THE APPLICATION OF BLOCKCHAIN IN HEALTHCARE

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ABSTRACT

Blockchain is the cutting-edge technology that everyone is raving about, and it might completely change how we manage data in our systems. It aids in the development of decentralized and distributed systems and exhibits significant distinctions from conventional databases. We can create systems that prevent a single authority from controlling all the data. There has been ongoing research into the possibilities of its use for other non-financial applications, ever since Bitcoin introduced the Blockchain. One of the key sectors involving Blockchain is the healthcare sector. Various healthcare associations along with the doctors at various hospitals use blockchain applications for the exchanging and storing of patients' data. Blockchain applications have the ability to identify severe mistakes, some of which could be dangerous, within the medical field. Since the use of blockchain technology in healthcare, various aspects of sharing medical data such as transparency, performance, and most important of all security have been improved at an exponential level. It is a technological tool that contributes to the improvement of medical record analysis for medical institutions. The present study examines how blockchain can be applied to healthcare. Additionally, the field is experiencing rapid research growth. Various applications such as managing electronic medical records, remote or you can say virtual patient monitoring and drug supply management over all the health care departments, hospitals, pharmacy firms, etc. can be well managed and implemented using this growing technology. This paper covers a few unresolved problems and various functionalities that show potential. It also examines various methodologies under the study's constraints.

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1. INTRODUCTION

Several academic papers and industry groups have been exploring the potential of blockchain in the past decade. Initial suggestions were made by Satoshi Nakamoto in his research in 2008. The blockchain contains a decentralized shared ledger that is used to manage and secure data. It supports peer-to-peer transactions without the necessity for a third party or single person authority in computer networks. Bitcoin is a type of cryptocurrency that was the first application of this technology which was discussed in the initial phase of the development of blockchain [1]. The term "smart contracts" was introduced with the next iteration of the technology, known as Blockchain 2.0. Blockchain 3.0 is primarily utilized in sectors other than finance, such as government, energy, healthcare, etc. Given the inadequacies of both public and commercial health information technology systems, several blockchain-based solutions have been put up in light of current developments in the medical industry. The following research issues are the main topic that is been discussed in this study:

Question 1: To learn about the fundamentals and numerous applications of blockchain technology;

Question 2: To study the importance and significant needs of blockchain in healthcare;

Question 3: To explore and discuss various blockchain applications in healthcare and how this technology can be of use to implement these applications;

Question 4: To talk about certain unresolved problems, prospective research fields, as well as the shortcomings of the examined methods;

2. CONCEPTS OF BLOCKCHAIN

2.1 BLOCKCHAIN

There are several ways that blockchain databases differ from traditional relational databases. In contrast to how data is maintained in conventional databases, the blockchain stores the data in discrete blocks that are connected by cryptographic hash functions. Only when the transaction has been approved by a group of individuals known as validators is the data saved as a block in a blockchain. To carry out a secure transaction, a variety of mathematical approaches are utilized to validate this fact.

2.2 HOW BLOCKCHAIN SYSTEMS WORK AND THEIR VARIOUS CATEGORIZATIONS

The first blockchain application that was widely popular online for its peer-to-peer network system was Bitcoin [2, 3]. Public ledgers exist in blockchains. Headers and bodies make up the blocks. Information about the preceding block, including its address, is contained in the block's header. All of the blocks are thus linked to one another. Block headers also contain these additional information: a timestamp, nonce, and merkle tree. The time stamp stores the time at which the block is published. A nonce is a random number generated by the miners to produce a specific hash value, and a Merkle tree is a binary search tree that minimises the amount of work needed to verify transactions within a block.

The system's small data units and the performed functionality are stored as transactions on the blockchain network when certain functionality is performed. Each transaction must be approved by the majority of system users before it can be recorded. All parties must replicate, host, and maintain a copy of the ledger in order for blockchain transactions to be tamper-proof and immutable [2]. One of the most crucial features that is used to encode the business logics is smart contracts, which are the self-executing codes. Smart contracts are used to construct the blockchain, guaranteeing that neither the data nor the transactions can be altered and that no one has the power to copy or remove any data from the blockchain.

Decentralization, a shared database ledger, immutability with offers tamper proofing of the data, availability by providing all peers with a copy of the ledger so they can access all time-stamped transaction records, privacy and confidentiality, which enable each user to interact with the blockchain using a produced address that conceals their true identities, are just a few of the key features of blockchain.

Blockchain technologies come in a variety of types, including public, private, hybrid, and consortium. The advantages and disadvantages of each Blockchain network are made up of blocks, which contain the history of all transactions in the network. [4] largely determine its optimal applications. The blockchain contains shared distributed ledger databases. Based on the data access public blockchain was first implemented as Bitcoin. Blockchain is a decentralized system that enhances security and transparency among the participants of the blockchain. Due to its decentralized nature, as data being dispersed all over the network, authentication of data is of great importance. As the term indicates, private blockchain is only accessible to a small network of users or is under the control of a single entity. All the other features are similar to that of the public blockchain only smaller. These are permissioned blockchains where the participants are known otherwise in public blockchains all the users have anonymous identities. The other kind of blockchain combines public or permissionless systems with private or permissioned blockchains based on the system's requirements and data access limitations. A hybrid blockchain system is what it is termed.

2.3 NEED AND IMPORTANCE OF HEALTHCARE IN BLOCKCHAIN:

Health is experiencing an unprecedented increase in the urgency of development. The Healthcare system in today's times needs facilities that are based on newer and more advanced technologies. The absence of a central administrator in the blockchain technology model for healthcare can offer many advantages to the users. The reason is the database's continued perception as a physical entity made up of binary codes. As a tangible item, data is extremely vulnerable to loss, misuse, or accidental deletion from manual records. The Healthcare system should focus more on the well-being of the patients and should prioritize two main requirements, access to services and availability of appropriate resources at all times. In healthcare organizations, Blockchain technology enhances patients' health care and has a positive impact on health facilities. Using this technology, the Healthcare Information Exchange can be handled more efficiently and cost-effectively, reducing the high costs in the health industry. Because blockchain technology is involved, more and more research can be done and more people can take part in various health-related surveys. Moreover, we can collect and manage data on the well-being of various communities which will enhance treatments and also become the basis of various researches begging made on various health issues. Healthcare systems and organizations are managed using a centralized database [4–6]. Up until recently, issues with data sharing, transparency, and security have plagued health management. Blockchain technology is a good solution for this problem. One can increase the safety, information sharing, interoperability, authenticity, legitimate update and accessibility, and data integrity by effectively utilizing this technology. Furthermore, data protection is of great concern, especially for personalized medicine and wearables. All these issues can be resolved using this advancing technology where doctors and other medical personnel can help the patients without any safety concerns by sending and recording patient data. [7,8].

3. IMPORTANT BLOCKCHAIN APPLICATIONS:

More than 12% of business decision-makers still have not adopted blockchain technology. One of the chief reasons for this is that blockchain technology is still in its early stages of development, and the many stakeholders are unaware of how useful it may be in a variety of fields, including medicine. A new technology like blockchain has the potential to enhance the security and effectiveness of an HIE while also delivering an improved healthcare model. As a result, HIE data can reduce or eliminate friction and costs associated with existing intermediaries. The ability of the system to handle a vast amount of medical data, minimize errors, and also maintain safety by offering increased administrative efficiency, is crucial to the quality and efficacy of modern healthcare. Blockchain technology is perfectly suited to meet all of these requirements. I have listed several blockchain applications in the article that might be of help to healthcare organizations based on the current scenario. Some of them are listed below :

3. 1 ELECTRONIC MEDICAL RECORDS

Changing healthcare requires a focus on how to manage health data and how to improve Electronic Health Records (EHRs) accuracy by connecting heterogeneous systems. It's important to note the distinction between electronic medical records (EMR) and electronic health records (EHR).; they are different from each other. Electronic medical records, or EMR for short, refer to the digitalized version of paper prescription charts in a clinic.EMR or Electronic Medical Records are used for storing the patient's information like medical and treatment history. EHRs, however, track a variety of additional pieces of information and give a more comprehensive picture of a patient's health in addition to storing medical information in the form of clinical data.

In research, it was found that blockchain technology is helpful in managing EHRs. EHR-related application MedRec[9], which suggests a decentralized architecture for controlling authorisation, permissions, and information exchange among healthcare system users. Individuals can use the MedRec Ethereum platform to find out who has access to their medical records.

Due to the risks associated with sharing confidential data, a similar programme called Medshare [10] leverages Ethereum to address the lack of cloud service agreement for data sharing. Medshare enables the sharing of medical data in cloud repositories while providing big data organizations with data management, verification, and management. Medshare enables the sharing of medical data using the cloud while providing big data organizations with data integrity, verification, and proper management.

The blockchain-based application omniPHR[11] also upholds interoperability and safety of the data while maintaining personal health information. a trustworthy and interoperable system controls all of the data. The way this application operates is by breaking up the patient's data into different data blocks and distributing them over the blockchain network while maintaining appropriate security.

3.2 REMOTE PATIENT TRACKING

A Blockchain-based trust system allows medical professionals access to medical equipment anytime anywhere. Additionally, watching patients from afar and reacting to health-related incidents could be more time-consuming for doctors. By using Blockchain in the healthcare industry, it is possible to monitor temperatures in inpatient rooms, beds in use, and supplies available. Healthcare organizations and providers can use this technology to create digital identities that are safer and can stay anonymous until and unless the patient wants to reveal himself. By combining Blockchain with IoT technology, healthcare logistics will become more transparent for proper patient monitoring, which will enhance responsiveness and traceability. [12–15]

Ichikawa et al. [16] present a method to leverage mobile devices to transmit data to blockchain-based hyperledger applications. A real-time patient monitoring application created using Ethereum smart contracts is demonstrated by Griffin et al. [17]. Combining the abilities of two major technologies that are Internet of Things (IoT) and blockchain can bring a major shift in how things work in the online world, especially in the area of healthcare. IoBHealth [18], a data-flow architecture that integrates the Internet of Things and blockchain is one such example and it helps in easier accessing and storing of the medical data online.

3. 3 SUPPLY CHAIN MANAGEMENT

The problem of ensuring the provenance of medical goods, as in many other industries, is a major challenge. Using a blockchain-based supply chain system, we can give customers complete transparency so they can track the things they can purchase from a manufacturing unit since every transaction is easily visible from the blockchain. Counterfeit prescription drugs pose a serious threat to the industry, especially in developing markets where thousands of lives are lost each year to counterfeit drugs. As medical devices rapidly proliferate with the adoption of more remote monitoring, is increasingly important for bad actors, too, as they are attracted by it. Drug supply chain management is supported by the MediLedger application, which runs on the blockchain. In addition to guaranteeing that the medicines being delivered are real, it also provides vitally crucial information on the manufacturing and expiration dates of the medications. In the area of supply chain management, blockchain presents a number of significant advantages when combined with AI. Farmers Trust uses blockchain technology to alert law enforcement when there are problems. Integrate manufacturers, wholesalers, and shipping for end-to-end tracking of each package, increasing customer confidence. Then, companies can better predict demand and optimize supply once all the data is in one place.

3.4 INSURANCE CLAIMS

Processing healthcare insurance claims is one potential area where blockchain might be used successfully. Blockchain should be utilised to construct the system due to its immutable nature, transparency, and ease of data verification, albeit there are only a few prototype implementations now available for such systems.

Pharmaceutical companies, medical device manufacturers, wholesalers, insurers, and healthcare providers can use blockchain-based systems developed by businesses like Chronicled and Curisium to authenticate their identities, record contract details, track transaction data, and settle payments for goods and services. It supports different trading partners in the supply chain management environment, as well as insurance providers.

Digital contracts between manufacturers, distributors, and healthcare organizations are stored using distributed shared ledger can significantly reduce the number of disputes over payment dispute chargebacks for prescription medicines. Since pricing structures change frequently, Chronicled estimates that more than one million chargebacks are made each year between these players, more than 5% of which result in conflicts which require to be resolved manually and the process gets lengthy.

3. 5 GUARANTEES SAFETY

Using a blockchain for patient health treatment increases safety, addresses medication validity problems, allows for safe interoperability, and addresses various other problems like drug validity and traceability. It will ensure better safety as well as the prevention of counterfeit drug manufacturers entering the market by replacing the current supply chain used in healthcare with the one based on blockchain. No matter how large or small the clinic or organization is. The blockchain allows for centralized storage of all data.As a result of Blockchain technology's interoperability, will allow the doctors and medical professionals to access detailed health records of the patients more easily so that they can determine a more accurate diagnosis and generate more accurate operations [19-23]

4. LIMITATIONS AND FUTURE SCOPE

Even with so many advancements and researches being made in modern healthcare sector using blockchain technology, there are still some limitations that need to be considered. the major impediment that is faced by these systems is lack of expertise. More researches and exploration in this field of non-financial sector is required since it is in the early stage of development. Secondly the interoperability of the EMR systems is not a subject that is widely discussed yet [24]. This means that the requirement of manual data analysis is still required . Because of this malpractices at the clinical level cannot be controlled . Scalability is another issue that needs to be addressed. To manage and secure the large chunks of data involved in this modern healthcare system is also a task and could lead to severe performance degradation . This is the reason that blockchain -based systems suffer latency due to speed of transactions being made and the data load [2]. Although with a little research and progress thus technology is going to flourish immensely in the future. For the security issue , in the upcoming days transactions will be authenticated and registered with the majority of network members . A new generation of medical information sharing will be founded using the blockchain, which encrypts data using both public and private keys to ensure digital security. In addition to maintaining and managing patients health records, infringement prevention, improving interoperability, rationalizing procedures, controlling medication and prescriptions, and monitoring medical and supply chains, this technology promises to resolve a number of other important issues. The application of blockchain in healthcare has enormous promise.

5. CONCLUSION

Blockchain is a fast expanding technology with a wide range of potential uses. Starting with cryptocurrencies, it has spread to a number of industries, and this study analyses its significance in the healthcare industry. With the advancement of this technology over the years, it has held its grasp on the other non-financial sectors as well. Blockchain in healthcare focuses primarily on sharing health records among the various medical personnel securely. In addition to domains like Electronic health records, supply chain management, insurance claims, etc. researchers should focus on the other domains as well. In addition to this, implementations are rarely discussed in the papers related to the concerned topic.

Blockchain-based healthcare system shows a promising future though more research is required to efficiently understand and securely develop this technology. The paper also discusses various limitations like scalability, interoperability, and managing large chunks of data. Hence to gain the trust of the various stakeholders, this should be focused upon with urgency.

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