

## BLOCKCHAIN TECHNOLOGY APPLICATIONS: A STUDY OF HEALTHCARE INDUSTRY

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### ABSTRACT

**Purpose:** The present paper mainly focuses to identify various applications of blockchain technology and challenges faced at blockchain adoption in healthcare industry.

**Design/Methodology:** This paper is based on qualitative research. This paper relies on secondary data from the public domain including research paper and article insights.

**Findings:** The paper's finding provides support for blockchain technology applications in healthcare industry such as remote monitoring, electronic health record, clinical research etc. This study also explains the challenges faced during blockchain technology adoption.

**Originality/Value:** This paper contributes an original analysis of the applications as well as challenges faced at adoption of blockchain technology in healthcare industry.

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**Keywords:** Blockchain, Distributed ledger Technology, Healthcare, Medical Data.

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### Introduction

One of the most significant and revolutionary technologies nowadays is blockchain technology. Blockchain technology is being adopted by several businesses to innovate how they operate. The healthcare sector is one of them looking to use blockchain technology.

The fundamental blockchain technology that underpins Bitcoin was first introduced by Satoshi Nakamoto in 2008. To keep immutable distributed ledgers up to date, it utilizes hundreds of nodes. Blockchain technology has an important role in business operations, educational institutions, and also has a significant impact on our daily lives in the twenty-first century. As a result, the current Internet may evolve from being "The Internet of Information Sharing" to becoming "The Internet of Value Exchange." When it first started to emerge, blockchain technology found it difficult to attract much attention. But as Bitcoin has remained stable and secure over time, society has come to understand the vast potential of the invention's fundamental technology in its use for crypto-currency as well as in many other industries (Underwood 2016). There are mainly three generations of blockchain applications- Blockchain 1.0, Blockchain 2.0, and Blockchain 3.0 (Swan, 2015).

Several industries, notably the banking sector and digital currencies like Bitcoin, Ethereum, and Zcash, are currently utilizing blockchain technology (Zerocash). Bitcoin is the first blockchain-based peer-to-peer electronic cash system. A technical protocol called blockchain enables direct data exchanges between various contracting parties within a network, cutting eliminating the need for middlemen. A blockchain is a digital public ledger that would keep all digital transactions in a distributed manner over a network and record them in chronological order.

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### Review of Existing Literature

**Mahadi, M. H. & Ali, M. (2018)** completed their work under the title "Application of blockchain technology beyond cryptocurrency", objective of which is to summarize the literature on implementation of blockchain in various domain other than crypto currency. This study provide implementation of blockchain in various non-monetary system such as online voting, distributed cloud storage system, proof- of- location, health care decentralized messaging and many more. This study tries to explain the further prospective of blockchain in developing countries for empowering citizens by e- governance application for identity mgt, health care and also in financial inclusion.

**Prolocofiea & Minah (2019)** conducted their study, objective of which is to identify the prospective uses of blockchain technology. This study is based on the literature review of academic and industry publications between 2008 and 2019 which were published in English. Out of the 136 paper identified for final sample, 23% belongs to social science, 41% to technology and 36% papers related to life sciences and biomedicine. This is study used input-process-output framework of blockchain health which provides the solution of various healthcare problem with the help of blockchain technology. This study showed that main of concern more than 50% of the papers are data privacy and security.

**Ullah et al. (2020)** explore the application of blockchain indifferent sub domain of healthcare industry. This study also provides the information of companies which are using blockchain as per their application. Some companies like Patientory, MEDISLOC, and medical chain used blockchain for data storage. Blockchain provide all data at one place and also enhance data security. Companies like CHRONICLED, BLOCKPHARMA and modum using blockchain for efficient logistic solutions. Sister de propose Ethereum smart contract for transparency and security is data management system in clinical trials and researches. Companies like nebula genomic, EncryGen, Doc. AI, health nexus using blockchain technology in genomic data generation and storage. Due to emerging technology major challenges faced by blockchain technology are interoperability, uncertainty, storages capacity and establishment and maintenance cost.

**Azim et al. (2020)** tries to explain blockchain as a solution for pandemic data management which ensure unified patients data storage and combat against covid-19 and future pandemics. This study provide the challenges faced by traditional healthcare system and provide solution have blockchain overcome these challenges.

**Heston, T. F. (2017)** indicates blockchain technology as a new phenomenon developed in modern healthcare industry. This study is based on case study in blockchain healthcare innovation in Estonia. This study explore the benefits of blockchain such as to secure medical record, sharing of medical data among authorized parties, decrease cost of medical care and improved data auditing with the help of immutable records etc. Due to blockchain world become more digitally and socially connected which needs worldwide solutions to health.

**Irene et al. (2019)** completed their research under the title " A framework for the adoption of blockchain technology in healthcare information management system: A case study of Nigeria". This study provides a framework for the application of blockchain technology. Results of the study showed that healthcare provider support the use of blockchain technology for record keeping and information sharing. This study also explain the benefits of adoption of blockchain technology i.e. to reduce the waiting time, to increase the quality of services rendered and easy detection of medical history. This study also detect the factors such as inadequate infrastructure, network issues, lack of computer expertise in healthcare sectors, which place is important role in application of blockchain technology. This study provides path for further research to evaluate the impact of proposed health care system from patient's perspective.

**Grover, et al. (2019)** found that blockchain is diffused in approximately all the industries but the stage of diffusion differs from industry to industry. Researcher adopts a literature review and social media to categorize industries in 5 main phases of innovation process. Finding of the study show that insurance, real estate and is at confirmation stages; service at implementation stage; transportation, communication, electric, gas and trading is at decision state; manufacturing at knowledge stage; public administration of persuasion stage and other industries has few evidence regarding blockchain adoption. This study also explains the use of this technology in diverse sectors. Main limitation of this study is that it is founded on literature review of journal articles, while there are many white paper and grey literature are available for tracing the diffusion of blockchain. This study provides some conceptual concepts which can be used for further research to find out whether blockchain applications are feasible or not.

**Bell et al.** (2018) concluded in their study that by offering a means for exchanging patient medical data in a publicly or semi-private manner, blockchain's record-keeping capabilities and smart contracts' privacy and security have considerably aided the medical industry. Blockchain can be used to improve the solution for missing medical records or past clinic visit information. Global healthcare is now conceivable thanks to Blockchain's potential to store patient records on the ledger. Additionally, the blockchain-based traceability system may be used to track down phoney medications and remove them from the supply chain, which will help to solve the issue of counterfeit drugs on the market.

#### **Objectives of the Study**

- To explain the basics of blockchain technology.
- To study the application of blockchain technology in healthcare industry.
- To know the challenges faced at blockchain adoption in healthcare industry.

#### **Basic Terminology of Blockchain**

- **Smart Properties:** Smart Properties are assets and properties whose ownership may be managed by a platform built on the blockchain.
- **Smart contracts:** Computer programmes called "smart contracts" hold the regulations for operating and controlling smart properties.
- **Block:** A block is a group of legitimate transactions that have been received within a certain amount of time, like 10 minutes.
- **Mining:** The process of validating transactions and adding them to the blockchain is referred to as mining.
- **Data Lake:** A data repository called a data lake would be used to store all of the medical data off of the blockchain. Images, documents, and key value stores can all be stored in data lakes, which are extremely scalable and capable of storing a variety of data.

#### **Generations of Blockchain**

There are mainly three generations of blockchain:

- **Blockchain 1.0:** First generation of blockchain technology is called Blockchain 1.0. Monera, Litecoin, Dash, and other blockchain technologies are also available.
- **Blockchain 2.0:** This second-generation version of the technology includes the addition of smart properties and smart contracts. Examples include QTUM, NEO, and Ethereum.
- **Blockchain 3.0:** Third generation of blockchain technology mainly focus on using blockchain technology outside of the financial sector. For example, e-governance, healthcare, education etc.

#### **Types of Blockchain**

Blockchain can be of two types:

- **Public or Permission Less Blockchain:** Any node is free to join the network and take part as a minor without needing any permissions or authorizations called permission-less blockchain.
- **Permissioned Blockchain:** In a permission blockchain, users must first be authorised and have access to permission before they can join the network and take part in its activities. There are two varieties of blockchain with permission:
- **Private Blockchain:** In a private blockchain, only one node can be a minor.
- **Consortium Blockchain:** A consortium blockchain is one that enables at least two nodes to participate in the mining process.

#### **Properties of Blockchain Technology**

According to Lin & Liao (2017), the blockchain technologies are often made up of six essential components or features:

- **Decentralized:** This is a fundamental characteristic of Blockchain technology. It means that data may be recorded, saved, and updated across several systems rather than in a single centralized system.
- **Transparency:** Each node in the blockchain system has access to the data record, which is transparent to all nodes and is therefore both transparent and consistent.

- **Open source:** Most blockchain systems are accessible to all users, records may be read by anybody, and anyone can utilise blockchain technologies to construct whatever kind of use they need.
- **Autonomy:** Because every node on the Blockchain system may move or update data safely due to the consensus basis, the idea is to trust from a single individual to the entire system with no one being able to intervene.
- **Immutable:** Records will be held in reserve status for all time and cannot be modified until a person controls more than 51% of the nodes concurrently.
- **Privacy:** All we need is the recipient's Blockchain address to enable anonymous data transfer or even transactions due to blockchain technologies, which have solved the problem of node to node trust.

### Healthcare Industry of India

The healthcare system in India has advanced tremendously since that nation's independence in 1947. The Bhore Committee was the organisation that first put forth the notion of universal healthcare with a larger role for government-funded healthcare. The First National Health Policy was created in response to the commitment to achieve universal health coverage by the year 2000. A notable government undertaking that started in 2005 was the National Rural Health Mission. In certain ways, the mission was successful in providing the needs of the underprivileged and disadvantaged in rural areas with healthcare. The federal and state governments introduced a number of programmes, including the National Urban Health Mission, Pradhan Mantri Swasthya Suraksha Yojana, Rashtriya Swasthya Bima Yojana (Hospital insurance scheme), and Janani Suraksha Yojana, to improve various aspects of the delivery of healthcare services. The government's role in affecting the ecosystem of healthcare delivery was clarified, reaffirmed, and explained in the newly released National Health Policy (2017).

Healthcare is currently India's largest industry in terms of both employment and money. Healthcare includes medical facilities, medical devices, clinical trials, outsourcing, health insurance, telemedicine, medical tourism, and medical equipment. The expansion of services and expenditures by both public and private organisations is contributing to the fast growth of the Indian healthcare system.

### Blockchain in Healthcare Industry

There is little doubt that India, a country with the population in the world and a variety of geographic, cultural, linguistic, and religious backgrounds, needs a healthcare system that enables the safe storage and convenient access of each citizen's health information. A robust, secure system is necessary for Indian healthcare to work on wide and varied level. Blockchain technology has provided its potential applications as a solution.

By 2030, India hopes to have universal healthcare (UHC), one of the Sustainable Development Goals. To achieve a sustainable Universal Healthcare, India requires a technological resolution that can stop drug piracy, reduce insurance claim fraud, and build strong accountability into the system.

**Stagnoro, C.** Study on new implications of blockchain technology in healthcare industry. Results of the study provide a number of uses of blockchain in healthcare i.e. longitudinal health care records, interoperability, automated health claims adjudication, supply chain management, online patient access etc.

### Application of Blockchain in Healthcare

With blockchain's popularity growing and its implementation in various sectors, healthcare has emerged as an important sector which uses blockchain technology. Major applications of blockchain technology in healthcare industry are:

- **Patient data management and sharing:** At the end of 2018, there have been over 350 data breaches reported to the Department of Health and Human Services, exposing 13,020,821 medical records. Blockchain overcomes such problems by providing a single platform for centrally managing all pertinent data while upholding security and access control. Blockchain blocks are used to store bits of patient data that can be identified by the patient's individual ID. If the patient wants to remain anonymous, this setup also allows transmission of health information (blocks) without disclosing the ID. Patients may instantly give their trusted healthcare provider access to their medical records thanks to blockchain technology. When dealing with elderly or unconscious patients, this is very helpful.

- **Telemedicine:** Healthcare facilities are increasingly implementing telemedicine and telehealth solutions. It enables doctors to interact with their patients via digital devices like smartphones and the internet of medical things. Telemedicine enables doctors to stream and analyse real-time data from patients' sensors. While this information provides understanding of the ailments of the patients, it also presents opportunity for hackers.
- **Medical staff credentialing:** Credential verification is a crucial step in the hiring process. The majority of the work is done by phone or mail, but it can be a time-consuming and expensive process. Blockchain records may be verified, updated continuously, and can be seen and altered by anybody with full or restricted permissions, making them an ideal replacement for this current procedure.
- **Drug Supply Chain:** A significant issue in the healthcare sector is adverse reaction of medication, Due to which thousands of people hospitalized and death every year. Furthermore, it is estimated that treating negative drug reactions costs billions of dollars every year. To track the origin of medications across the supply chain, a blockchain technology database can be employed. As a result, it would be possible to spot fake or contaminated pharmaceuticals early on. The tracking of health outcomes via blockchain also enables the early identification of negative effects.
- **Drug Traceability:** The capacity to monitor a drug product from producers to patients along the whole supply chain is known as drug traceability. By offering an unchangeable record of the movement of drug products, blockchain technology has the potential to revolutionise medication traceability. Currently, the majority of drug traceability solutions rely on a centralised database that is vulnerable to manipulation or hacking.
- **Facilitating clinical trials and research:** Clinical trial fraud is a problem that can be addressed with the aid of blockchain. Fraud is defined as the alteration of facts to hide the true impact of tested medications or other therapies. Researchers may trust on blockchain to guarantee the confidentiality and authenticity of clinical studies. Every paperwork produced for clinical trials can be time-stamped there and kept in a secure manner. These consist of project proposals, research designs, questionnaires, blood tests, and informed consent from the participants. For clinical studies, blockchain offers a lot more advantages. As every record on the blockchain can now be independently verified, it gives the research more legitimacy. Also, it lowers audit expenses and solves the problem of lost datasets or documents.
- **Health Insurance:** Smart contracts have the potential to significantly enhance the current insurance system and get rid of all extraneous middlemen. The policy information will be saved in the patient's profile on the blockchain if they purchase their medical insurance policy using smart contracts, making it less vulnerable to hacking than if it were kept in a conventional database. Additionally, filing time-consuming insurance claims won't be necessary anymore. The smart contract will automatically activate when a patient has an insurance-covered operation, transferring funds from the payer to the hospital.
- **Remote Patient Monitoring (RPM):** RPM entails the gathering of biomedical data from Internet of Thing devices and mobile devices in order to remotely monitor the condition of the patient outside of traditional healthcare environments like hospitals. Blockchain has been suggested as a method for storing, sharing, and retrieving the remotely collected biomedical data.
- **Health Data Analytics:** To implement predictive analytics of healthcare data and advance research in the field of precision medicine, deep learning and transfer learning techniques are used.
- **Other Areas of Application of Blockchain in HealthCare:** Dental Industry, legal Medicine, Social Technical implication of using Blockchain Technology in HealthCare.

#### **Challenges of the Application of Blockchain Technology in Healthcare**

Main challenges faced at the time of blockchain adoption are:

- **Governance**  
Public and private blockchains must be able to communicate with one another in order for the proposed blockchain-based healthcare system to function. This emphasises the need for internationally coordinated norms and agreements that go across national boundaries and legal systems.

- **Lack of Legislation**

The proposed blockchain-based healthcare system confronts difficulties in creating suitable legislation to control ownership rights pertaining to international medical transactions. Due to the existence of various stakeholders, ownership of data and current medical law are important difficulties in the traditional healthcare system that need to be addressed in a proper manner.

- **Privacy and Transparency**

Blockchain technology emphasizes transparency, which may not always be desirable in the healthcare industry. Healthcare stakeholders consider the accessibility of a database, even in encrypted form, to be a serious issue notwithstanding encryption's security benefits. As a result, in the context of blockchain, access control needs to be properly managed.

- **Scalability**

Blockchain expands as users add data, in this example by storing all of the hashes related to the newly added data. Due to the increased storage and processing requirements, the network may have fewer nodes with sufficient processing capacity to process and validate data on the blockchain. The risk of higher centralization and slower data validation and confirmation increases if health professionals are unable to meet storage and processing capacity demands.

### **Future Prospective of Blockchain Technology in Healthcare**

New ways to use blockchain technology will emerge as our understanding of it grows. The main barrier now is the cost of putting a blockchain into use. This will definitely change as this technology is used more frequently and advances are made to make it more affordable. EHRs that patients may access with a single tap on their smartphones have the potential to completely alter how we now see personal healthcare. Patients may be given true control over their health and encouraged to participate more actively in healthcare procedures. Blockchain technology has the potential to alter logistics and supply systems, potentially increasing efficiency. With the help of blockchain technology, it is possible to quickly and easily access large amounts of data from anywhere in the world. By doing this, existing systems would become more transparent and new opportunities for medical research would be created.

### **Conclusion**

Presents paper provide several insights towards application of blockchain technology in health care industry. Blockchain technology could provide various benefits in healthcare industry, like, maintaining patient medical records, supply chain, interoperability, longitudinal patient care records etc. Although the growth of blockchain technology is at rapid rate, however, it is still at emerging state. This study also explains the challenges faced at the time of blockchain adoption in healthcare industry such as governance, scalability, lack of legislation, transparency and privacy etc.

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