

A Systematic Literature Review: Applications, Challenges and Technology of Blockchain in Healthcare

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ABSTRACT

Blockchain can be viewed like a ledger system that manages data and their transactions using time stamped blocks through cryptography and works in a decentralized manner over the computer network. Although blockchain was originally designed for the cryptocurrency, its applications have been extended to other domains like medicine, health record, transportation agriculture and lots more. In this study, a systematic literature review regarding Blockchain technology in healthcare was conducted, with the objective of identifying and discussing the challenges, applications and technology used in the healthcare sector. The authors have highlighted Blockchain's potential for the healthcare sector, from the review, it can be depicted that healthcare sector is faced with a lot of challenges like the issue of security and privacy of data, managing storage capacity, interoperability, standardization and social challenges. It is the authors belief that this systematic literature review will go a long way in assisting new researchers in this domain of study.

Keywords- Blockchain, Medical Data, Healthcare, Blockchain Technology.

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1. INTRODUCTION

Blockchain is a system that stores information in a network of computers called nodes. There is no central entity like a bank or government controlling it. The system is call distributed that means that the entire computer in the network has the same information [1]. Imagine the blockchain like a big public ledger with the list of all transactions have been executed between two parties each transaction is time termed and immutable, that means that one you add a transaction or information to the blockchain. You cannot go back and change it or delete it. The people in the network that add and verify the transactions are called miners [2]. To do so they take the transaction information and run it through secure hash algorithm that provides them with unique output of the hash. What is important to remember is that only the hash is stored on the blockchain not in transaction information. That means that if you see or have the hash, you cannot go back and retrieve the transaction information this insures privacy [1]. Each hash is added to a ledger and the ledger is stored in a block and each block is linked to the previous one creating a chain which forms a blockchain of course the blockchain does not store just the list of transactions it can provide proof-of- existence for any document like audio files, images or even complete medical records.

There are a lot of uses cases with blockchain for one main reason, the power of blockchain lies in the fact that it can proof what eccentric event occurred at a certain time, that event can be financial transaction or the creation of a new document. Now this characteristic is very powerful as you can imagine [2]. And many sectors are very interested in it; like health care.

The medical and scientific communities do not have access to data and when they finally finds an information, it becomes hard to find the patient and ask for consent, but now imagine, we have a system like a ledger with list of all information about a patient, with all his history and imagine that the ledger is public and access for doctors, nurses, pharmacist, scientist, imagine that we have a system that allows us to access the data only upon the concern given by the patient, now stop imagine it because it is happening and it is called the blockchain [3].

The healthcare industry has been adopting inventive technologies that allow digitalization of health records and automation of clinical tasks. The need for interoperability across various departments in healthcare requires a smooth and continuous data exchange within the system. However, confidentiality and integrity of data are censorious matter during the process of sharing data across different authorized parties. Hundreds of millions of medical records have been compromised in 2016 and the number increases. The arising blockchain technology is a futuristic system, which ensures data integrity and confidentiality inside any system. Some healthcare providers have been prepared to apply blockchain technology as it presents a decentralized and encrypted way of storing and sharing information [4].

The aim of this paper is to carry out a systematic literature review (SLR) in order to systematically examine the recent research with the objective of identifying the applications of using Blockchain Technology in healthcare sector. Also, the traditional uses of Blockchain Technology in securing patients data and challenges in healthcare sector. The types of methodology used by the researchers are to be considered in more details.

The contributions of this paper include:

1. A specific summary of Blockchain Technology in healthcare sector
2. A description on the applications of Blockchain technology to secure Patients medical data in healthcare sector;
3. A summary of various challenges of Patients medical data security in healthcare sector;

The remaining sections of this paper are arranged as follows. Section 2 presents the related works and study as well as showing the similarities between previous surveys and review with this new study. Section 3 is the methodology on the selection of articles . Section 4 gives the results to the research questions this research. Section 5 provides the conclusion for this review.

2. RELATED WORK

[5] did a solid Systematic Literature Review, aiming to explore the recent literature on Blockchain and healthcare domain and identify existing challenges and open questions, guided by the raise of research questions regarding EHR in a Blockchain .the authors concluded that Blockchain could reinvent the way patient's electronic health records are shared and stored by providing safer mechanisms for health information exchange of medical data in the healthcare industry, by securing it over a decentralized peer-to-peer network. Authors in [6] reviews existing literature in order to identify the major issues of various healthcare stakeholders and to explore the features of blockchain technology that could resolve identified issues.

Authors in [7] aimed to reveal the potential applications of the technology and to highlight the challenges and possible directions of blockchain research in healthcare. First, background information is discussed, followed by a description of the exact methodology used in this paper. Next, an analysis of the results is given, which includes a bibliometric overview, an analysis of gathered data and its properties, and the results of a literature quality assessment.

2.1 Systematic Review Methodology

This review covers the search duration of 2011 to 2019. To accomplish the entire review activities, the processes utilized: research questions.

2.2 Research Questions

This study makes use of the following research questions including:

1. What are precise technologies of Blockchain in healthcare sector?
2. What are Applications/Uses of Blockchain Technology in Healthcare?
3. What are various challenges of Patients medical data insecurity in healthcare sector?

3. METHODOLOGY

To cover as many related studies as possible, we selected articles from reliable academic repositories such as Science Direct Google Scholar, IEEE, ACM, and Springer as our main electronic databases for our literature review, which cover the most relevant journals and conferences within the computer science and healthcare fields. To limit our search, we set the years to range from 2011 to 2019.

Upon retrieving the appropriate articles from various databases and sources, every title and abstract were screened for eligibility in an independently style by the researchers.

4. RESULTS

A. Blockchain Technology in Healthcare Sector

Blockchain technology in healthcare sector as presented in Table 1.

Table 1. Blockchain Technology in Healthcare Sector

Reference	BC Technology	Description of Technology
[8]	MedRec	A novel, decentralized record management system to handle EMRs, using blockchain technology. The system gives patients a comprehensive, immutable log and easy access to their medical information across providers and treatment sites
[9]	MeDshare	Data transitions and sharing from one entity to the other, along with all actions performed on the MeDShare system, are recorded in a tamper-proof manner.
[10]	Data integrity service	Blockchain-based framework for Data Integrity Service. Under such framework, more reliable data integrity verification can be provided for both the Data Owners and the Data Consumers, without relying on any Third Party Auditor (TPA).
[11]	Permissioned Blockchain	Permissioned Blockchains meets the fundamental requirements for longevity, agility, and incremental adoption. Distributed Identity Management is an inherent feature of our Permissioned Blockchain and provides for resilient user and device identity and attribute management
[12]	Fair access	Fair Access as a fully decentralized pseudonymous and privacy preserving authorization management framework that enables users to own and control their data.
[13]	BlochIE	Blockchain-based platform for healthcare information exchange. They consider two kinds of healthcare data, i.e., electronic medical records and personal healthcare data, and analyzed the different requirements to store and share them.
[14]	OMNIPHR	A distributed model to integrate PHRs, for patients and healthcare providers use. The scientific contribution is to support a distributed PHR, where patients can maintain their health history in and unified viewpoint, from any device anywhere.

From the table above blockchain technology is used in diverse ways of action like data sharing, data integrity, medical record keeping and so on in healthcare sector.

B. Applications/Uses of Blockchain Technology in Healthcare

Several studies provided Applications/Uses of Blockchain Technology in Healthcare as presented in Table 2.

Table 2. Applications/Uses of Blockchain technology in healthcare

Reference	Application/uses	Description
[17,18,19, 20 21,22,23,24,25]	Scientific Data Sharing	Sharing of health care records and medical data is one Essential way to improve the standard of healthcare providers and make the sector smarter. Healthcare records can be shared between individual, for instances between doctors and patients, between insurance companies or even research centers. An efficient data sharing can be done using blockchain technology.
[16,26,27,28]	Data management	The volume of data been generated in healthcare sectors is growing rapid in the era of technology, meanwhile, data security is being violate intentionally or unintentionally therefore, blockchain technology can help the mode of access to be in a seamless form such blockchain techniques are MedRec.
[29,30,31,32,33]	Data storage (cloud based)	In healthcare sector, patient medica data are organized in electronic healthcare records. Blockchain based healthcare data storage is transacted in blocks on decentralized and distributed format cloud-based storage comprises of voluminous devices cost of storage and enhances easy access of data with dynamic association.
[34,35,36,37,38,39 15,30]	Electronic Health Record (HER)	The traditional way of keeping medical records is the paper-based format, this is prone to errors, mix up of laboratory reports and even sometimes patients got maltreatment. Blockchain based frame work design for medical data sharing, storage of patient's sensitive data are achieved through the deployment of secure HER using blockchain based cryptosystem.
[40,41,42,43,44,45 46]	Supply Chain Management (SCM)	Blockchain can stand as a trusted network of vendors that allow healthcare administrator to guard patients from disreputable suppliers. Also blockchain is revenant for forecasting demand of healthcare products, fraud prevention and enhance secured transaction of
[47,48,49,50,51,52]	Pharmaceutical	pharmaceutical industries are fervently struggling improve the quality of medicine and even invent new Medicine for different aliments. This company is vulnerable to drug counterfeit due to lack of security and Privacy. Blockchain is developed as pharmacosurveillance in a simulated network to improve Traceability of fake drugs.

From the above table blockchain technology is applied and use in many areas of healthcare sector like data management, pharmaceutical and many other areas in this sector.

C. Challenges of Patients Medical Data Security in Healthcare Sector

The studies reviewed the challenges of patient's medical data security in healthcare sector as shown in Table 3.

Table 3. Challenges of Patients Medical Data Security in Healthcare Sector

References	Challenges	Description
[53,54,55,56,57, 58]	Security & Privacy	The most crucial, challenge is the security and privacy of data. With implementation of applications based on the technology of blockchain, the need of a third party to carry out a transaction is eliminated. Since the mechanism of blockchain allows the entire community, rather than a single trusted third party, to verify the records in a blockchain technology, the data becomes prone to potential privacy and security Risks.
[59,60,61,62]	Managing storage capacity storage space.	With time, as it spread its wings into the domain of healthcare, storage challenges became evident. The healthcare sector has a large amount of data that must be processed on a daily basis. From patient records, health history, and test reports, to MRI Scans, X-rays, and other medical images—all the data, in the blockchain scenario, will be available to all the nodes in the chain, which requires a massive
[54,63]	Interoperability issue	Blockchain also suffers from the issue of interoperability; that is, making blockchains from various communicating providers and services talk to one another seamlessly and appropriately. This challenge creates hindrances in the effective sharing of data.
[54,63]	Standardization challenges	Blockchain technology is still in its infancy, and thus towards its practical implementation in medicine and healthcare it will certainly face standardization challenges. A number of well-authenticated and certified standards would be required from international standardization authorities. These predefined standards would be helpful to evaluate the size, data nature, and format of the information exchanged in blockchain applications
[53,62]	Social Challenges	Although the medical industry is slowly moving towards digitization, there's still a long way to go for it to completely move on to this technology, especially to ones like blockchain—which has yet not been validated in clinical aspects. Convincing doctors to switch from paperwork to making use of technology will take time and effort.



From Table 3, it is obvious that there so many challenges that can affect the security (confidentiality, integrity and availability) of the patient medical records in healthcare sector, these issues have been studied by many researcher.

5. CONCLUSION

In this study, a systematic literature review regarding Blockchain technology in healthcare was conducted, with the objective of identifying and discussing the challenges, applications and technology used in the healthcare sector. The application of Blockchain has exceeded the scope of the field of cryptocurrency and the authors have highlighted Blockchain's potential for the healthcare sector, from the review, it can be depicted that healthcare sector is faced with alots of challenges like the issue of security and privacy of data, managing storage capacity, interoperability, standardization challenges and even social challenges.

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