Blockchain in Health Care: A Review

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Abstract Blockchain is taken to be a system of ledger which handles data and manages their transactions with the help of their time stamps through cryptographic hashing and serves in a decentralized technique over the computer networks. Despite the fact that blockchain concept is used on a large scale for cryptocurrency, this paper explores some potential applications of the blockchain concept in the healthcare industry as well. It discusses the use of blockchain technology in the healthcare sector and how it can help in overcoming the present challenges like interoperability, security, and cost of maintenance in the traditional healthcare system. This paper highlights the applications of blockchain in detail and why it is hard to implement in the healthcare sector.

Keywords Blockchain · Internet of things · Security · Health care

1 Introduction

Blockchain [1] is a type of database that consists of information in the form of blocks connected to each other using cryptographic methods, with each block containing the hash of the previous block, the records, and their time stamps. These blocks are consistently growing in number with the present value at 672,425 (recorded at 05:00 PM February 27, 2021).

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The features of blockchain are:

1.1 ***Immutability***: Blockchain does not allow any modification or deletion of the data once it has been recorded. This is because each block contains the hash of the previous one and if we modify the data then the hash of every following block will have to be altered.

1.2 ***Decentralization***: Blockchain does not have a central entity that manages or controls the system. Instead, it works on the concept of a distributed network in which data is shared with all the computers on the network. This is called a ledger. Each time a new block is added, all these computers display the addition as every connection has the same copy of the ledger.

1.3 ***Transparency***: This feature of blockchain allows anyone to join the network and validate the transactions of their peers so they can be added to a block. A history of all the transactions is also available.

1.4 ***Trust and Consensus***: The blockchain system is established on trust as data is secured with the help of cryptographic methods. Consensus is a way of validating transactions on a distributed ledger by establishing an agreement between the peers. It eliminates the need of a central authority.

In this paper, Sect. 2 discusses the literature available for the applications of blockchain in health care, and Sect. 3 focusses on challenges in the healthcare sector and various domains where blockchain can be implemented. Section 4 concludes the paper.

2 Literature Survey

In [2], authors have presented a structured literature survey of research on blockchain applications such in the healthcare area. This analysis includes 42 article write-ups presenting the most up-to-date knowledge on present-day implications and loopholes in the blockchain execution for improvement in the healthcare sector. The findings in the sheet show that blockchain is being utilized to build advanced and up-to-the-minute interventions to upgrade the universal standards of handling, processing, and sharing of medical information/data and health records of the patients. This technology is going through an evolution in the healthcare sector where it has added a positive impact through improved efficiency, technological advancements, access control, security of data handling, privacy protection, etc. The sheet also presents some discoveries that suggest that some limitations primarily prevail to model the performance as well as have some effect on the cost of execution.

This research paper [3] addresses the potential areas where the future researchers or experimenters could contribute some value in the areas like system architecture,

data security, etc. Concluding the research, the findings suggest that the researches in the future will contribute in the deployment of this technology on a larger scale and also in the critical issues related to legal consents, security measures, medical diagnostics, and improving patient care in some cases like remote monitoring or emergency situations.

In this research paper [4], the researchers have surveyed a lot of interesting implementations of blockchain technology. Apart from the financial sector, a lot of sectors have been implementing the blockchain concept where its beneficial features add innovations and solutions to some compromised areas. These sectors which are mentioned in this paper are—health care, electronic voting, etc. For each of these topics, they have given a detailed study including the problems and solutions given by the blockchain concept.

In this research paper [5], authors reviewed important use cases of blockchain in the healthcare industry: patient record management, research, and billing claims management alongside the related projects. The authors have also discussed the challenges in the implementation of blockchain technology in the healthcare industry. Most of the blockchain projects and concepts are still in the form of prototypes and white papers. However, the use of blockchain technology is expanding.

In this research paper [6], authors gave an overview about the application of blockchain in the healthcare sector and how it helps in automation of healthcare services. The authors have not only focussed on the different applications of the technology but also identified the limitations of existing research and surveys. The authors conclude with stating the need of research for better understanding and development of this technology.

This research paper [7] gives us knowledge of how blockchain is gaining popularity in the market due to its concept of digitally shared ledger and consensus algo removing all the risks and threats of the mediators and intercessors. It also shows that the usage of blockchain has now extended to all the major sectors of research including banking, governance, IoT, health care, education, etc. The study reviews the existing literature about this field so as to list the major issues in health care and inspect the features of blockchain that could rectify the identified issues. However, a few challenges and limitations of this technology still need more research.

In this research paper [8], authors gave an overview of benefits and drawbacks related to blockchain technology. This paper also discusses the existing challenges related to crypto-currencies. Authors have discussed the advantage of using blockchain in the healthcare industry. There are various potential challenges in implementing blockchain in the healthcare sector; authors have also provided solutions to some of the challenges. Blockchain can help in the advancement of the medical sector in various ways and authors expect many more applications of blockchain in the near future.

In [9], the authors proposed a medical data management system using blockchain technology, which is much more secure than the traditional model and also allows patients ownership over their records while granting hospitals a temporary

and easy access to the data. This patient-centered blockchain model is based on Ethereum and it stores the actual medical records on a decentralized cloud system, Ethereum Swarm. Each medical record having its unique swarm hash is combined with the decryption key to form the root chunk and only the authorized personnel have access to the content in the root chunk.

In this research paper [10], authors have presented a basic introduction of blockchain technology and its structure. The authors have discussed the implementation of blockchain in the healthcare sector. Blockchain is an emerging technology but has some major challenges including usability and authentication of patients. The paper also briefly mentions the impact of blockchain in the near future. Future of blockchain in the healthcare sector is promising and will authorize the patients to take control of their medical records so that they can keep track of their health condition.

This research paper [11] discusses the management of confidential medical information of patients, sharing of medical records, image sharing, and log management. The authors have also reviewed studies that intersect with other areas and have performed SWOT analysis on the basis of these to analyze their positive and negative aspects. The authors provide guidance to future researchers by assessing the benefits and limitations of the medical concepts of blockchain. The paper concludes by summarizing the techniques used in health care, their applications, and pros and cons.

3   Blockchain and Health care

With the concept of blockchain becoming increasingly popular, it is believed that this technology will also evolve the healthcare sector in the near future. It can grant a new framework for health information exchanges (HIE) by listing medical records of patients more systematically keeping privacy, security, and interoperability in check.

3.1   Blockchain Versus Current Healthcare Challenges

This section provides an insight on how blockchain technology can help in overcoming some of the existing challenges in the healthcare field. Some of these are:

(i)   *Interoperability*: It refers to the characteristic of health information systems to operate together with other such organizations to deliver quality healthcare services to people more efficiently.
      Blockchain overcomes this challenge by retrieving data with the help of APIs, which helps in achieving data format standardization.

(ii) *Security and Integrity*: It refers to the set of guidelines and standards to protect the confidentiality and integrity of personal health information. Data tampering and breach is a matter of concern in the healthcare sector.

Blockchain provides security as it is immutable and data is stored in encrypted form so it is not possible to modify information.

(iii) *Access Rights*: Managing health records across the organization is a challenge where blockchain technology can come in use.

It makes sure that records are updated and available at every node. Also, access rights can be defined using the concept of smart contracts.

(iv) *Cost of Maintenance*: Maintenance of healthcare systems includes various actions such as backup and recovery mechanisms.

In the case of blockchain, there is an open-distributed network where data is shared with all the nodes in the network. Therefore, failure of one node does not affect the other nodes. This reduces the need of a backup mechanism.

3.2 Applications of Blockchain in Health care

In this section, several important use cases and applications of blockchain in health care are discussed below:

(i) **Blockchain for Electronic Health Record (EHR):**

Ideally, it is required that EHR should maintain a lifetime medical record which is accessible to the entire medical staff. In the present application of EHR, patient information is stored in multiple organizations throughout his lifetime. The physician conducts the diagnosis, specifies the problem, medication, and this record remains with him even after the patient is treated.

In the blockchain implementation of EHR, only the individual will have access to his medical record and doctors will be granted access through smart contracts when required.

At present, interoperability and data fragmentation is a huge challenge among different organizations as they are reluctant to share data with each other. Using blockchain, the owner can set viewership permissions on the data shared with another entity. This is supported by smart contracts which are self-executing conditional contracts in which the agreement is coded. New records can be updated regularly on the patient's profile and he can decide which entity has access to which content, hence providing authorization.

(ii) **Blockchain in Clinical Research:**

This also centralizes around the issue that an individual's medical data is scattered across the databases and records of multiple organizations which causes hindrance in sharing of data. Not only does it leads to inefficient treatment of patients, but also causes a setback in the domain of clinical research.

Clinical trials require real-time medical information of patients to conduct a sound hypothesis and research which is backed up by a set of realistic data. Gathering all these records from the scratch can be a very hard, time consuming, and costly process. Surveys show that people are ready to share their medical records for research provided that their data is not compromised.

Blockchain supports this due to its features of transparency and trust. The data is public and anyone can write to it but no one has the permission to store it because of encryption. Patients can manage their data and also have the rights to deny access to it anytime. This framework would be beneficial for research entities to get hold of secure and accurate data.

(iii) **Blockchain in Drug Supply Chain Management:**

Transparency and security of the supply chain are major challenges in the pharmaceutical sector. These services of this sector directly impact the lives of their consumers which is why safety and efficiency of the product are necessary. The product reaches the consumer after passing multiple stages: manufacturing, transportation, handling, storage, redistribution, and retail. Anything can go wrong in these stages from a simple human error to a malicious fraud as in the traditional system, identifying the cause of the issue can be very difficult. This is because records are maintained on a personal level and can be tampered with very easily. Such an unorganized set of data is not available to the company itself, let alone the government and consumers.

Blockchain solves this problem by providing a distributed ledger shared among all concerned members in the supply chain. The records stored in the form of blocks are immutable, permanent, and transparent. This reduces the possibility of errors and frauds significantly and also provides organized data visible even to the consumers.

(iv) **Blockchain in Claim and Billing Management:**

Fraudulent claims and billing is one of the issues in the healthcare sector that needs to be eliminated. Some of the challenges faced in the claim and billing process are overcharging, performing unnecessary medical tests, and claiming charge for non-performed services. There are a lot of third parties involved in resolving the claim process, to ensure faster processing of claims and cost reduction for suppliers and clients.

Blockchain technology can help in automation of claim processing with the help of a smart contract between the involved parties. Also, the challenges faced in this process can be reduced to a great extent because of the transparent and distributed network in blockchain.

(v) **Blockchain Application in Health Information Exchanges (HIE):**

HIE's goal is to offer secure delivery of healthcare data beyond geographical boundaries. To achieve this goal, data privacy and security should be given priority.

Security: Securing patient data is important and blockchain can be useful in doing so. On a blockchain, data is in encrypted form and can be accessed by using

the shared public key of a patient. Use of private and public keys defines access rights and ensures data privacy.

Decentralization: Centralized network is a traditional setup for HIE in which data from patients is stored in a central storage system where failing of the central node will lead to loss of medical records. Blockchain is an open-distributed ledger where each node will have the updated records and patients can define the access rights of their medical records, thereby scaling the infrastructure to a decentralized network from a traditional centralized network.

Interoperability: It refers to the characteristic of health information systems to operate together with other such organizations to deliver quality healthcare services to people more efficiently.

Blockchain offers access to patient's data with regular updates across all healthcare organizations. Itss distributed-ledger feature removes the chances of duplicity as the same copy of data is available to all the organizations.

3.3 Blockchain Technology—Challenges in Health Care

Applying blockchain in the domain of health care has numerous advantages but the practical implementation of this technology is not as easy as it seems. This portion of the paper will discuss the challenges which blockchain technology has yet to overcome.

  (i) Blockchain has already been widely accepted in the field of banking but the awareness regarding this technology in the healthcare sector is yet to come by. Organizations are not aware of this technology and even if they are, the crucial challenge is understanding how it works and the benefits of adopting this technology.
 (ii) Organizations are comfortable with working in a centralized environment and do not prefer to shift to a decentralized system as it incurs cost for ensuring speed and efficiency.
(iii) Another reason why healthcare entities are resistant to change is that shifting from their current system would require a lot of time and effort.

4 Conclusion

Blockchain is an emerging technology and has the capability to change the traditional business model to a brand-new advanced framework. Some organizations have started to adopt this technology in the healthcare sector, and it is expected to take over at least 55% of the global healthcare system by the year 2025. Blockchain technology offers promising solutions to the healthcare industry, and at this rate, it will soon become an integral part of the data management and supply chain

systems. There are various advantages of this technology in the healthcare sector; however, there are some challenges related to the implementation of blockchain such as lack of awareness regarding the working and implementation of technology that have yet to be tackled. Another challenge in implementation of blockchain in the healthcare sector is the amount of time and effort that will be required in shifting from the current centralized system to the decentralized system. This paper presents a review of numerous studies that deals with the use of blockchain technology in the healthcare sector.

On the basis of all the studies reviewed, it is evident that blockchain technology has a lot of scope in the future to develop and take over most of the traditional healthcare models. With this advancement in the health care, patients will have the assurance that their private data will not fall in the wrong hands and be misused.

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