

A Systematic Review on the Role of Blockchain Technology in Healthcare: Challenges and Solutions

Ruqiya¹, Muhammad Waqas², Noman Khan³, Umair Saeed⁴, and Rehan Ali⁵

¹Benazir Bhutto Shaheed University Lyari Karachi, Pakistan, ²University of Electronic Science and Technology of China, ³Sir Syed University of Engineering & Technology Karachi, Pakistan, ⁴Bahria University Islamabad, Pakistan, ⁵Dawood University of Engineering and Technology, Karachi, Pakistan

Email: ruqiyaabbasi42@gmail.com, muhammad.waqaspn@gmail.com, nomankhanabbasi@gmail.com, umairsaeedmixit@gmail.com, eng.rehan75@yahoo.com

Corresponding Author: Muhammad Waqas, muhammad.waqaspn@gmail.com

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Abstract: Blockchain technology is used to record information in a way that makes it problematic or impossible to modify, hack or cheat the method. Blockchain has gained significant attention in various applications such as IoT, cybersecurity, finance, network data management, supply chain, and insurance. Many applications extend beyond financial services such as the healthcare industry. The healthcare industry has also adapted blockchain technology in its numerous sub-domains such as electronic health records (EHR), clinical research, genomic market and medical supply chain management, the healthcare system is gradually incorporating artificial intelligence (AI) into its systems, but it is not a one-size-fits-all solution these challenges. This research paper is conducted on a systematic literature review to discover the state-of-the-art research studies conducted on the issues of healthcare applications and different frameworks researchers suggested as their solutions through using blockchain technology. This paper also presents some challenges and future research directions, which can be develop with various methods of artificial intelligence and blockchain technology, as well as patients who can diagnose and treat using blockchain technology for safe and secure data sharing, it will transform healthcare systems with personalized, authentic and secure access to patient clinical data, and these data can be used for more health development and clinical research.

Keywords: Internet of Things (IoT), Blockchain technology, Electronic Healthcare Records (EHR), Medical Supply Chain Management Healthcare System, Patient Clinical Data, and Personalized Healthcare.

1. INTRODUCTION

Blockchain technology and its architecture had launched in 2009. It was originally design for Bitcoin cryptocurrency [1], but now it has been evolved to the point of being mentioned to as a foundation for numerous decentralized applications [2]. The primary benefit of blockchain, the technology that strengthens Bitcoin, is that it enables electronic currency exchange between users in a distributed network without the need for a centrally managed trusted third party. Blockchain also offers a secure distributed database that can carry out its functions without interference from outside parties or centralized management [3,4]. The term blockchain refers to the sharing of an immutable record of a chain of transactions, each containing a single block, the blocks being held together using cryptographic "Hash" keys. Once accepted into the blockchain, these blocks are linked to previous and future blocks using cryptographic protocols [5].

According to the National institute of standards and Technology (NIST), blockchain is fundamentally a digital ledger of transactions that is clone itself and spread across the whole network of computer system. Each block in the chain covers a number of transactions and when new transaction occurs on the blockchain a record of those transactions is added to every participant ledger. This technology is also known as digital ledger technology (DLT) [6,7]. DLT can be useful in various healthcare areas but all activities within healthcare is not related to transaction. Healthcare is the enhancement or maintenance of health through the diagnosis, disease treatment, prevention of injury and illness or other physically disable persons which is delivered by doctors [8].

The healthcare industry is currently developing a smart healthcare system in which all stakeholders are connected to create ubiquitous and comprehensive healthcare facilities. The security and privacy of data collected and stored by IoT devices pose particular challenges to the healthcare industry [9], which has led to additional legal obligations to protect patients' medical information [10, 11]. Due to its extreme security and openness, blockchain technology benefits the healthcare industry in several ways, including reducing costs and creating new ways for patients to receive care [12]. Because bank and credit card information as well as health and genomic testing data, are highly valued in the healthcare industry, approximately 176 million patient records were compromised through data breaches between 2009 and 2017 [11]. It is not to surprise that the most widely used blockchain applications in the healthcare industry today protects medical data of the patients. The use of blockchain technology in healthcare can provide new and effective ways to improve many tasks related to the treatment and prevention of diseases. As shown in Fig. 1, many healthcare companies are currently using the Internet of Things for inventory tracking, asset maintenance, and newborn monitoring, among others [13, 14, 15].

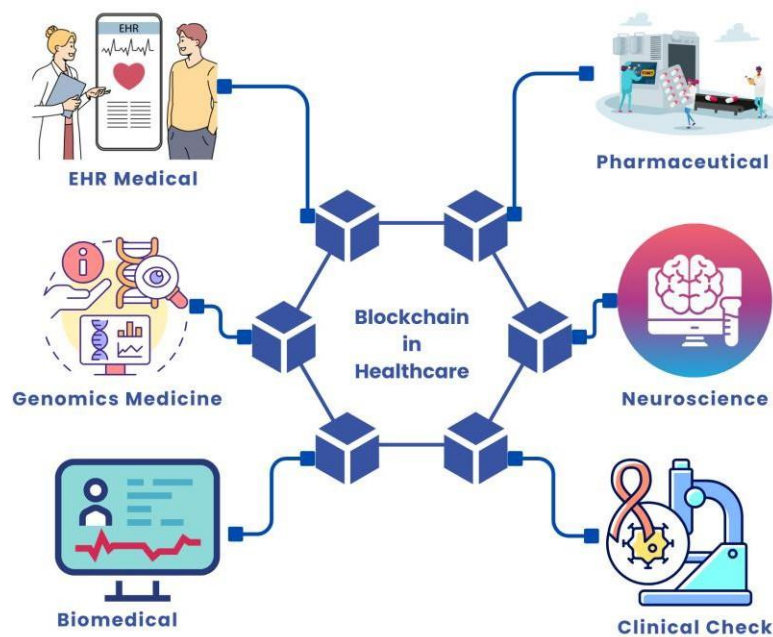


Figure.1. Healthcare system application in Blockchain

This review paper has been organized in which section 2, provides the literature review to the use of blockchain in healthcare. Section 3 describes the methodology and research questions. Section 4 depicts the critical issues in healthcare and blockchain solutions. Section 5 provides the conclusion.

2. LITERATURE REVIEW

The idea of blockchain was initially implemented over finance area but now this concept has been extended to almost all the major sectors of research including banking, defense, IOT, supply chain, governance, capital market, insurance, peer to peer transaction, money laundering protection and healthcare. However, integrating IoT into the healthcare system can put patient privacy at risk. They need to consider security because there are many malicious users and hackers on the Internet, which creates security and privacy issues for sensitive and secret data. Blockchain is an innovative way to solve these problems and the aim of using blockchain in healthcare for some feature decentralization, immutability, security and privacy [16,17]. There are central characteristics of Blockchain, Blockchain are decentralization and has clear

visibility, they are accurate accuracy in term of they have immutable and deterministic data [18]. Building trust in data exchange between distributed parties is made possible to the integrity and immutability guarantees of the decentralized blockchain method, which eliminate the need for a central authority [19]. Additionally, data stored in a blockchain cannot be modified or deleted, making it an immutable data repository [20]. Patient health data that is more meaningful and contains important information requires better management of data security, privacy and accessibility. Patient health requires full monitoring by both hospitals and physicians to provide better care, while maintaining privacy and data security of sensitive patient data, and better understanding of relevant cases. Information should be shared with medical institutions and major hospitals for expert advice [21].

Apart from other fields, blockchain technology has the potential to have a significant impact on the healthcare industry by improving the interpretation of medical information and providing new insights. As new and advanced technologies enable the delivery of improved healthcare facilities, blockchain is playing a key role in transforming the healthcare industry [22]. Concurrently, this technology will significantly improve and ultimately transform the way physicians and patients collaboration, leverage clinical information, and modernize healthcare organizations. Through a patient-centered strategy that eliminates intermediaries and IoT-based blockchain technology can leverage real-time health data in a peer-to-peer interoperable manner [23]. Globally, almost all governments are promoting the use of e-procurement platforms to reduce direct interaction between officials and companies, increase transparency, facilitate access to public procurement, and facilitate fraud detection. The author focuses on a blockchain-based solution that adapts the auctioneer-solved auction protocol from exploiting cryptographic primitives to solving the problem [24]. The combination of blockchain and machine learning methods offers unique benefits in healthcare. Which allows organization to implement these benefits include predicting illness risk, picture classification in magnetic resonance imaging (MRI) machine leaning methods can identify pictures from chest x-rays or MRIs [25].

With the advent of the Internet of Things, it has brought unprecedented innovation and advantages in terms of suitability and efficiency to many tasks that would otherwise be extremely difficult to accomplish. IoT security remains an important issue and the infinite number of applications of this technology can lead to various security threats [9,26]. With significant improvements in electronic health data, medical records, and insurance information, advances in the IoT paradigm have completely transformed the healthcare industry [27]. A.A.Abdellatif et al proposed a new eHealth system to create an efficient, large-scale, and collaborative system capable of providing high-quality patient care and making significant progress in disease management through secure data sharing [28]. The future of the health care system is shaped by the incorporation of new technological innovations that lead to a new model of patient care [28]. The main challenges in current health data management systems are audit immutability, data openness, flexible access, privacy and security concerns [27]. In order to access patient records more quickly when needed, many hospitals use electronic medical records or digital health records [29]. For the patient digital record, cyber security, privacy control, and artificial intelligence, blockchain may have the potential to boost the value of radiological data in both clinical and research settings [30]. Healthcare services increase security and reliability of patient's centric method. Blockchain based healthcare systems could improve security and reliability of patient's data [31]. By enabling open marketplaces for exchanging patient-centric healthcare data, blockchain can solve problems associated with provider-centric healthcare data storage [32].

Implementation of blockchain is possible and can be either public or private. In a public blockchain, anyone can participate, and anyone can access the network. When nodes linked to the network are reachable by anybody online, blockchain is regarded as an unpermissioned ledger. Additionally, limiting network membership is a private blockchain that runs on a permissioned network. It is essential to pre-verify that the participants in a private blockchain are acquainted with one another [33, 34, 35]. The next step is to extract and evaluate data from the studies that we have already classified in the systematic review as shown in Table 1.

Table 1 Summary of Blockchain in healthcare privacy and security

<i>Reference</i>	<i>Objective</i>	<i>Blockchain-based system Frameworks and Protocols</i>
J.Jayabalan et al.[36]	The blockchain structure is protected from scalability issues by the blockchain platform, which is recommended for off-chain healthcare data storage using IPFS.	IPFS
N.fatima et al.[37]	This study discusses the flexibility of healthcare and the need for further research on blockchain applications to ensure security and privacy.	No
S.Qahtan et al.[38]	In this paper the new version of FWZIC fuzzy weighted with zero inconsistency security and privacy is discussed.	MCDM
Z.Zulkifl et al.[39]	This work focused on using fuzzy logic to provide behavior-based security mechanisms for blockchain-based healthcare IOT networks.	FBASHI
Y.Ibrahim et al.[40]	The main focus of this study was the impact of blockchain technology on the privacy and security of fog computing.	No
R.Kumar et al.[41]	To ensure secure and efficient data sharing, this study integrate deep learning techniques with permissioned blockchain technology.	PBDL
Y.Himeur et al.[42]	This study presents a comprehensive analysis of the behavior of blockchain in recommendation systems.	NO
J.A.Alzubi et al.[43]	This study presents a novel method for protecting the privacy of electronic health records that combines deep learning and blockchain technologies.	CNN
S.Azemour et al. [44]	This article examines the use of blockchain technology in healthcare, addressing privacy and security issues.	PRISMA-P

3. METHODOLOGY

This literature study enables us to discuss the most recent developments in the development of blockchain-based healthcare applications, including techniques, technical approaches, and conceptual frameworks. A systematic literature review is a second study that first defines specific research questions before using a precise methodology to gather, classify, and extract all relevant research findings. It also describes the most recent integrated blockchain technology used in the healthcare industry.

A total of 104 documents have been obtained by the authors for this literature study from the scientific databases. After the initial review, which was based on article titles, 32 articles were eliminated, leaving 72 articles for further review. There is no connection between medicine and suppressed literature. Our search procedure returned them because they were able to identify healthcare as one of the non-financial blockchain use cases in their summaries. The authors then reduced the number of selected papers to 57 by merging the 72 publications in Mendeley to eliminate duplicates.

To further screen the papers, the authors reviewed over chosen paper abstracts and, in certain cases, introductions and conclusions. 52 research papers were chosen as a result. Five further papers were eliminated after carefully reading each of the five that had been chosen because they lacked a healthcare-related focus. These articles do not offer any original ideas or suggestions and one of the subsections only mentions possible applications of blockchain in healthcare. After screening, 46 articles were selected for the study, as shown in Fig. 2. The data was conducted using following electronic database such as IEEE Xplore, BMC Medicine, medical journals, these databases were designated on the base of various collected journal and conference on emerging topics including blockchain.



Figure.2. Systematic Selection Criteria for Research Papers

This systematic review is significantly focused to figure out the classifications and categories of related studies based on various case studies. It also outlines the goals, difficulties, and suggestions of combining blockchain technology with healthcare to increase technology efficiency, look into challenges with blockchain-healthcare applications, and offers solutions that are included within the scope of this study.

3.1 Research Question

RQ1: What is the goal of an in-depth literature review on the use of blockchain technology in healthcare?

Answer: Many industries have successfully adopted blockchain technology, and it is important to understand blockchain architecture as it relates to healthcare applications.

RQ2: What are the biggest challenges and motivations behind blockchain in healthcare applications?

Answer: We already define challenges and motivations used in blockchain in healthcare applications.

RQ3: What are the main issues related to the healthcare stakeholder?

Answer: The goal is to highlight main issues obstructing the success of healthcare sector.

RQ4: What are the blockchain features, which are used to resolve the identified issues?

Answer: The purpose is to discover the developing technology that resolves the relevant issues and accelerate in the healthcare industry.

4. CRITICAL ISSUES IN HEALTHCARE AND BLOCKCHAIN SOLUTIONS

Many key issues and challenges in the healthcare industry including supply chain management, clinical trials, health insurance, data interoperability, data security and privacy, data management, medical identity, and telemedicine, can be solved using blockchain technology. Healthcare providers can improve patient outcomes, reduce costs and provide better treatments by using blockchain technology.

4.1. Supply Chain Management

Managing the supply chain for medications and medical supplies is one of the biggest challenges in the healthcare industry. A transparent and secure method for following the flow of supplies and equipment from producer to patient can be made possible using blockchain technology. This can assist stop the market entry of fake medications and guarantee that medical equipment is kept in good working order [45,46].

4.2. Clinical Trials

Although clinical trials can be costly and time-consuming, clinical trials are an essential step in the development of novel medications and medical treatments. By providing a safe and open platform for data exchange between researchers, patients, and regulators, blockchain technology can speed up the clinical trial process. This can hasten the discovery of novel medicines and guarantee their efficacy and safety [45,46].

4.3. Health Insurance

With numerous parties involved, the health insurance industry is complicated and frequently opaque. For the management of health insurance claims and payments, blockchain technology can produce a system that is more effective and transparent. This can save costs and raise the general standard of care provided to patients [45,46].

4.4. Data Interoperability

Electronic health records (EHRs), which are frequently held in silos and difficult to share between various healthcare providers, are used in e-healthcare. By guaranteeing that healthcare providers have access to complete and correct patient data, blockchain technology can offer a secure and effective platform for the sharing of EHRs amongst various providers, improving patient outcomes [45,46].

4.5. Data Security and Privacy

Data used in e-healthcare is extremely sensitive and needs to be shared and stored securely. For the storage and distribution of EHRs, blockchain technology can offer a tamper-proof platform, guaranteeing that patient data is secure and can only be accessed by authorized individuals [45,46].

4.6. Medical Identity Management

Patient identities are used in e-healthcare to manage healthcare data. With the use of blockchain technology, patient identities may be managed securely and effectively, lowering the possibility of identity theft and guaranteeing that patient data is correct and current [45,46].

4.7. Telemedicine

Technology is used in telemedicine to deliver healthcare remotely. Blockchain technology can offer a reliable and effective platform for managing telemedicine services, guaranteeing the security of patient data and the fair payment of healthcare professionals [45,46].

4.8. Challenges and Future Research Directions

The healthcare industry faces many significant challenges, including complex patient data, fraud issues, supply chain failures, data protection, security vulnerabilities and interoperability issues. Blockchain technology, a decentralized and immutable platform for transferring and storing private data, could help solve these problems. Fraud and data breaches are less likely when cryptographic databases are used to ensure data security and integrity. Additionally, interoperability facilitates communication between different healthcare systems, improving patient outcomes and treatment. In addition, a verifiable and public registry will be created, and integrated into the supply chain, making it easier to identify counterfeit medicines and verify product authenticity. Finally, the adoption of blockchain technology modernizes secure, permission-based access to patient-friendly medical records while maintaining privacy. Blockchain technology has the potential to completely transform the healthcare industry by solving these problems.

To ensure seamless data transfer between systems and providers, further research can be conducted into the use of advanced cryptographic techniques to maintain data integrity and increase confidentiality, as well as improve scalability for broader applications and standards. For example, blockchain can be used to create secure and compatible electronic health records to improve medical supply chain management, transparent data exchange for clinical trials and other research, and the creation of an efficient healthcare billing and payment system. Research in the field can be conducted through pilot programs and collaborations between healthcare providers and technology providers and regulatory agencies. For instance, blockchain-based EHR systems are being developed, which would allow patients to retain more control over their health information. Additionally, several pharmaceutical firms have begun utilizing blockchain to monitor the provenance and authenticity of medications. Furthermore, blockchain-based smart agreements play a crucial role in eliminating numerous problems in health payment methods, particularly the high administrative and fraud costs. Blockchain technology shows great opportunity to change healthcare in multiple ways.

5. CONCLUSION

The aim of this review study was to provide a comprehensive overview of existing healthcare research models and show how blockchain technology can be used to solve them. Blockchain technology is a state-of-the-art decentralized architecture that has applications in healthcare and information technology. Blockchain technology is used in numerous industries and shows its potential to completely transform healthcare systems. Although blockchain technology is still in its infancy, research into its healthcare applications is increasing, raising concerns about the security and privacy of patient data in today's healthcare system. To fully realize its benefits, it is important to understand blockchain architecture in healthcare applications. We have laid the foundation for overcoming key barriers to success in healthcare by identifying and characterizing the obstacles and challenges associated with blockchain technology. The main goal is to find new technology that can solve these problems and accelerate the development of the healthcare sector. Through continuous research and collaboration, we can leverage blockchain technology to improve data security, interoperability and efficiency. Ultimately, this will lead to better patient care and promote innovation in healthcare. This literature review highlights current issues and how they can be addressed to expand the application of blockchain technology in this area.

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