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Blockchain Technology In Health Care: Advantages, Limitations, And Open Research Challenges

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Abstract: The healthcare sector is constantly looking for innovative methods to deal with the problems that it faces on a daily basis, including data security, interoperability, and confidentiality for patients. Global healthcare systems might see a revolution thanks to the growing concept of blockchain technology. This study examines the potential of blockchain technology to change the healthcare industry by showing its main applications, uses, and drawbacks. This study attempts to illuminate the opportunities and difficulties related to the use of blockchain by offering an in-depth study of how it might improve healthcare delivery, and patient outcomes. It also provides the light on the moral and legal problems that need to be solved if blockchain technology in healthcare is to be used to its full potential.

I. INTRODUCTION

By use of this Bitcoin cryptocurrency development, Satoshi Nakamoto initially unveiled blockchain technology in 2008 [1]. Since then, businesses, financial institutions, and the healthcare sector have all used blockchain technology. Blockchain technology iused to safeguard patient information in the healthcare sector [1].

A increasing collection of information known as blocks make up the complex data structure known as blockchain [1]. Blockchain technology is beneficial for use in the healthcare industry because to a variety of factors, including immutability, decentralization, transparency, and traceability [1]. Decentralization refers to a process where there is no single authority of any transaction that occurs within the system, when immutability may be defined as the durability of the blockchain ledger and the capability to maintain the data ignored and constant.

Traceability refers to the capacity to trace the data with verifiable dates and times, whereas transparency refers to a scenario where everyone in the network may examine all the information stored within a blockchain transaction. While maintaining the confidentiality and privacy of sensitive information that patients share with hospitals and medical institutions, doctors and hospitals must have access to the patient's medical records in order to provide effective care.

II. WHAT IS BLOCK CHAIN

Blockchain technology is characterized as distributed ledger technology that records transactions in an affordable, secure, open, and efficient manner. The technology that underpins bitcoin, which was created in 2008 under the alias Satoshi Nakamoto, is known as the blockchain. It is necessary to first understand the bitcoin process in order to comprehend how blockchain functions. A peer-to-peer, distributed, and decentralized digital currency is bitcoin. Anyone with bitcoin can participate in the network, read, write to, and hold a copy of the transaction records, and the bitcoin system does not rely on a third party as a trusted intermediary.

III. BENEFITS OF BLOCK CHAIN TECHNOLOGY

In the health sector, blockchain technology has improved transparency, communication and more benefits among patients and healthcare professionals . The healthcare area is concentrating its efforts on employing modern technology to improve the efficiency and effectiveness of healthcare systems . The healthcare area is concentrating its efforts on employing modern technology to improve the efficiency and effectiveness of healthcare systems

A. SECURITY AND AUTHORISATION:

Benefits for patients. The primary benefit of blockchain technology for patients is security and authorization. research found that using blockchain to secure patient data across decentralized peer-to-peer networks and put the patient at the center of the system can improve the security of health information.

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When healthcare providers implement the idea of shared medical data to develop and share specific treatment plans for patients, blockchain can support personal healthcare. By using the timestamps that are recorded for each transaction, blockchain may help doctors easily track patient data doctors can closely monitor the patients and take immediate action in case of an emergency.

B. INTEROPERABILITY AND SEAMLESS DATA SHARING

Blockchain makes it possible for systems and healthcare providers to share data easily and securely. Interoperability is made possible by the uniform format of data kept on the blockchain, enabling effective patient data sharing between hospitals, clinics, laboratories, and other healthcare organizations.

C. IMPROVED MEDICAL RECORD MANAGEMENT

Patients may maintain ownership as well as authority over their health data by storing medical records on a blockchain. This allows enterprises to improve medical record administration by decreasing unnecessary data collecting and allowing them to communicate particular information with authorized healthcare providers.

D. DECENTRALIZATION

In contrast to conventional databases, which are managed by a central authority, a blockchain is a distributed system that maintains the structure of a timestamped record ledger that is secured cryptographically against fraud and modification[]. Decentralization refers to the changing of decision-making and a centralized entity's control over a distributed network in the context of block chain[2] . The decentralized storage system, which enhances system security and data authentication, is the main feature of this technology .

Each block also contains the transaction data, a time stamp, and the cryptographic hash of the previous block. It also contains details about all earlier blocks and transactions, which are necessary to build a network or chain. Any change to the data in any of the blocks could start a chain reaction that could lead the blockchain as a whole to freeze. After the blockchain has processed the data, each machine on the network will lock at the exact same time, creating an immutable record of the data. Each blockchain system specifies who is in charge of creating new blocks for the network and how this takes place [2]. After placing the information in a particular block in the chain, it is difficult to change or alter the data, and updates or modifications are not allowed

IV. BLOCKCHAIN IMPLEMENTATIONS IN HEALTHCARE

A. PHARMACEUTICAL INDUSTRY:

Improved pharmaceutical supply chain security was demonstrated by Zakari et al. [2] using a blockchain-based method. They have put into action a LifeCrypter prototype. By implementing a blockchain solution that empowers patients, the prototype was intended to demonstrate the usefulness of blockchain technology and how it may preserve patient lives. The smart contract enables unrestricted trade for all parties, with the potential to define terms for transactions that are open to all parties and self-enforcing at all times. The costs of drug use to the general public and to governments are substantial, according to this study's findings by Sylim et al. Because of periodic sequential hashing, a consensus tolerant and immutable, blockchain technology is used. They develop a blockchain-based pharmaceutical surveillance system and evaluate it on a test network. The Gcoin blockchain should serve as the basis for providing transparent drug transaction data, according to Tseng et al. [2]. Additionally, the regulatory framework for the drug supply chain may be changed from inspection and examination alone to a monitoring net, allowing all participants this includes patients to contribute simultaneously to the fight against fake drugs and the preservation of public health. As a framework for the drug data flow to give transparent pharmaceutical transaction data, the Gcoin blockchain is suggested.

According to Gatteschi et al. , insurance firms, like many other According to Gatteschi et al[2]. , insurance companies have already started investigating and integrating blockchain technology with significant investments from big and small businesses, like many other industries. According to Chen et al.[2] , traditional insurance plans are frequently carried out through paper contracts, making privileges and payments liable to error and frequently requiring human oversight. The basic complexity of traditional insurance also includes customers, agents, insurers, and reinsurers, in addition to the main product-risk of insurance. As a distributed ledger, the blockchain improves the performance of the insurance industry in four areas: reinsurance, IoT-based data analysis, claims processing, and fraud prevention. Heston is in favor of the Estonian medical record blockchain project's potential to protect patient privacy while making the records accessible to the general public and healthcare professionals.

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The Philippine Food and Drug Administration (FDA) invites the public to check drug approval certificates and to report any instances of drug fraud. The Philippine National Police reacts to such reports through a specific task unit. and insurance companies determines their success.

B. TELEMEDICINE AND REMORTE PATIENT MONITORING

Secure Data Sharing: During telemedicine consultations, blockchain ensures the secure sharing of patient health data. The temporary access that patients allow to their medical records can be validated via blockchain smart contracts.

Patient Consent: The immutability of blockchain technology enables the creation of an immutable record of patient consent for telemedicine consultations and data sharing, promoting accountability and transparency.

Privacy and Security: Blockchain improves the privacy and security of patient information during telemedicine sessions by encrypting health data and employing cryptographic algorithms.

Payment and billing: Blockchain-based smart contracts can streamline payment procedures for telemedicine services, enabling prompt and clear payment settlements for both patients and medical professionals.

C. CLINICAL TRIALS:

Researchers, doctors, and patients are frequently denied access to clinical trial data, according to Nugent et al.[2] , undermining their confidence in the system and emphasizing the need for structural change. The authors presented how a smart contract built on the Ethereum blockchain may be used to improve clinical trial data management transparency. According to the secure qualities of blockchains, this study has demonstrated that the cryptographic assurances provided by present protocols should go beyond "proof-of-existence" and be used for complex clinical trial data government. The blockchain technology, according to Benchoufi and Ravaud

[2] , has a significant promise for clinical research. Once a set of necessary metadata is produced, it can contribute to the more transparent and mostly algorithmic proof of the integrity of clinical trials. It makes methodology structure easier and more verifiable. To reduce the administrative costs, time, and effort required to maintain data integrity and privacy in framework research, Choudhury et al. developed a contemporary data management system based on permissioned blockchain technology. They demonstrate how our architecture, which uses private channels and smart contracts to execute.

V. BLOCKCHAIN LIMITATION

The efficiency and cost-effectiveness of handling massive amounts of data have not yet been put to the test in real-world settings. Depending on the protocol, transaction times can lengthen as traffic volume rises, which has an effect on scalability [1] and necessary processing power.

While converting the current electronic health system to blockchain-based technology, the viability of costs and setup for hardware, software, implementation, and support needs to be evaluated [1].

To store, access, and exchange encrypted data in the cloud, a universal standard is also required [1]. The final difficulty is that the security component is in doubt because there is now no guarantee that the data blocks cannot be faked, decrypted, or altered. There is a hypothetical 51% likelihood of a security concern if the entire network is taken over by malevolent attackers .

VI. OPEN RESEARCH CHALLENGES

The implementation of blockchain for COVID-19 reducing is complicated by a number of significant open research issues, The goal is to offer tips and suggestions to fresh academics looking to create right away blockchain-based solutions to combat COVID-19

A. CROSS-PLATFORMS COMMUNICATION CAPABILITIES

Cross-platform communication is the ability to transfer data, information, and digital assets between various blockchain systems. The two blockchains are likely to run on slightly distinct administrations and protocols given the intrinsic diversity of each platform. They can safely communicate data

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and information by utilizing a "bridge" created by an intermediary chain. [3] By (a) enabling faster and more transparent shipment of COVID-19 prevention materials, (b) improving the traceability of shipping materials, and (c) raising trust among participating organizations by presenting a single and synchronized view of shipment data, blockchain technology can significantly improve the supply chain of PPE and vaccines. To combat the COVID-19 epidemic, it creates a cooperative, accountable, and collaborative environment among the collaborating organizations, including law enforcement, the government, hospitals, and research institutes. The blockchain interoperability feature enables continuous communication between various blockchain-based systems. Users can see, share, and access data across many blockchain platforms without the need for a middleman (for translation services). Thus, the interoperability support provided by the blockchain platform can boost a system's throughput, security, and productivity. It also enables a user-friendly experience for many users, offers a frictionless and simpler environment for smart contract execution, gives participating firms the chance to build collaborations, and permits easy information sharing [3]. For instance, a user can conduct commercial transactions utilizing Bitcoin tokens on the Ethereum blockchain network using interoperability-supported blockchain platforms. The main obstacles to developing an interoperable blockchain-based system, however, are the diversity of technology and variations in software architecture of existing blockchain platforms [3]. It is challenging to suggest solutions that allow broad interoperability due to the discrepancy in supported languages, data and transaction security in smart contracts, and advised consensus protocols. Furthermore, a platform that is interoperable and hosts services for agencies battling the COVID-19 epidemic should offer high security, fault tolerance, and quick transaction processing.

B. DATA PRIVACY AND ETHICS

Issues with traditional clinical trial data management systems, like data duplication and inconsistency, can be considerably reduced with blockchain. It allows all miner nodes to have access to the complete database and keeps clinical trial data in a distributed manner. Organizations have unique worries regarding data security and privacy assurance due to the open nature of the database [3]. Clinical trial data recorded on the blockchain network is guaranteed to be invisible to unauthorized people by data privacy. It ensures compliance with the terms and conditions stated in the consent form and GDPR privacy rules and that health data is only shared with authorized organizations (government or authorities). Because data and transactions on public blockchain platforms like Bitcoin and Ethereum are open to the public, it is challenging to guarantee clinical trial data privacy; in contrast, private and consortium platforms like Hyperledger Fabric and Quorum operate in a controlled environment, protecting clinical trial data privacy. Another use case that necessitates data privacy assurance (from unauthorized users) is issuing immunity passports to people or employees based on vaccination certification. This will effectively eliminate any social discrimination with COVID-19-infected patients. Patients' COVID-19 data can be kept private using methods including zero-knowledge proof, attribute-based encryption (ABE), and multi-party homomorphic obfuscation [3]. Although the privacy of COVID-19 data has been rigorously safeguarded by the medical passport production schemes currently in place, there are certain ethical concerns that may limit its adaptation [3]. Examples of significant difficulties that require proper attention include the impact of blockchain on the environment, such as carbon emissions caused by massive electricity use. [3].

VII. FUTURE RESEARCH FOCUSES ON BLOCKCHAIN HEALTHCARE SECURITY

According to the kind of blockchain, the security differs for public and private blockchains, and this distinction is another important aspect of well explained blockchain security. Private blockchain requires more regulatory and compliance controls whereas public blockchain networks are open to all users and allow anybody to join while protecting participant anonymity[4]. Only authorized parties can access encoded personal health records that are stored on a blockchain. Healthcare has additional standards, like interoperability and data sharing, to protect patient information. Interoperability is the process of sharing data with different sources. Healthcare recipients, providers, insurers, and regulators can all participate in distributed ledgers to enable secure and private healthcare administration[4]. Data from personal health records was previously maintained and saved on paper; however, with the introduction of the cloud, the records were moved to a centralized storage facility. The new healthcare age, commonly referred to as "Health 5.0," calls for the remote and real-time collecting of massive user populations' health data using various sensors and smart wearable devices

[4] employed for remote health monitoring [4]. These data must be monitored, transmitted, and handled securely because they are produced in vast amounts. Some patients are apprehensive about disclosing their personal health information to a distributed network, and some hospitals are wary of telling insurance companies specifics about their patients' medications. In addition to diagnosis and treatment, blockchain technology can assist the healthcare sector with a number of security concerns [4] In the field of healthcare, blockchain has a wide variety of uses. Blockchain technology supports healthcare researchers in deciphering genetic codes by controlling the medicine supply chain, simplifying the safe transmission of patient medical records, and more [4]. The usage of blockchain technology in healthcare-related applications and the technology's entirely digitalized components are the main drivers of its adoption.

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CONCLUSION

In conclusion, the overall paper discusses how blockchain technology used to address some of the issues facing the healthcare sector. The benefits of blockchain technology that have been extensively studied, such as security, integrity, and decentralization, and Block chain implementation in Healthcare , open research challenges and Block chain limitations in health care.

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