

Application of Blockchain Technology in Healthcare Management: Literature Review and Evidence-Based SWOT Analysis



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Abstract This study investigates the recent literature regarding the application of blockchain in healthcare management. A systematized search methodology was implemented to identify 129 scientific publications related to blockchain and healthcare management during the period from January 2018 to December 2024 based on Scopus database. The current study provides an overview of the blockchain technology in the healthcare sector, with a detailed emphasis on its application in various domains including electronic health records, patient data security and medical supply chains management. Moreover, the SWOT analysis provides a strategic assessment of the internal and external factors influencing the adoption and implementation of blockchain technology in healthcare. The key findings emphasize the advantages of blockchain technology in improving the accuracy, openness, and distribution of data, while also tackling obstacles associated with scalability, regulatory considerations, and compatibility problems. This literature review enhances comprehension regarding the potential ramifications of blockchain technology on healthcare administration and provides valuable perspectives for researchers, practitioners, and policymakers aiming to harness its potential in enhancing healthcare provision and patient results.

Keywords Blockchain · Healthcare · Electronic health records · Peer to peer · Internet of medical things

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1 Introduction

Technology's rapid advancements require organizations to use and embrace technology in decision-making [1]. Blockchain technology acts as a destructive weapon with the potential to revolutionize diverse sectors, including healthcare management. By serving as a secure and decentralized platform for data storage and transactions [2]. Blockchain serves as a hopeful solution to the obstacles encountered by the healthcare industry concerning data security, interoperability, and transparency [3]. In healthcare, where safeguarding patient information's privacy and integrity reign supreme, blockchain technology stands poised to ensure medical records' confidentiality and precision.

Previous studies have utilized SWOT analysis for blockchain in healthcare, predominantly adopting either a descriptive use-case methodology [4] or a patient-centric conceptual framework [5], without conducting a systematic literature review or suggesting strategies to address identified weaknesses and threats. This study addresses the gap by performing recent systematic literature review, categorizing findings based on SWOT dimensions, and delivering strategic, solution-focused insights for healthcare management, thus providing both extensive evidence and practical guidance for policymakers, practitioners, and researchers.

The purpose of this literature review is to critically evaluate current blockchain technology research in healthcare. This review examines the latest research to show how blockchain can improve healthcare management, patient outcomes, and healthcare organizations' daily operations. This study examines the pros, cons, and future of blockchain technology in healthcare using a systematic literature review. This literature review examines blockchain technology's potential to address healthcare management issues like data security, interoperability, and patient privacy. Blockchain will be reviewed in healthcare applications like electronic health records management, supply chain oversight, and genomic data handling. This review examines post-2018 research on blockchain technology in healthcare to find the latest advances and insights. This literature review also seeks to demonstrate how blockchain technology improves healthcare data security, transparency, and efficiency. Consider regulatory barriers, interoperability issues, and data management governance issues to overcome blockchain technology's limitations in healthcare. This review examines blockchain technology in healthcare in detail. This will help us understand its potential impact on the industry and highlight the need for more research and development.

The primary objective of this literature review is to shed light on the potential for transformation brought about by blockchain technology in the field of healthcare management. Additionally, it aims to outline a trajectory for future advancements in utilizing technology to enhance patient care and improve operational efficiency within healthcare organizations.

2 Literature Methodology

The methodology outlines the process for executing a comprehensive literature review on blockchain technology within the healthcare sector. This analysis examines fundamental procedures. This study primarily uses the Scopus database, one of the largest curated abstract and citation databases [6]. With its extensive global and regional coverage of scientific journals, it serves as a reliable source for systematic reviews. To ensure comprehensive coverage of scholarly articles published from January 2018 to December 2024, a comprehensive search strategy was utilized, incorporating precise keywords and Boolean operators such as “blockchain technology,” “healthcare,” “electronic health records,” “healthcare supply chain management,” and “health care data management.” Inclusion criteria were defined to select peer-reviewed journal articles and conference papers published in English that specifically focused on blockchain applications in healthcare. The exclusion criteria eliminated editorials, non-English publications, and studies not pertinent to healthcare management or blockchain implementation. The preliminary search results underwent a triadic screening process: (1) title evaluation, (2) abstract review, and (3) comprehensive text assessment for pertinence and quality. A total of 129 peer-reviewed journal articles were found and examined. The chosen articles were analyzed to identify the primary themes and conclusions regarding blockchain technology in healthcare. A quality evaluation was conducted based on methodological rigor, relevance to the study objectives, and contribution to SWOT categories. The literature review was segmented into sections addressing electronic health records management, supply chain management, and healthcare data management. This methodology facilitated a systematic exposition of the applications and implications of blockchain technology in healthcare. The review emphasized the potential advantages and disadvantages of blockchain technology in healthcare. The findings were synthesized based on SWOT dimensions (strengths, weaknesses, opportunities, and threats), facilitating a structured and strategic analysis of blockchain adoption in healthcare.

3 Overview of Blockchain Technology

Blockchain technology is a new technology that will add huge value to industries by offering more reliable solutions to complex business challenges. By its nature, blockchain is a decentralized and distributed ledger system that serves secure and transparent transactions without any interaction from intermediaries. A list of transactions is formed into one unit called a block, which is interconnected through cryptographic principles, forming a chain of blocks. A network of participants who each hold a copy of the entire blockchain maintains this continuous sequence of blocks, ensuring security and transparency [7, 8]. Blockchain technology’s defining attribute is its decentralized structure, which removes the need for a central entity to validate transactions. This feature enhances security and transparency by distributing control

among network participants. All transactions recorded on the blockchain are visible to every participant, ensuring transparency and accountability. Once a transaction is recorded on the blockchain, it becomes unchangeable, making it unable to be edited or deleted [3]. The integrity of data comes from the concept of cryptographic hashing of blocks, which makes it tamper-resistant and secure [7].

There exist three distinct types of blockchain, each possessing unique characteristics and applications: [9, 10]. Firstly, a public blockchain allows anyone to join the network without the need for verification. Secondly, a private blockchain, offers greater privacy as it requires trust and verification from anyone seeking to join the network. The Third Consortium blockchain is a fusion of the preceding blockchain types.

4 Blockchain Technology in Healthcare

The implementation of blockchain technology in healthcare management presents numerous significant advantages: Blockchain enables the management of personal health records by patients and promotes secure protocols for exchanging data. This enables individuals to exercise control over their health data, ensuring the protection of privacy and promoting well-informed participation in healthcare decision-making. Further, the encryption protocols and consensus mechanisms of blockchain technology align with regulatory frameworks, thereby enhancing data security and compliance protocols in healthcare settings [11]. Furthermore, the implementation of blockchain technology has the potential to enhance the accessibility of fragmented medical data while simultaneously ensuring its security [8]. In addition, smart healthcare ecosystem utilizes blockchain technology to consolidate patient medical records into a single block, enhancing doctors' capacity to accurately diagnose patients [8]. The implementation of blockchain technology in drug supply chain management can improve transparency and traceability of drug overflow, thereby reducing the risk of inventory leakage and enhancing overall drug safety [12]. Above all, the implementation of blockchain technology in health insurance can enhance the value of insurance companies by reducing costs through the elimination of paperwork [13].

Nevertheless, the implementation of blockchain technology in the healthcare sector is not without its challenges and limitations [8]. Firstly, scalability is a concern due to the large size of health data and the decentralized nature of blockchain technology, which leads to the exponential growth of this data [11]. Second, managing healthcare data on a blockchain is complex, making it difficult to choose the right network type for blockchain implementation. Third, user Participation: Using this technology means everyone can access their data. Due to age-related disinterest, particularly among the elderly and young, this may be difficult. Fourth, consider regulatory compliance. When using blockchain technology in healthcare, complying with regulatory obligations like the General Data Protection Regulation (GDPR) is difficult, especially when protecting the "right to be forgotten" and privacy. Fifth, privacy/security risks: Blockchain technology improves security, but permissioned

blockchain and strict security protocols are needed to address security vulnerabilities and protect patient privacy. Sixth, blockchain platforms and healthcare systems must overcome interoperability issues to integrate smoothly. Above all, privacy concerns arise despite the secure and private nature of blockchain technology, as there remains a potential for data breaches and unauthorized access to sensitive patient information [14].

5 Findings from the Literature Review

Blockchain lets patients manage their health data, protect privacy, and participate in healthcare decisions [15]. Blockchain encryption and consensus protocols improve healthcare data security and compliance with GDPR and Health Insurance Portability and Accountability Act (HIPAA) [2]. By tracking products, blockchain can secure and transparently manage drug supply chains, reducing delays and errors and combating counterfeit drugs [16]. These use cases show how blockchain technology can secure, manage, and exchange large amounts of confidential patient data. Healthcare companies use the technology to verify product authenticity and manage supply chain costs, labor, and emissions. Blockchain technology enhances healthcare data security and privacy [17]. Decentralization and multiple data storage locations prevent loss and unauthorized access. Block-stored data is immutable, ensuring medical record integrity [10]. Blockchain secures data and restricts access to authorized users using advanced cryptography. Multi-party consensus mechanisms authenticate all blockchain changes, reducing unauthorized changes [3]. Smart contracts enable smart healthcare by reducing medical record fragmentation. Smart contracts ensure data availability and patient confidentiality by providing time-limited access to electronic health records [18]. After typing and saving into a block, doctors' notes, scans, lab results, and medication are medical history and cannot be deleted. Blockchain provides data and meets healthcare regulations. Compliance and audits require data source and change information. Patient control lets patients control data sharing, processing, and use according to privacy laws [2].

Cybersecurity is essential in the interconnected world we inhabit today, where digital transactions are a fundamental aspect of our daily life [19, 20]. The blockchain features secure and private healthcare data management, solving some of the industry's biggest problems. Decentralized and immutable blockchain technology disrupts healthcare management with new data management, security, and interoperability methods. This technology combined with healthcare infrastructures promises to streamline procedures, improve data velocity, and improve patient care [21, 22]. Blockchain has many uses in healthcare interoperability. Decentralized blockchain simplifies data exchange by eliminating third parties. Third-party elimination speeds transactions and reduces errors and untrusted data. Blockchain preserves medical data across healthcare providers by preventing corruption [22]. Blockchain's ability to help patients manage their health records is a major step toward autonomy. Blockchain technology empowers individuals to control their

health data, promoting informed healthcare decisions and privacy. The technology's encryption and consensus protocols comply with regulations, improving healthcare data security and compliance [2]. Blockchain, healthcare analytics, and Internet of Things (IoT) devices enable real-time monitoring, data-driven analytics, and personalized patient care. Blockchain's data integrity and security, combined with IoT devices' vast data streams, enable healthcare providers to gain comprehensive insights into patient well-being, refine treatment approaches, and optimize resource allocation to improve healthcare outcomes and predict hazards [12]. Finally, blockchain could change healthcare delivery, data management, and patient care. Blockchain's collaboration and patient-focused approach may improve healthcare, population health, and lifespan. Blockchain's ability to solve complex problems and create a more efficient, transparent, and patient-centered healthcare system is evident in its digital transformation [13].

Blockchain technology could reduce healthcare costs and increase efficiency. Blockchain technology reduces administrative workload by decentralizing and securing healthcare data management [8, 9]. By eliminating intermediaries and enabling peer-to-peer sharing, blockchain simplifies data access, sharing, and storage. The result is improved data management, streamlined operations, and lower costs. By connecting providers, insurers, and patients, blockchain solutions offer hope in the complex healthcare system. Blockchain's connected data sharing infrastructure reduces duplication, promotes care coordination, and reduces errors. Results include cost savings and improved operational skills, paving the way for a better healthcare future [13, 21].

Optimized Supply Chain Oversight: Blockchain reduces counterfeit drugs, helps manage inventory, and improves pharmaceutical regulatory compliance. Drug traceability and authentication using blockchain can improve inventory control, fraud prevention, and supply chain processes in healthcare [23, 24].

Managed supply chain Blockchain reduces pharmaceutical counterfeits, improves inventory management, and boosts regulatory compliance. By using blockchain for drug traceability and authentication, healthcare organizations reduce risks, streamline supply chains, and save money [23, 24]. Healthcare data is protected from breaches, fraud, and unauthorized access by blockchain's immutability and tamper-proof properties. Healthcare organizations can avoid costly breaches, regulatory fines, and reputation damage by improving data security and privacy with blockchain technology. Information security and compliance saves money [12, 25]. Blockchain lets patients send their health data to healthcare providers, saving time, reducing unnecessary procedures, optimizing resource allocation, lowering costs, and improving healthcare delivery [23]. Claims processing, billing, and contract management can be automated with blockchain smart contracts, reducing manual intervention, errors, and processing times. Healthcare organizations will save money, improve efficiency, and improve financial and administrative accuracy with smart contracts for automated workflows and transactions [18].

6 The Future of Blockchain Technology in Healthcare Data Management System

Blockchain technology is set to transform healthcare management data by enhancing security, interoperability, and efficiency across various healthcare processes. The integration of blockchain into healthcare systems addresses many challenges faced by traditional electronic health record (EHR) systems, as highlighted in the four re-search studies [26, 27]. Information security and privacy are among blockchain's biggest benefits. A secure blockchain framework for healthcare records management systems uses cryptographic methods like hashing and public-private key encryption to secure patient data, according to research. This dramatically reduces data breaches and unauthorized access by restricting sensitive data access to authorized parties [28]. The decentralized nature of blockchain eliminates the need for a central authority, which mitigates the risk of a single point of failure and enhances the overall reliability of the system [28]. Moreover, blockchain technology facilitates seamless interoperability and data sharing among healthcare providers. The study on integrating electronic records of digital healthcare systems demonstrates that blockchain allows for secure and efficient sharing of patient data across hospitals, clinics, and laboratories. This capability improves the coordination and continuity of care, as healthcare professionals can access comprehensive patient information in real-time [29]. By streamlining data exchange, blockchain can reduce inefficiencies and complexities associated with current practices, ultimately leading to better-informed clinical decisions and improved patient outcomes.

In addition to enhancing security and interoperability, blockchain empowers patients by giving them control over their health data. The research indicates that patients can own and manage their healthcare records, allowing them to share their information with healthcare providers of their choice [30, 31]. This level of control fosters a more patient-centered approach to healthcare, enhancing patient engagement and trust between patients and providers. By enabling patients to manage their health information, blockchain can lead to better health outcomes and increased satisfaction with care. The potential applications of blockchain in healthcare extend beyond EHR management. The study on innovations in hospital management highlights that blockchain can be utilized in various areas, such as drug supply chain management, remote patient monitoring, and clinical trials. For instance, blockchain can enhance the traceability and authenticity of pharmaceuticals, addressing issues like counterfeiting and ensuring that patients receive safe and effective medications [29]. Additionally, the integration of blockchain with IoT devices can facilitate real-time monitoring of patient health data, improving the management of chronic conditions and enhancing patient care [28]. Despite its promising potential, the adoption of blockchain technology in healthcare faces several challenges. Issues such as security, privacy concerns, high implementation costs, and the need for interoperability with existing systems must be addressed to facilitate widespread adoption. Furthermore,

regulatory frameworks and standards for sharing healthcare data vary across countries, necessitating careful consideration of these factors to ensure compliance and effective implementation [28, 31].

7 Discussion and Analysis

The convergence of blockchain technology and healthcare presents a number of research gaps and potential avenues for future investigation. Blockchain technology offers strong security, but advanced encryption and privacy-preserving mechanisms are needed to protect healthcare data. Future research could address evolving cybersecurity threats and regulatory requirements like GDPR and HIPAA [2, 3]. Different blockchain platforms hinder data flow. Future research should examine blockchain platform standards and policies to improve data workflow, smart contract interoperability, and cross-platform integration for efficient and secure patient data sharing [32]. Scalability and Performance: blockchain technology's scalability is a weakness because it grows larger and more complex. Thus, research could investigate new consensus algorithms, sharing methods, and network optimizations to scale blockchain solutions in healthcare [18]. It is crucial to adhere to healthcare regulations, such as HIPAA, and understand the legal frameworks concerning data ownership and consent. Potential areas for future research may involve exploring the advancement of governance models, smart contracts for regulatory compliance, and frameworks for auditing and accountability within healthcare systems that are enabled by blockchain technology [18]. When blockchain technology empowers patients to manage their medical records, it is crucial that the interface is user-friendly to ensure efficient management by the patients. Subsequent investigations may delve into the application of user-centric design principles, tools for managing patient consent, and decentralized identity solutions as means to augment patient engagement and foster trust in the management of healthcare data [13]. Blockchain's convergence with Artificial Intelligence, IoT, and big data analytics opens up new healthcare innovation possibilities. Blockchain-enabled predictive analytics, personalized medicine, and real-time monitoring could improve patient outcomes in future studies [32, 33].

SOWT Analysis

Building upon the prior research finding on the integration of blockchain technology in healthcare, a strategic assessment through a SWOT analysis was conducted as illustrated in Fig. 1.

This framework will uncover the internal strengths and weaknesses of using blockchain of blockchain as presented in Table 1, as well as the external opportunities and threats as presented in Table 2, that shape its potential impact on the healthcare sector. By exploring these facets, we can gain a deeper understanding of the landscape for future advancement and identify key areas for targeted intervention and optimization. Exploring these facets will allow us to acquire a more



Fig. 1 SWOT Analysis of using blockchain technology in healthcare management

in-depth understanding of the landscape for future advancement and will also allow us to identify key areas that require targeted intervention and optimization.

Table 1 The Strength and weaknesses of using blockchain technology in healthcare

Strength	Details	References
Data security and privacy	Blockchain's decentralization, immutability, and data provenance make it ideal for EMR storage and management. It allows patients to control how their data is shared, processed, and used in accordance with the GDPR	[2, 17]
Healthcare use cases	Blockchain is used in electronic medical records, drug and pharmaceutical supply chain management, biomedical research and education, remote patient monitoring, and health data analytics	[10, 16, 17]
Smart contracts	Blockchain paradigms like smart contracts can automate and improve healthcare applications	[18]
Tamper-resistant	Blockchain technology provides tamper-resistant storage of medical data, ensuring the integrity and authenticity of the information	[7]
Decentralization and reliability	The decentralized nature of blockchain enhances the reliability and robustness of healthcare data management systems	[10]
Patient-centric data sharing	Blockchain allows providers, researchers, and insurers to securely share patient-centric data while ensuring patient consent. These strengths show that blockchain technology can solve healthcare data management and security issues, creating more efficient and patient-centered systems	[2, 13]
Weaknesses	Details	
Scalability	Distributing large amounts of health data on the blockchain can be difficult. There are proposals to store encrypted health data "off-chain," which may compromise blockchain's redundancy and data availability	[11]
Data management complexity	The complexity of managing healthcare data on a blockchain, including issues related to data storage, access control, and data deletion, presents challenges in practical implementation	[8, 9]
User participation	Some patients, especially the elderly and young, may not be interested or able to actively manage their health data, which could affect patient-centric blockchain solutions	[2]

(continued)

Table 1 (continued)

Strength	Details	References
Regulatory compliance	Adhering to regulatory requirements, such as GDPR, while using blockchain in healthcare poses challenges, particularly in ensuring the “right to be forgotten” and addressing privacy concerns	[14]
Security and privacy risks	While blockchain offers enhanced security, the use of permissioned blockchain and rigorous security measures is necessary to mitigate potential security threats and protect patients’ privacy	[14]
Interoperability	Ensuring interoperability between different blockchain platforms and existing healthcare systems is a significant challenge that needs to be addressed for seamless integration	[21, 22]

8 Conclusion

This paper provides a concise analysis of the definition of blockchain technology and its potential to enhance operational efficiency and security within various healthcare departments. It highlights the ability of blockchain to ensure the seamless flow of reliable data, enabling comprehensive flow tracking across departments. This paper also addressed the transformative impact of blockchain technology on the healthcare industry, highlighting its significant value in enhancing patient outcomes and prolonging their lives [21]. Nevertheless, the implementation of these technologies necessitates substantial endeavors and stringent regulations due to the prevailing reliance on traditional methods within the healthcare sectors and industries. In order to effectively utilize blockchain technology, it is imperative to develop a distinct platform that is specifically tailored to the healthcare sector, utilizing blockchain technologies. In order to enhance the reliability, it is necessary to augment the quantity of networks (ledgers) that impede unauthorized users from accessing the data stored in the Blockchain (peer to peer). In order to enhance the proliferation of these platforms, it is imperative to initiate efforts aimed at persuading institutions with expertise in the healthcare sector to embrace these novel technologies. Nevertheless, in order to incentivize this institution to adopt these technologies in their operations and bear the expenses associated with implementation, they require advantages that outweigh these costs. For instance, obtaining an international certificate can elevate their institute’s ranking within the healthcare sector and foster a sense of safety among individuals and patients, thereby providing them with a competitive edge.

The research orientation toward future research subjects are to investigate the consequences of blockchain technology and its potential to reach an entirely new level in the management of healthcare data, and it will alter the structure of this industry dramatically.

Table 2 The opportunities and threats of using blockchain technology in healthcare

Opportunities	Details	
Electronic health records (EHRs)	Blockchain technology can revolutionize the management of patient electronic medical records, allowing for secure and efficient access to patient data across different healthcare providers	[32]
Drug supply chain management	Blockchain can be utilized to enhance the transparency and traceability of pharmaceutical supply chains, reducing the risk of counterfeit drugs and improving overall drug safety	[12] [29]
Health insurance	Implementation of blockchain technology in health insurance can streamline processes, reduce administrative costs, and enhance the efficiency of insurance payment systems through the use of smart contracts	[13]
Biomedical research	Blockchain has the potential to provide access to a large pool of anonymized health data, which could be used for personalized drug development and biomedical research	[28]
Public health	Blockchain technology can guide public health policies by utilizing large pools of anonymized patient data, allowing for more effective resource allocation and improved population health management	[32]
Medical education	Blockchain can be used to store and track student achievements, competencies, and educational records, providing a comprehensive digital record system for medical education participants	[29]
Threats	Details	
Privacy concerns	While blockchain technology is designed to be secure and private, there is still a risk of data breaches and unauthorized access to sensitive patient information	[28] [31]
High implementation and maintenance costs	High cost of implementing and maintaining blockchain-based systems. For healthcare organizations, this can be a major financial threat, especially when considering the need for specialized technical expertise and infrastructure	[34]
High energy consumption	High energy consumption associated with some consensus mechanisms, like proof of work (PoW). This could be an environmental and operational threat, particularly for large-scale healthcare systems that need to be energy efficient	[34]

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