

Application of Blockchain in Healthcare

Vaibhav Rastogi, Associate Professor

College of Pharmacy, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh, India

Email id- vaib.asa@gmail.com

ABSTRACT: *Without the need for a central authority, blockchain technology allows for a decentralized and distributed ecosystem. Due to the application of cryptographic concepts, transactions are both safe and trustworthy. Due to the popularity of cryptocurrencies, blockchain technology has been extremely fashionable in recent years and has infiltrated many industries. Due to the need for a more patient-centric approach to healthcare systems, as well as to link disparate systems and improve the accuracy of electronic healthcare data, blockchain technology offers great promise in healthcare (EHRs). An examination of state-of-the-art blockchain research in the area of healthcare is performed in this systematic review. The goal is to showcase the technology's potential uses as well as the difficulties and future directions of blockchain research in healthcare. The article begins with a discussion of background material, followed by an explanation of the precise technique utilized in this research. The findings are then analyzed, with a bibliometric overview, an analysis of the collected data and its characteristics, and the results of a literature quality evaluation included. Finally, there is a discussion of the analyses' findings. According to the results, blockchain technology research in healthcare is growing, and it is mostly utilized for data exchange, health record management, and access control. The majority of research focuses on providing new structural designs as frameworks, structures, or models. Findings also indicate that most of the examined papers do not include technical information regarding the utilized blockchain components, and that most study does not provide any prototype implementation or implementation details. Even with a prototype implementation, no information regarding blockchain components is often provided.*

KEYWORDS: *Blockchain, Consensus, Cryptocurrency, Healthcare, Patient.*

1. INTRODUCTION

Blockchain technology has pervaded every area of information and communication technology (ICT), and its use has accelerated in recent years. The huge increase in the value of cryptocurrencies has sparked interest in the development of this technology. Venture capitalists are pouring money into blockchain startups in huge amounts. The blockchain market is expected to grow. Technology will continue to advance until 2021[1]. There are now about 1500 crypto coins in circulation. Bitcoin was developed just a few years after it was first introduced. Bitcoin was the first digital currency [2].

It ensures that transactions are carried out decentralized, eliminating the need for a trusted central authority. There is no need to reveal someone's identity since public keys are used. A crucial component. Miners are members of the Bitcoin network who earn bitcoin in exchange for their computing labor in verifying and storing transactions. Bitcoin blockchain transactions (payments). More information is available to those who are interested. talks about Bitcoin. Blockchain technology is used in a variety of ways, including cryptocurrencies. In general, there are [3]. The blockchain, the protocol, and the currency are three ideas that must be differentiated in a cryptocurrency. A coin may utilize the blockchain of another coin to create its own money and protocol. A cryptocurrency like Bitcoin or ethereal

The blockchain serves as a distributed ledger in the cryptocurrency industry. A ledger that keeps track of all currency transactions. As a result, such a blockchain expands in a logical manner. As more blocks are added over time, the game will continue to evolve. The majority of well-known

cryptocurrency blockchains are open to the public. Web systems such as blockchain.com—a web platform for blockchain transactions—allow users to query their transactions[2]. Querying the Bitcoin blockchain's transactions Blockchain eliminates the requirement for a (trusted) third-party to facilitate transactions between entities. Validators (typically miners) take the role of third parties and validate transactions on the blockchain. In a decentralized manner This is accomplished via distributed consensus—the capacity to reach an agreement on a wide range of issues. anything between a group of people that don't trust each other.

In the realm of cryptocurrency, this computational issue is linked to the double-spending problem, i.e., how to ensure that no money has been spent twice. A certain quantity of a digital currency has not yet been spent without the approval of a trustworthy third party a third-party (often a bank) that maintains track of all transactions and user balances. Several surveys on the use of blockchain in various areas have already been published. The architecture as well as the many processes involved in the process. The blockchain is a kind of technology. Karafiloski and Mishev [12] and Ahram et al. [13] also contributed. Overviews of blockchain technology, with a focus on its use in big data and manufacturing.

Blockchain application domains and associated research topics There are papers that deal with the subject. Blockchain technology's usefulness in the healthcare sector [16–25], however none of them took off. A blockchain-based records system would give patients complete control over their data, allowing them to choose when and to whom they grant permission to view it. That authorization might be given to a healthcare practitioner in a physician-patient context, or it could be extended to commercial purposes, such as allowing a pharmaceutical company doing clinical research access to your data in return for micropayments in digital currency. Putting the patient in charge would make moving between healthcare providers much easier than it is now, while also guaranteeing that any information given is comprehensive and verifiably correct — a procedure that could be used in a number of situations. EHRData, a Texas-based effort founded by the founders of PDX, Inc., a U.S. medical data business with 40 years of experience dealing with pharmacy software and technology solutions, is one company spearheading this goal.

EHR Data is building the world's first global electronic health record on the Bitcoin SV blockchain, allowing people to securely own, manage, and profit from their own medical data while also providing health care professionals and researchers with improved real-time access to data. The platform may enable a wide range of use cases to improve health outcomes, including opioid medication monitoring and Covid-19 tracking, all while ushering in a new age of patient empowerment. Consider the effect a blockchain-based records system might have on administering the Covid-19 vaccine deployment as governments and healthcare professionals across the globe embark on the biggest public health campaign in human history.

A global electronic health record would guarantee that each vaccination course was given the proper kind and dose at the appropriate intervals, regardless of where it was delivered. This immutable record of immunization may then be used to create digital 'passports' that authenticate admittance to public venues or modes of transportation. The effect of blockchain technology on the healthcare industry isn't limited to the patient-provider relationship. Blockchain technologies may help guarantee honesty and openness in the creation of pharmaceutical goods, which is a time-consuming process requiring stringent data integrity or "hygiene" checks. Entire research, as well

as possibly billions of dollars and years of effort, may be thrown out if data is not properly documented, or worse, is intentionally falsified or obscured. Government organizations charged with authorizing medicines and generating improved health outcomes for patients would benefit from blockchain technology, which allows for simple, auditable monitoring of information produced by clinical researchers.

1.1 The Need Of Blockchain In Healthcare :

Healthcare is among the areas where blockchain is seen to have a lot of promise. In order to modernize healthcare, the emphasis should be on data management, which has the ability to link disparate systems and improve EHR accuracy. Access control, data sharing, and the management of an audit trail of medical activities can all be supported by blockchain technology. It can also be used to support drug prescriptions and supply chain management, pregnancy and any risk data management, as well as access control, data sharing, and the management of an audit trail of medical activities. Provider credentials, medical billing, contracts, medical record sharing, clinical trials, and anti-counterfeiting medicines are some of the other sectors where blockchain technology may help.

Healthcare services are evolving to allow for a more patient-centered approach. Because individuals would have ownership over their medical information, blockchain-based healthcare solutions may improve the security and dependability of patient data. These systems may also aid in the consolidation of patient data, allowing for the interchange of medical information across various healthcare facilities. In healthcare, it's critical to keep track of patients' medical information. These are highly sensitive data, making them a perfect target for cyber-attacks. It's critical to keep all sensitive information safe. Another consideration is data management, which should ideally be handled by the patient.

As a result, another use case that may profit from sophisticated contemporary technology is sharing and obtaining control of patients' healthcare data. Blockchain technology is very resistant to assaults and failures, and it offers a variety of access control options. As a result, blockchain is an excellent foundation for healthcare data. A private blockchain would be the most appropriate kind of blockchain for sensitive medical data. A blockchain may be utilized in a situation where many parties that do not trust each other need to communicate and share common data but do not want to engage a trusted third-party (TTP) , according to the Würst and Gervais choice model. Their approach identifies a number of variables to examine when determining if a certain situation necessitates the use of blockchain.

To begin, we must assess the requirement for data storage (in a typical scenario this is a database). Following that, it must be decided if numerous parties need writing access. If there is just one writer, there is no need for a blockchain, and other alternatives may be explored (e.g., a database). It's worth noting that conventional databases perform better than blockchains. There is no need for blockchain if a TTP is accessible, constantly online, and can be completely trusted. The Würst and Gervais choice model also helps in determining which blockchain to utilize (e.g., public permission less, public permissioned, or private). The only apparent option if the authors are unknown is a public permission less blockchain. If the TTP is down, it could act as a certifying authority, and the parties involved do not have mutual confidence, a permissioned blockchain may

be used. If all parties are mutually trustworthy, a database with shared access may be utilized instead of a blockchain.

If the authors are known and can be trusted, however, the option is between a public permissioned blockchain and a private blockchain. The first is when public verifiability is required, while the second is when it is not required[4]. Please keep in mind that these portions of the model assume that the previous three questions be answered affirmatively—otherwise, installing a blockchain isn't required. The existing medical data infrastructure is mostly reliant on third-party providers. In a number of instances, they can't be completely trusted. A potential answer to this issue is the blockchain, which is based on consensus and does not need a central authority[5].

1.2 Application Of Blockchain In Healthcare:

- *Transparency in the supply chain:* Assurance of the provenance of medical products to ensure their validity is a significant issue in the healthcare industry, as it is in many others. Customers may have complete visibility and transparency of the products they are purchasing by using a blockchain-based system to monitor items from the production site to each step of the supply chain[6]. This is a key concern for the business, particularly in emerging countries, where counterfeit prescription drugs are responsible for tens of thousands of fatalities each year. It's also becoming more essential for medical equipment, which are rapidly multiplying as more remote health monitoring is used, drawing the attention of unscrupulous actors. MediLedger is a prominent example of a blockchain system that allows businesses across the prescription medication supply chain to verify the legitimacy of medicines, as well as expiration dates and other critical data[7].
- *Electronic health records that are centered on the patient:* Every nation and area is grappling with the issue of data silos, which means that patients and their healthcare professionals have an incomplete picture of their medical history. Medical mistakes arising from poorly coordinated treatment, such as planned actions not performed as intended or errors of omission in patient records, were the third largest cause of mortality in the United States in 2016, according to data released by Johns Hopkins University. One possible answer to this issue is to develop a blockchain-based medical record system that can be integrated with current electronic medical record software and serve as a single, encompassing view of a patient's data. It's important to clarify that real patient data isn't stored on the blockchain; instead, each new item added to the blockchain, whether it's a doctor's note, a prescription, or a test result, is converted into a unique hash function - a short string of letters and numbers. Every hash function is unique, and it can only be decrypted with the permission of the data owner — in this instance, the patient. In this scenario, any change to a patient record, as well as the patient's permission to disclose a portion of their medical data, is recorded as a transaction on the blockchain. Medical chain is a prominent example of a business that works with healthcare providers to deploy blockchain-enabled electronic medical records (EMRs)[8].
- *Insurance and supply chain settlements using smart contracts :* Pharmaceutical companies, medical device OEMs, wholesalers, insurers, and healthcare providers, for example, can authenticate their identities as organizations, log contract details, and track transaction of goods and services, as well as payment settlement details for those goods and services, using blockchain-based systems from companies like Chronicled and

Curisium[9]. This kind of environment extends beyond supply chain management to allow healthcare trade partners and insurance providers to work on completely digital and, in some instances, automated contract terms. Instead of each player having their own version of contracts, they can significantly reduce disputes over payment chargeback claims for prescription medicines and other goods by having shared digital contracts between manufacturers, distributors, and healthcare organizations logged on a blockchain ledger. Because price structures vary often, there are over one million chargeback claims filed between these participants each year, according to Chronicled, with more than 5% of them being contested and needing long human settlement. Curisium says that 10% of claims are contested, thus shared smart contracts may be used to handle medical insurance contracts for patients. Once this data is digitized and readily available, insurance companies may employ more sophisticated analytics to optimize health outcomes and costs, just as they do with other use cases[10].

- *Verification of medical personnel credentials:* Blockchain technology can be used to track the experience of medical professionals in the same way that it can be used to track the provenance of a medical good. Trusted medical institutions and healthcare organizations can log the credentials of their staff, which helps to streamline the hiring process for healthcare organizations. Pro CredEx, headquartered in the United States, has created a medical credential verification system based on the R3 Corda blockchain technology.
- *Internet of Things (IoT) security for remote monitoring:* The use of remote monitoring systems, in which all types of sensors detecting patients' vital signs are utilized to assist offer healthcare practitioners greater insight into patients' health, allowing more proactive and preventive treatment, is one of the greatest developments in digital health. Many potential remote monitoring use cases were already addressed in our articles on 5G and edge computing in digital health. However, security is a major concern in health IoT, both in terms of keeping patient data private and safe and preventing it from being tampered with to generate misleading data. In certain instances, when a connected device may be relied on in an emergency situation, such as notifying an elderly person's caregiver that they have fallen or had a heart attack, it is equally critical that the supporting systems be highly robust to DDoS or other assaults interrupting service.

2. DISCUSSION

According to our results, blockchain technology research and use in healthcare is on the rise. Blockchain research in healthcare shows that it is primarily utilized for data sharing, health records, and access control, but it is seldom employed for other situations like supply chain management or medication prescription management, according to current trends. As a result, much of blockchain's potential remains untapped. The majority of research in the field of healthcare uses blockchain technology to offer a new framework, design, or paradigm. Furthermore, technical information regarding the blockchain components utilized are often omitted, such as the blockchain platform, consensus method, blockchain type, or usage of smart contracts. Smart contracts, in particular, may be more widely utilized since they allow for the automation of operations on a blockchain platform. Most studies could additionally offer a working prototype or at the very least explain the implementation specifics of their ideas. Further study is needed since blockchains are still a relatively new technology in the area of healthcare, and new methods to use

it are constantly being discovered and explored. To summarize, blockchain should be utilized in situations where it is both acceptable and necessary.

3. CONCLUSION

The current blockchain research trends in healthcare were examined in this paper. Because of the sensitive nature of the data being processed and maintained, blockchain technology is seen as having tremendous potential for application in healthcare. The study's goal was to determine the present state of blockchain research and implementation in the healthcare industry. To accomplish this goal, we developed research questions and used a predetermined approach to limit the examined literature down to 33 articles. These were then dissected further. We looked for articles published between 2008 and 2019 in nine different online databases. Three reviewers looked through the 33 articles for the in-depth study. We gathered data in response to our study questions and evaluated the articles based on predetermined criteria.

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