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A Comprehensive Study on the Use of Blockchain Technology in Healthcare

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***Abstract* – Blockchain technology has emerged as a potential solution to improve healthcare services by offering secure, transparent and efficient management of healthcare data. The paper presents an overview of the applications, benefits, challenges and recommendations for using Blockchain technology in healthcare. A systematic literature review has been conducted to identify relevant articles published in recent years, using the PRISMA framework to ensure methodological rigor. The review has revealed that Blockchain technology can be used in various healthcare applications, including data management, drug supply chain management, clinical trials, medical record keeping, and telemedicine. Blockchain technology offers several benefits in healthcare, such as secure and efficient data sharing, real-time access to patient data, improved patient outcomes, and lower costs. However, the adoption of Blockchain technology in healthcare also presents some challenges, such as regulatory barriers, interoperability issues, data privacy and security concerns, and technical limitations. To overcome these challenges, recommendations are provided, including developing a regulatory framework, addressing interoperability issues, implementing robust data privacy and security measures, and investing in Blockchain technology research and development.**

***Keywords* – Blockchain, distributed ledger, disrupted technology, healthcare.**

I. Introduction

Blockchain technology has gained tremendous interest [1] and emerged as a revolutionary innovation in recent years, disrupting traditional industries and providing novel solutions to various problems. At its core, Blockchain is a decentralized, transparent, and secure digital ledger system that records transactions and stores data across a distributed network of computers.

The technology was originally designed to facilitate peer-to-peer transactions in a trustless environment, without the need for intermediaries such as banks or financial institutions [2]. However, its applications have expanded beyond the realm of finance to include areas such as healthcare, supply chain management, voting systems, real estate [3] and others.

One of the key features of Blockchain technology is its decentralization, which means that there is no single point of control or authority over the network. Instead, the network is made up of nodes, or individual computers that work together to verify and validate transactions. This consensus mechanism ensures that the data stored on the Blockchain are accurate, immutable, and tamper-proof.

Another important feature of Blockchain technology is its transparency. As the Blockchain is a public ledger, anyone can view and audit the transactions recorded on it. This transparency ensures that there is no room for fraudulent or malicious activity on the network, as all transactions are visible to all participants.

The security of the Blockchain is also a critical aspect of its design. The data stored on the Blockchain are encrypted using complex mathematical algorithms, which make it virtually impossible to hack or alter. Additionally, the decentralized nature of the network means that there is no single point of failure, and even if one node is compromised, the rest of the network can continue to function without interruption.

Despite its many benefits, however, Blockchain technology is not without its challenges. One of the key issues is scalability, as the current Blockchain infrastructure is limited in terms of the number of transactions it can handle. There are also concerns around the energy consumption required to maintain the network, as the complex mathematical algorithms used in Blockchain mining can be energy intensive.

Despite these challenges, however, the potential benefits of Blockchain technology are too great to ignore. As the technology continues to evolve and mature, we can expect to see even greater innovation and disruption in a wide range of industries.

Blockchain technology is a transparent and decentralized network that creates distributed ledgers to enhance the authentication and auditing of transactions. In this network, computer miners compete against each other to solve an energy-intensive mathematical problem. When over 50% of the network agrees, the information is stored on a block, and the transaction is added. Blockchain was created to give customers more control over their personal information, as a block can withhold personal records, data, research, and more. This innovative technology has now found its way into healthcare and helps establish a sense of security over personal health information. The transparent network builds trust, as data cannot be accessed without permission, which rules out any other access point. Verification is needed to add healthcare data to records and to be viewed by any person.

Blockchain technology has the potential to disrupt a wide range of industries, from finance and healthcare to logistics and

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supply chain management. This study focuses on the use of Blockchain technology in healthcare to store and share patient data securely and efficiently, while also ensuring that patient's privacy is protected.

Studies have shown that Blockchain technology in healthcare offers numerous advantages, including real-time sharing of precise and comprehensive healthcare data, faster communication and interoperability among systems, low-cost communication, and built-in features, such as disaster recovery and fault tolerance [4], [5]. Blockchain technology is transforming traditional healthcare practices into more reliable and effective means of diagnosis and treatment by facilitating safe and secure data sharing. It has the potential to revolutionize personalized, authentic, and secure healthcare by merging a patient's entire real-time clinical data and presenting them in an up-to-date, secure healthcare setup [6].

Research has proposed the management of patient health records using Blockchain technology, where medical history is stored in a decentralized system that can be accessed by doctors and insurance providers [7]. Another proposed method for Blockchain healthcare data management involves using data lakes as data repositories for the Blockchain. Data lakes are valuable for data storage repositories of any kind of data, as well as being compatible with data mining, interactive querying, and machine learning technologies [5].

The use of Blockchain technology in healthcare has been explored in various areas, including medical records management, patient data sharing, clinical trials, and supply chain management. The technology has been found to offer several benefits, such as improved data security, privacy, and interoperability. Some studies have also highlighted the potential of Blockchain technology to reduce healthcare costs and improve patient outcomes.

The objective of this study mainly focuses on the major uses of Blockchain technology in healthcare, key gaps of using Blockchain technology in healthcare, and solutions to overcome the identified challenges.

II. Research Methodology

To fully comprehend the potential of Blockchain technology, a systematic literature review (SLR) approach was adopted to collect freely available online content and articles published. Brocke et al. [8] recommends that researchers conducting SLRs should make clear decisions on selecting databases and journals, defining search terms, selecting criteria for including and excluding papers, and developing strategies for citation analysis. For this study, a focus was placed on collecting sample articles through open-sourced Google Scholar database due to the innovative nature of Blockchain and the longer time frames required for reviews.

The criteria for inclusion of content in the review required that the article be published in complete form, whether in a journal, conference proceedings, technical report, white paper, or blog, and be written in English. Various search terms were used to satisfy PRISMA conditions [9]. The PRISMA framework specifies an evidence-based minimum set of items for reporting in systematic reviews and meta-analyses and has been widely utilized in academic studies [10].

Using PRISMA for the analysis allowed for the employment of guidelines to review clearly formulated questions and use systematic and explicit methods to locate, select, and critically evaluate relevant publications to conduct the research addressed in this paper. In addition to academic publications, technical reports and prominent blogs were reviewed to reflect on the rapidly changing nature of Blockchain. The time frame for the analysis was from the first reference to Blockchain appearing in 2008 and until 2022, as most of the research has appeared in recent years.

III. Literature Review

Blockchain has been defined in three generations to represent the development of Blockchain over time. It is described as a distributed, decentralized, paperless ledger which is used to securely document health transactions across many networks. Blockchain 1.0, also called the first generation of Blockchain, is underlying on Bitcoin, which is the first implementation of Blockchain based on cryptocurrency applications [2].

The next generation, Blockchain 2.0, emerged with the concept of smart contract that it is considered as a piece of code defined, executed, and recorded in the distributed ledger. The third generation of Blockchain technology, Blockchain 3.0, deals with non-financial applications such as government, energy, health, etc. [11].

Problems in healthcare are slowly being evolved into solutions. Biomedical scientists study how to collect various healthcare domains such as claims, longitudinal records, legal drug development, health population, citizen help, online patient portals, data security, and reducing costs by supply chain management. This technology has the potential to offer long-term benefits despite its challenges, such as improved cash flow, lower transaction costs, reduced settlement times, asset provenance, native asset creation and creating new models of trust. Blockchain has the ability to export the uses of central authorities when creating transactions. The positive evolution of applications in healthcare can exchange information, combat prescription drug fraud, exchange patient data, applications for supply chain and healthcare insurance [12].

The healthcare industry oversees large networks of Internet of Things (IoT) that repeatedly monitor and deliver the data information to the nearby devices or server to prevent data from being messed up and to preserve the privacy of the patients. Aujla and Jindal [13] presents a decoupled Blockchain-based approach in the edge-envisioned ecosystem, which helps reduce data duplication when a huge amount of data is transmitted in the large IoT healthcare network to preserve security of the collected data while reducing the block preparation and header generation time.

The design of Blockchain created access control to be an important network security service that is critical to authorized patients using their mobile phone. Blockchain databases are distributed into data blocks stored in the form of a linked list on a peer-to-peer network. Saha et al. [14] proposed a design of access control scheme using private Blockchain technology which is shown to be secure against various well-known attacks

and provides better security and functionality features, as well as requires low communication and computational costs. Xu et al. [15] proposed a Blockchain-based smart healthcare system for large-scale health data privacy preserving, called Healthchain, where users are enabled to upload IoT data and read doctors' diagnoses. Meanwhile, doctors are allowed to read users' IoT data and upload diagnose. Also, it is claimed that data cannot be tampered or denied. Transaction data and published data are encrypted. Blockchain has been used in a traditional smart healthcare system. An attribute-based encryption (ABE) system has been introduced to achieve fine-grained access to control semi-trusted cloud servers in order to protect personal health data [16]. A novel patient-centric framework has been proposed for fine-grained and scalable data access control by using ABE technology to encrypt users' electronic health record (EHR) data [17]. Zhang et al. [18] proposed an effective solution to allow cloud servers to remove duplicate data in order to reduce the storage cost in cloud servers.

Hua et al. [19] proposed an effective, privacy-preserving primary diagnostic framework, CINEMA, for online healthcare, in which, users can implement query operations on cloud servers without decrypting their private data based on the fast secure permutation and comparison technologies.

Blockchain can be a promising technology for personal health information and security in smart healthcare systems [20], [21] but specific implementation details are not clear. Some studies focus on fine-grained access control of IoT data but privacy protection of electronic medical records (EMRs) is not considered [22], [23]. Some researchers proposed dedicated utilization of Blockchain technology to enable users to control their EMRs compared to the EMRs controlled by the hospital in a traditional healthcare system [24]–[28].

Healthcare domains can transfer essential informational data, so new borderless healthcare services can be accessible to customers. The organised study of Blockchain can be defined as a distinct, decentralized ledger that collects transactional records linked to patient and provider. Even though Blockchain has been used in various applications for secure transactions, various challenges need to be considered when implementing Blockchain in healthcare applications [29]–[31]. Blockchain displays immense potential in the healthcare world. Blockchain finds solutions to issues related to health records, such as insurance privacy, security, and authentication. This technology develops algorithms to correct issues related to clinical trials, data breaches, and errors.

Healthcare data have been researched on a large-scale for the past decade, for the collection of data to be generated, broadcast and stored. Kassab et al. [32] argue that the history of Medicare and Medicaid service have developed new incentives to have "real time" monitoring. Blockchain creates a service that allows the data of patients to become assessable through online access. Blockchain technology has the ability to collect data in a proficient, precise, and resourceful manner. Blockchain technology influences recording financial transactions. This form of technology creates blocks with a timekeeper and links or connections, without having a third party. The future studies of Blockchain are coming to the senses of being a potent program. The assortment of data will grow and enhance in future years, where the importance of Blockchain studies will advance. The collection of data will grow into a wide range of information. Understanding every detail of database management comes with "pros & cons" to centralization and decentralization, the opportunity to store medical architecture that leverages the assets of each set of technologies for the use they are best suited for.

As Blockchain is built upon a chronological chain of block-like data structures, a block hosts with a timestamped set of transactions that are bundled together. Each new block is linked to its preceding block. Combined with cryptographic hashes, this time-stamped chain of blocks provides a hopefully "immutable" record of all transactions in a network, from the genesis block until the last / most current block.

The structures of Blockchain are grouped into "blocks" with time stamps, hashes, and Nance. The hash of transactions is linked by different grouped titles. The security and preserving privacy of healthcare data in e-health are crucial. Electronic health record sharing may help improve the diagnosis of patients. This merger of health and electronics has been coined as "e-Health". A patient may be seen by several different doctors throughout their lifetime; due to this situation, health record sharing and exchange have attracted attention of the research community. Data security and privacy preservation are critical issues in this field. To ensure that these issues are remedied, Blockchains are introduced. Both private and consortium Blockchains work together to ensure that patient's information is spread effectively and safely [33].

Khujamatov et al. [34] focus on the issues related to the introduction of recent technologies in the healthcare system. They point out several weaknesses in the current technologies introduced, but due to their own scope and limitations the focus ends up being 5G and Blockchain. They present the capabilities and importance of 5G as well as the specific roles 5G plays in the healthcare system. The same framework is used to introduce and describe Blockchain to the readers. The authors label several weak points in the current healthcare system using numbers. The same numbers are used to explain how the application of Blockchain and 5G may be used to fix weaknesses in the healthcare system.

Sharing data among healthcare organisations is challenging. Alzahrani et al. [35] emphasise the global issue about security threats. They investigate many factors that encourage the secure exchange and sharing of healthcare information and talk about the need for the implementation of a solution that would allow doctors to access the updated medical information, as well as present a framework based on Blockchain technology.

Healthcare uses IoT to connect everything to the internet. This allows research and improvements in the field in healthcare to stay current with development. It will help improve living conditions by attacking illnesses and health issues. Computer technologies will detect diseases faster in their preliminary stages. Security remains a major aspect of all technologies and plays a vital role in the functions of IoT networks. The Blockchain system in healthcare is a decentralized technology.

This technology is used to enhance security. It creates a safeguard for patient's important health records. The Blockchain system has three main security areas in healthcare remote monitoring of patient's health, drug traceability, and medical record management. IoT and Blockchain technologies have greater access to this information. IoT and Blockchain have enormous potential in the healthcare sector. The new computer technology will show direct concern for the social welfare and lives of people [36]. Public Blockchains have been proven to be easier to access than private Blockchains with downloads, data access, and provision of authorized nodes [37].

Healthcare data management systems face hard challenges with data transparency, traceability, audit, and security. IoT data device can control real time results for patients. The device will allow patients to decrease their routine checkups to hospitals.

Healthcare systems are focused on vulnerable single points of failures to healthcare information. This is due to cybersecurity attacks. Yaqoob et al. [38] present case studies to show the practicality of Blockchain technology for various healthcare applications.

Siyal et al. [6] discuss future perspectives on healthcare data technologies. Smart contracts would allow unbreakable chain of blocks to be considered in individual care. Blockchain smart contract allows patients to control their personal health data. Documentation of Blockchain record would allow history to be sustainable in the research. With medicine, Blockchains are guaranteed not to adulterate information. The practical application of Blockchain technology in the healthcare domain will gain many individuals, medical practitioners, healthcare providers, R&D specialists, healthcare entities, and biomedical researchers to effectively disseminate the vast amount of data, share clinical knowledge, and communicate recommendations with greater security and guaranteed privacy protection. Combining Blockchain and healthcare will decrease processing time for the collection of patient data. The transition of information from one source to another will also become easier.

Interoperability is the use of computer systems or software that exchanges and uses information. It is usually focused on data exchange with business entities, through the Health Information Exchange (HIE). There has been a push toward patient-driven interoperability where health data exchange will be patient mediated and patient-driven with hope to lay a new tactic for data sharing in healthcare. The benefits of interoperability can include well-communicating systems that can improve operational efficiency and reduce the time that would usually be spent by administrators for manually entering the data. The landscape of interoperability in healthcare is centered around hospitals, private clinics, and pharmacies where data are usually created and filed within an information system, and the goal is to encourage better health data liquidity [39].

The healthcare industry faces a lot of challenges and Blockchain technology has potential applications to some of those challenges. The strongest potential of Blockchain technology in the healthcare arena is its heavily researched applications, namely, security, integrity, decentralized nature, availability, and authentication principles due to the general ledger and block related infrastructure [31].

Health records in electronic form, Electronic Medical Records (EMRs) contain medical data and clinical data that are related to a given patient and stored by the healthcare provider. Electronic Health Records (EHRs) are made to allow the medical history of a patient to move with the patient or made available to multiple healthcare providers. With EMRs, patient's medical history can be shared among different providers across nations. The main problem with using EMRs and EHRs is ensuring security. Blockchain has been thought of as an option to utilize to secure healthcare data management. Blockchain is a technology that can build an open online database that contains lists of data structures that are linked.

By design, Blockchain is secure and contains the key benefit that all changes to the Blockchain are visible to whoever is issued access to the patient's network, and all data insertions are not changeable. Unauthorized changes will be questioned and detected. Esposito et al. [21] study the potential to use the Blockchain technology to protect healthcare data hosted within the cloud and describe the practical challenges of such a proposition.

Blockchain technology gives the patient the ability to develop and update their own patient medical data. The concern with Blockchain is the security implications but it is claimed to be "tamperproof" and unable to be hacked, but research has shown that is not completely true. Researchers in healthcare can benefit from anonymized data that can be shared to help develop new insights into patient care and patient healthcare services while still maintaining the privacy of the patient. With time and more innovation in Blockchain and its security, this system can become exactly what the future needs in healthcare. El-Gazzar and Stendal [40] states that Blockchain technology will not solve the issues encountered by the healthcare sector; in fact, it may raise more issues than it will solve.

IV. Major Uses of Blochchain Technology in Healthcare

Blockchain technology has the potential to revolutionize healthcare by enabling secure, decentralized storage and sharing of patient health records. Some of the key advantages of using Blockchain in healthcare include faster communication and interoperability among systems, low-cost communication, real-time sharing of precise and comprehensive healthcare data, and built-in features such as disaster recovery and fault tolerance.

Blockchain technology in healthcare market size was valued at US Dollars 281 million in 2021 and estimated to be over 52.1% CAGR from 2021 to 2027 as displayed Fig. 1.

Research has proposed using Blockchain to manage patient health records by storing medical history on a decentralized system that can be accessed by doctors and insurance providers. Blockchain technology can also facilitate personalized, authentic, and secure healthcare by merging a patient's entire real-time clinical data and presenting the data in an up-to-date, secure healthcare setup.

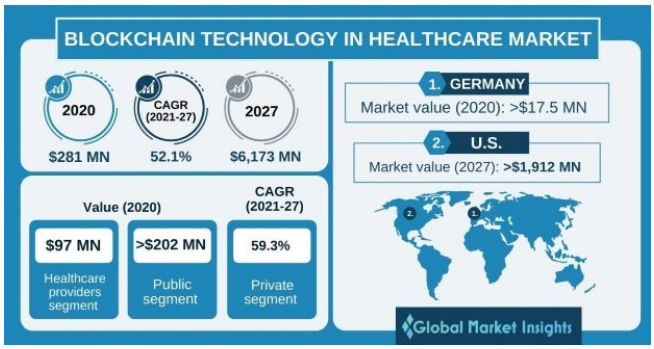

Fig. 1. Blockchain technology in healthcare market size.

Source: https://www.gminsights.com/industry-analysis/blockchain-technology-in-healthcare-market

Other proposed uses of Blockchain in healthcare include data lakes as data repositories for the Blockchain, which can be valuable for data storage repositories of any kind of data and compatible with data mining, interactive querying, and machine learning technologies. Overall, Blockchain technology has the potential to transform traditional healthcare practices into more reliable and effective means of diagnosis and treatment by facilitating safe and secure data sharing.

One study conducted by Kuo et al. [41] explored the use of Blockchain technology in clinical trials. The study found that Blockchain technology can improve the transparency, security, and efficiency of clinical trials. Another study conducted by Choi et al. [42] examined the use of Blockchain technology in patient data sharing. The study found that Blockchain technology could enable secure and efficient sharing of patient data among healthcare providers.

Several studies have also highlighted the potential of Blockchain technology to improve medical records management.

A study by Zhang et al. [43] explored the use of Blockchain technology in electronic health records (EHRs) management. The study found that Blockchain technology can improve the security and privacy of EHRs by enabling patients to control access to their medical records.

However, some studies have also identified challenges in the implementation of Blockchain technology in healthcare. One study by Azaria et al. [27] identified technical challenges, such as scalability and performance, as well as regulatory challenges, such as legal and ethical issues, as potential barriers to the adoption of Blockchain technology in healthcare.

Some major uses of Blockchain technology in healthcare, along with their benefits, are:

1. Electronic Health Records (EHR): Blockchain can provide secure and decentralized storage of EHRs, which can be accessed by authorized parties only. This can lead to better interoperability, patient privacy, and data integrity [44].
2. Clinical Trials: Blockchain can help in the management and tracking of clinical trial data, ensuring transparency, security, and data privacy. It can also prevent fraud and tampering of data [45].
3. Supply Chain Management: Blockchain can be used to track the entire supply chain of medicines, from manufacturing to delivery, ensuring transparency, security, and authenticity. It can also prevent counterfeiting and drug diversion [46].
4. Health Insurance: Blockchain can provide a secure and decentralized platform for the management of health insurance claims, reducing fraud and improving efficiency [47].
5. Medical Billing: Blockchain can streamline medical billing by creating a transparent and secure platform for the management of claims, reducing administrative costs and errors [48].
6. Health Information Exchange (HIE): Blockchain can facilitate secure and interoperable sharing of health information among providers and patients, improving patient outcomes and reducing costs [49].
7. Telemedicine: Blockchain can provide a secure and decentralized platform for telemedicine, improving patient privacy and data security. It can also enable remote monitoring and diagnosis of patients [50].
8. Precision Medicine: Blockchain can enable the creation of a decentralized and secure platform for the sharing of genetic data, allowing for personalized and targeted treatments [51].
9. Medical Research: Blockchain can facilitate the management and sharing of medical research data, ensuring data integrity, transparency, and privacy [52].
10. Public Health Surveillance: Blockchain can help in the management and tracking of infectious diseases, enabling real-time data sharing among public health agencies and reducing the spread of diseases [53].

Overall, the benefits of using Blockchain in healthcare include improved data privacy, security, and integrity, reduced costs and administrative burden, and better patient outcomes. However, challenges include regulatory compliance, standardization, interoperability, and data privacy.

V. Gaps on Using Blockchain Technology in Healthcare

Blockchain has the ability to control the amount, importance, and the skill of data to be converted and stored. Blocks of healthcare data store patients' records and chain the block of information together. This easy system allows the correct parties to be involved during this transaction. Blockchain is a brilliant invention soaring for greater heights, but the interoperability of the system in healthcare needs awareness.

Acknowledging the value of awareness in Blockchain opens the program to new possibilities. There are primary things based on the government and healthcare officials that are required to ensure nationwide interoperability among the healthcare systems. Formulating a secure exchange of electronic healthcare information has consistently formed the latest problems of interoperability. Does Blockchain facilitate? It is a question asked by many researchers. Nationwide patient care coordination is hampered because of the lack of healthcare interoperability. The inadequacy of interoperability negatively impacts the seamless flow of health information to the right person, right place, and right time to ensure healthcare delivery to better

inform decision making for the patients' care. Low control of the decision making allows passing the misleading content. Having a lack of expanding data sources and users in the interoperable health IT ecosystem cannot improve health or lower the cost for the patient.

Cryptocurrencies have been classified as a speculative bubble. Illegal transactions of information can be produced due to anonymity. Anonymity helps organise or develop small internet crime groups to invade healthcare transactions. Blockchain receives and stores multiple strings of data every ten minutes. The faster the collection, the harder the control of security in the cyber healthcare world. People who have decrypted algorithms can try to calculate the health transaction serial number. Encryptions made to a healthcare block with a public key can be published and viewed by anyone whom the encryptor sends. The only party who can decrypt the messages is the creator of the encryptions. If a patient has healthcare results given to them by a healthcare official, the patient does not have control over who will be able to view or receive the information. The creator of the healthcare block can manufacture it to become private and control the distribution of the records. When exporting information of people's personal records, it is the healthcare system's duty to create a safe regulatory for the Blockchain cryptographic system.

Is it realistic to create a global universal healthcare database that allows people to trade and research records? If this question is ideal, will patients have the option to remove themselves from the database? Blockchain is built for patients and physicians to have total access to the transactional process of health records.

Once a party decides to join this network system, there is no way to remove your personal information from the database. This contradicts the trust made between Blockchain and consumers. People should be able to trust the system to protect their health blocks, but also trust to receive them back. The problem lies between the terms and conditions of the application process of the Blockchain. Terms and conditions need to be carefully explained to new joining members. The misplacement of records can shift the initial feeling of a person who has data stored in the base. There is not a way-out of the program once you join, but the healthcare system needs to create an exit system for those who wish not to be a part. Blockchain technology is a new program that has immense potential to succeed in the future.

For Blockchain to be successful, it must be dynamic, and choices must be created because people do not agree on everything. The system can be hard to understand for the senior citizens. On the elderly side, the functions of new developments are hard to grasp and completely understand the material. During the development process, the creators of Blockchain did not form an end or an exit plan for the system. Every system has its problems, but these are just a few minor fixable issues of Blockchain in healthcare.

While Blockchain technology has promising potential in healthcare, there are also some gaps that need to be addressed before it can be widely adopted in the industry. Some of the key gaps include:

- Lack of standardization: There is no universal standard for data structure or terminology in healthcare, which can hinder interoperability and data sharing on a Blockchain network.
- Regulatory challenges: The use of Blockchain technology in healthcare raises several regulatory concerns, such as privacy, security, and data ownership.
- Scalability: The current technology may not be able to handle the vast amount of data generated in the healthcare industry, especially as Blockchain networks grow in size.
- Cost and infrastructure requirements: Implementing and maintaining a Blockchain network can be expensive and may require significant investments in infrastructure and personnel.
- Technical complexity: Blockchain technology can be complex, requiring specialized knowledge and skills to design, implement, and maintain the network.
- Limited adoption: Despite the potential benefits of Blockchain technology, there is still limited adoption in the healthcare industry due to a lack of awareness, understanding, and trust in the technology.

Addressing these gaps will be crucial for the successful adoption and integration of Blockchain technology in healthcare.

VI. Recommendations

Creating awareness for interoperability in healthcare will allow the importance of Blockchain to be stable in the future. Creating content to highlight the simplicity of technology will grant the consumer a sense of understanding. New opportunities are granted to the system when information is shared electronically. Requirements will become more fulfilled when the beliefs of improving Blockchain become more relevant in the healthcare industry. Cloud blockers build security around the patient's block of information. The facilitation of transactions is the monitored Blockchain in healthcare. Having a positive impact on the healthcare system, the interoperability gap will shorten. The flow of health information is logical when given promptly to the correct recipient and location. Misleading information can be reduced by consistently updating the personal health records. Information Technology ecosystem will grow to perfect the health system and lower the patient cost.

Cryptocurrencies in the past have been put under the category of an experimental balloon. Anonymity groups or cyber crews organised small invasions to dispute the information on the database. Illegal transactions act to rest with the development of a crypto cyber security. This opportunity will create more careers in the tech industry. Crypto security can formulate security questions upon login to ensure the protection of the patient's identity. The fast advancement of Blockchain technology in healthcare will need faster protection of its database. Algorithms made by decryption coders can break calculations if found in a timely manner during the transactions. Any medical information added to the health block can be viewed only if the patient grants access. It is important to know who is overseeing the health transactions. The pharmaceutical industry has had countless issues with the supply chain of medication. The new encryptions made in healthcare are to ensure stability in the network. Patients

will take control over their personal information, while the system protects the information from the dark Cyberweb. This will construct a safer regulatory internet environment for the Blockchain cryptographic system.

Having the entire world on one network system seems very ideal, until reality sets come to show. Blockchain is an innovative technology with a lot of new and bright things to learn about. Blockchain system can help insurance companies check the safety of the patient in the health – the ability to receive direct data from the base to indicate the amount awarded to the patient. Every participant in the Blockchain exchange will have total access by the improvements of the collection of data. The important documents placed on the block will have to be approved by selecting the terms and conditions. This will explain the functions, fundamentals, cost, and system breakdown in an understanding consumer comprehensive way. Simplifying the explanation of Blockchain to the elderly community will create a sense of peace for the older patients when attending doctor appointments.

Based on the literature review and gap analysis, some recommendations for successful implementation and adoption of Blockchain technology include:

1. Standardization: Developing a universal standard for data structure and terminology in healthcare can facilitate interoperability and data sharing on a Blockchain network. Healthcare organisations and industry groups should work together to establish these standards.
2. Regulatory compliance: Blockchain technology should comply with existing regulations, such as HIPAA and GDPR, and any new regulations specific to Blockchain technology should be developed to address privacy, security, and data ownership concerns.
3. Scalability: Healthcare organisations should evaluate the scalability of Blockchain technology and consider solutions that can accommodate the vast amount of data generated in the healthcare industry. This may include exploring alternative consensus mechanisms or implementing off-chain solutions.
4. Cost and infrastructure: Organisations should consider the cost and infrastructure requirements of implementing and maintaining a Blockchain network. Collaboration and partnerships among healthcare organisations, technology companies, and governments may be necessary to share costs and resources.
5. Technical expertise: Healthcare organisations should ensure they have the technical expertise necessary to design, implement, and maintain a Blockchain network. This may require training or hiring specialized personnel.
6. Adoption and education: Healthcare organisations should prioritize educating stakeholders, including patients, providers, and payers, about the benefits and potential of Blockchain technology. Increasing adoption and trust in the technology will require transparent communication and collaboration.

Overall, successful implementation and adoption of Blockchain technology in healthcare will require collaboration, standardization, regulatory compliance, technical expertise, and education. These recommendations can help address the gaps and challenges associated with using Blockchain technology in healthcare and unlock its full potential in transforming the industry.

VII. Conclusion

This paper conducts the study on the use of Blockchain technology in healthcare through literature review and gap analysis. Overall, the literature suggests that Blockchain technology has the potential to transform healthcare by enabling secure and transparent data sharing, improving data interoperability, and reducing healthcare costs. However, the implementation of Blockchain technology in healthcare faces several challenges that need to be addressed to ensure its widespread adoption. Further research is needed to explore the feasibility and effectiveness of Blockchain technology in healthcare and to develop solutions in order to address the challenges associated with its implementation.

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