

# The Use of Blockchain Technology in E-Healthcare Systems

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**ABSTRACT:** *The healthcare sector has been embracing cutting-edge technology that allows for the digitization of medical data and the automation of clinical procedures. The requirement for interoperability across various departments in healthcare necessitates a system that allows for smooth data exchange. However, when exchanging data with many authorized parties, data confidentiality and integrity are important concerns. In 2016, hundreds of millions of medical records were hacked, and the number continues to rise. The new blockchain technology is a groundbreaking technique that guarantees data integrity and secrecy inside any system. Blockchain technology has piqued the interest of certain healthcare professionals because it offers a decentralized and encrypted method of storing and exchanging data. This new technology holds a lot of promise for improving the security and integrity of electronic health records. We performed a comprehensive literature analysis in order to identify research gaps and future research directions in blockchain technology in healthcare research in this article. The literature is examined to determine the benefits, drawbacks, and difficulties of using blockchain technology in healthcare from the viewpoints of people and process technology.*

**KEYWORDS:** *Blockchain, Electronic, Information, Security, Technology.*

## 1. INTRODUCTION

Every day, a huge quantity of medical data is collected and transmitted thanks to the Internet of Things (IoT) and the availability of health gadgets and applications. This huge database of medical data requires privacy, security, and availability management. During the treatment process, hospitals and physicians require access to the patient's medical information while also maintaining the confidentiality and privacy of sensitive information that patients share with hospitals and medical institutions. Law enforcement and other specified public entities may also lawfully access health information under the Health Insurance Portability and Accountability Act. As many as 150 to 400 people may access a person's Electronic Health Records (EHR). Because the data is shared extensively and kept in numerous locations, protecting it becomes a more pressing concern. According to the Ponemon Institute, over 112 million medical records were breached in 2016, and data breach assaults have risen by 162 percent in 2017[1]–[4].

Blockchain technology offered a financial application that has sparked a revolution in a variety of sectors, including healthcare data systems. Blockchain technology has the potential to offer a solution that not only secures the recording and sharing of medical information, but also ensures the privacy of each patient's data by transferring ownership of their medical data to the patients. We performed a systematic review of the literature on blockchain technology and healthcare research in this study. We went through the fundamentals of blockchain technology in the next part. The examination of the chosen articles in terms of research technique, as well as any research gaps.

### 1.1 Technology Based on Blockchain:

Blockchain technology is a distributed ledger system that records transactions in a secure, transparent, decentralized, and cost-effective way. The blockchain is the technology that underpins bitcoin, which was first presented in 2008 by Satoshi Nakamoto under the alias Satoshi Nakamoto. To comprehend how blockchain works, it is necessary to first comprehend

the bitcoin process. Bitcoin is a digital money that is peer-to-peer, distributed, and decentralized. In the bitcoin transaction system, there is no trusted intermediary, and anybody with bitcoin may join the network, read, write to, and keep a copy of the transaction records.

### *1.2 What Is the Bitcoin Blockchain and How Does It Work?*

*The transaction system without a central control agency has two challenges:*

- Single point of failure.
- Peer-to-peer double spending of the same digital asset, such as money.

The issue is solved by blockchain technology utilizing two mechanisms: hash-chain time stamping and the proof of work algorithm. To begin, each transaction needs be recorded in each computing node in the network in order to validate it. All transactions in the network are timestamped and disseminated. The Bitcoin blockchain uses hash-chain as a distributed timestamp method to assess if a transaction is possible and to keep a copy of the transaction chain at each node. Second, the bitcoin blockchain employs a reward and punishment system to guard against any potential disruption or fraudulent transaction. Miners are those who participate in the blockchain mining process, which entails generating new blocks with transaction lists contained in addition, chaining them to prior blocks.

#### *1.2.1 Each block contains two key components:*

##### *1.2.1.1 Content:*

A transaction list that has been verified. Digital money (e.g., Bitcoin, Ethereum) or any kind of data (e.g., a school certificate, a medical record) may be used as the transacted digital asset.

##### *1.2.1.2 Header:*

This section contains metadata such as

- The hash root, which is a block reference number to the content of the block.
- The timestamp.
- A link back to the previous block.
- A random number (nonce) that is added to the block address according to the proof of work algorithm.

Miners utilize the proof of work mechanism in the bitcoin blockchain system to discover a new address for a new block with specified characteristics. This bitcoin blockchain property is a 32-bit crypto number with seventeen zero bits at the start. Miners use various random integers to execute this process many times in order to obtain such a number (nonce). The miner changes the ledger and sends it to the whole network after discovering a new address for the new block. The majority of the network should then confirm the new block. In the bitcoin blockchain system, this process is known as proof of work or consensus. Because the mining process is complex, time-consuming, and expensive, it prohibits the creation of invalid or fraudulent transactions. Providing a result, the bitcoin system pays the miner who adds the new block first, as an incentive to compensate for the time and work involved in the mining process[5]–[7]. Another advantage of utilizing the proof of work consensus technique is that it allows for immutable audit trails by chaining blocks together using a hash function. Because each block includes the hash value of the preceding block's header, if an attacker modifies one block, all subsequent blocks should be changed as well. Such a change requires a lot of computing power, effort, and money. Even if the attacker succeeds in creating the fraudulent block chain, replacing it with the legitimate chain needs the agreement of the majority of the network's

nodes. Because of its unique structure, the bitcoin blockchain system is very secure against any change or failure.

### *1.3 Applications of Blockchain Technology in Other Industries:*

Although blockchain was initially used in the financial sector, it has now been expanded to include a wide range of applications. Blockchain technology is changing the future of transaction-based exchange in sectors such as banking, insurance, telecommunications, and healthcare as a horizontal technology. There are three stages of blockchain adoption, according to Melanie Swan: The initial development of blockchain as a cryptocurrency, bitcoin, is known as Blockchain 1.0. Smart contracts, financial data, and monitoring the ownership of assets are all part of the blockchain 2.0 system. Science, health, and education will all benefit from Blockchain 3.0.

### *1.4 Healthcare Blockchain Technology:*

The necessity for security and interoperability in healthcare inspired the concept of using blockchain in healthcare. Every day, a significant quantity of medical data is collected and transmitted thanks to the development of IoT and the availability of health devices and mobile healthcare apps. This data flow requires privacy and security control. Blockchain technology has the potential to offer a solution that not only secures the recording and sharing of medical information, but also ensures the privacy of each patient's data by giving individuals ownership of their medical data. Aside from the benefits of blockchain for healthcare administration, its difficulties must be addressed ahead of time.

### *1.5 Analytical Framework:*

Identifying and listing the benefits, drawbacks, and difficulties of using blockchain technology in healthcare. We divided them into three categories for ease of understanding:

- people
- process
- technology

### *1.6 Individual Advantages:*

Interoperable, uniform, and secure views and exchanges of electronic health data are possible using blockchain technology. Instead of keeping this sensitive information separately on the networks of different healthcare providers, patients may control their medical records. Because the data is unified, any changes are made worldwide. When required, up-to-date data is accessible. Patients may also select whom they want to share their information with. As a result, control may be directed more towards the customer while maintaining a balance with other system actors. Authorities may use blockchain technology to get access to health records when they are required[8].

### *1.7 Processes Benefits:*

Security is a major concern in the healthcare industry. Because blockchain technology has a high degree of tamper resistance, vulnerable health data may be guaranteed to be maintained in a secure environment. Furthermore, since health data from a variety of sources may be kept on a distributed blockchain that does not depend on a single central storage facility, the government and other organizations would be freed from the burden of managing massive quantities of data. Blockchain offers the ability to automate claim validation, eligibility

verification, and preauthorization, which may improve the process' transparency, authenticity, efficiency, and security. In addition to improved security, patients and medical stakeholders would gain a new degree of trust because of the shared infrastructure's openness. Another important area of the healthcare industry where blockchain technology may assist is research. Its decentralized approach to permits, authorisation, and providing fast and safe access to longitudinal study data. MedRec, for example, offers a mining approach that enables medical researchers and healthcare stakeholders to mine the network for aggregated medical data. By reducing the amount presently spent on third-party confirmation, blockchain technology may improve the development of medicines and medical equipment, as well as decrease the manufacturing of counterfeit medicine and clinical trials. Blockchain technology may also aid in the development of new hardware and software to aid in the improvement of healthcare procedures. It may address the issue of appropriate device usage and integration into an existing network with sensitive health records. Blockchain also has the potential to make healthcare procedures more efficient and reliable. No matter where the health record was produced, it is kept in a single format and linked across different organizations via blockchain. This simplifies the process of storing and exchanging electronic health records. Furthermore, since the system could limit human interaction with data, the risk of human mistake and processing times would be minimized. The robustness and availability characteristics ensure record preservation by keeping a full copy of historical data records on each node and making them accessible to users at all times. Because the assets' origins can be traced, the reusability and robustness of validated data improves. This is also known as data provenance, and it is necessary for certain healthcare procedures like insurance transactions. It is also expected that in the future, users of healthcare applications would be compensated for the data they contribute for medical research[9], [10].

#### 1.8 *Disadvantages:*

- There are several drawbacks to blockchain technology.
- This technology is still surrounded by a lot of excitement and ambiguity.
- This raises questions regarding the technology's legality (e.g., for access management).
- It must first be legally authorized before the modifications to the existing infrastructure needed for this technology can be implemented.

#### 1.9 *Challenges:*

Several possible obstacles exist in the areas of ethical and operational advice, regulatory compliance, and technological data storage and delivery restrictions. One of these difficulties is determining data exchange protocols. For example, how a patient may select which data to share and with whom is an issue that has to be addressed. The patient, as the data owner, must provide permission for a healthcare practitioner to access the information. If the patient is unable to do so for whatever reason, it is unclear who has the authority to act on their behalf. It is also unclear how much health data should be kept online and if data may be shared with one another forever or for a limited period. While data on the blockchain may be de-identified and encrypted, in an event involving a decentralized autonomous organization, data security may be compromised owing to poorly maintained or obsolete codes. Even though a user's identity is obscured by a hash value, the person may still be discovered by inspecting and analyzing publicly accessible transaction data, resulting in pseudonymity rather than anonymity. While blockchain helps avoid data block fraud, ensuring the identity and authenticity of the informant and stakeholders remains a problem. Because of the openness, protecting data from hostile traffic analysis while preserving accountability and transaction privacy is challenging. Other issues arise because of the transition to blockchain technology in healthcare operations. Both healthcare professionals and patients must get enough training. To

guarantee vertical and horizontal scalability, users must be educated on how to build and operate distributed controllers and network functions, as well as how to autonomously orchestrate network activities and services throughout the softwarized middleware. Furthermore, the changeover may take a long time, and there may be some problems with the procedures throughout that period. For example, the capacity of patients to self-report their illness symptoms is presently app-specific. Patients will only be able to use this function if their provider's medical system supports it. As a result, problems like these should be addressed to ensure a seamless transition. In addition, measures to evaluate the efficiency of this technology in healthcare are still needed. Policy compliance, high-level computation capabilities, authentication, interoperability, scalability, cost-effectiveness, and domain-specific healthcare needs are among the metrics proposed by several studies.

#### 1.10 Technological Benefits:

With high performance and low latency, the blockchain technology infrastructure is versatile, adaptive, agile, and secure. It has a lot to offer the healthcare industry, as well as other industries. Decentralized technology allows for the avoidance of time-consuming and resource-intensive identification and information processes, which speeds up healthcare operations. The blockchain technology has been in use for some time. For compliance with the Drug Supply Chain Security Act, software intended to guarantee the transparency of the medication production process, monitor medical distribution, and verify the validity of prescriptions. Cost and complexity are disadvantages that may have severe implications for healthcare stakeholders. Many EHR services may move to third-party providers due to the high cost of data centers, and healthcare providers may have to pay to access the data. For all parties, the technical intricacy of the encryption and networking involved may be difficult to comprehend. Due to the difficulty of blockchain setup, many patients may be hesitant to handle their medical data. Another technical drawback of blockchain is that it is not well suited for data with high temporal precision, and it has problems processing multi-dimensional data, such as complicated text, pictures, and graphs. Furthermore, since it is an open network that anybody can join, it requires a lot of computer power to prevent tampering.

#### 1.11 Challenges:

In industrial settings, the cost-effectiveness and efficiency of processing huge quantities of data have yet to be determined. Depending on the protocol, transaction times may become lengthy as traffic grows, affecting scalability and needed computing power. While transitioning current electronic health systems to blockchain-based technologies, the feasibility of expenditures and setup for hardware, software, implementation, and support must be evaluated. Furthermore, a worldwide standard for storing, accessing, and sharing encrypted data in the cloud is required. The last issue is that there is no evidence that the data blocks cannot be faked, decrypted, or rearranged endlessly, which calls into doubt the security component. If hostile attackers gain control of the whole network, there is a 51 percent probability of a security issue. Final thoughts the presented blockchain technology in this article, which is well known for its use in cryptocurrencies but has a wider range of applications ranging from banking to healthcare. Since 2012, there has been a lot of research on blockchain. However, blockchain integration in healthcare is a relatively young and rapidly growing field. With its unique approach to decentralized administration, resilience, security, and an indelible audit trail, the blockchain is positioned as a paradigm shifter. Early blockchain applications in healthcare have shown that it is not only altering technology, but also a method of conducting business, rethinking the relationships between players ranging from healthcare professionals to patients, pharmaceutical companies to scientists. There are also certain issues regarding blockchain

technology, which need more investigation. The main technological problems to be solved are transparency, secrecy, speed, and scalability. Legal and regulatory concerns must also be addressed. Before using blockchain in the healthcare system, feasibility studies using a system of systems approach should be conducted. Because it examines all three elements of people, process, and technology to give a holistic perspective, the system of systems method is the most important approach for feasibility studies.

## 2. DISCUSSION

The author has discussed about the block chain and its applications, the need for interoperability across different departments in healthcare requires the use of a system that facilitates data sharing. When sharing data with a large number of authorized parties, however, data integrity are critical issues. Hundreds of millions of health records were compromised in 2016, and the number is still rising. The new blockchain is a game-changing method for ensuring data integrity and privacy inside any system. Certain healthcare practitioners are interested in blockchain technology because it provides a distributed and encrypted way of storing and sharing data. This new technology has a lot of potential in terms of strengthening the security and accuracy of healthcare data. In this study, we conducted a thorough literature review to identify research gaps and future research objectives in blockchain technology in the health research.

## 3. CONCLUSION

The author has presented blockchain technology in this article, which is well known for its use in cryptocurrencies but has a wider range of applications ranging from banking to healthcare. Since 2012, there has been a lot of research on blockchain. The main technological problems to be solved are transparency, secrecy, speed, and scalability. Legal and regulatory concerns must also be addressed. Before using blockchain in the healthcare system, feasibility studies using a system of systems approach should be conducted. However, blockchain integration in healthcare is a relatively young and rapidly growing field. With its unique approach to decentralized administration, resilience, security, and an indelible audit trail, the blockchain is positioned as a paradigm shifter. Early blockchain applications in healthcare have shown that it is not only altering technology, but also a method of conducting business, rethinking the relationships between players ranging from healthcare professionals to patients, pharmaceutical companies to scientists. There are also certain issues regarding blockchain technology, which need more investigation. The main technological problems to be solved are transparency, secrecy, speed, and scalability. Legal and regulatory concerns must also be addressed. Before using blockchain in the healthcare system, feasibility studies using a system of systems approach should be conducted. Because it examines all three elements of people, process, and technology to give a holistic perspective, the system of systems method is the most important approach for feasibility studies.

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