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Review Article

Blockchain Revolutionizing Healthcare Industry: A Survey of Existing Literature

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Abstract : Health care is a vast industry that requires huge data storage and sharing and this is where this industry faces multiple challenges and requires an efficient system. This review article aimed to summarize the benefits of the blockchain industry in the healthcare sector. Literature review was conducted through PubMed and Google Scholar. A total of 30 articles were selected for review purposes with keywords health care, blockchain technologies, and benefits of blockchain and blockchain and health care industry with search engines like Google Scholar, Research Gate, and APA journals. A thorough review of existing literature suggests that blockchain technology can be beneficial for many fields and subfields of the healthcare industry including patients, organizations, hospitals, pharmaceuticals, global record-keeping organizations, health professionals, and researchers. Blockchain can be beneficial as it is efficient, reliable, transparent, cost-effective, easily accessible, vast data storage and management enable, and many in many more ways. In a nutshell, the importance of blockchain in the healthcare industry and suggests incorporating this technology in healthcare for efficient working.

Keywords: Health care, Blockchain, Review study, Data storage, Google Scholar, Research Gate.

INTRODUCTION

2008 can be the first year when blockchain technology was first introduced and then practically started using in 2009 it can consider a ledger for public transactions where all the transactions are stored and collected in a form of a chain of blocks and it continuously grows with the addition of blocks of information and it has some specific characteristics such as audibility, transparency, persistency and so on [1].

Blockchain can also be understood as a chain of informative blocks mostly related to crypto currency in a form of digital signatures and it is being excessively used in transactions as it makes transactions more safe and secure to the users it is not solely related to security but it also provides privacy, scalability, resolution of regulation related issues and it has enormous scope to support other industries [2].

There are multiple benefits of using blockchain technology as it is an innovative method which have revolutionized the trading ways of society and as one of the most prominent feature it provides is allowing trustworthy transactions between 2 parties without the involvement of a third anonymous party and provides a safe monetary exchange and hence this technology is being used and praised in numerous industries and it is being emphasized to use blockchain technology in other industries along with digital and marketing industries [3].

Like all these industries, blockchain has also contributed a lot and has more potential to contribute to the healthcare industry. The healthcare industry requires a secure and efficient system of record keeping for patients which can be acquired by the blockchain method as it has the potential to link electronic records of patients all across the country and provide easy accessibility. The healthcare industry is one of the largest and most prominent industries in the world which is interconnected with preventive, rehabilitative, and therapeutic interventions for patients hence it requires excessive data and data storage which is challenging for the healthcare industry as keeping effective data of millions of patients requires a secure, transparent and large capacity based system which can be possible through the application of blockchain methodologies [4].

Blockchain can also help in industries within health care such as pharmaceuticals, and health insurance; patients secure health care and safety along with device tracking, data of surgical instruments, records related to clinical trials of specific medicine or therapy, and many other issues can be solved using blockchain technology in health care industry [5]. The healthcare industry suffers from data storage and data management associated with transparency in data, traceability of the record, immutability, examination, and management of the record, data attribution, flexible access, trustworthy partner, privacy, and security of the data related to hospitals, pharmacies, patients and billing and expenses [6]. Block-chain supply has been proven to be effective in not only patients data recording but also helps in the maintenance of patients' demographic data which also helps in global reports related to a specific disease, medicines, and therapies, and their recovery rate, it also helps in data sharing between different hospitals which also helps in referrals along with having

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effective records of dentistry industry, drug fraud and drug malfunctioning, various prescriptions, and other patient-related records [7].

Hospital-related data is vast and has numerous categories such as departments of different diseases, departments of various organs, doctors, and other departments related to record-keeping and maintenance of health care departments which requires a lot of data sharing and record keeping. For that reason, an effective and high-capacity system is required which is challenging and can be resolved using the block-chain method. In this review article, we are focused to summarize benefits of using blockchain in the healthcare industry, benefits of using blockchain for therapeutic and other management departments of the healthcare industry and how blockchain can be effective for overall patient care.

RESULT

Total 40 articles related to block-chain and health care sector were selected from which 10 articles were excluded due to irrelevant results and variables. 30 articles were selected for the purpose of article review. Table 1 represents the review articles used for this study.

Total 14 articles were related to direct association between health care and block-chain technology which suggests that block chain industry can be revolutionary in health care sector and it can help in improvement of health care sector in various ways.

3 articles highlighted the challenges, opportunities and threats of block-chain in health care sector which suggests that there are more opportunities of block-chain technology in health care sector than threats and challenges such as vast data sharing and managing, pharmaceutical and surgical data, medicine and clinical trial record and many more opportunities for health care sector as compared to the threats and challenges.

7 articles were associated with electronic innovations in medical health which indicated that block-chain technology provided cyber security, easy access, electronic billing and data sharing, reliable data privacy and many more.

While 6 articles focused on innovations and current status of block-chain technology in health care sector which showed that block-chain technology provided various innovative ways to support medical record keeping and even though currently it is not being applied according to its scope, it has significant chances of revolutionize health care industry in future.

Table 1. Summary of Extracted Articles.

S.No	Author	Area	Focus	Findings
1	(Zubaydi *et al*. 2019) [8]	Review of Block-chain in the health-care domain	Challenges resolution by adopting block-chain in the healthcare domain	Healthcare is in dire need of adopting blockchain methodology as it resolves many challenges associated with patient record-keeping through secure, private, and efficient ways.
2	(Heston, 2020) [9]	A case study in block-chain innovations in health care	Innovations produced by blockchain technology in the field of health care.	Wide record availability, privacy and security of records, and easy accessibility of the patient-centric record are innovative measures provided by blockchain technology in healthcare departments.
3	(Hathaliya *et al*. 2019) [10]	Remote patient monitoring via block-chain technology	Remote patient monitoring in healthcare	Remote health care monitoring is efficient in reducing manpower and labor related to data storage along with reducing time, cost, and energy by patients and staff in record keeping hence it can be effective to use in the health care domain.
4	(Pilkington, 2022) [11]	Improvement of health care management with blockchain technology	Importance of block-chain technology in consumer medical electronics and connected portable devices.	Consumer medical electronics are fast growing and emerging and hence blockchain plays a pivotal role in e-record keeping and managing by providing easy accessibility along with records of not only patients but patient-related things such as medicines, surgical instruments, medical devices, and so on.
5	(Ali *et al*. 2021) [12]	Security, reliability, and privacy in health care using blockchain technology.	Perks of using block-chain technology in health care.	Blockchain technology efficiently provides security, privacy, reliability, and easy availability of data in the healthcare domain.

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6	(Ramzan *et al*. 2022) [13]	Healthcare applications using blockchain technology	Innovations and revolutions in the health care domain using blockchain technology.	Supply chain management, remote patient monitoring, and electronic medical records are innovations provided by blockchain technology in the healthcare domain.
7	(Agbou & Mahmoud, 2019) [14]	Blockchain frameworks in the health care industry.	Comparison of blockchain technologies and frameworks in health care domain.	Bitcoin, Ethereum & hyper ledger fabric are the three most common frameworks associated with blockchain in which hyper ledger fabric is most efficient and competent to use in health care technology.
8	(Shuaib *et al*. 2019) [15]	Block-chain for secure digitalized medicines.	Scope of blockchain technology in medicines.	Ensuring secure drug trials, clinical trials of patients, medicinal effects, and data associated with no. of patients using particular medicines, their distributors, and factors can be observed and easily secured in digital forms which can benefit the medicinal field of health care through the blockchain methodology.
9	(Tanwar, Parekh & Evans, 2020) [16]	Electronic record-keeping system and blockchain methodology in health care.	Digitalized health care department for record keeping using blockchain technology.	Easy and increased accessibility of data storage and sharing, tracking of medical devices, data associated with prescriptions, and hospital billing and assessment can easily be dealt with using blockchain technology.
10	(Sharma,Kaur & Singh, 2021) [17]	Review of blockchain and other internet-based technologies in healthcare.	Various perspectives of using Blockchain technology in healthcare.	Blockchain technology and another internet of things have their pros and cons while utilizing them in health care creates easy-to-use and easy-to-reach environments for consumers.
11	(Dimitrov, 2019) [18]	Data management and health care through the lens of blockchain technology.	E-applications for data storage and management using blockchain technologies in the health care system.	New digital platforms based on block-chains have been proven to be fast, simple, and offer seamless interaction between data providers, including patients themselves.
12	(Elezz *et al*. 2020) [19]	Benefits and threats of using blockchain technology in the health care system.	Scoping view of blockchain technology in health care.	Blockchain cannot only befit the patients but can be very effective for organizations including security, health situation tracking, clinical trials, pharmaceutical supply chain, medical insurance, and so on.
13	(Antoniadis, 2019) [20]	Blockchain integration with health care.	Future of health care in electronic data storage.	Blockchains exhibit many promising applications in clinical trial management such as smart-contract applications, participant-controlled data access, trustless protocols, and data validity. Electronic health records (EHRs), patient-centered interoperability, remote patient monitoring, and clinical trial data management were found to be major areas for blockchain usage, which can become a key catalyst for healthcare innovations.
14	(Durneva, Cousins & Chen, 2020) [21]	Current status of blockchain in health care.	Block-chain in health care and its future scope and challenges.	Blockchain can help in patient health care through mobile health care applications, data preservations, data monitoring, record sharing through social records, and much more.

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15	(Hardin & Kotz, 2019) [22]	Block-chain and health data survey.	Potential application and challenges of blockchain technology in the health care system.	It has been evident that blockchain-based healthcare researchers need to place more emphasis on real-world deployments and testing, smart-contract security, efficient and usable audit tools, blockchain governance, and adherence to healthcare data regulations and standards.
16	(Alla *et al*. 2018) [23]	Blockchain technology and electronic health care system.	Innovations of block-chain in electronic health care system.	Data integrity, transparency, security, privacy, and confidentiality are provided by adopting blockchain in health care systems which reduces data wastage and data loss with efficiency.
17	(Hussain *et al*. 2019) [24]	Emerging block-chain technology and health care.	Challenges and future directions for using block-chain in health care.	Blockchain technology is associated with security, privacy, easy sharing, and management of patient and organization-related data which can be helpful in the healthcare industry.
18	(Khezr *et al*. 2019) [25]	Blockchain technology for health care system.	Future directions and possibilities for block-chain in health care.	Blockchain can be revolutionized in many ways for the healthcare industry as emerging technologies of blockchain can convert physical medical systems into e-system with e-records and applications.
19	(Meinert *et al*. 2019) [26]	Implementation of blockchain in health care.	Review of scope of block-chain and its extent to provide transparency, privacy, security, and scalability to health care data storage systems.	Blockchain can be the one-stop solution for all the data-related issues faced by the healthcare system.
20	(Velmovitsky *et al*. 2021) [27]	Blockchain tech-nology in health care and public health system.	Block-chain en-hances transpar-ency in public health care.	A combination of health care and technology is re-quired for the resolution of challenges in the health care system.
21	(Tandon *et al*. 2020) [28]	Block-chain in health care.	A systematic review and future opportunities of block-chain in health care.	Efficiency, access control, technological advancement, privacy protection, and security of data management processes are little advanced provided by blockchain technologies in the healthcare industry while regulatory compliance and architecture are still topics of concern.
22	(Yaeger *et al*. 2019) [29]	Blockchain technologies for modern health care infrastructure.	Modernized healthcare facilities through blockchain technology.	Blockchain has the potential to contribute to health care through easy data access, data storage, security, low cost, e-payment mechanisms, medical supply chain, and many other ways hence it is important to incorporate blockchain in health care.
23	(Xie *et al*. 2021) [30]	A narrative review of blockchain in the medical field.	Emerging technologies and scope of block-chain in the medical field.	Blockchain technology can improve healthcare services in a decentralized, tamper-proof, transparent, and secure manner. With the expansion of this technology and its integration with other developing technologies, blockchain has the potential to bid long-term benefits. Not only can it be a mechanism to secure electronic health records, but blockchain also provides a powerful tool that can empower users to control their health data, enabling a foolproof health data history and establishing medical responsibility.

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24	(Gazzar & Stendal, 2020) [31]	Is blockchain hope or hype in the healthcare industry?	Scope of block-chain in health care.	Blockchain can be useful to some extent in health care but it will not completely solve the issues related to safe and secure transactions of patient data.
25	(Khatri *et al*. 2021) [32]	Systematic analysis of the block-chain in healthcare domain integration.	Trends of block-chain technologies and challenges in incorporating block-chain in health care domain.	Blockchain along with artificial intelligence has the potential to resolve data storage, vast data sharing, and security issues related to the patient-centric approach to data keeping and sharing.
26	(Zhang & Ji, 2018) [33]	Health care records and blockchain technology.	Resolution of data records and keeping issues in health care via blockchain technology.	Data access, data control, data keeping and sharing, privacy, and security of the data are the most prominent values added to the health care system by blockchain and although this system is yet not mature enough for a larger scale still it can help in many ways in the health care industry.
26	(Siyal *et al*. 2019) [34]	Challenges and opportunities of blockchain in medicine and health.	Developments in the field of health care associated with block-chain technology.	Cost efficiency, easy accessibility, and data anonymity, easy data keeping sharing are some of the most prominent advancements provided to health care by blockchain technology.
28	(Chattu *et al*. 2019) [35]	Blockchain technology in global health care.	Real-time use of block-chain technology in global disease surveillance	Block-chain is effective in aiding global health care by the anonymity of data while having vast records of patients all around the globe with easy accessibility and in case of pandemics it can serve in global surveillance of the disease.
29	(Dhillon *et al*. 2021) [36]	Blockchain in healthcare	Block-chain's role in reducing workflow related to patient record keeping.	As blockchain technology is associated with providing a safe, secure, efficient, and vast range of record keeping related to different categories, it is efficient to use it in health care as it reduces data managing challenges and resources.
30	(Attaran, 2020) [37]	Challenges and opportunities of blockchain technology in healthcare	Blockchain technology as a problem-solver of data management in health care.	Blockchain technology resolves many patient data-related issues such as data sharing, managing, drug trials, health supply chain, and so on hence it is important to incorporate this technology in the health care system.

DISCUSSION

The healthcare industry is one of the largest industries in the world which has and requires data in trillions of numbers related to patients, medicines, organizations, instruments, surgical treatments, clinical trials, health-based recovery tracking, and many more things. As it has such large data to manage it becomes difficult to deal with it without using technology. It is found there are majorly seven countries that are using block chain in their health care sector name as Estonia, United Arab Emirates, Georgia, Singapore, Sweden, Australia and Norway [38]. Blockchain in this reference has been innovative in many ways as it provides various pros such as easy accessibility, easy data management and sharing, effective record keeping, and many more. Various research has been done in this reference.

One study was conducted by Aguair & Colleagues in 2020 among various technologies of blockchain required for the health care system. The main objective of this study was to investigate the real-world application of blockchain technology in the healthcare sector. Results of this study suggested that blockchain technology is effective in privacy, reliability, and transparency of the data as well as its applications in supply chain management, data sharing, patient-centric data security, drug trials, and record-keeping of recovery progress [39].

Another study was conducted by Haleem & Colleagues in 2021 on the applications of blockchain technologies in the healthcare sector. This study focused on the benefits of using blockchain technology in the healthcare sector. Results of this study indicated that blockchain has the capability of improving the efficiency of data storage related to patients, their clinical trials, and unique patterns of data storage with a greater degree of security and confidentiality of data with proper authentication and accountability of the data and provides decentralized protection of data to ensure protection from any threats. These researches emphasized the importance of blockchain technology in the healthcare sector as well its implications for inefficient data storage [40].

Previous research solely focused on implications of blockchain only associated with patients and their health records while other organizations such as hospitals, global surveys, record-keeping organizations, caretakers, and various other sub-fields of health care were not efficiently addressed. Previous research also neglected the impact the IT industry can get from reviewing the benefits of the blockchain industry in health care. IT industry can understand their pros and cons and they can improve their shortcomings to effectively enter the healthcare sector.

The role of the blockchain industry in providing easiness for caretakers of the patient in taking second opinions, sharing information with different doctors, and so on was also neglected in previous research.

CONCLUSION

Results of the reviews suggest that blockchain technology has multiple benefits for various fields and subfields of the healthcare industry. The incorporation of blockchain can efficiently enhance the functioning of the health sector with data security, data storage, data efficiency, data management, transparency, electronic medical health, and many more advantages provided by blockchain technology. Hence it is high time to link healthcare with block-chain for modernization and advancement in the healthcare industry.

AUTHORS' CONTRIBUTION

- **Danish Khilani**: Conceptualized the study, Performed literature search, Study drafting, Revised initial manuscript draft.
- **Pranitha Shanthi Lobo and Haider Ali**: Performed literature search, Study drafting.

CONFLICT OF INTEREST

Declared none.

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