Applications of Blockchain Technology: A Review of Health Care Systems

Rakesh Kumar Khare[1], Somesh Kumar Dewangan[2], Swati Jain[3]

[1]Associate Professor, Department of Computer Science and Engineering, SSIPMT, Raipur, CG, India
[2]Assistant Professor, Department of Computer science and engineering, SSTC,Bhilai, CG, India
[3]Assistant Professor Govt. J. Yoganand College/Pt. Ravishankar University Raipur Raipur, C.G., India

Received: 05.04.2024 Revised : 10.05.2024 Accepted: 20.05.2024

ABSTRACT
Blockchain is a new technology used to create new solutions in many areas, including healthcare. Blockchain networks are used in healthcare systems by hospitals, laboratories, pharmaceutical companies and doctors to store and share patient information. Blockchain applications can detect serious and dangerous errors in healthcare. Therefore, it can increase the efficiency, security and transparency of medical information sharing in healthcare. These technologies help healthcare organizations gain insight and improve analysis of healthcare data. In this article, we examine blockchain technology and its key benefits in healthcare. It schematically discusses the various capabilities, operators, and collaborations of blockchain technology to support global health. Finally, the article identifies and discusses fourteen key applications of blockchain in healthcare. Blockchain plays a decisive role in combating fraud in clinical trials; Here the potential of this technology is to improve health information. It helps eliminate the fear of data management in the medical field and supports private data storage model with maximum security. Provides versatility, interconnection, accountability and authentication in data entry. Health information must be kept secure and confidential for many purposes. Blockchain helps decentralized data protection and threat avoidance in healthcare.

Keywords: Blockchain Healthcare Data Storage Clinical Trials Capabilities Technology

1. INTRODUCTION

Blockchain is a decentralized public ledger that records transactions across multiple computers so that no relevant information can be changed retroactively without changing any blocks after the fact. The blockchain is verified and linked to previous “blocks” to create a long chain. After all, blockchain is the name of data. Blockchain provides a lot of accountability because all transactions are public and auditable. Once logged in, no one can change all the information recorded in the blockchain. It is used to prove that the information is correct and has not been changed. In blockchain, information is stored online rather than in a central repository, which increases security and makes it less vulnerable to hackers. Blockchain provides an excellent forum to develop and compete with traditional companies for modern and creative business models [1].

Blockchain helps marketers control the content of products in the pharmaceutical industry It is possible. , healthcare and pharmaceutical industries will use blockchain technology to eliminate counterfeit drugs. All these medications have follow-up. It helps discover the causes of fraud. Blockchain can ensure the confidentiality of patient information; Once a medical history is created, the blockchain can still store it and this information cannot be changed. This decentralized network works with all hospital equipment. Researchers have allowed the resources collected from these tools to be used to evaluate the prediction of treatments, drugs, and cures for a variety of diseases and disorders [2].

Blockchain is an organized business system where information can be added, deleted, or changed without incident. agreement. The value of the blockchain hash is determined by the cryptographic hash that binds the new block of data to each block of data. The decentralized blockchain ledger architecture ensures that information is not processed in a central location, making this information accessible and accountable to all Internet users. This decentralized system strengthens and protects the system by preventing all kinds of attacks. It supports better management of medical information and patient care by reducing the volume of treatment and care by two-fold, saving doctor and patient time and resources. Patients will see where their information goes and know by storing medical records on the blockchain [3].

Researchers can use this technology to examine many of the previously unknown experiences of specific individuals. Providing the necessary support for long-term research can help advance medicine. With the help of the Internet of Things (IoT) and wearable devices, we are instantly using Blockchain in healthcare to collect and update important patient information such as blood pressure and blood sugar. It helps doctors keep track of sick patients and advises and alerts their employees and families in emergency situations. Blockchain has a decentralized structure that makes it safe from hacking and does not leak a copy of the data [4]. This paper addresses the following research questions:
RQ1: Examine blockchain technology and its critical needs in healthcare;
RQ2: Identify the potential of blockchain technology to support a global culture of health;
RQ3: Improve healthcare Identify and discuss the drivers of blockchain technology for healthcare;
RQ4: Describe the "collaboration" enabled by blockchain technology in the delivery of healthcare facilities;
RQ5: Identify and discuss key uses of blockchain in healthcare.

1.1. Blockchain

Blockchain is a decentralized network of nodes that stores information. It is an excellent tool to protect confidential information on your system. This technology helps share important information and keep it secure and private. It is the best tool to keep all data safe in one place. Blockchain can also use the same patient data to search for candidates who meet certain criteria. Blockchain can be defined as a peer-to-peer (P2P) network consisting of individual computers, called nodes, that manage, store and record historical data or transactions. It enables reliable collaboration because all network members store and share messages and store historical and current information. These technologies can integrate different networks to provide insight into the importance of self-healing. Therefore, blockchain is widely recognized for its flexibility and security. Blocks, nodes and miners are the three main concepts of blockchain. Blockchain does not store information in one place. Instead, a network of computers copies and transmits the blockchain. Every computer on the network updates the blockchain to find new blocks in the blockchain. Figure 1 shows the basic working steps of blockchain technology.

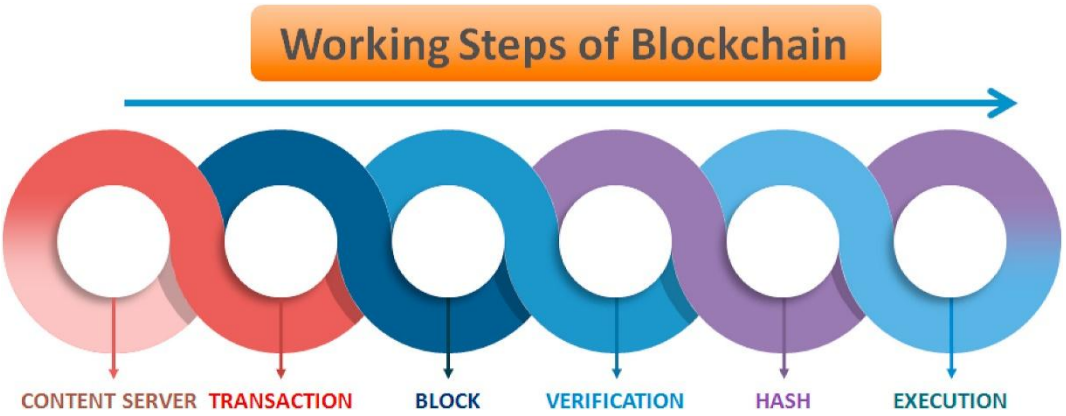

Fig 1. Working steps of Blockchain Technology.

The blockchain system operates on a P2P computer network on top of the Internet; each computer runs the protocol and has the same copy of the transaction data; It enables P2P value exchange without using machine negotiation intermediaries. There are different types of blockchain technology such as public, private, hybrid or shared. Each blockchain network has different advantages and disadvantages that significantly affect its successful implementation.

- Public blockchain is the first type of blockchain technology that supports Bitcoin and other cryptocurrencies and helped popularize decentralized ledger technology (DLT). It eliminates the disadvantages of centralization such as lack of security and transparency. DLT distributes data across the P2P network rather than storing it in a single location. Due to its decentralized nature, it requires some form of data authentication method.
- Private blockchain is a blockchain network that operates in a limited environment such as a closed network or is controlled by each other. place. It works similarly to P2P connections and distributed public blockchain networks, but is much smaller in scale. In a private blockchain, the inventors of the network know who the participants are at the beginning. Permissions cannot be created as a solution on a public network and users are completely anonymous.
- Organizations that want the best of both worlds sometimes use hybrid blockchains, which are features of a blockchain that has both a private blockchain and a public blockchain. It allows companies to create

permissionless citizen-based privacy, and authorization, allowing them to control who can access certain information stored on the blockchain and what data is publicly available.

1.2. Need of blockchain in healthcare

When it comes to health, the pace of development is increasing at an incredible pace. What is needed today is good hygiene supported by new and advanced technology. Here blockchain will play an important role in the transformation of the healthcare industry. Additionally, the field of healthcare has evolved into a patient-centered approach that focuses on two important aspects: easy access to services and the clean healthcare services required. Blockchain empowers healthcare organizations to deliver adequate patient care and quality healthcare facilities. Exchanging health-related information is a time-consuming and repetitive process that incurs high costs for the healthcare sector. Technology may soon solve the problem here. Using blockchain technology, the public can participate in health research. Additionally, better research and public health information will improve health care for many people. Centralized repositories are used to manage all treatments and organizations [5].

The most important issues now are data protection, sharing and public health management. Thanks to the use of blockchain, this particular problem is made reliable. When used correctly, these technologies can improve security, information exchange, collaboration, integrity, instant updates, and access. There are also significant concerns regarding data protection, particularly in the areas of personal medicine and wearable technologies. Patients and medical staff need a secure and direct way to collect, send and request information online without worrying about security issues; Therefore, blockchain technology is used to solve these problems [6].

2. The many strengths of blockchain technology promote a global health culture

There are many applications and functions of blockchain in healthcare. This evidence-based technology helps healthcare researchers discover genetic diseases by enabling the secure transfer of patient information, controlling pharmaceutical products, and supporting the security of patient information. Figure 2 shows the various features and main features of the blockchain concept in various medical and other fields. Protection of medical information, various genome management, electronic information management, medical information, interoperability, digital monitoring and event, etc. things. The successful digitalization of blockchain technology and its use in health-related applications are important reasons for its adoption [7].

Fig 2. Capacities of blockchain technology for healthcare domain.

The Blockchain makes the entire prescription process transparent, from manufacturing to pharmacy shelves. Congestion, freight direction, and speed may all be tracked using IoT and Blockchain. It offers the chance to schedule acquisitions efficiently to prevent disruptions and shortages in clinics, pharmacies, and other medical facilities with a given medication. The deployment of digital frameworks built on Blockchain would help ensure that the logistics data avoid uncontrolled adjustments. It increases trust and prevents the illicit handling of records, payments, and medication themselves by various people interested in purchasing drugs. The technology can effectively improve the condition of patients while at a competitive cost retaining the funds. It eliminates all obstacles and barriers in multi-level authentication [8]. Because Blockchain can preserve an incorruptible, decentralised, and transparent log of all patient data, it is ripe for security applications. Furthermore, while Blockchain is visible, it is also private, hiding any individual's identity behind complicated and secure algorithms that can preserve the sensitivity of

medical data. Thanks to the technology's decentralised structure, patients, doctors, and healthcare providers can all share the same information swiftly and safely.[9]
Blockchain technology makes the transition to interoperability led by patients easier as it allows patients to make their medical data accessible and access laws. This gives a patient greater power over personal information and improves confidentiality and privacy. The measurement and implementation of quality management and enforcement are difficult. Any of these technical issues could be solved by Blockchain applications throughout the industry. Blockchain headlines will assist regulatory authorities in tracing legal drugs against falsified ones. This ensures that all approved parties exchange digital transactions containing the patient's details. Patients who move medical practitioners may merely update a single consent to exchange their complete records [10].
Blockchain has reached the healthcare industry with a rising acceptance rate. Also, in the early stages, people in the health ecosystem accept the technologies favourably. In the coming years, the holistic vision of Blockchain to transform the healthcare market will be to address problems affecting the present structure. It allows physicians, patients, and pharmacists to conveniently access all the available information at a given moment. Medical firms are exploring, experimenting, discovering day and night for Blockchain technologies, in the medical field for health records. It has confirmed itself as an irreplaceable instrument in healthcare by following pharmaceuticals, improving payment options, and decentralising patient health history records. In addition to robust technology such as machine learning & artificial intelligence, the medical sector is highly dependent on Blockchain. There are some genuine uses of how Blockchain changes the healthcare industry. The program is built on Blockchain monitoring technology to fine-tune the medical supply chain [11].
Blockchain's ability to create a complex data storage system that can record a person's entire health history, including diagnoses, test reports, past treatments, and even a smart meter. Doctors can use this method to easily obtain all available information to make an accurate diagnosis and make recommendations. Since all information is stored in the blockchain system, it cannot be lost or transferred. It can use blockchain to bypass the organization's internal network. The parent organization consists of many independent actors with different levels of control over the encrypted blockchain that protects the organization from external risks and attacks. If healthcare organizations use blockchain networks correctly, they will eliminate such attacks and other problems such as computer damage or hardware failure [12].

3. Blockchain technology is the engine of healthcare support

Fig. Figure 3 shows the potential of blockchain to achieve healthcare and general development for many representatives of the underground economy. There are also many business/health-related sponsors or service providers that can assist in research and discoveries to enable the treatment and importance of blockchain work in the field [13]. Recommended vendors, BurstIQ, Guardtime, Robomed, Only One Key, Encrypgen, Chronicled, Tieion, etc. are among the few organizations that enable and support the implementation of legacy urine blockchain technology.

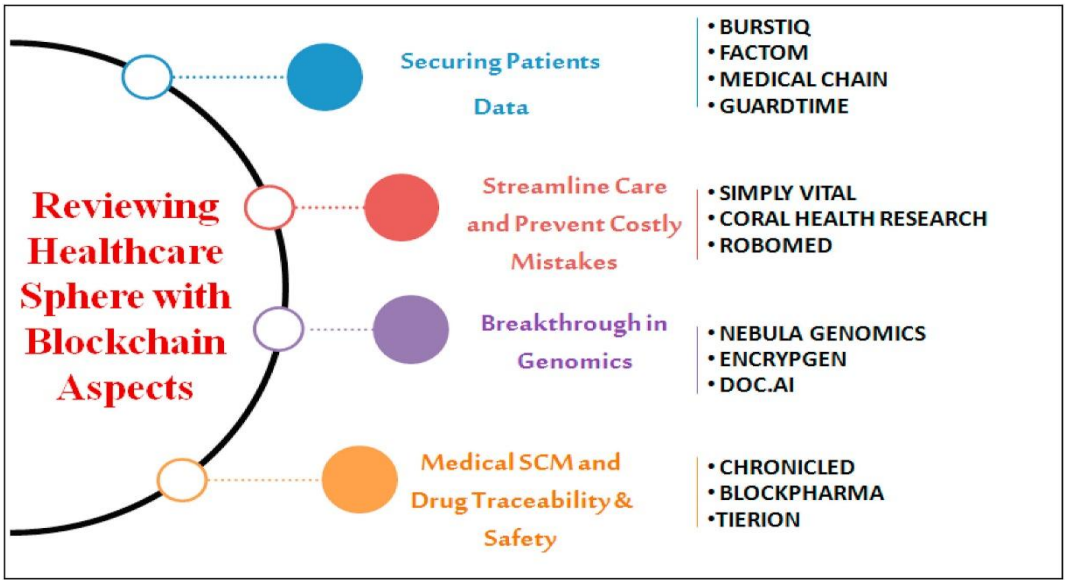

Fig 3. Enablers of blockchain implementation in healthcare services.

Blockchain involves creating new patient information for doctors at other hospitals. Newly added information is frequently copied, causing loss of time, which is unhealthy. Each may have different rights or access options depending on their location on the equipment. Additionally, a block containing drug information will have a hash linked to another block.[14]

Also, the data transparency feature in the blockchain framework will help find all root routes and eliminate the distribution of counterfeit drugs. When a patient goes to a new medical center, a new medical card is created for the patient and stored in a special place. These details are often missing from the public and consist of information collected by nursing staff in surveys. Blockchain can easily be collected as a data issue. This technology will create an open and similar medical blockchain worldwide [15].

In healthcare, clinical trials are conducted to evaluate the effectiveness of such treatments or to provide partial cures for certain diseases. Researchers can collect information about test results, head counts, patient information, and other variables. Data collected during clinical trials need to be validated so that researchers, pharmaceutical companies, and policymakers can have confidence in the quality of the results. In clinical trials, blockchain technology can provide greater transparency and accountability. Medical blockchain has a large database because the blocks are available to doctors and patients and the medical history is made by knowing about the patient's problem. Blockchain on chain is very popular and is also suitable for medical professionals [16].

Blockchain provides forward-thinking convenience and services to healthcare providers. In the healthcare industry, this blockchain power can manage approvals, operations, and purchases. Waste can easily be avoided by queuing, thus increasing the efficiency and productivity of the business through blockchain. The technology is designed to support personalized medicine, medical advice and health research. Blockchain has become one of the most popular technologies today. The latest news about blockchain is that the company believes the platform can change the healthcare industry for the better. This will transform the healthcare industry into a trusted and sustainable digital brand in many aspects. Blockchain medical technology will improve many problems such as clinical research, patient information management and data analysis [17].

Blockchain can succeed in healthcare as a good choice in the healthcare ecosystem. A decentralized blockchain platform provides healthcare providers with the opportunity to track fraud, reduce administrative costs, increase efficiency, eliminate fraud, and improve the healthy environment of open consumption. It is also used in handling distributions as well as assets such as disputes and trusts. Clinical trials and physical validation of content are areas where blockchain has the opportunity to increase trust, accountability, and accountability for doctors and researchers. The benefits to patients are that their medical history is better preserved and that an accurate diagnosis increases the chance of further care [18].

Patients will now have a better say in the handling of their medical records. Information exchange will be allowed as a partner on the blockchain network, providing greater privacy and control. The promise of blockchain has broad implications for healthcare stakeholders. Different networks can interact to provide information and help define the importance of treatment based on these technologies. In the long term, a national blockchain network of electronic medical records will increase efficiency and promote improved patient health. Specifically, a blockchain is an integrated, immutable database of transactions created by interconnected networks and stored in a digital ledger [19]. Medical records such as important patients, medical equipment or medical supplies may be saved during transport from the hospital.[20]

4. Composite workflow diagram using blockchain technology in healthcare

Figure 4 is a schematic diagram exploring collaboration for the overall development of blockchain technology and its impact/benefits from a healthcare perspective. It focuses on medical chain management, interaction, individual and long-term data, etc. mastering dedicated patient index demand change are benefits associated with blockchain application in treatment [44]. Networking begins with network flow, digitalized transactions, and information and data sharing, ultimately leading to blockchain drivers trusting the business, making technical services healthier and more creative than before [21].

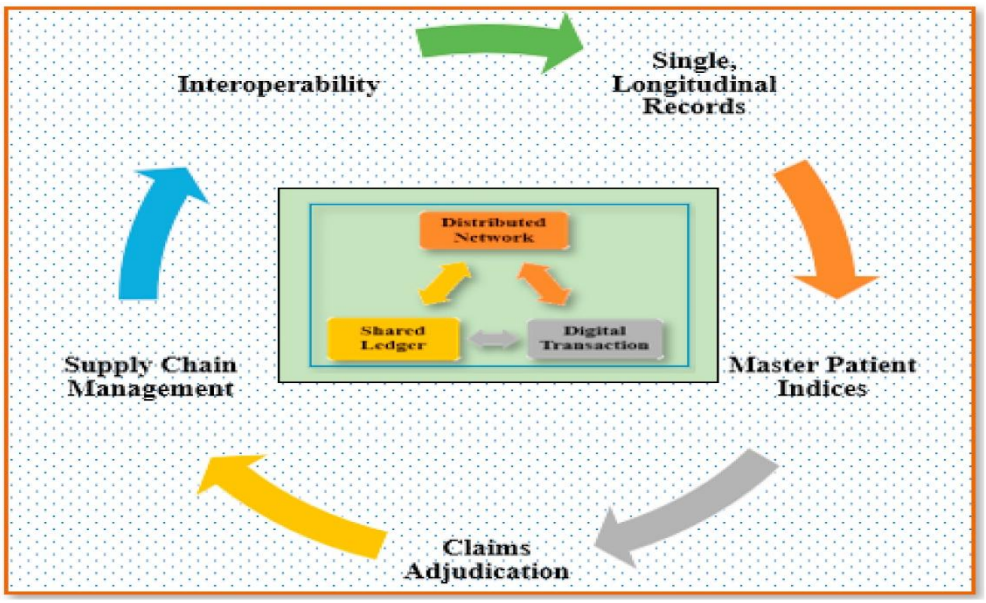

Fig 4. Integrated workflow process of blockchain technology for healthcare culture.

The principles of blockchain technology are very simple and constantly changing; Blockchain networks are being added that adapt to the various needs and specific characteristics of the business. The independent blockchain framework provides a complete audit trail and allows instant replication of results. Blockchain will reduce financial inefficiencies, prevent theft and illegal transfer of information. It can solve the problem of currency conversion and information snooping. It allows clinical data and results to be transmitted through permanent records, thus reducing the incidence of fraud and error in clinical trials. The healthcare industry is primarily responsible for the adoption of blockchain technology [22].

Blockchain is a technology that affects all industries to some extent. Blockchain technology is only used in areas where trust needs to be established between different individuals and stakeholders. Currently, patients must sign a new consent form for any appointment, medical procedure or diagnosis, but blockchain could change the consent process. Sharing diagnostic information and the ability to find results for tests are some of the promises blockchain holds for these applications. Blockchain can become an important part of the healthcare consensus by supporting the exchange of information. Now patients can connect to other hospitals and receive their medical information through blockchain technology [23].

A validated blockchain is a closed network that connects all members of the network system. For this reason, it is designed and used in institutions and companies to share information and send it securely. Once the transaction is completed by consensus, it is considered a permanent record and added to the existing blockchain as a new block. The Internet encourages everyone to create their own website. Anyone on the network can communicate with other users on the same network by establishing their own network address in the blockchain without permission [24].

Blockchain-driven supply chain systems can increase the protection, efficiency and security of the supply chain. Giving the medicine on time. It ensures that producers have the right combination of treatments. Medical devices can collect patient information, identify medical goals for patients, and share procedural information anonymously with patients and regulators. Blockchain technology is very attractive for the healthcare industry. In recent years, medical research has made great advances in effective treatments. It is a decentralized, transparent management widely used in many computers to monitor the work. It has been recognized for its huge impact on many markets and businesses. The existence of this tool solves problems that existing methods cannot solve. Excellent healthcare requires trust, protection, privacy and interoperability of data across disparate systems. Blockchain offers an opportunity to solve this problem in healthcare in a new way [25].

Because of its timelessness, freedom, and complete openness, blockchain is becoming the answer to protecting health information. When blockchain is used, people's personal and medical information will remain private as long as the system remains stable. This technology will streamline the complex payment process by avoiding inefficiencies and recovery tools. It also helps patients upload medical records and approvers view medical records. Blockchain technology can provide a new model for sharing medical information by making electronic medical records more efficient, reliable and secure. Blockchain is a record of data stored in important transactions [26].

5. Blockchain Applications in Healthcare

Blockchain is a modern technology with new applications in healthcare. Facilitating the sharing and dissemination of information by all key members and doctors in the network helps improve cost-effective and complex treatment for many diseases. This will enable treatment to improve in the coming years. The opportunities provided by blockchain technology in the logistics sector have recently been reported and have also been shown to be beneficial in the healthcare sector. Since this area directly affects the quality of life, it is one of the first areas that need to be developed and renewed with digital transformation. At the same time, blockchain technology is becoming more common, especially in the financial sector. It has many important and exciting opportunities for the healthcare industry, such as researching and presenting the relationship between doctors and patients [27] .

1 Retention of individual patient information

Many patient information and health information will be generated before and after different studies. There are blood tests, quality tests, prognoses, and health evaluations for many people. It may provide results that indicate the presence of certain data or information. If doctors access the stored data and have doubts about its validity, they will check it against the original data stored in the blockchain system. Blockchain is based on existing encryption techniques, including encryption techniques suitable for information sharing. Physicians record the patient's name, date of birth, diagnosis, treatment, and medical history in patient records in EHR format. This information is stored in the cloud or in the existing database.

2. Analysis of the Effects of Specific Procedures By accessing patient records, researchers can determine the effects of specific procedures on a large proportion of patients. This has had significant consequences for these patients and improved standards of management. With blockchain infrastructure in place, pharmaceutical companies will instantly collect data to deliver more customized medicines or services to patients. Blockchain makes the job of pharmacies easier because it has all the information. Based on these results, they will give patients good advice about taking their medications. It will use wear data collected in real time to inform doctors about the patient's current condition and alert them of any emergencies.

3 Transactions are verified on the blockchain until they are linked to the chain and processed by the algorithm. Authenticity is sealed until the item is encrypted, digitally signed and stored. Healthcare companies, technology and the medical industry are working hard to identify opportunities to understand what is happening now and what will happen next so that the future is safer and cheaper. When healthcare management can identify benefits, Blockchain can compete successfully in the healthcare ecosystem. [28].It will also support clinical research and treatments for all rare diseases. Seamless exchange of information between healthcare facilities contributes to accurate diagnosis, effective treatment and cost-effectiveness in healthcare. Blockchain allows many healthcare organizations to stay connected and exchange messages through a single community leader for security and transparency. When using these systems, users can share and monitor their data and other activities in the system without having to find additional integrity and privacy solutions. [76] Applications include health information sharing, electronic health record management, insurance management, and administrative processing. Patients can send their medical information to the blockchain network through the application. Enable collaboration between sensors and smart devices based on digital blockchain contracts. In general, electronic health records are reported by more than one source. Blockchain will consolidate all the details and give patients access to the history. Connecting all information to the same place will give us new insights into patient health. Thus, the blockchain paradigm will ensure that the information is accurate and legal and protect the user's privacy. [29]

6 Clinical Trials In clinical trials, blockchain technology is used to solve problems such as outcomes, not facts and information inconsistent with standards. aim. and research objectives. Blockchain will increase trust in clinical trials. Business analytics platforms analyze business changes, allowing healthcare businesses to understand what's happening. Pharmaceutical management on blockchain is another opportunity to build and track the supply chain from manufacturer to consumer by integrating blockchain reliability.

7 Information Blockchain system will publish information about the source of the drug to ensure the quality and information provided by approved pharmaceutical companies. Used correctly, blockchain can provide better protection for sensitive data than ever before. Various industries, including finance, retail, and arbitration, have begun using blockchain for different applications and realizing the many benefits of disseminating information. Its treatment is also considered sensitive and difficult. This announcement may cause controversy. Due to its complexity and sophistication, the business has become a significant advancement in fields such as pharmaceuticals, pharmaceuticals, vaccines, clinical trials and aerial applications. [30]

8 Clinical trials should also be easily accessible to participants and consumers. Intelligent systems are good for publicly and verifiable recognition and keeping of records of the processes used and their results. Advances in technology allow the public to monitor the results of clinical trials. The motivation behind this technology is that it is user-centric and provides patients with secure, rapid access to their medical and insurance information. [31]
9 Reduce unnecessary administrative costs Blockchain enables the correct use of medical information by reducing unnecessary administrative costs. The technology will also reduce the need for multiple intermediaries to oversee the sharing of critical health information. Doctors, whose primary responsibility is to provide quality, timely and appropriate service to their people, can adapt. Thanks to blockchain medical technology, service providers will already know the medical information of any patient. Many health-related problems can be solved, including interoperability, successful reporting, theft, and even data destruction. Additionally, physicians may spend more time caring for patients and be distracted by eating disorders. Thanks to blockchain and healthcare, temperature monitoring, bed utilization and ward inventory can be improved. Blockchain medical network creates a permanent digital identity for hospitals and doctors. Integrating blockchain with IoT technology enables product value and tracking, thus making healthcare more transparent and ensuring patients are properly cared for. [32]
11 Creating a research project Blockchain can provide reliable information. Blockchain could replace accounting for property claims and disputes. Blockchain can enable the widespread sharing of patient information, creating new and creative research opportunities. In addition, communicating the patient's findings in depth will contribute to new, creative research and create different collaborations between stakeholders and experts. The system can also be useful for managing patient referrals. When a patient consults a doctor and develops a treatment plan, the treatment plan is applied to the blockchain as part of the patient's medical record.[109] Clinical studies are necessary for good performance and evaluation. Here blockchain companies have developed ways to improve business and reporting processes. With this app, anyone can plan a doctor's visit and complete information in advance. This saves them time by preventing them from waiting in line. But we can learn about the risks and benefits of practical use of blockchain and the types of problems it can solve in healthcare.[33]
13 Security Improvements Blockchain increases the overall safety of the patient's treatment, solves the impact of drug quality and tracking chemical problems, and increases occupational safety has been achieved. This is the only way to change the current supply chain management and prevent counterfeit pharmaceutical companies from bringing their medicines to market more safely. Regardless of the clinic and organization. Blockchain will allow all information to be stored centrally. The interaction of blockchain technology will allow doctors to easily view medical information to help them diagnose and plan surgeries better, more precisely. [34]
14 Blockchain networks are expected to solve the problem of fast and efficient verification of evidence. The blockchain network guarantees patient anonymity and protection. This will lead to new ideas and important discoveries that will change the world of healthcare. The use of blockchain will enable an efficient and privacy-oriented information sharing network. Blockchain is an electronic network that allows real-time transaction history and information to be stored. Each part of the network identifies and records all incoming data.
15 Among other healthcare management models, the role of blockchain is to record any transaction in a decentralized database. It is clear, direct, saves time, effort and cost, thus saving administrative work. The biggest problem facing the medical industry is the leakage of important information and its use by poor equipment and other special interests, application of technology. This medicine can solve these problems quickly. Another important area is allowing data users and third parties to access new information, actual patient data and measurements [125]. The potential of blockchain in healthcare seems promising and exciting because it helps solve some of the problems in the industry. By networking healthcare professionals and other services through blockchain, we can ensure everyone has access to the same information. There are many ways to use blockchain technology in healthcare that will benefit the entire business. Provides patient information, clinical research, clinical trials, medical supply chain and product integrity [35]

6. DISCUSSION

Blockchain technology brings trust and results to clinical trials. This information can be stored in digital fingerprints as a smart contract on the blockchain. Security of network infrastructure at all levels, identification and authentication of all participants, and unified authorization standards for access to electronic medical records are just some of the benefits of blockchain technology in healthcare. Blockchain is used to manage pharmacies and track illegal drugs. The machine is even suitable for storing information about a patient, thus helping to determine and verify the effectiveness of certain procedures.

Blockchain is used for storing medical information, clinical research, patient care, improving security, disclosure of information, and transparency. It keeps the hospital's financial records and reduces data transfer times and costs.

Can solve many problems in a data-centric environment. Blockchain technology will create a hash value for the individual in a patient's medical records. The blockchain system will also encourage patients to disclose their personal information to third parties while keeping their identities private. Empirical analysis requires large data sets. Researchers focus on this information and conduct routine experiments to provide analysis, prediction, and performance for various situations. Analyze the data and make further decisions based on these findings. However, many researchers may alter the data and evidence collected to change the results.

In addition, many pharmaceutical companies want to collect research results that will provide advantages to their companies. Therefore, researchers are using blockchain technology to make research simpler and more understandable. It will help make the data safe, consistent and easy to diagnose. The information collected can improve patient care and provide post-marketing analysis to improve outcomes. These standards are based on the core values of blockchain technology, such as open governance, transparent auditing, transparent information, sustainability, and enhanced privacy and security. This ensures that doctors meet current health standards, including safe medication use.

7. Limitations and future scope

There are certain challenges that need to be resolved before blockchain technology can be incorporated into the healthcare industry. One of the biggest problems in using this technology in healthcare facilities is the lack of expertise. Blockchain applications are still in their infancy and more research and research is needed. But it also applies to the roles of medical organizations and regulatory bodies. It is time for the healthcare sector to evolve. It is likely that blockchain application will become widespread in healthcare in the future. According to this new technology, it will be better used in treatment as it helps explain the results and progress in treatment. Blockchain technology is key to verifying transactions and data transfers.

In the future, transactions will be confirmed and recorded using blockchain technology with the approval of network members. Blockchain will provide patient-level digital security through public and private key encryption as the foundation for next-generation health information sharing. The technology holds promise for processing patient data, crime prevention, improved collaboration, process design, drug and medication management and monitoring, and controlling medical care and supplies. The future of Blockchain in healthcare is promising.

8. CONCLUSION

Due to encryption and decentralization, blockchain has new applications in healthcare. It improves the security of patients' electronic medical records, makes it easier to monetize health information, increases collaboration between healthcare organizations, ensures clean beverages, and helps prevent counterfeit medications. Different healthcare systems can be revolutionized using blockchain technology; Healthcare, digital processes authorized by smart contracts and other areas are one of the most important areas of blockchain use. By removing intermediaries from the payment chain, smart contracts will reduce costs. The potential of blockchain in healthcare largely depends on the use of key technologies in the ecosystem. It includes tracking systems, health insurance, drug testing, and drug testing. Hospitals can use a blockchain framework to identify their services and even use tracking devices throughout their lifecycle. Blockchain technology can be used effectively to improve patient history management, especially tracking and insurance processes, thus accelerating treatment with accurate information. Overall, these technologies will greatly improve and ultimately change the way patients and doctors treat, use medical information, and improve health.

REFERENCES

[1] S. Khezr, M. Moniruzzaman, A. Yassine, R. BenlamriBlockchain technology in healthcare: a comprehensive review and directions for future researchAppl. Sci., 9 (9) (2019), p. 1736

[2] M.H. Kassab, J. DeFranco, T. Malas, Giuseppe Destefanis Laplante, V.V. NetoExploring research in Blockchain for healthcare and a roadmap for the futureIEEE Trans. Emerg. Top. Comput. (2019)1-1

[3] U. Chelladurai, S. PandianA novel blockchain based electronic health record automation system for healthcareJ. Ambient Intell. Humanized Comput. (2021)

[4] I. Yaqoob, K. Salah, R. Jayaraman, Y. Al-HammadiBlockchain for healthcare data management: opportunities, challenges, and future recommendationsNeuralComput. Appl. (2021 Jan 7), pp. 1-6

[5] M. Hölbl, M. Kompara, A. Kamišalić, L. Nemec ZlatolasA systematic review of the use of Blockchain in healthcareSymmetry, 10 (10) (2018 Oct), p. 470
[6] D.V. DimitrovBlockchain applications for healthcare data managementHealthcare informatics research, 25 (1) (2019 Jan), p. 51
[7] J. Chanchaichujit, A. Tan, F. Meng, S. EaimkhongBlockchain technology in healthcare 4.0, Palgrave Pivot, Singapore (2019), pp. 37-62
[8] G. Srivastava, R.M. Parizi, A. DehghantanhaThe future of blockchain technology in healthcare internet of things securityBlockchain Cybersecurity, Trust and Privacy (2020), pp. 161-184
[9] M. Bhavin, S. Tanwar, N. Sharma, S. Tyagi, N. KumarBlockchain and quantum blind signature-based hybrid scheme for healthcare 5.0 applicationsJournal of Information Security and Applications, 56 (2021 Feb 1), p. 102673
[10] G. Rathee, A. Sharma, H. Saini, R. Kumar, R. IqbalA hybrid framework for multimedia data processing in IoT-healthcare using blockchain technologyMultimed. Tool. Appl. (2019 Jun 3), pp. 1-23
[11] E. Chukwu, L. GargA systematic review of Blockchain in healthcare: frameworks, prototypes, and implementationsIEEE Access, 8 (2020 Jan 28), pp. 21196-21214
[12] K. Paranjape, M. Parker, D. Houlding, J. CarImplementation considerations for Blockchain in healthcare institutionsBlockchain in Healthcare Today, 2 (2019 Jul 9), pp. 10-30953
[13] T. Le NguyenBlockchain in healthcare: a new technology benefit for both patients and doctorsIn2018 Portland International Conference on Management of Engineering and Technology (PICMET), IEEE (2018 Aug 19), pp. 1-6
[14] M. Javaid, A. Haleem, R. Vaishya, S. Bahl, R. Suman, A. VaishIndustry 4.0 technologies and their applications in fighting COVID-19 pandemicDiabetes & Metabolic Syndrome: Clin. Res. Rev., 14 (4) (2020 Jul 1), pp. 419-422
[15] L. Bell, W.J. Buchanan, J. Cameron, O. LoApplications of blockchain within healthcareBlockchain in healthcare today, 1 (8) (2018 Jul 9)
[16] K.A. Clauson, E.A. Breeden, C. Davidson, T.K. MackeyLeveraging blockchain technology to enhance supply chain management in healthcare: an exploration of challenges and opportunities in the health supply chainBlockchain in healthcare today, 1 (3) (2018 Apr 11), pp. 1-2
[17] K. Yaeger, M. Martini, J. Rasouli, A. CostaEmerging blockchain technology solutions for modern healthcare infrastructureJournal of Scientific Innovation in Medicine, 2 (1) (2019 Jan 24)
[18] P. Pandey, R. LitoriyaSecuring and authenticating healthcare records through blockchain technologyCryptologia, 44 (4) (2020 Jul 3), pp. 341-356
[19] A. MubarakaliHealthcare services monitoring in cloud using secure and robust healthcare-based BLOCKCHAIN (SRHB) approachMobile Network. Appl., 25 (4) (2020 Aug), pp. 1330-1337
[20] A. Sharma, S. Bahl, A.K. Bagha, M. Javaid, D.K. Shukla, A. HaleemBlockchain technology and its applications to combat COVID-19 pandemicResearch on Biomedical Engineering (2020 Oct 22), pp. 1-8
[21] T. Mikula, R.H. JacobsenIdentity and access management with Blockchain in electronic healthcare recordsIn2018 21st Euromicro Conference on Digital System Design (DSD), IEEE (2018 Aug 29), pp. 699-706
[22] W.J. Gordon, C. CataliniBlockchain technology for healthcare: facilitating the transition to patient-driven interoperabilityComput. Struct. Biotechnol. J., 16 (2018 Jan 1), pp. 224-230
[23] J. Daniel, A. Sargolzaei, M. Abdelghani, S. Sargolzaei, B. AmabaBlockchain technology, cognitive computing, and healthcare innovationsJ. Adv. Inf. Technol., 8 (3) (2017 Aug)
[24] S. Chakraborty, S. Aich, H.C. KimA secure healthcare system design framework using blockchain technologyIn2019 21st International Conference on Advanced Communication Technology (ICACT), IEEE (2019 Feb 17), pp. 260-264
[25] N. Tariq, A. Qamar, M. Asim, F.A. KhanBlockchain and smart healthcare security: a survey Procedia Computer Science, 175 (2020 Jan 1), pp. 615-620
[26] K.M. Hossein, M.E. Esmaeili, T. DargahiBlockchain-based privacy-preserving healthcare architectureIn2019 IEEE Canadian Conference of Electrical and Computer Engineering (CCECE), IEEE (2019 May 5), pp. 1-4
[27] K.N. Griggs, O. Ossipova, C.P. Kohlios, A.N. Baccarini, E.A. Howson, T. HayajnehHealthcare blockchain system using smart contracts for secure automated remote patient monitoringJ. Med. Syst., 42 (7) (2018 Jul), pp. 1-7
[28] R. Bhuvana, L.M. Madhushree, P.S. AithalBlockchain as a disruptive technology in healthcare and financial services-A review based analysis on current implementationsInternational Journal of Applied Engineering and Management Letters (IJAEML), 4 (1) (2020), pp. 142-155

[29] P. Zhang, M.N. BoulosBlockchain solutions for healthcarePrecision Medicine for Investigators, Practitioners and Providers, Academic Press (2020 Jan 1), pp. 519-524View PDFViewarticleGoogle Scholar
[30] K. Khujamatov, E. Reypnazarov, N. Akhmedov, D. KhasanovBlockchain for 5G healthcare architectureIn2020 International Conference on Information Science and Communications
[31] L. Ismail, H. Material, S. ZeadallyLightweight blockchain for healthcareIEEE Access, 7 (2019 Oct 15), pp. 149935-149951
[32] L. Soltanisehat, R. Alizadeh, H. Hao, K.K. ChooTechnical, temporal, and spatial research challenges and opportunities in blockchain-based healthcare: a systematic literature reviewIEEE Trans. Eng. Manag. (2020), pp. 1-16
[33] V. Ramani, T. Kumar, A. Bracken, M. Liyanage, M. YlianttilaSecure and efficient data accessibility in Blockchain-based healthcare systemsIn2018 IEEE Global Communications Conference (GLOBECOM), IEEE (2018 Dec 9), pp. 206-212
[34] N. Islam, Y. Faheem, I.U. Din, M. Talha, M. Guizani, M. KhalilA blockchain-based fog computing framework for activity recognition as an application to e-Healthcare servicesFuture Generat. Comput. Syst., 100 (2019 Nov 1), pp. 569-578
[35] H.M. Hussien, S.M. Yasin, S.N. Udzir, A.A. Zaidan, B.B. ZaidanA systematic review for enabling of develop a blockchain technology in healthcare application: taxonomy, substantially analysis, motivations, challenges, recommendations and future directionJ. Med. Syst., 43 (10) (2019), pp. 1-35