for any user's entire healthcare procedure. A blockchain based healthcare system must thus make sure that the healthcare data is consistent and impossible for unauthorized parties to change.

D. Cost/Resources Effectiveness

The cost, calculations, time, and physical resources used by current healthcare systems are all increasing. For instance, the majority of transactions require intermediaries, which may require more time or resources to complete the required activities. Reducing transaction costs and delays, whether they be caused by third parties, many parties engaged, or other factors, will be one of the essential criteria.

E. Trust less and Transparent

Building on pre-existing trust among many stakeholders is necessary to allow safer data storage and exchange processes in the current healthcare system. Given that the raw data is owned and shared by several parties, maintaining complete confidence and data openness would be challenging. By eliminating intermediaries, a blockchain based healthcare system should produce more transparent and reliable healthcare systems.

F. Complexity:

The storing, distribution, and processing of medical data and other billing-related information is comparatively more complicated in today's multi-stakeholder healthcare systems. Therefore, in order to prevent complications and pointless delays at various stages, one prerequisite for a blockchain healthcare system is to have less complicated operations.

IV. POTENTIAL CHALLENGES

We then highlighted certain possible issues that must be appropriately resolved before the actual deployment of blockchain-based healthcare solutions.

A. Scalability Restrictions

Scalability would be one significant obstacle in blockchain healthcare. The trade-off between the volume of medical transactions and the computational resources available may restrict how large these healthcare systems may grow.

B. High Development Cost

Healthcare systems built on blockchain might have expensive operating and development costs. Government agencies and the healthcare industry still need to specify the many forms of development, operations, and overall deployment costs for all parties involved. Finding the best methods to lower the overall cost and resources required to develop such systems is so essential.

C. Standardization Challenges

The right standards must be established by standardization groups in order for the implementation in healthcare applications to be effective. It should be made clear what data, size, and format may be supplied to blockchain, for instance, in the case of healthcare data kept on the blockchain. Therefore, it is important to clearly identify whether medical data is kept on or off the blockchain.

D. Cultural Resistance

The majority of healthcare operations in the modern world are accessed either through paper-based processes or, in certain situations, online using EHR/EMR and other online health services. The sharing of patient data with numerous parties is not as widespread as it formerly was. Because it will take work to change people's attitudes on dispersed data sharing, this cultural shift will be one of the biggest hurdles.

E. Regulatory Uncertainty

Regulatory agencies would have a difficult time defining the rules that would take into account how different stakeholders will work together to create a full ecosystem that also considers the current regulatory framework. In order to protect the confidentiality of users' medical information, the Health Insurance Portability and Accountability Act (HIPAA) is also presently setting the requirements.

F. Security and Privacy Concerns

With healthcare data, blockchain technology offers certain security characteristics. But with blockchain-based healthcare, security and privacy remain the top issues, necessitating practical security solutions. For instance, data must be stored and shared in a safe manner, and only authorized parties should be able to access the data.

G. Unwillingness to Share:

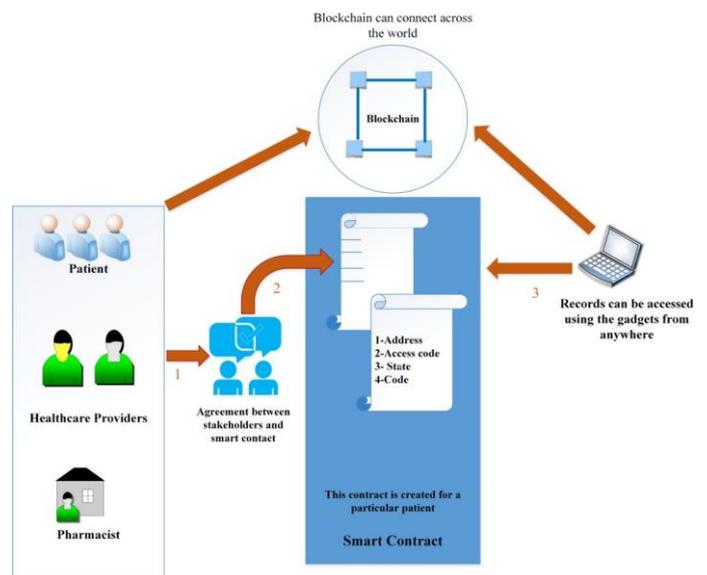
A few parties involved in the provision of healthcare services continue to hold back on disclosing information to third parties. For instance, hospitals and insurance companies might not wish to easily exchange data with other organizations. One explanation for this would be that the hospital wants to keep the pricing information to themselves and may establish various prices for certain people. Therefore, trust between diverse entities must be built in order for each organization to consent to sharing the data for better healthcare systems.

V. SMART CONTRACTS FOR BLOCKCHAIN BASED HEALTHCARE SYSTEMS

An essential component of blockchain-based apps is a smart contract. It is an agreement reached between multiple system participants. A smart contract is a computer protocol that adheres to particular guidelines, limits, and regulations that have been approved by all users on network. For instance, a smart contract for banking or financial transactions contains all the terms and conditions agreed upon by all parties involved in that procedure. Smart contracts, in contrast, are computer-based digital programs that execute on their own when the conditions are met.

A smart contract is quicker than already accessible contracts, and it also cuts down on the time needed to execute and deliver the patient's data. No one can take on the roles of a patient or healthcare provider because it's a decentralized system. The protection of any medical record is comparatively safer with this technique. The document cannot be altered or edited by hackers without the patient's consent. A smart contract can interact directly with the parties whose signatures are on the contract's legal documents. Because a smart contract will utilize less resources and avoid unnecessary expenditures, it is thought to be more cost-efficient. Smart contracts are more reliable because they have the immutable feature, which implies that no one can alter, remove, or modify patient data without the patient's consent. This trait also enables smart contracts to automatically encrypt the protocol and regulations. The Blockchain transaction is made simpler and easier to carry out thanks to the Smart Contract.

In addition to the beneficial advantages of creating smart contracts, there are several difficulties that must be overcome before smart contracts can be successfully implemented in healthcare systems. For instance, the procedure will create a mistake if the codes or rules are written incorrectly (having some fault). Without programmable expertise, writing or understanding an algorithm is difficult, and if errors are made in the code, fixing them may be quite expensive. The fact that the legal framework of a smart contract has only partial



government approval is another issue. A smart contract cannot operate autonomously without any input or assistance since some tasks require an initiating support.

VI. DISCUSSION AND FUTURE SCOPE

A digital revolution is underway in the healthcare sector because of the quick advancements in ICT (ICT). As academics look at many facets of blockchain healthcare systems, the excitement around the use of blockchain in healthcare appears to become reality soon. Offering safe and secure ways to access patients' medical information throughout the process is the top priority in the healthcare industry. Blockchain technology is seen to be one of the best methods for storing and exchanging medical data, ensuring that only authorized parties may access it. Various interested parties are beginning to recognize the potential of blockchain in healthcare and its enormous influence to improve the healthcare sector in terms of improved medical services for the necessary patients and increased healthcare economies and revenues. Lack of countrywide healthcare interoperability is one of the major ongoing challenges facing the present EHR systems, and blockchain technology has the potential to partially address this problem.

Blockchain should address the issues with the storage of medical data in addition to other issues. Due to the fact that blockchain technology itself has relatively limited capacity for keeping genuine healthcare data, there is more room to suggest specific strategies for the safe storage of medical data. The real data can be stored on the server or database, and the blockchain can record the address of that data, according to one approach already proposed in the literature. Using that address, which is saved on the blockchain and connected to the database, you may get data, insert data, and do other activities. In addition, precise solutions are required for a variety of security measures, like which security model (symmetric or asymmetric) is best suited for certain healthcare systems and how credential managements will be handled. Additionally, several use cases in healthcare need that the solutions be revocable, transparent, and anonymous.

Blockchain technology appears to have a bright future in the healthcare industry. Blockchain applications for the healthcare industry have not yet been extensively evaluated for their viability. However, the present healthcare systems would be able to provide better and more high-quality healthcare services with the characteristics that blockchain promises to offer. Blockchain technology will provide patients more control over their medical information and the ability to handle it in a way that will help them manage their overall health issues. An accurate, quicker, and enhanced data sharing healthcare mechanism might be created in this way to meet the demands of the present healthcare system and provide patients with the services they need.

VII. CONCLUSION

The quality of medical and healthcare services clearly needs to be improved in light of current developments in internet and network technology. The present healthcare systems have a number of issues that call for decentralized and distributed methods of solving them. In this situation, decentralized solutions that can guarantee the confidentiality and integrity of the medical data can be provided in large part thanks to blockchain technology. The purpose of this work is to give an overview of blockchain technology's application in the healthcare industry. Additionally, this paper presents several criteria and difficulties for blockchain-based healthcare systems. Finally, the idea of smart contracts is presented for blockchain-based healthcare systems.

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