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Dear Esteemed Readers, Authors, and Colleagues,

I hope this letter finds you in good health and high spirits. It is my distinct pleasure to address you as the Editor-in-Chief of Integrative Omics and Applied Biotechnology (IIOAB) Journal, a multidisciplinary scientific journal that has always placed a profound emphasis on nurturing the involvement of young scientists and championing the significance of an interdisciplinary approach.

At Integrative Omics and Applied Biotechnology (IIOAB) Journal, we firmly believe in the transformative power of science and innovation, and we recognize that it is the vigor and enthusiasm of young minds that often drive the most groundbreaking discoveries. We actively encourage students, early-career researchers, and scientists to submit their work and engage in meaningful discourse within the pages of our journal. We take pride in providing a platform for these emerging researchers to share their novel ideas and findings with the broader scientific community.

In today's rapidly evolving scientific landscape, it is increasingly evident that the challenges we face require a collaborative and interdisciplinary approach. The most complex problems demand a diverse set of perspectives and expertise. Integrative Omics and Applied Biotechnology (IIOAB) Journal has consistently promoted and celebrated this multidisciplinary ethos. We believe that by crossing traditional disciplinary boundaries, we can unlock new avenues for discovery, innovation, and progress. This philosophy has been at the heart of our journal's mission, and we remain dedicated to publishing research that exemplifies the power of interdisciplinary collaboration.

Our journal continues to serve as a hub for knowledge exchange, providing a platform for researchers from various fields to come together and share their insights, experiences, and research outcomes. The collaborative spirit within our community is truly inspiring, and I am immensely proud of the role that IIOAB journal plays in fostering such partnerships.

As we move forward, I encourage each and every one of you to continue supporting our mission. Whether you are a seasoned researcher, a young scientist embarking on your career, or a reader with a thirst for knowledge, your involvement in our journal is invaluable. By working together and embracing interdisciplinary perspectives, we can address the most pressing challenges facing humanity, from climate change and public health to technological advancements and social issues.

I would like to extend my gratitude to our authors, reviewers, editorial board members, and readers for their unwavering support. Your dedication is what makes IIOAB Journal the thriving scientific community it is today. Together, we will continue to explore the frontiers of knowledge and pioneer new approaches to solving the world's most complex problems.

Thank you for being a part of our journey, and for your commitment to advancing science through the pages of IIOAB Journal.

Yours sincerely,

Vasco Azevedo

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ARTICLE

BLOCKCHAIN IN MANAGING HEALTHCARE CHALLENGES

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ABSTRACT

In terms of data and revenue, healthcare has seen the most rapid growth. For so many EHRs, confidentiality has become a top priority. There has been a push to use blockchain technologies to make this sensitive data more secure. Blockchain technology has been very common in the healthcare industry in recent years. Due to the desire for a more patient-centric method to healthcare services and the need to integrate fragmented systems and improve the quality of EHRs, blockchain technology has enormous promise in healthcare. The use of blockchain technologies for the distribution of secure and safe healthcare data management has sparked a lot of interest. Furthermore, blockchain is evolving conventional healthcare practices into a more dependable way of delivering efficient services through the secure and safe exchange of data. This paper presents the study about managing healthcare with Blockchain and discussing how blockchain technology can help spur innovation and improve healthcare data management systems. In this paper we firstly introduce the Blockchain, its characteristics and different types of Blockchain. Then we will focus on the need for Blockchain in Healthcare management and review its applications, benefits and challenges in healthcare management using Blockchain.

KEY WORDS
Healthcare; Blockchain; Security; Electronic Healthcare Records; Decentralization

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INTRODUCTION

Blockchain technology has been entering all ICT (Information and Communications Technology) areas, and its application has been increasing steadily in current years. This technology's development and interest has mainly been motivated by massive investments of venture capital in blockchain start-ups and the tremendous valuation growth of cryptocurrency. It is estimated that the demand for blockchain technologies will expand before 2021 [1]. In current years, the banking/financial disciplines have given blockchain technology a lot of thought. The blockchain system has gotten a lot of attention because it helps you record all financial transactions in a verifiable (peer-to-peer) and safe way with no other stakeholder's requirement to process them. Transactions are then merged into block, all of which is connected to its precedent and has a timestamp. Data cannot be changed after it has been registered, and the past transactions are merged into a chain system with no risk of new parts of alternate transactions arise or wedged into the centre of a chain [2].

Healthcare is a data-intensive discipline [3] that generates, disseminates, stores, and accesses vast amounts of data regularly. Globally, 16.5 million patients used digital health surveillance in 2017 (a 41 percent improvement from 2016), and this figure is projected to rise to 50.2 million by 2021 [4]. In addition, the United States Centers for Medicaid Services1 and Medicare has introduced new payment incentives that encourage the use of "active feedback loop" devices that offer real-time surveillance since January 1, 2018. When a patient is tracked or undergoes testing, data developed must be saved to be later retrieved by a healthcare provider on a different setting or in a similar network. Concerns over reliable and effective delivery of medical data are growing as this field progresses. It is tempting to believe that technologies will improve the efficiency of health care while still saving money. Like as in 2014, 15 percent patients of U.S. who attended a healthcare facility said they had to show their diagnostic test findings to their consultation, and 5% said they had to have a treatment, or a test repeated so they did not have access to a previous test result [5].

Although blockchain implementations have traditionally been used to create distributed ledgers involving virtual tokens (such as cryptocurrencies), the platform has recently gained traction across a number of other areas. Mark Walport, the United Kingdom's chief science advisor, claimed in a January 2016 paper that blockchain technology could be used for more than just trading: "Distributed ledger systems have the ability to help governments ensure the supply chain of goods, record land registries, grant visas, provide benefits, collect taxes and simply ensure the transparency of government services and records."

The momentum has now expanded to the medical industry. After the last half of 2017, we have seen a surge of enthusiasm from healthcare giants to get interested in blockchain, whether by entering consortiums like Hyperledger2 or building their own products and services. As of the beginning of September 2017, the search question "blockchain" yielded 15 results in the electronic medical library PubMed3 [2]. In December 2018, we conducted a related search and found 98 publications. The textual review of these articles reveals the blockchain's ability to exchange of health records and increase confidentiality, lead to successful drug supply chain management, avoid research conclusions from being distorted and improve the accuracy of clinical trials.

The use of blockchains for e-health data sharing [6], distribution of secure and safe healthcare data [7, 8], brain simulation, and thinking, and biomedical [9], has recently sparked a lot of interest. A blockchain is based on a P2P (peer-to-peer) network. Basically, it is a peer-to-peer integrated multi-field network architecture aimed at to solve conventional distributed database synchronization limitations with the help

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of distributed consensus algorithms to solve, which is made up of mathematical expressions, algorithms, and cryptography.

Each new transaction must be verified by a member of this network. Each transaction in a blockchain block is validated by all nodes in the network, making it increasingly immutable. As seen in [Fig.1] [10], the workflow of the blockchain mechanism is depicted in the diagram below.

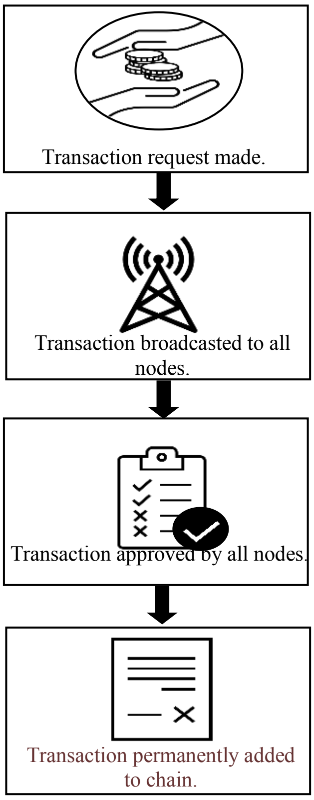

Fig. 1: Blockchain process workflow. [10]

By integrating all patient's real-time clinical details wellbeing and displaying it as an up-to-date, safe healthcare system, blockchain may be a tool that helps in customized, secure, and accurate healthcare in the future.

RELATED WORK

For several years, the healthcare industry has been working to incorporate blockchain technologies into their systems, and it has been the subject of several reports. Private Blockchain is the most secure and encrypted way to store and monitor healthcare data. HDG (Healthcare Data Gateway), a customized healthcare method built on a private blockchain that allows patients to monitor, access, and maintain their information separately, was released in [11].

A public blockchain with safe encryption approaches was introduced in [12] for safely managing patient health information. Data was stored in encrypted codes and made freely accessible on the blockchain network, enabling patients to monitor and access their information. In [13], a private Ethereum-based blockchain was proposed to incorporate secure and safe medical sensors as well as safe remote surveillance of patients in various locations. Practitioners used this method to monitor the condition of their patients with real-time surveillance in order to keep a secure and up-to-date medical record.

Another research [14] suggested a system focused on the incorporation of cloud computing and blockchain to monitor and share a patient's medical information. This new scheme was used to ensure the reliable and safe collection and transmission of patient medical data and records. Patients were given direct access and oversight of their information using approach without the intervention of a third party.

A blockchain architecture was proposed in [15] to determine the state of diseases in patients by using artificial healthcare technologies and parallel execution to measure the overall illness, diagnosis, and recovery phase of the patients. The surgical methods were then evaluated using computational trials and parallel executions in order to make the best decision possible regarding the patient's health problems depending on their disease. The proposed scheme was put to the test on artificial and real healthcare environments to see how accurate the diagnosis was and how successful the prescribed therapy was.

BloCHIE, a blockchain-based application for information sharing and healthcare data, was introduced in [16]. The proposed framework used blockchain to manage electronic healthcare records and personal data records in a number of scenarios. They used off-chain and on-chain authentication mechanisms to verify the platform's legitimacy in terms of privacy and authenticity.

Catalini and Gordon [17] concluded that about how blockchain technology would allow patient-centric control of healthcare data sharing over institution-centric control in a study on healthcare blockchain. They looked at patient authentication across the network, data immutability in their report, managing large amounts of healthcare data, and how blockchain technology changes the healthcare industry by allowing digital access rights.

Daisuke et al. [18] used the Hyperledger fabric blockchain technology to operate on medical information, submitting data to the Hyperledger blockchain network. They used smartphones to collect the medical data. They were attempting to ensure that healthcare data are registered on the Blockchain as part of their work.

Anuraag et al. [19] investigated blockchain as a means of effectively managing healthcare data. They included different forms of experiments in their research, with the majority of the work focusing on the possible advantages and disadvantages of blockchain technology in healthcare without including any evidence or device assessment. They've reached an agreement about how blockchain could be a perfect for storing health-care information on the cloud while preserving data privacy and security.

Drew [20] showed a mechanism for storing protected health data by encrypting it with a shared blockchain (a decentralized storage system with free access control for everyone linked to the network). The encrypted healthcare data is maintained publicly in this form, resulting in a blockchain-based PHR (personal health record). Their proposed solution encouraged patients to have greater autonomy of their medical record, allowing them to easily monitor, access, and add to their records, as well as share them with every related caregiving organization.

Table 1: The comparison of existing blockchain-based Healthcare approaches

S.No.	Refs	Year	Idea	Benefits
1	[13]	2016	Healthcare Data Gateway based on private Blockchain	Patients can manage, monitor, and access their records independently.
2	14]	2018	Private blockchain based on Ethereum	To implement secure and safe medical sensors and secure remote monitoring of patients
3	15]	2018	The integration of blockchain and cloud storage-based framework.	Ensure the confidential records and personal medical details are shared and processed in a secure and safe manner..
4	[16]	2018	Framework based on artificial healthcare systems and parallel execution.	Evaluate the status of diseases in patients.
5	[17]	2018	A unique blockchain-oriented BloCHIE platform.	Handle the requirements of electronic healthcare records and personal data records.
6	18]	2017	Using a mobile app, developed a mHealth framework for cognitive behavioural therapy for insomnia.	Combining mHealth and blockchain technology could result in a novel approach that offers data transparency and accessibility without the need for a third party.
7	[19]	2019	Conduct a comprehensive analysis to determine the effectiveness of blockchain as a means of efficiently managing health-care records	Increase interoperability while maintaining privacy and security of data.
8	[20]	2016	Implement a public blockchain to provide a method for storing secure health records.	Patients now have more access to their health records, allowing them to not only monitor and access their information, but also add to it and share it with every related caregiving organization.

BLOCKCHAIN

On a peer-to-peer network, blockchain is a distributed ledger technology run by separate peers [21, 22]. Without a system administrator or centralized data storage management, this approach functions [23]. Data is dispersed across several nodes, and data integrity is retained by encryption and replication [24, 25]. The idea of blockchain was realised on October 31, 2008, when Nakamoto released a white paper [26]. He devised bitcoin transactions on a network that allowed online payments to be transmitted directly from one peer to another without using a financial institution. His primary purpose was to develop a trustless [27] mechanism to address the double-spending issue by computing the sequential order of transactions [28] that uses peer-to-peer distributed ledger technology. The word "blockchain" implies to a sequence of blocks, all of which stores a data about the chain's history, current, and future [29, 30]. As soon as it enters the system to become a part of the chain, all block performs a critical part in interacting with the subsequent block and the previous block [31]. Every block's primary feature is to validate, record, and shares transactions with other blocks. This suggests that subsequent block is affected by removing or changing a link in the chain [32, 33].

As a result, the blockchain network is a transparent information system [34, 35] that preserves information from all prior transactions and runs on a pre-determined algorithm that determines how transactions are conducted and authenticated, as well as how the whole network and its participants operate [36]. Furthermore, since data is stored on all nodes working in all independent networks, this network is commonly referred to as a distributed registry [37,38].

In blockchain networks, a transaction category is unified into transactions block associated in the chain by hashing the previous block's record [39]. As a result of this property of immutability, blockchain networks' basic security feature is applied [40]. The data in a block is more secure from modifications the farther down the chain it is [41]. The local register will become invalid automatically when an attacker attempts to change some of the keys, because based on the hash function mechanism [42,43], the hash values within the following block headers will be totally unique.

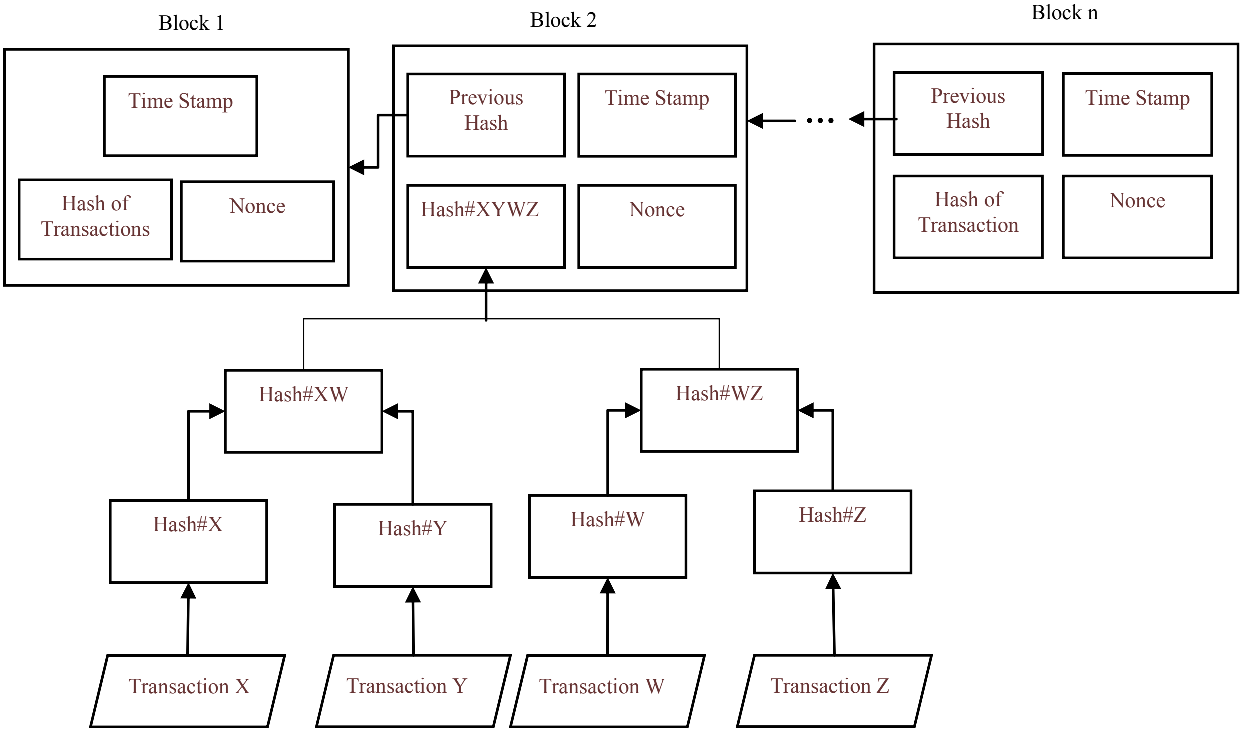

Fig. 1: A basic Blockchain structure. [44]

The blockchain is the backbone of cryptocurrencies' networks and Bitcoin. As the name implies, a blockchain is made up of a chronological series of block-like data structures. A collection of transactions is referred to as a block that have been timestamped and packed together. Each new block is connected to the one before it. This time-stamped sequence of blocks, when paired with cryptographic hashes in a network, gives a “immutable” archive of each transactions, from the genesis block to the most recent block. [Fig. 2] shows a regular blockchain structure, which includes the following 4 metadata pieces:
1) Merkle tree root for the block transactions
2) Previous block reference
3) Proof of work (a.k.a. a nonce)
4) Time-stamp

EVOLUTION OF BLOCKCHAIN

Satoshi Nakamoto first proposed the technology's concepts to the public in 2008. About a year, the idea of developing architecture for a transaction was introduced in a modern digital experiment named “Bitcoin,” which has the indisputable benefits of unlikely device timestamp operation and double cost. Technology named Blockchain and its architecture was launched in 2009. This technology works by feeding the data in a distributed ledger in decentralized manner over all the computing devices which are intact in blockchain infrastructure. Blockchain is a distributed ledger where files are distributed across hundreds of computers, they are networked together. Managing the debit or credit within the platform across hundreds of computers actually provide a lot of benefit such as hard to hack and creating a level of trust in user's mind. The infrastructure is peer to peer based and functions by having both users of the network and Blockchain miners. The ledger is stored in decentralized network of nodes that are created through cryptographic process computed by all the miners within network . The Blockchain ledger is reliable as it is created using consensus mechanism, digital signature and hash chain.

Blockchain version 1.0

An experiment with digital money: The first wave of Blockchain was focused on collecting unique identity, securing confidential consumer records, and preserving a payments transaction audit trail, which was the original aim of historically accepted Bitcoin or other crypto-currencies. Almost all large financial institute globally is actively studying blockchain, and 15 percent of banks are projected to use the platform in 2017 [45].

Blockchain version 2.0

Ethereum smart contracts: Claim forms, links to third-party information, claims or policy records, invoices that link to end transactions with the client, agreements, as well as the content of contracts, are all included in the second generation of Blockchain. This version enables customers to perform stock, bill of trade, intellectual property rights, and other smart contract transactions, especially in the finance and banking industries.

Blockchain version 3.0

Proof of stake: Internet of things data reporting and programmable services (asset indexation – pushing third-party verification and automation services) are the third technology. It is protected by a process known as "evidence of work," in which decision taken by the party with the most processing power. These companies are classified as "miners," and they run huge data centers in return for cryptocurrency payments. It is used in several areas, including human nature, digital, art, health, government, and education.

CHARACTERISTICS OF BLOCKCHAIN

Decentralization

Each transaction in a standard centralized transaction structure must be checked by a central trusted entity (e.g., the central bank). As a consequence, decentralization necessitates trust, which is the most pressing problem, as well as failover, availability, and lift resilience for which the decentralized peer-to-peer blockchain framework might be a better match. A transaction in the blockchain network can be performed between any two peers (P2P) without the need for authorization by a central agent, unlike in a centralized system. By using a variety of consensus procedures, blockchain can help to alleviate confidence concerns.

Persistency

Blockchain provides the infrastructure for measuring reality [46] which allows both suppliers and users to show that their data is accurate and unaltered. If a Blockchain has ten blocks, for example, block number ten includes the hash of the preceding corresponding block, and the information from the existing block is used to generate a new block. As a result, in the current chain, all of the blocks are attached and linked. Also, the transfers are connected to the previous one. A quick modification to every transaction would now dramatically alter the block's hash. If anyone tries to change some details, he must change all of the previous block's hash data, which is an astronomically complicated process given the amount of work involved. Furthermore, when a miner produces a block, it is confirmed by other users in the network. As a result, the network will detect any data falsification or manipulation.

Anonymity

A randomly generated address can be used to communicate with the blockchain network [47]. To protect his identity, a user may have multiple addresses within a Blockchain network. No central government is recording or monitoring user private information because it is a decentralized system. Because of its trustless setting, blockchain offers some privacy.

Auditability

A digital public ledger records all transactions in a blockchain network and verifies them with a digital timestamp. As a consequence, any node in the network can be accessed to inspect and track previous records [48]. In Bitcoin, for example, all transactions can be tracked iteratively, enabling transparency and auditability of the blockchain's data state. However, once money is tumbling through several accounts, it becomes very difficult to track it back to its source.

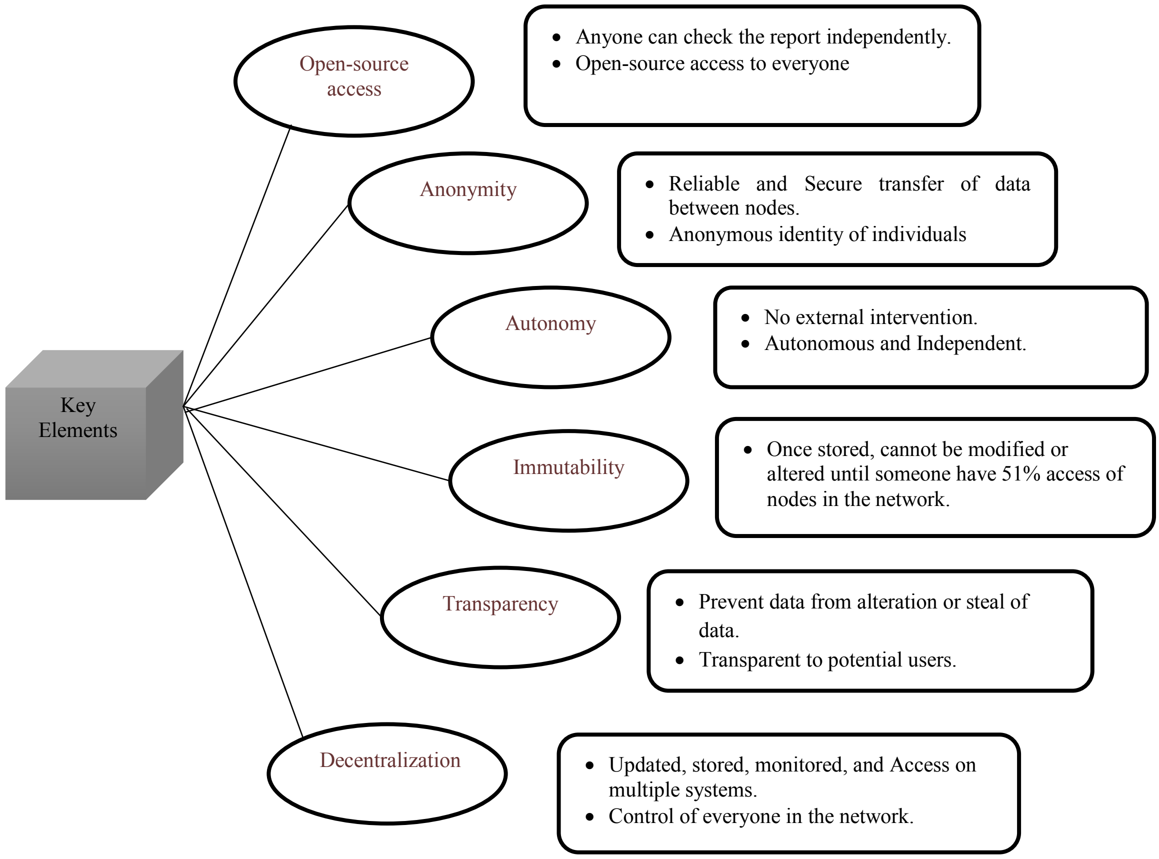

Fig. 2: key Elements of Blockchain. [49]

TYPES OF BLOCKCHAIN

In general, depending on managed data various kinds of blockchains exist that is handled, the availability of that data, and the user's behavior. These are: (a) public permissionless and (b) private (c) consortium (public permissioned).

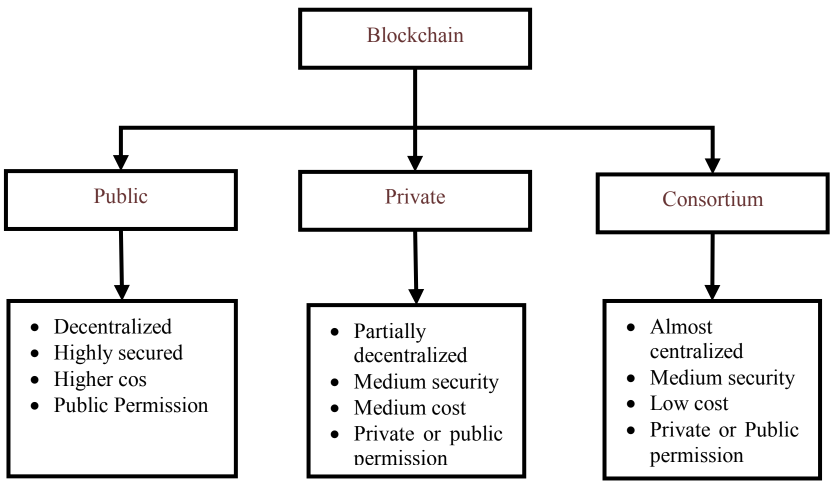

Fig. 3: Different types of blockchain technology. [50]

Public permissionless

The decentralized permissionless (often referred to simply as public) blockchain contains all data that is open and available to the general public. Any portions of the blockchain, however, may be encrypted to shield a client's privacy

[51]. Anybody may enter the blockchain in a public permissionless network and function as a miner or simple without requiring consent (node). In cryptocurrency networks, for example, these kinds of blockchains are typically given an economic opportunity. Litecoin, Bitcoin, and Ethereum are representations of such blockchains.

Consortium

Only a small number of nodes will engage in the distributed consensus process in a consortium blockchain [51]. It may be seen in a single industry or through many. Where a consortium blockchain is built within a single company (for example, the finance sector), it is partly centralized and available to the public. A consortium of industries (example, governmental institutions, financial institutions, and insurance providers) is, on the other hand, opened for uses by the public while also maintaining a partly consolidated trust.

Private

Selected nodes will access a private blockchain network only. As a consequence, it is both a centralized and a distributed network [51]. It is permissioned networks that limit which nodes are allowed to serve as miners, perform transactions, or execute smart contracts. They are overseen by a central agency, which is a reputable third party and only for personal reasons it is used. Only private blockchain networks are funded by blockchain systems such as Ripple and Hyperledger Fabric [52].

BLOCKCHAIN IN HEALTHCARE

Legacy programs in the healthcare and medical fields typically only distribute healthcare services directly and are not entirely compliant with external systems. Despite this, evidence shows that combining these networks for integrated and improved healthcare has multiple advantages, necessitating interconnection between various organisations for health informatics researchers [53]. Multi-organizational data sharing is one of the most pressing topics, since it necessitates that patient information gathered by a healthcare provider be readily accessible to other institutions, such as a research institute or physician. Blockchain technology is redefining governance and data management in various applications of healthcare because of its unprecedented segmentation and flexibility, security, services, and medical information sharing. Blockchain technology is at the core of numerous current trends in the healthcare sector.

The permissionless, decentralized architecture and transparency of the blockchain can provide a one-of-a-kind solution for healthcare. The technology's wider applicability opens the door to a number of facets of healthcare, including wearables and medical science development. The healthcare industry is increasing its appetite for blockchain technologies, according to a recent Deloitte report, and the traditional industry is aggressively exploring new ways for using the blockchain to address its vital needs.

The blockchain's immutability is a critical feature for healthcare records. It will protect patient data, clinical trial reports, and regulatory enforcement. Smart contracts are being used to illustrate how blockchain can assist with real-time medical treatments and patient monitoring [54]. HIPAA (Health Insurance Portability and Accountability Act) compliance programs provide record confidentiality while ensuring access to patients and medical providers.
Further blockchain application develops measures against counterfeit drugs and include the pharmaceutical supply chain. While the production of experimental drugs requires considerable expenses for testing to test the drug's safety and effectiveness, the use of smart contracts makes for more effective informed consent processes as well as better data storage and consistency [55]. Providing patients with rights to administer their own identity enables the informed consent process to be incorporated while maintaining the integrity of individual health records.

NEED OF BLOCKCHAIN IN HEALTHCARE

Healthcare is one of the fields where blockchain is supposed to have various assurance [56]. The emphasis should be on data processing to alter healthcare, enhancing electronic health record accuracy and integrating fragmented networks. The maintenance of an audit trail of medical activities, access regulation, data exchange can all be assisted by blockchain technology. It can also provide facilities for pregnancy, risk data management, drug prescriptions, supply chain management, and data sharing, the management of an audit trail of medical activities and access control. Anti-counterfeiting drugs, clinical trials, medical record sharing, patient billing, and provider certificates are other fields where blockchain technologies can help. Healthcare systems are changing to allow for a more patient-centered approach. Since patients would have power of their medical history, blockchain-based healthcare services could increase the confidentiality and safety of patient data. These programs can also assist in the consolidation of patient data, allowing for the sharing of medical information between various healthcare facilities.

In hospitals, it is important to keep records of patients' personal details. These are extremely classified documents, making them a primary target for cyber-attacks. It is essential to keep each classified information secure. The other consideration is data management, which the patient can preferably handle. As a result, the other use case that can gain advantage from latest modern innovations is accessing and sharing ownership of patients' healthcare records. Blockchain infrastructure is highly resistant to failures and attacks, and it offers a variety of access control options. As a result, for healthcare data, blockchain is an outstanding platform.

A private blockchain will be the most appropriate form of blockchain with personal medical details. The scenario where a blockchain can be used is when several parties that do not trust each other must communicate and share standard information but do not want to include a TTP (trusted third-party) [57], according to the Gervais and Würst decision model. Their model defines a variety of variables to weigh when deciding whether a particular situation necessitates the use of blockchain.

HEALTHCARE MANAGEMENT WITH BLOCKCHAIN

The authors of this paper [58] recommend blockchain as an effective foundation for healthcare data exchange. The authors have implemented a unique consensus algorithm named "Proof of Interoperability" built on the FHIR (Fast Healthcare Interoperability Resources) compliance protocol to promote healthcare data compatibility among organisations. The writers of this paper [59] demonstrate that in pervasive social network (PSN)-based healthcare, how blockchain technology can be used.

Healthcare data is particularly valuable, and it has a requirement of protection from unauthorized access. To that end, the writers of this paper [60] introduce MedRec, a novel, open record management scheme that uses blockchain technologies to manage Electronic Health Records (EHRs). A private, peer- to-peer network's members share viewership permissions and data control, which are defined by the block content. For execution on external databases, they register patient-provider relationships using smart contracts on the Ethereum blockchain, which link a medical record with viewing rights and data extraction commands. The MedRec architecture expands its value proposition in exchange for anonymized medical data by allowing health scientists to mine in the Blockchain network.

A federated Blockchain depend on the Ethereum network is used in the medChain project2 for retrieval and patient data storage. Patient data privacy is protected by encrypting electronic Protected Health Information (ePHI) with the patient's private key and hashing it until it is deposited on the medChain Blockchain.

With the goal of enhancing data transparency in clinical trials, the authors of this paper [61] recommend using a private IPFS network to store the data structure that stores the clinical trial protocol if huge file storage is needed, and smart contracts organized on a permissioned, proprietary Ethereum blockchain to rule Clinical Trial Authorization (CTA) information.

This work [62] addressed various architectural considerations as well as blockchain network architecture's challenges and technical specifications for precision medicine and clinical trials. This paper [63] discusses the use of the public Bitcoin Blockchain network to improve the traceability and transparency of consent given by patients participating in clinical trials.

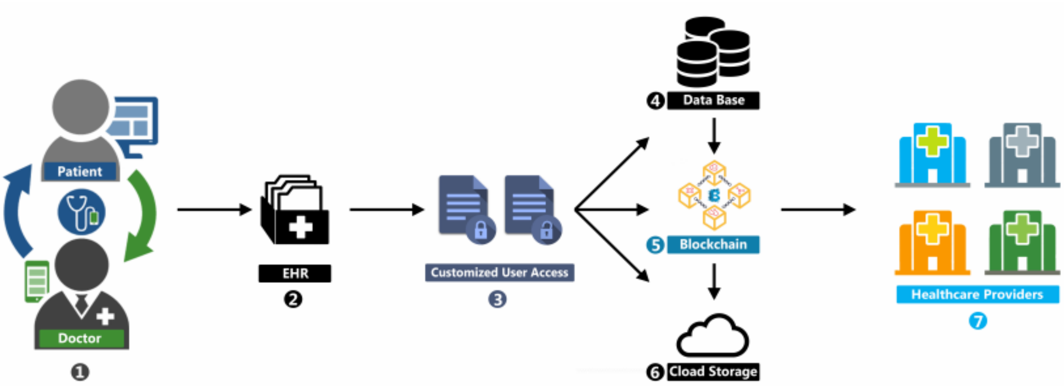

Fig. 4: Process of Healthcare management using blockchain. [64]

[Fig. 5, 6][64] represent seven stages in a blockchain-based healthcare data storage workflow, which are addressed further down. Data storage, data management, and data sharing (e.g., cloud-based applications), and EHR are examples of blockchain-based applications in this group, which are discussed in more detail below.

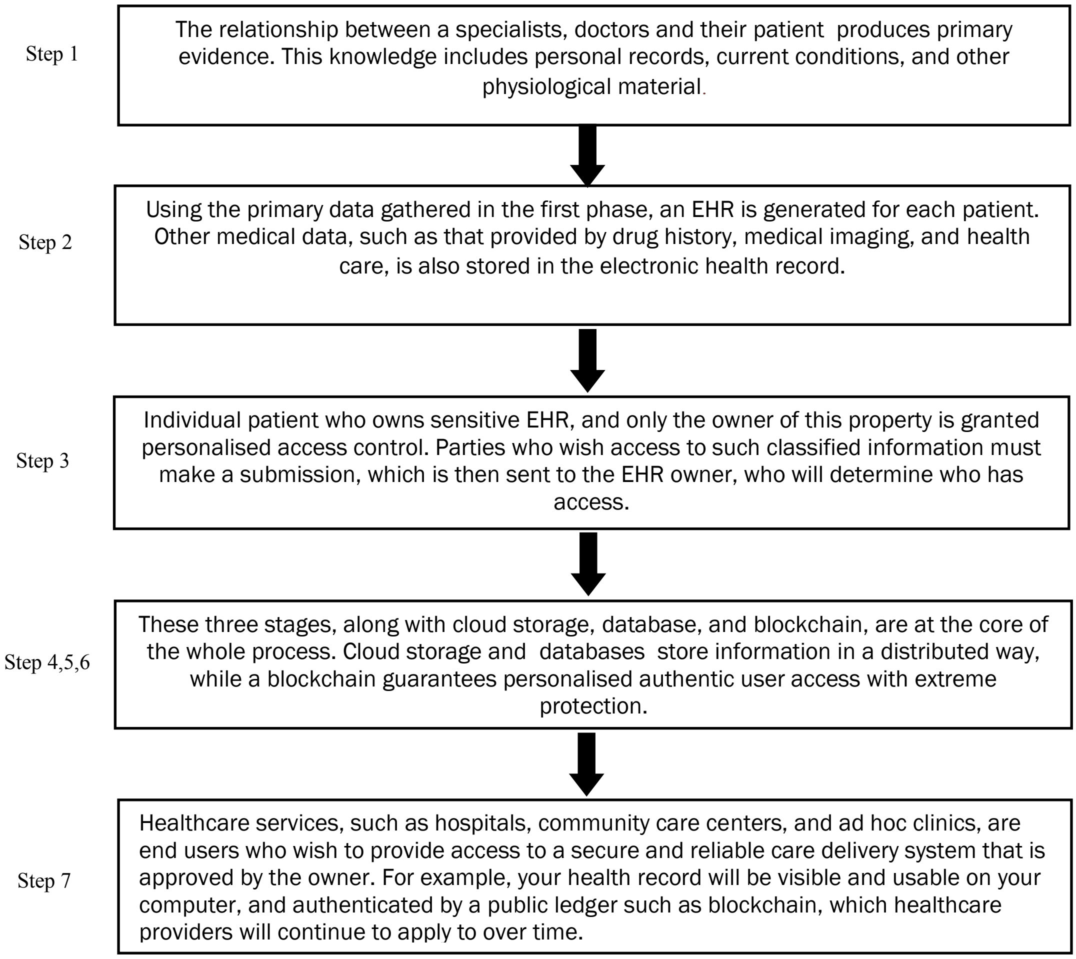

Fig. 5: Steps of Healthcare management in Blockchain. [64]

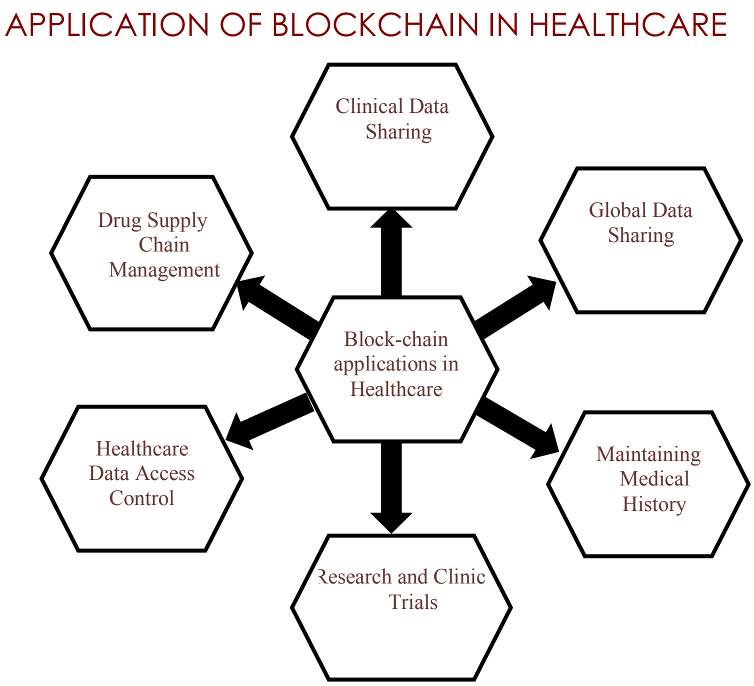

Fig. 6: Applications of Blockchain in Healthcare.

Drug Supply Chain Management

Medical medication supply control is critical in today's medical market, but it is also beset with complexities and losses due to pilfering and counterfeiters. The traceability of such supply chain processes can be maintained using blockchain, which improves the overall process transparency [65], [66], [67]. To approved parties, the blockchain can be useful in checking the validity of the drugs and their supply chain. As a result, blockchain may be critical in tracking the different stages of opioid SCM and granting access to legitimate patients.

Healthcare data access control

Users' control/grip on their own data is eroding as a result of recent technical advances. Users are often unsure of the agencies have access to their medical records, for what reasons, and whether they are allowed to do so. This is particularly true for healthcare data. In the case of electronic medical record/electronic health record, for example, multiple healthcare service providers are connected, and patients are often unaware of who is storing, accessing, and exchanging their medical data. Patients may use blockchain technologies to not only access their patient records more efficiently and conveniently, but also to ensure that only approved individuals have access to and change the data [68-70].

Research and Clinical trials

Clinical trials is an important and useful method in the healthcare industry that necessitates careful observation at any level. For eg, trial monitoring and trial mechanisms, data collection, and data management [71], [72], [73]. Many parties will need to collaborate during these trial times, which will take a lot of time. These phases of the trail have necessitated a high degree of confidence among the different parties concerned. As a result, the blockchain may be a key method for coping with such study trials, allowing each process to be properly traced and data to be handled and evaluated with minimum resource loss.

Maintaining medical history

The blockchain technology can also be used to record and preserve a patient's medical records. Patients can attend disjointed clinics, for example, and the whole chain of their medical records may not be accessible or managed (due to unavailability and discontinuity of previous records). To address these problems, blockchain can be helpful in preserving the documents history for each patient visit.

Global data sharing

Also, there are some events where patients go outside of their hometown for travel or other causes and in some conditions, they will need to see a specialist for the cure of an illness. In that case, respective hospitals/doctors in the other nation should be aware of the patient's healthcare records in order to offer quality treatment coverage. Medical records can be conveniently exchanged with required institutions in another country using blockchain-based approaches, and the patient can have approval and control over the details. The respective patient's medical history should be identified to get good medical care outside of the world, for example, if the respective patient has some knowledge of his/her recent treatment or some sort of allergy to such drugs. As a result, the service provider would have safe access to the patient records [74], [65].

Clinical data sharing

The medical data distribution of between different entities in the system is a critical and core application of blockchain in healthcare. EMRs and EHRs contain extremely confidential and vital patient medical records that must be carefully stored, exchanged, processed, and obtained. Health information must be maintained and exchanged regularly by different related parties, such as researchers, insurance agencies, pharmacies, healthcare service providers, physicians, and patients, among others, in order to enhance and increase the healthcare services quality. In general, vital data sharing necessitates stringent confidentiality and compliance mechanisms during data transfers. As a consequence, since it maintains a public ledger for all interested organisations within the network, blockchain adds more accountability in such situations [75] [65] [76].

Table 1: Blockchain applications based on healthcare systems. [77]

Application Area	Description	Target Research Challenge
Drug Supply Chain Management	It can be used to monitor and manage supply chain operations of healthcare networks in a safe manner.	Pilfering and Counterfeiters of supply chain process
Healthcare Data Access Control	It promises to allow patients more safe access to their medical information.	Managing access control
Research and Clinical Trials	It may be an effective method for ensuring safe traceability in clinical trials and crucial research.	Traceability of trial phases
Maintaining Medical History	It should ensure the medical evidence is still accessible in order to protect the medical record and prevent losing time and money.	Availability of medical records or data
Global data sharing	It should be able to provide safe healthcare knowledge even outside of the respective country/from everywhere in the world on a global scale.	Securely global data storing and sharing
Clinical data sharing	It must ensure that medical data is processed and exchanged in a safe manner by all parties involved.	Secure data accessibility

ESSENTIAL REQUIREMENT OF BLOCKCHAIN FOR HEALTHCARE SERVICES

Complexity

In terms of collecting, exchanging, and analyzing patient records and other billing-related information, today's multi-stakeholder healthcare networks are relatively more complex. As a consequence, one of the conditions for a blockchain healthcare infrastructure is for the healthcare networks to provide less complicated procedures in order to prevent complexities and needless delays at different points [69].

Trustless and transparent

To make sure the secure storage and exchange of data in the recent healthcare system, pre-existing trust must be established between different stakeholders. Maintaining full confidence and data integrity will be a tall order because data is processed and exchanged by different parties [71], [72], [68]. Since a blockchain-based healthcare infrastructure reduces the costs of intermediaries, it can be used to create transparent and trustless healthcare systems.

Cost/Resources effectiveness

In terms of physical capital, time, cost, and computations, today's healthcare services spend more. For example, in most transactions, intermediates are expected to perform particular tasks, which may require additional resources or time [69], [70]. One of the most critical conditions would be to reduce processing costs and delays, which may be caused by third parties, various involved individuals, or other causes.

Data consistency/Integrity/Immutability

The inconsistency and fragmentation in patient records is one of the problems in today's healthcare management structures. Inconsistent results will lead to delays and increased costs when it comes to completing the total healthcare process for every person. As a result, a blockchain-based healthcare infrastructure makes sure that healthcare data is unfeasible and consistent by unauthorized parties [60], [79], [80].

Data Security

Another important consideration when developing blockchain healthcare applications is the protection of patients' personal information. Since the blockchain-based healthcare mechanisms require multiple entities, confidentiality should be a top priority. and In contrast to conventional healthcare systems, blockchain is supposed to offer greater trust, protection, and privacy. Since all concerned organisations are aware of each data transactions within the system [81], [79], [80].

BENEFITS OF BLOCKCHAIN IN HEALTHCARE SECTOR

Data verifiability

The credibility and authenticity of data stored on blockchain can be checked even without accessing the plaintext of those records. This functionality is particularly useful in healthcare areas where record checking is needed, such as insurance claim processing and pharmaceutical supply chain management.

Trust and Transparency

Blockchain fosters interest in collaborative healthcare applications by virtue of its transparent and open nature. Which makes it possible for healthcare stakeholders to consider applications.

Robustness/Availability

The availability of stored health data on blockchain is assured since the records on blockchain are mirrored in several nodes, and the mechanism is resilient and robust to security attacks, data manipulation, and any data losses on data availability.

Health data ownership

Patients must be the owners of their data and have discretion of how it is used. Patients require the confidence that their health record will not be accessed by third parties and the ability to detect any abuse. Well-defined smart contracts and strong cryptographic protocols help blockchain satisfy these criteria.

Improved data security and privacy

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Since the data saved on the blockchain cannot be altered, distorted, or recovered, the of blockchain's immutability property substantially increases the reliability of the health data held on it. On the blockchain, all health data is appended, encrypted, and time-stamped in linear sequence. Furthermore, by using cryptographic keys, health data is stored on blockchain, which facilitates to secure patient's identities and privacy.

Decentralization

The essence of healthcare, with its multiple stakeholders, necessitates the use of a decentralized management system. Blockchain has the ability to become the open health data storage infrastructure, encouraging all users to provide managed access to the same health information to monitor global health data without the requirement for a central authority.

Table 2: Benefits of blockchain for healthcare management systems [82]

S.No.	Benefits	Description
1	Improved Healthcare Data Audit	Aids in the avoidance of redundant data. Allows auditors to check transactions quickly and accurately. Maintains compliance with important regulatory standards and legislation for healthcare institutions.
2	Global Health Data Sharing	Offers traceability features and global access to medical institutions.
3	Health Data Handling Costs	Medical firms can conveniently access any of a patient's information without having to go to different locations.
4	Health Data Security	Natural disasters do not pose a threat to health data deposited on blockchain. Removes the possibility of data mishandling or theft.
5	Health Data Interoperability	Any EMR/EHR on the blockchain framework adheres to a structured data code.
6	Health Data Accor	Provides treatment providers with a comprehensive understanding of the patient's medical history. Any of a patient's data that is spread through several hospitals may be combined in an automatic way.

CHALLENGES OF BLOCKCHAIN IN HEALTHCARE

Even though blockchain is a multidisciplinary concept with limitations and difficulties, it can be extended to a number of areas [83]. Researchers in this field are working to counteract or mitigate the negative effects of these causes. The below are some of the problems (i.e., technological challenges) that blockchain technology faces as used in healthcare [84, 85, 83, 86]:

Privacy

The Bitcoin architecture, it is generally assumed, allows blockchain to protect the privacy of its nodes. The results of [87], on the other hand, contradict this assumption. Furthermore, strategies to provide this capability to blockchain-based applications are needed [87]. The General Data Protection Regulation (GDPR) requires blockchain-based applications to comply with privacy laws and regulations.

Centralization

Despite the fact that blockchain is a decentralized architecture, certain techniques prefer to centralize miners, which decreases network efficiency. Since this central node is insecure and can be hacked, malicious attacks can gain access to the data it holds [87].

Usability

Since these applications are too complicated to manage, usability is also a challenge. Furthermore, users may need an API (Application Programming Interface) with user-friendly functionality. Since health care providers do not have the same level of technological expertise as IT experts, the programs should be intuitive and simple.

Resource consumption

Since the mining process uses a lot of energy, using this technology could result in a substantial loss of resources. Since multiple machines are necessary to track patients in a healthcare setting, energy costs are high; however, the use of blockchain may result in energy costs and high computing. Managing these risks is a challenge for organizations.

Security

If an individual has ownership of 51 % of the network's computing capacity, this may be compromised. This is a major problem that needs to be resolved because a harmed healthcare system will lead to healthcare institutions losing their reputation.

Latency

Validating a block takes about 10 minutes; this can be harmful to system security resources since active attempts may occur during that period. Healthcare services are complex and should be accessed at all times when any interruption will have a negative impact on exam analysis.

Throughput

If the number of transactions and nodes in the network increases, further checks will need to be done, eventually creating a network congestion. While dealing in healthcare services, high throughput is a challenge since a cure that might save someone's life could be compromised if there is not fast access.

CONCLUSION

The latest blockchain analysis developments in healthcare were examined in this paper. Because of the delicate nature of the data being stored and handled, blockchain technology is seen as having tremendous potential for use in healthcare. The objective of this paper was to examine the existing state of blockchain research and implementation in the healthcare industry. We also suggested blockchain technology's possible uses in the management of health records. Blockchain technology has the power to help the healthcare sector solve a variety of issues. Privacy, confidentiality, availability, and fine-grained control of access to Electronic Health Records data will all be guaranteed using blockchain technologies. The overarching aim of implementing blockchain in the manner described in this paper is to improve healthcare systems, neurology experts, biomedical, external healthcare entities, clinical researchers, healthcare providers, physicians, doctors, and patients, and others all benefit from the use of blockchain in the healthcare industry. They can quickly disseminate a vast volume of data, exchange clinical data and outcomes, and interact and recommend their patients and other healthcare system agencies in a safe and confidential way.

FUTURE SCOPE

Healthcare industry in countries like India needs transformation, as automation is required in healthcare when patient centric model is concerned. Blockchain is, and will be the future technology which can give a totally new and secured shape to electronic health record system. Further analysis is needed because blockchains are still a relatively latest tool in the area of healthcare, and new approaches to use it are still being developed and investigated. To summarize, blockchain can be used in contexts where it is both fair and necessary. In next paper, comparison of the existing electronic health record (EHR) systems will be communicated and how blockchain can lead to development of a secured EHR system.

CONFLICT OF INTEREST
Authors declare no conflict of interest.

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ARTICLE

A NOVEL ALGORITHM FOR CONTROLLING TRAFFIC CONGESTION

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ABSTRACT

Efficient traffic management is a vital component in the growth of the Nation. Traffic congestion is a prominent issue in the metro cities where travelers are spending the maximum commutation time in the traffic jam which is serious hazard. To find the solution of such problem a new algorithm is developed which efficiently control the traffic congestion problem by diverting the vehicles to different lanes in shortest possible the time. Different Traffic control systems have also been reviewed in this paper by investigating the upsides and downsides of each in cost, dependability, exactness, effectiveness, and upkeep upward.

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KEY WORDS
raffic Congestion; Computer Vision; Threshold frequency; junction points

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INTRODUCTION

Traffic Congestion word which is clouded with unexplained fear and stress. Many researchers are working on this particular problem still there is more scope and improvement in this area. Traffic congestion is directly proportional to the efficiency of the daily commuter. If the start of the day is the well due to unexplained and uncontrolled problems leads to the full day of stress and anxiety. Researchers have discovered that ants just like commuters, they also analyze the traffic issues from their end and if they found themselves to be stuck suddenly they change their routes to some alternate and best possible shortest path. The major issue is that the majority of users are using GPS app to find the best possible path for a chosen destination. This GPS gives the information in close integration with multiple servers connected through IOT (Internet of Things) and that information is stored in cloud. The traffic could be managed if we could identify at a particular junction on stated time how many vehicles pass though which could analyze the trend at that particular junction what is the statistics so that if that junction is overloaded with vehicles an alternate route can be suggested on the basis of threshold frequency. The proposed system is developed considering the scenario wherein there are multiple lanes at a particular junction. The ideology behind the development of this novel algorithm is that the number of vehicles passing through a particular lane at a particular junction is calculated with the help of threshold frequency. Once that limit that is the number of vehicles passing through that lane gets exhausted the algorithm will redirect to the next lane to the round robin manner. Once the limit on all the lanes is exhausted the new algorithm will redirect to the alternate path.

LITERATURE REVIEW

An extensive literature review has been carried out in the existing literature.
Kirschfink et al. in 2000[22] propose new algorithm which were able control traffic [1]. Papageorgiou et al. [35] give outline of problem faced in traffic control and method to resolve such problems [2]. H. Ceylan et al. in 2004[14] studied the road reserve capacity network under seedtime traffic control [3]. Hong & Lo [16] developed a algorithm that study the Phase Clearance Reliability (PCR) and improve the performance of traffic signal. Han & Zhang [4] proposed an approach to detect and count vehicles at an intersection in real- time to increase efficiency on traffic control. Some of the author's works have been encapsulated in [Table 1].

Table 1: Literature survey(Source:Self)

Name of Paper	Author Name	Approach	Description
A genetic algorithm for the vehicle routing problem	Baker, B. M. and Ayechew, M. (2003)	Genetic Algorithm	This study construe genetic algorithm (GA) operation to the basic vehicle routing problem (VRP), in which customers of known demand are supplied from a single depot.[2]
Vehicle Routing Problem With Time Windows, Part II: Metaheuristics	Br¨aysy, O. and Gendreau, M. (2005)	Metaheuristic Approach	This paper is about the surveys on the research of the metaheuristics approach for the Vehicle Routing Problem with Time Windows (VRPTW). The VRPTW can be depict the problem of drafting lowest cost routes from one signal point to a set of geographically scattered points.[3]
Applying the ANT System to the Vehicle Routing	Bullnheimer, B., Hartl, R. F., and Strauss, C. (1999)	ANT colony	In this paper Ant System has been used to solve the Vehicle Routing Problem

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Problem			w.r.t capacity and distance from one central depot.[4]
Analysis of Noisy Evolutionary Optimization When Sampling Fails	Chao Qian et al.(2018)	Evolutionary Algorithm	This paper includes a description about the effect of sample size from a theoretical perspective. By analyzing the the noisy Leading Ones problem, it has been shown that as the sample size increases, the run time can also become reduced exponentially [5]
The Truck Dispatching Problem	G. B. Dantzig and J. H. Ramser	Linear Programming Formulation	The shortest paths have been found between any two points in the system and a demand for one or several products is specified for a number of stations within the distribution system. [6]

PROPOSED SYSTEM

Since the traffic management system in India has been designed technically but still there is a need for the improvement. A new algorithm has been designed which evaluate the how many traffic vehicles can be allowed to pass through the one lane at the particular junction point and redirect the traffic to another path accordingly.
This dataset used comprise of collection of numbers of vehicles at four junctions points at an hourly frequency.

- Date and Time
- lane points
- No. of Vehicles
- Distance covered by the junction point

The data has been collected by the sensors functional in different junctions in different interval of time.

The current Traffic Management system is designed technically but usually fails to provide an optimum[7-9] throughput of vehicles. Providing effective real time traffic signal control for a large complex traffic network is an extremely challenging distributed control problem. We aim to develop an efficient traffic adaptive control strategy that identifies the real time traffic scenario in small steps (surveillance interval), and gives appropriate green time extensions to minimize time function consisting of linear combination of performance indexes of all the four lanes [10-12] .

The key idea behind the Developed algorithm is to calculate the threshold frequency according to the distance covered by the lane point [13-17]. The threshold frequency indicate the number of vehicles pass through the one point and beyond that frequency automatically redirect towards another lane, if all the lane threshold limit exhausted then redirected to the best possible route.

Threshold value=area covered by junction point/no. of lanes*no. vehicles covered in 1 lane

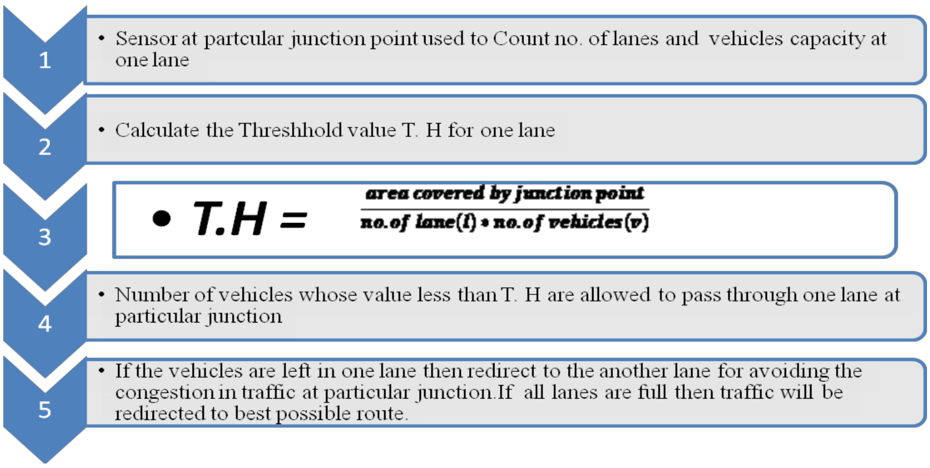


Fig. 1: Flow chart of Proposed Methodology (Source: Self).

The steps of the developed algorithm are as follows:

Algorithm 1: Algorithm for evaluating the frequency of vehicles in lane points.
Input: no. of vehicles, junction point, date and time
Output: Frequency of each variable (vehicles and junction points) and if deadlock occur redirect for the most suitable junction point(route)

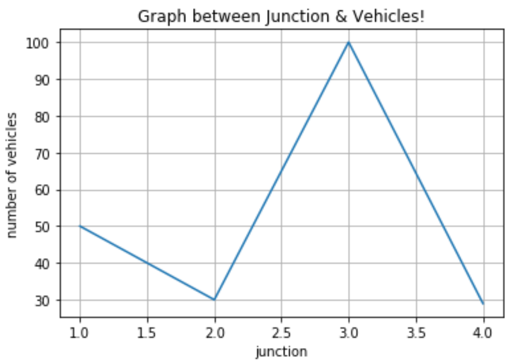
Algorithm
{
1. for i (1 to n) do (#where i is time)
2. for j (1 to m) do (#where j loop for lane)
3. Count [] =0
4. Scan (j) (#where j is the lane point)
5. Count l and v (# of lanes and vehicles capacity at one lane)
6. Calculate $T.H = \frac{\text{area covered by junction point}}{\text{no.of lane}(l) * \text{no.of vehicles}(v)}$
7. V= (1 to p)
8. Do while (V<T.H)
9. Scan (V) at j^{th} *lane point*
10. Count+=V
11. if sensor[j] ⟸ *(true) added to (V to war []) and count added to var [i][j])*
12. V++
End loop
/ If still no. of vehicles left greater than T.H then redirect to the another junction* /*
13. If (j≠m) Go to step 2 for another junction
14. Else redirect j=1;
End loop
End loop
End loop

The above algorithm evaluates the Threshold frequency so that it can calculate the capacity of vehicles that can pass through the one lane after that all the vehicles whose value are greater than the T. H value can automatically redirect to the another lane point to avoid the congestion[18][19]. If deadlock occur all the traffic will pass to another possible path [20-22].

RESULTS

The data has been taken for an arbitrary location. The proposed algorithm has been implemented in Python. The IDE used for the implementation is Jupyter. The results after executing the algorithm threshold frequency of each four lane points are calculated which are as follows:
[50, 30, 100, 29].
The threshold frequency indicates the number of vehicles that pass through one lane.
The above array indicates the 50 vehicles can pass through one lane 30 can pass through 2nd lane and so on. Below is the result which calculates the T.H value of every lane point.
Parameters of junction 1
[1, 2, 3, 4] [50, 30, 100, 29]
Distance 2252
Lanes 1 Threshold Frequency 15
In the above parameters Ist array denote the number of lanes, 2nd array denote the vehicles waiting to pass respectively. Distance can be calculated by sensor at each junction point. Threshold frequency can be calculated by
T.H =
In the similar manner the below T. H value has been calculated
Parameters of lane 2
[1, 2, 3, 4] [50, 30, 100, 29]
Distance 2602
Lanes 2 Threshold Frequency 17
Parameters of lane 3
[1, 2, 3, 4] [50, 30, 100, 29]
Distance 3949
Lanes 3 Threshold Frequency 20
Parameters of lane 4
[1, 2, 3, 4] [50, 30, 100, 29]
Distance 3494
lanes 4 Threshold Frequency 60
[15, 17, 20, 60]
Since after calculating the threshold frequency now it's a time to pass the vehicles from the particular lane and rest has been redirected towards the next lane.
[50, 30, 100, 29] [15, 17, 20, 60]

The first array indicated the no. of vehicles waiting to pass through lanes and 2nd array indicated the T. H value respectively.
Vehicles can pass through junction 0
15
According to T. H value only since only 15 can pass through first lane. So rest vehicles i.e 35 will be directed towards 2nd lane. At 2nd junction already 30 vehicles have been waiting so the total will be 65. But at that point only 17 that pass through the 2nd lane so the rest will directed to 3rd lane and so on.
Vehicles at lane 1
65
Vehicles can pass through lane 1
17
Vehicles at lane 2
148
The above results
Vehicles can pass through lane 2
20
Vehicles at lane 3
157
Vehicles can pass through lane 3
60
No. of vehicles left 97 and they will redirect towards another junction
The above 97 vehicles are left after covering up the entire junction, so they redirect to another junction. This loop will be continued till all the vehicles passed. The time consumption will be so small to avoid the traffic congestion.



CONCLUSION

Since the traffic jam is the matter of serious concern which leads to the many complications like missing the fight, train, exams, and patients could not reach on time. To avoid such situation, a new algorithm have been generated which can eradicate the problem of traffic congestion. This algorithm has been tested on particular location and has seen that the results are efficient and it can be implemented in real time. Since shortest path (optimal)routes has not taken into consideration when the deadlock occur, so in the next paper optimal path will be selected for choosing the next junction point

CONFLICT OF INTEREST

None

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