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on

Blockchain in healthcare: Portal for electronic health records

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BACHELOR OF TECHNOLOGY DEGREE

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in

Computer Science and Engineering

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(Formerly UPTU)

May, 2023

DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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CERTIFICATE

This is to certify that Project Report entitled "Blockchain in healthcare: Portal for electronic health records" which is submitted by Lakshay Kumar, Aayush Sharma and Harshal Sharma in partial fulfillment of the requirement for the award of degree B. Tech. in Department of Computer Science & Engineering of Dr. A.P.J. Abdul Kalam Technical University, Lucknow is a record of the candidates own work carried out by them under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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Date:

Swati Sharma

(Assistant Professor)

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We also do not like to miss the opportunity to acknowledge the contribution of all faculty members, especially faculty/industry person/any person, of the department for their kind assistance and cooperation during the development of our project. Last but not the least, we acknowledge our friends for their contribution in the completion of the project.

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ABSTRACT

Blockchain is a technology that uses sophisticated algorithms and a digitally distributed ledger to prevent data tampering. It started out in the financial sector, but it is now used in the Internet of Things, banking, supply chain, defense, and healthcare, among other major sectors. Patients, providers, payees, organizations, and intermediaries all require streamlined transactions in a secure, authentic, and transparent environment in healthcare. Blockchain technology, which is based on the internet, has the potential to revolutionize the way healthcare data is used in a decentralized and interoperable manner, without relying on intermediaries. With this technology, it is possible to develop applications that ensure secure, transparent, and unchangeable records, which can help prevent systematic fraud. This study examines previous literature to identify the key challenges of implementing blockchain in healthcare and explores potential solutions to address these issues.

Keywords—blockchain, electronic health record, EHR, healthcare.

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CHAPTER 1

1.1. INTRODUCTION

The rapid acceptance of digitalization in the healthcare sector has resulted in the creation of enormous numbers of electronic patient records. Such expansion places a lot of expectations on how healthcare data is used and shared, which must be protected. There are now more opportunities to address serious issues with data privacy, security, and integrity in the healthcare sector thanks to the development of blockchain technology as a responsible and transparent way of data storage and delivery. Over the past few years, blockchain technology has drawn a lot of interest from both the industry and the academic community. In fact, fresh blockchain applications and academic research is published every day. Particularly in the fields of healthcare, medical research, and insurance, blockchain is being hailed as an effective tool for managing sensitive data. Healthcare can be viewed as a system with three main components:
(a) core medical care providers like doctors, nurses, hospital administrators, and technicians;
(b) essential medical services like medical research and health insurance; and (c) recipients of medical and health-oriented services, i.e. patients or the general public. Over 300 security and privacy breaches were reported in the healthcare industry in 2017, and 37 million medical records were allegedly compromised between 2010 and 2017. This suggests that these breaches are becoming more frequent every year. Concerns over the ownership, sharing, and secure storage of patients' personal health records and related medical data have also been acknowledged as a result of the healthcare industry's growing digitalization. The use of blockchain has been proposed as a solution to some of the most pressing problems facing the healthcare industry, including the secure sharing of medical records and adherence to data protection rules. Patient data management is one of the most well-liked blockchain applications in healthcare. Since health organizations frequently separate medical records, it is impossible to

ascertain a patient's medical history without first contacting their previous healthcare provider.

This procedure can be time-consuming, and mistakes brought on by human error may frequently occur. Blockchain technology, which has gained popularity through cryptocurrencies like Bitcoin, holds the potential to revolutionize the way medical data is stored and secured, leading to a more comprehensive and reliable system. At its core, a blockchain serves as an unalterable ledger, leveraging cryptography to ensure its integrity. By utilizing blockchain technology, medical data can be stored in a manner that allows universal accessibility for network users while remaining immutable and highly resistant to hacking attempts.

Implementing blockchain-based electronic health records would empower doctors by granting them control over the information flow from a single, trustworthy platform. This would enable uniform access to the same information for all stakeholders, and any updates made would be instantly accessible to everyone on the network.

A system like this might be used in hospitals and medical offices all across the world in a variety of ways. However, a vital piece of technology that can enable all of this already exists in the wallets of a large portion of the population: mobile smartphones. Phones and other comparable devices now have the computing capacity and networking capabilities to keep track of a person's vital signs and serve as a hub for entering and retrieving data. Many people already monitor their exercise, caloric consumption, and even mental health with their phones or smartwatches, to mention a few. As a result, blockchain facilitates the development of various services. It is more efficient to combine various types of health monitoring into a single, standardized platform that is available to medical practitioners since it enables better control over the grade of care being delivered. Blockchain data backup ensures that once data is inputted, it cannot be changed or really altered in any manner. In some circumstances, it may even be possible to use a gamified and rewards system to encourage healthy lifestyle choices through blockchain-based electronic health data. The development of blockchain technology and its use in various contexts have gone through several stages.

The first stage of blockchain development concerned cryptocurrencies, and the second concerned the use of smart contracts in industries like finance and real estate. The third stage of evolution concentrated on using blockchain in non-financial fields like politics, healthcare, and culture. Additionally, blockchain is now thought to be in its fourth stage of evolution with the introduction of artificial intelligence, pushed by cutting-edge technological capabilities like data immutability. The claimed diversity of applications for blockchain may be linked to its ability to establish decentralized and trustworthy transaction environments.

The healthcare sector can greatly benefit from the implementation of blockchain technology due to its potential to address critical issues such as automated claim validation and public health management. One of its key advantages lies in giving patients control over their own data, allowing them to decide who can access it, thereby alleviating concerns surrounding data ownership and sharing. Through consensus protocols, blockchain enables the unification, secure exchange, and rapid accessibility of data records for authorized parties. This stands in contrast to traditional methods that involve storing data with external entities. Additionally, blockchain has the potential to enhance transparency in data management processes and reduce the risk of incorrect or inappropriate handling of information.

A small task that is stored in public blocks is referred to as a blockchain transaction. A majority of system participants must agree in order for each transaction to be confirmed. When transactions are added to the blockchain in this manner, tamper-proofing is guaranteed. According to blockchain immutability, each member replicates, hosts, and maintains the exact identical copy of the ledger.

Using smart contracts, a self-executing piece of code on the blockchain architecture that enables straight-through processing, the business logic is encoded regardless of the type of blockchain. Because nothing can be changed once it has been encoded, smart contracts contained in the blockchain become permanently tamper-proof. They also become self-verifying due to automated possibilities and self-enforcing when the rules are followed at all times.

Among the key characteristics of blockchain are decentralization, which makes the ledger available to all participants, immutability, which makes the blockchain resistant to

censorship, availability, which gives all peers access to a copy of the blockchain so they can access all time-stamped transaction records, and anonymity, which allows each user to interact with the blockchain using a generated address that hides their true identities.

The lack of awareness and understanding among the general public, patients, and doctors regarding the technical aspects and benefits of blockchain technology for data management poses social, organizational, and implementation barriers. These barriers, including concerns related to security and governance, suggest that it might take considerable time for blockchain to realize the expected levels of business transformation. Furthermore, the lack of confidence in the application of blockchain technology in terms of legal compliance and government regulations exacerbates these challenges. To address these issues, ongoing research is focused on facilitating the operational development of blockchain and promoting its adoption.

The development of blockchain technology and its use in various contexts have gone through several stages. The first stage of blockchain development concerned cryptocurrencies, and the second concerned the use of smart contracts in industries like finance and real estate. The third stage of evolution concentrated on using blockchain in non-financial fields like politics, healthcare, and culture. Additionally, blockchain is now thought to be in its fourth stage of evolution with the introduction of artificial intelligence, pushed by cutting-edge technological capabilities like data immutability. The claimed diversity of applications for blockchain may be linked to its ability to establish decentralized and trustworthy transaction environments.

Blockchain technology offers a seamless fit for the healthcare sector, providing effective solutions for crucial matters like automated claim validation and public health management. By empowering patients to retain control over their data and determine its sharing preferences, this technology addresses existing concerns regarding data ownership and sharing. Through consensus protocols, it enables the unification, secure exchange, real-time updates, and efficient access of data records

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The lack of familiarity among the general public, patients, and healthcare professionals regarding the technical aspects, features, and benefits of blockchain technology for data management implies that there are significant social, organizational, and implementation barriers to overcome. These barriers, which encompass concerns related to security and governance, may delay the expected levels of business transformation that blockchain can bring to the healthcare sector. Additionally, a general lack of confidence in the application of blockchain technology in terms of legal compliance and government regulations further complicates its adoption. Current research endeavors are focused on addressing these challenges and facilitating the operational evolution of blockchain while promoting its wider adoption in the healthcare industry.

1.2. PROJECT DESCRIPTION

In the realm of healthcare, the pace of development is rapidly accelerating, highlighting the growing importance of advancing and adopting innovative technologies. The current imperative is to establish high-quality healthcare facilities that are bolstered by state-of-the-art and cutting-edge technologies.

As we know it is very important to keep the privacy of each person's data as it can be used in the wrong way.

One of the major challenges in population health management revolves around ensuring data protection, sharing, and interoperability. However, the implementation of blockchain technology provides a reliable solution to address this specific problem. By leveraging blockchain, various aspects such as security, data exchange, interoperability, integrity, and real-time updating and access can be significantly enhanced. Notably, concerns related to data protection are also appropriately addressed through the use of blockchain technology.

To meet the needs of patients and medical professionals, there is a demand for secure and user-friendly methods of recording, transmitting, and accessing data over networks, eliminating any safety concerns. As a solution, the implementation of blockchain technology aims to address these challenges effectively.

This project comprises a web portal that both patients and doctors can use. Patients can access their health records as well as update them. They can grant access to other doctors so that they can read / write their health records.

CHAPTER 2

2.1. BLOCKCHAIN

Blockchain is a transformative technology that serves as a decentralized and transparent ledger for recording and verifying transactions. It operates on a distributed network of computers, known as nodes, where each node maintains a copy of the entire blockchain.

At its core, a blockchain is a series of blocks, with each block containing a unique set of data. These blocks are linked together using cryptographic hashes, which are unique digital signatures generated from the data within each block. The hash of each block also includes the hash of the previous block, creating a chain-like structure.

The decentralized nature of blockchain means that there is no central authority or single point of control. Instead, transactions are verified and added to the blockchain through a consensus mechanism. Common consensus mechanisms include proof-of-work (PoW) and proof-of-stake (PoS), which ensure that the network agrees on the validity of transactions.

Once a transaction is added to the blockchain, it becomes permanent and virtually immutable. Modifying or tampering with previous blocks would require changing the data in all subsequent blocks, which is computationally infeasible due to the consensus mechanism and cryptographic hashes.

The transparency of blockchain arises from its public nature, allowing all participants in the network to view and validate the entire transaction history. However, while the transaction data is transparent, the identities of the parties involved can remain pseudonymous or anonymous, depending on the implementation.

Blockchain technology extends beyond cryptocurrencies like Bitcoin. It has diverse applications in various industries, including supply chain management, healthcare, finance, voting systems, and more. By leveraging blockchain, organizations can achieve enhanced security, efficiency, and trust in their operations.

As the technology continues to evolve, advancements such as smart contracts have emerged. Smart contracts are self-executing contracts with predefined rules encoded into the blockchain. They automatically trigger actions or transactions based on specific conditions, removing the need for intermediaries and streamlining processes.

To expedite transactions, predefined rules known as smart contracts are stored on the blockchain and executed automatically. Smart contracts can establish conditions for bond transfers, outline terms for travel insurance payments, and more.

At its core, blockchain is a decentralized database that stores a sequence of blocks, each containing unique data. These blocks are linked through cryptographic hashing, creating an immutable record of all network transactions. Notably, blockchain technology offers heightened security and transparency by distributing the ledger across a network of computers, eliminating central points of control or failure and enhancing resilience against hacking and data breaches.

Beyond cryptocurrencies, blockchain technology boasts diverse applications such as supply chain management, voting systems, and identity verification. As the technology advances and matures, we can anticipate the emergence of innovative use cases.

Overall, blockchain technology offers a promising solution for secure, transparent, and efficient data management and transactional systems, with the potential to revolutionize multiple sectors and drive innovation in the digital era.

2.2. ELECTRONIC HEALTH RECORDS

Electronic Health Records (EHRs) are digital versions of patient medical records that provide a centralized and comprehensive repository of health information. They contain a wide range of data, including patient demographics, medical history, diagnoses, medications, lab results, imaging reports, and more.

EHRs offer numerous advantages over traditional paper-based records. They enable easy access to patient information, streamline workflows, and enhance communication and collaboration among healthcare providers. EHRs also support decision-making by providing real-time access to critical patient data, promoting safer and more efficient care delivery.

In addition, EHRs facilitate interoperability, allowing secure sharing of patient information between different healthcare organizations and systems. This promotes continuity of care and eliminates the need for redundant tests and paperwork.

Furthermore, EHRs play a vital role in patient engagement and empowerment. Patients can access their own health records, review test results, schedule appointments, request prescription refills, and communicate with healthcare providers through secure online portals. This promotes active involvement in their own healthcare journey and facilitates better communication between patients and providers.

While EHRs offer numerous benefits, their implementation requires careful attention to data privacy and security. Safeguarding patient information is crucial to maintain confidentiality and prevent unauthorized access.

Usability is a significant challenge associated with Electronic Health Records (EHRs). Inefficiently designed EHR systems can be challenging to navigate, resulting in errors and reduced productivity for healthcare providers.

The effectiveness of EHRs relies on accurate and comprehensive data. However, issues such as data entry errors and incomplete documentation can undermine the accuracy and quality of the information stored in EHRs.

Given the sensitive nature of patient information stored in EHRs, ensuring the privacy and security of these records becomes a critical concern. Healthcare providers and organizations face significant challenges in safeguarding EHRs from cyberattacks and other security threats.

EHR implementation and maintenance can be expensive for healthcare organizations, particularly for smaller practices and hospitals. This can make it difficult for some organizations to adopt EHRs, which can limit their ability to provide quality patient care.

Blockchain can give patients greater control over their health data. By using blockchain-based identity management systems, patients can securely manage and control their own health data and decide who has access to it.

Blockchain can increase the efficiency and cost-effectiveness of EHR systems. By automating processes such as data sharing and record-keeping, blockchain can reduce administrative costs and streamline workflows, which can lead to improved patient outcomes and reduced healthcare costs.

With blockchain, researchers can access a large amount of high-quality patient data for research purposes. This can lead to the development of new treatments and cures for diseases.

In summary, addressing usability issues, improving data accuracy, and fortifying the privacy and security of EHRs are ongoing challenges for healthcare stakeholders. Overcoming these challenges is vital for optimizing the potential benefits of EHR systems and ensuring the delivery of safe and efficient healthcare services.

Overall, electronic health records are a cornerstone of modern healthcare, enabling efficient data management, improved care coordination, and enhanced patient engagement. They contribute to better healthcare outcomes and pave the way for a more connected and patient-centric healthcare system.

CHAPTER 3

3.1. METHODOLOGY

The methodology for implementing blockchain in healthcare involves several key steps and considerations:

1. Identify Use Cases: Identify specific areas in healthcare where blockchain can address challenges and provide value. This could include data security, interoperability, supply chain management, clinical trials, or patient empowerment.

2. Define Objectives: Clearly define the objectives and goals of implementing blockchain technology in the identified use cases. Determine the desired outcomes, such as improved data security, streamlined processes, or enhanced collaboration.

3. Stakeholder Engagement: Engage with relevant stakeholders, including healthcare providers, technology experts, regulatory bodies, and patients. Collaborate to understand their needs, requirements, and concerns regarding the implementation of blockchain in healthcare.

4. Technology Selection: Select a suitable blockchain platform or framework that aligns with the identified use cases and objectives. Consider factors such as scalability, security features, consensus mechanisms, and interoperability with existing systems.

5. Design Architecture: Design the blockchain architecture, including the network structure,

6. data models, and smart contracts. Define the data elements to be stored on the blockchain, data access controls, and the integration points with existing healthcare systems.

7. Development and Testing: Develop the blockchain solution based on the defined architecture. Implement smart contracts, data storage mechanisms, and user interfaces. Conduct thorough testing to ensure the reliability, security, and performance of the solution.

8. Regulatory Compliance: Consider regulatory requirements and compliance standards applicable to healthcare, such as data privacy (e.g., GDPR), security (e.g., HIPAA), and consent management. Ensure that the blockchain solution adheres to these regulations and provides the necessary controls.

9. Pilot Deployment: Deploy the blockchain solution in a controlled pilot environment to validate its functionality, performance, and user acceptance. Gather feedback from users and make necessary refinements based on the pilot results.

10. Evaluation and Iteration: Evaluate the effectiveness and impact of the implemented blockchain solution against the defined objectives. Identify areas for improvement and iterate on the solution based on user feedback and evolving requirements.

Close collaboration between healthcare professionals, technology experts, and regulatory bodies is crucial throughout the implementation process to ensure successful integration of blockchain technology in healthcare.

3.2. SYSTEM DESIGN

To design a blockchain-based healthcare system, we need to consider the following aspects:

Architecture and Components:
The blockchain-based healthcare system can have the following components:

Blockchain network: A decentralized network that stores and shares healthcare data.

Smart contracts: Self-executing digital contracts that enforce rules and automate processes.

Cryptography: Algorithms that ensure data privacy and security.

User interface: An intuitive and user-friendly interface that allows patients, doctors, and healthcare providers to interact with the system.

Data Storage and Security:
The healthcare data is sensitive and needs to be stored securely. In a blockchain-based system, the data is stored in a distributed ledger that is tamper-proof and transparent. The cryptography algorithms ensure the privacy and security of the data. Only authorized users with the right keys can access the data.

Interoperability:
The healthcare system needs to be interoperable with different healthcare providers, hospitals, and clinics. The blockchain-based system can achieve interoperability by creating a standard format for healthcare data and using smart contracts to automate the data exchange between different parties.

Patient Control:

Patients should have full autonomy and control over their healthcare data, including the ability to grant or revoke access to different healthcare providers. A blockchain-based system has the potential to empower patients in managing their data by utilizing smart contracts to enforce access control policies.

Regulatory Compliance:

The healthcare system needs to comply with various regulatory requirements, such as HIPAA, GDPR, and others. The blockchain-based system can ensure regulatory compliance by using smart contracts to enforce rules and automate compliance processes.

Overall, the architecture of a blockchain-based healthcare system should be designed to ensure data privacy, security, and interoperability while complying with regulatory requirements. The system should also be scalable, efficient, and easy to use for patients and healthcare providers.

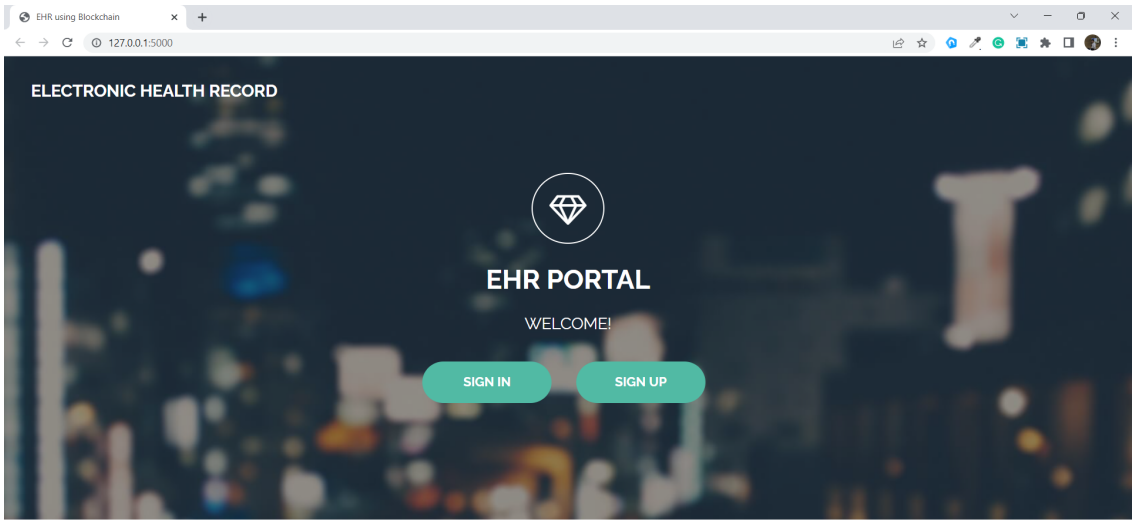

Fig 3.2.1 Front Page of portal for sign in and sign up.

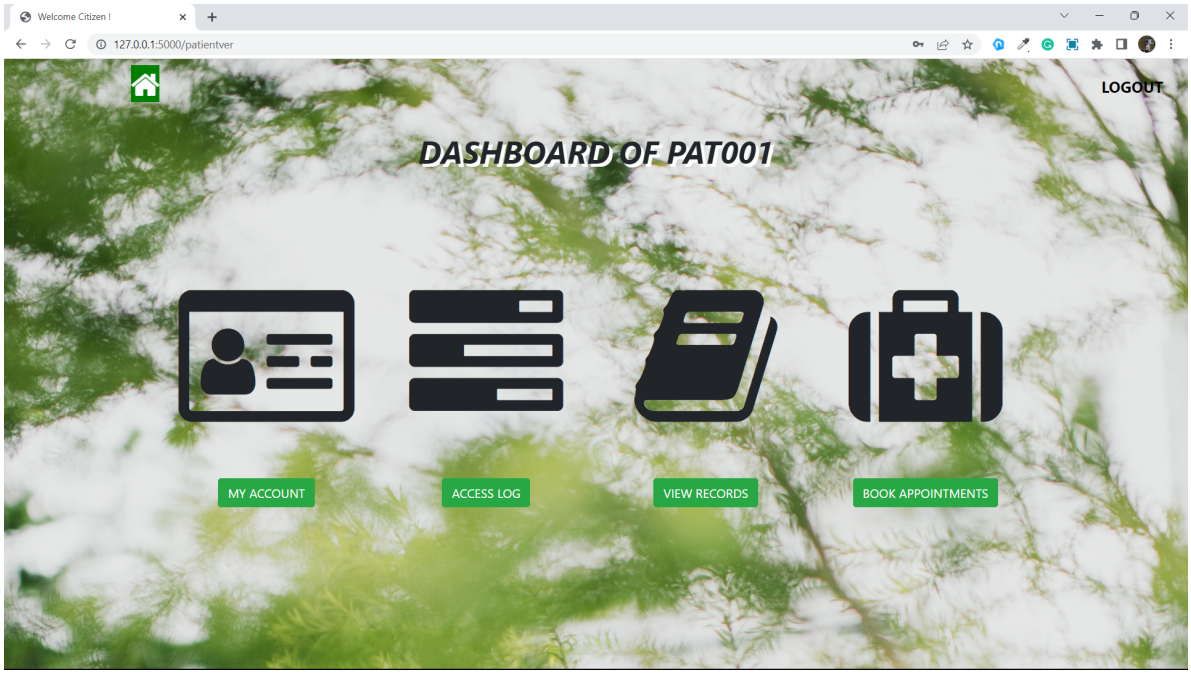

Fig 3.2.2 Dashboard of each patient after logging in.

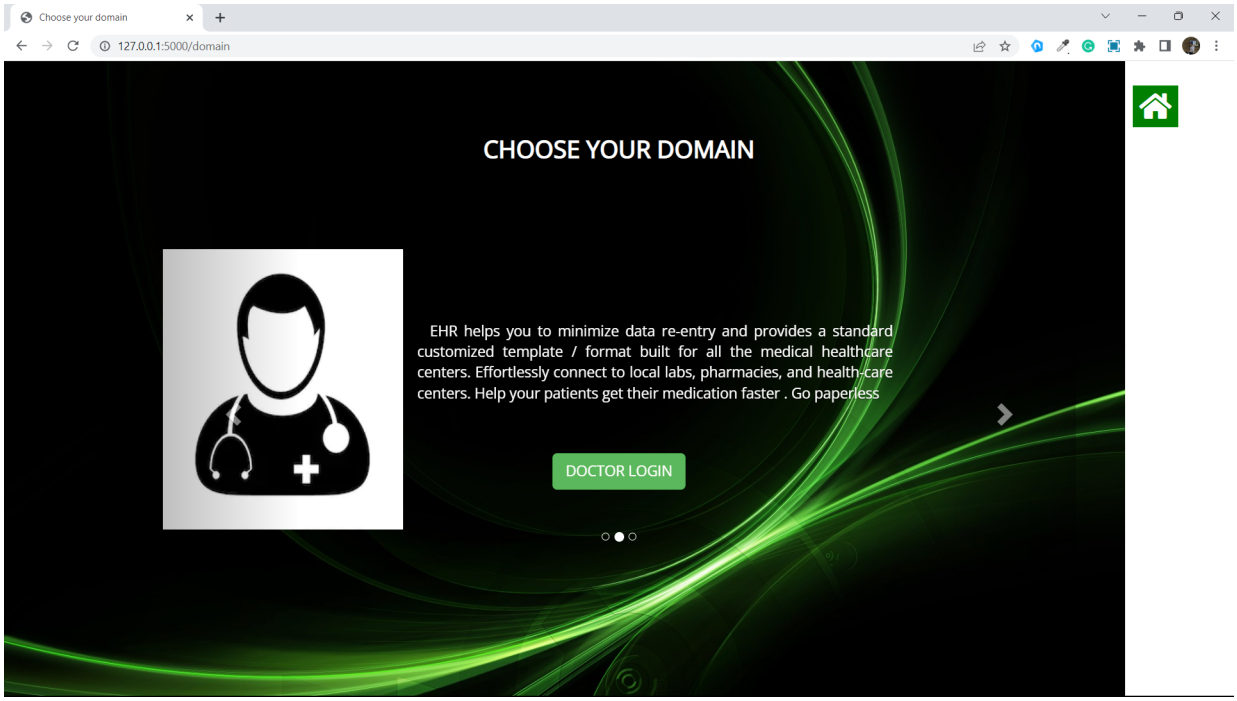

Fig 3.2.3 Doctor Login Page.

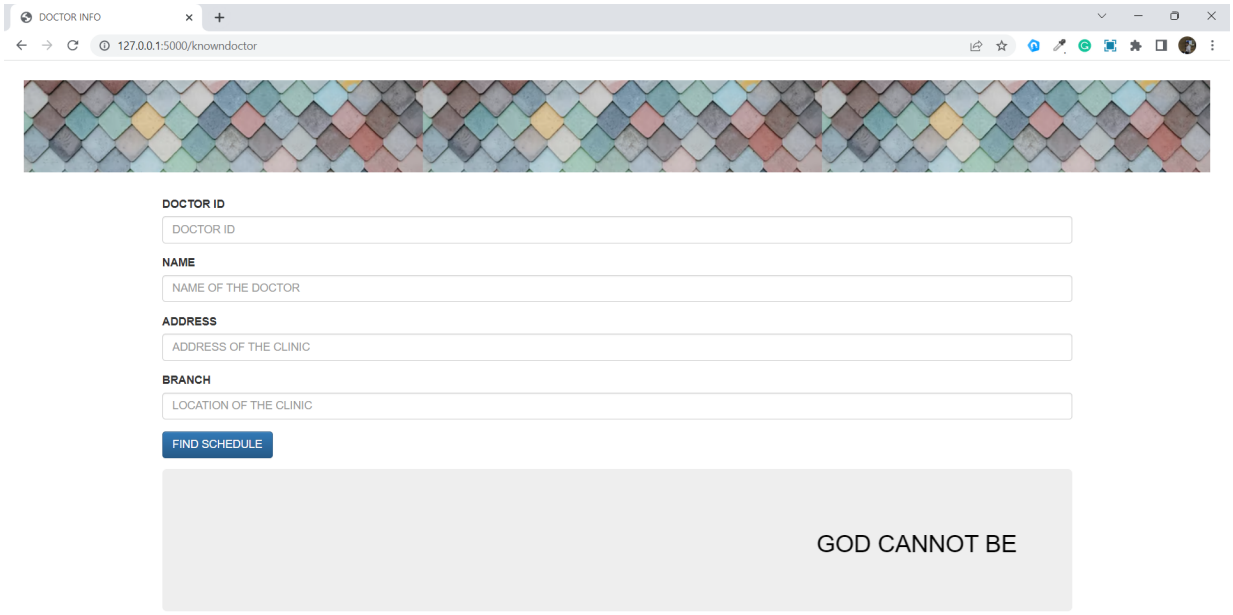

Fig 3.2.4 Doctor Registration Page.

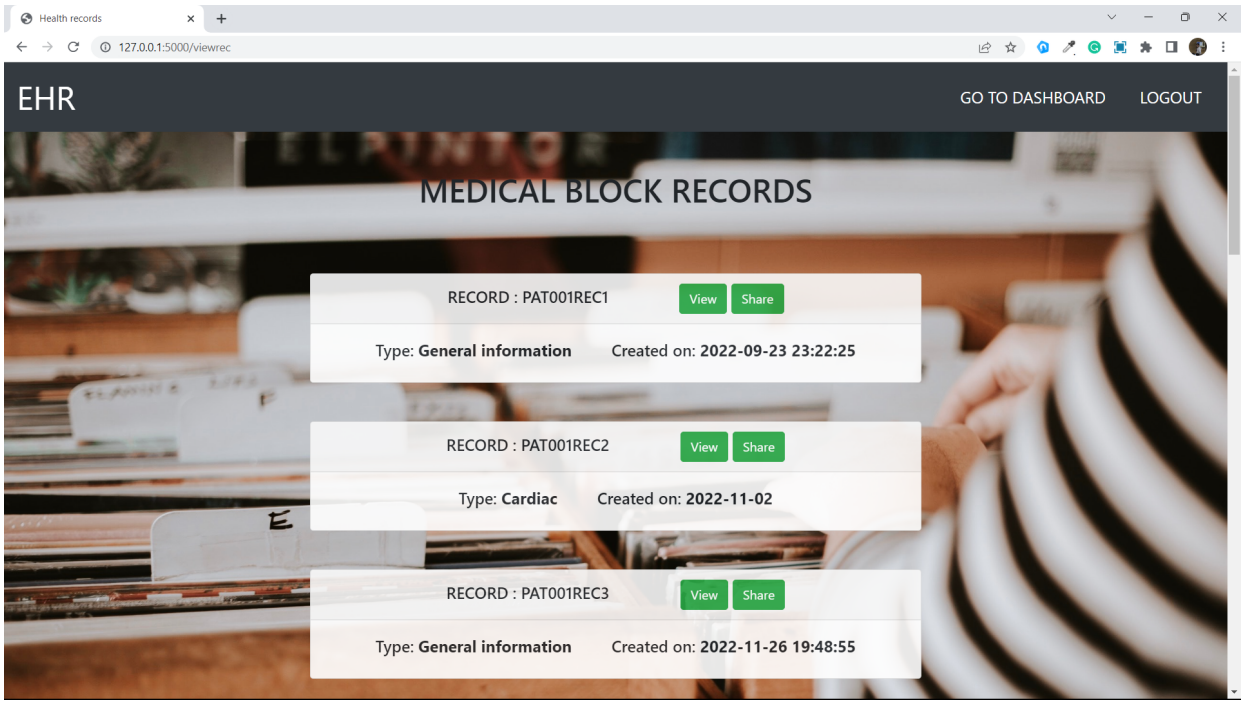

Fig 3.2.5 Record of each patient in the dashboard of the doctor.

3.3. ARCHITECTURE

Step 1: Patients / Doctors will register on the portal and then they can access their dashboards.

Step 2: Patients will be able to view / update their health record. Grant access to doctors for reading / updating their health record or view previous access history.

Step 3: After a patient grants access to a doctor for their health record the particular doctor will receive a request on their dashboard.

Step 4: The doctor can then view / update them based on the access type i.e read / write.

Step 5: The EHR will update in realtime and will be added in the patients blockchain.

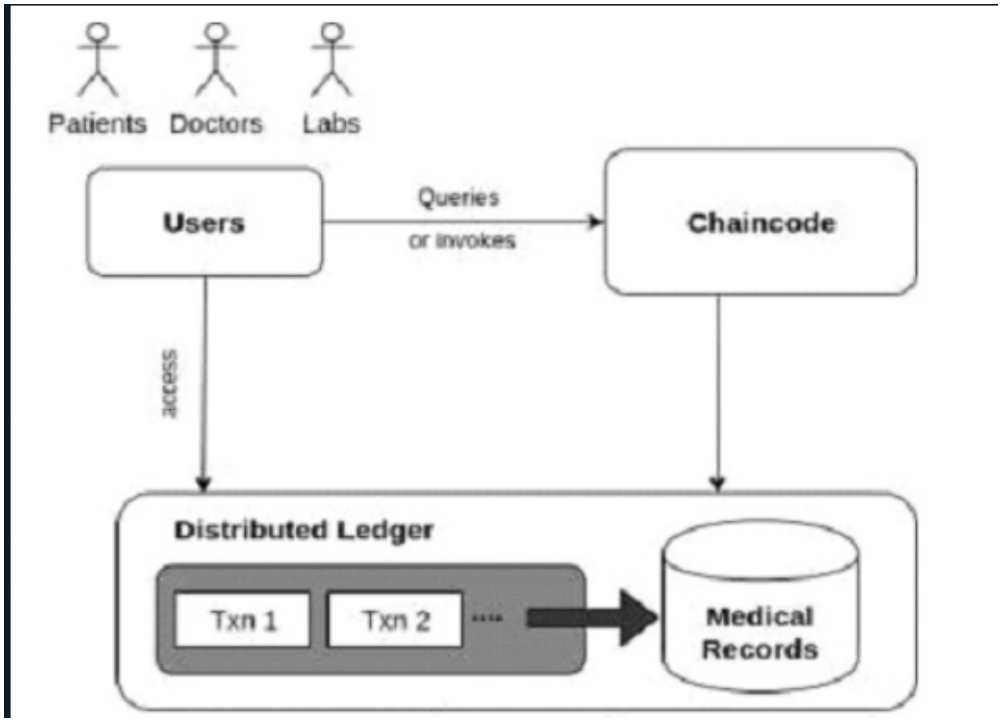

Fig 3.3.1 System Architecture

CHAPTER 4

4.1. RESULTS AND DISCUSSION

An overview of blockchain applications in healthcare was given in this study. Blockchain is being used in many sectors to improve the automation of medical services due to its exponential expansion. Based on our analysis, the majority of research on blockchain in the healthcare industry is primarily centered around the exchange and management of Electronic Health Records (EHRs). Blockchain applications in biological research, pharmaceutical supply chains, and insurance should be taken into consideration by researchers.

In our research, we noticed a lack of discussion in papers regarding the implementation details of blockchain technology. Although this technology has potential benefits, further research is necessary to fully comprehend, develop, and evaluate it in a secure and effective manner. To encourage the adoption of blockchain technology among stakeholders, it is important to address its scalability, security, and privacy issues.

CHAPTER 5

5.1. CONCLUSION

Blockchain technology offers innovative applications in the healthcare industry, leveraging its inherent encryption and decentralization features. It provides enhanced security for patients' electronic medical records, facilitates the monetization of health information, improves interoperability between healthcare organizations, and aids in combating counterfeit medicines. Various healthcare domains can benefit from the implementation of Blockchain technology, particularly in areas such as healthcare insurance, digital agreements enabled by smart contracts, medicine tracing, clinical trials, and system tracking. By eliminating intermediaries in payment processes, smart contracts can reduce costs. The success of Blockchain in healthcare relies on the adoption of complementary advanced technologies within the ecosystem, including device tracking, insurance mediation, and patient history management. By leveraging Blockchain, hospitals can efficiently manage services throughout their life cycles and optimize data maintenance for accelerated clinical actions. Ultimately, Blockchain technology has the potential to significantly enhance and revolutionize the way patients and physicians interact with clinical records and improve healthcare services.

Additionally, blockchain technology can support the monetization of health information, allowing patients to have more control over their data and potentially benefiting from sharing it with researchers or other stakeholders in a transparent and incentivized manner.

Furthermore, blockchain has the potential to combat counterfeit medicines by providing a secure and immutable ledger for tracking the entire supply chain, ensuring the authenticity and safety of pharmaceutical products.

While blockchain in healthcare shows immense promise, its successful implementation relies on

addressing challenges such as usability, data accuracy, and ensuring robust privacy and security measures to protect against cyber threats.

In the near future, Blockchain technologies have the potential to authenticate and record transactions with the approval of network members. By leveraging public and private key encryption, Blockchain will offer robust security measures at the patient level, paving the way for a new era of health information sharing. This technology holds promise in various aspects of healthcare, including safeguarding patient records, preventing breaches, enhancing interoperability, streamlining processes, improving medication and prescription control, as well as monitoring medical and supply chains.

Overall, with further research, development, and collaboration, blockchain technology has the potential to transform healthcare by improving data management, interoperability, patient outcomes, and the overall quality and efficiency of healthcare services.

5.2. FUTURE SCOPE

The future scope of blockchain in electronic health records (EHRs) holds significant potential for revolutionizing healthcare. Here are a few key areas where blockchain technology can make a positive impact:

1. Interoperability: Blockchain can improve data interoperability by creating a unified and standardized system for sharing EHRs across different healthcare providers. It can ensure secure and seamless exchange of patient data, enabling healthcare professionals to access comprehensive and up-to-date medical information regardless of the EHR platform or location.

2. Data Security and Privacy: Blockchain's decentralized and immutable nature provides enhanced security and privacy for EHRs. Patient records can be securely stored and accessed using cryptographic techniques, reducing the risk of data breaches and unauthorized access. Patients also have greater control over their health information, determining who can access and modify their records.

3. Data Integrity: Blockchain technology ensures the integrity of EHR data by creating a transparent and tamper-proof audit trail. Every transaction and modification made to the EHRs is recorded and time-stamped, making it easier to trace the origin and verify the authenticity of the data. This feature can help eliminate discrepancies and fraudulent activities, improving trust in the healthcare system.

4. Clinical Trials and Research: Blockchain can streamline the process of conducting clinical trials and medical research. By securely recording and sharing data related to patient recruitment, consent, and trial outcomes, researchers can accelerate the discovery of new treatments and therapies.

5. Blockchain's transparency can also address issues like data manipulation and reporting biases, fostering more reliable research outcomes.

6. Health Data Exchange and Monetization: Blockchain enables patients to control and monetize their health data. They can selectively grant access to researchers or organizations, ensuring privacy while still contributing to medical advancements. Patients can receive compensation or rewards for sharing their data, creating new economic models around health information and incentivizing data sharing.

7. Patient Empowerment: Blockchain empowers patients by giving them greater control over their health data. Patients can securely access and share their medical records, enabling more active involvement in their healthcare decisions and facilitating personalized care.

8. Streamlined Processes and Cost Savings: Blockchain can streamline administrative processes, such as claims management and billing, by eliminating intermediaries and reducing administrative burdens. This can lead to cost savings, increased efficiency, and faster transaction processing.

9. Supply Chain Management: Blockchain has the potential to transform supply chain management in healthcare. It can track and authenticate the movement of pharmaceuticals, medical devices, and supplies, reducing counterfeit products and improving inventory management.

10. Continued Innovation: As blockchain technology advances, new applications and use cases will emerge in healthcare. Innovations such as decentralized identity management, precision medicine, AI integration, and telemedicine can leverage blockchain to enhance healthcare delivery and outcomes.

It's important to note that while the future scope of blockchain in EHRs is promising, there are still challenges to overcome, including regulatory frameworks, scalability, and standardization. However, as technology advances and these challenges are addressed, blockchain has the potential to reshape how healthcare systems manage and utilize electronic health records, leading to improved patient care, research outcomes, and overall efficiency in the healthcare industry.

5.3. LIMITATIONS

Definitely blockchain has a future scope in the field of healthcare. Blockchain could change the whole process of sharing and exchanging data from multiple clients. It also increases communication between receiver and sender at the level of payments.

The honesty of the data entered into the medical documents would also be guaranteed by the unchangeable nature of blockchain technology. The potential for more precise documentation of any medical mistakes and the capacity to track the effects of a specific treatment.

The authors of the study, Yue et al., created an application called Healthcare Data Gateway (HDG) that utilizes blockchain technology and a secure computation technique known as MPC. This system allows for encrypted data to be processed on a private blockchain cloud without revealing the raw data, and produces computation results in a secure manner.

Blockchain is simpler to use in creating and updating documents and records of different providers in the healthcare sector but it is still in its early stage and needs some more inventions to improve the health sector.

It also uses concepts like asymmetric key cryptography which involves use of both public and private keys to encrypt and decrypt data.

One biggest problem is that people using this need should understand this completely and have enough knowledge where to apply this concept and it also uses power to run these types of applications which can affect scalability.

Patient records, breach of data, consistent results, procedural rationalization, decreasing the use of drugs and supply chain tracking are all expected to be addressed by this technology. Healthcare is expected to be a huge success for blockchain technology.

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APPENDIX - I

The outcome of a project on "Blockchain in healthcare" can vary depending on several factors such as the project's goals, implementation strategy, and the specific use cases targeted. Here are a few potential outcomes that such a project could aim to achieve:

1. Drug Traceability and Supply Chain Management: Blockchain can enhance transparency and traceability in the pharmaceutical supply chain. The project might involve building a blockchain platform that enables real-time tracking of drugs, ensuring their authenticity, preventing counterfeit medications, and improving the efficiency of recalls if necessary.
2. Patient Empowerment: Blockchain can give patients greater control over their healthcare data and enable them to securely share it with healthcare providers as needed. The project might aim to create a patient-centric blockchain platform that allows individuals to manage their health records, control data access permissions, and even participate in research studies or monetize their data if they wish.
3. Streamlined Claims Processing: Blockchain-based smart contracts can automate and streamline insurance claims processing in healthcare. The project could explore the development of a blockchain solution that enables automatic verification of claims, reduces fraud, and accelerates the reimbursement process for both healthcare providers and patients.

It's important to note that the success of a project on blockchain in healthcare will depend on factors such as regulatory considerations, stakeholder adoption, technical implementation, and addressing potential challenges related to scalability, privacy, and integration with existing systems.

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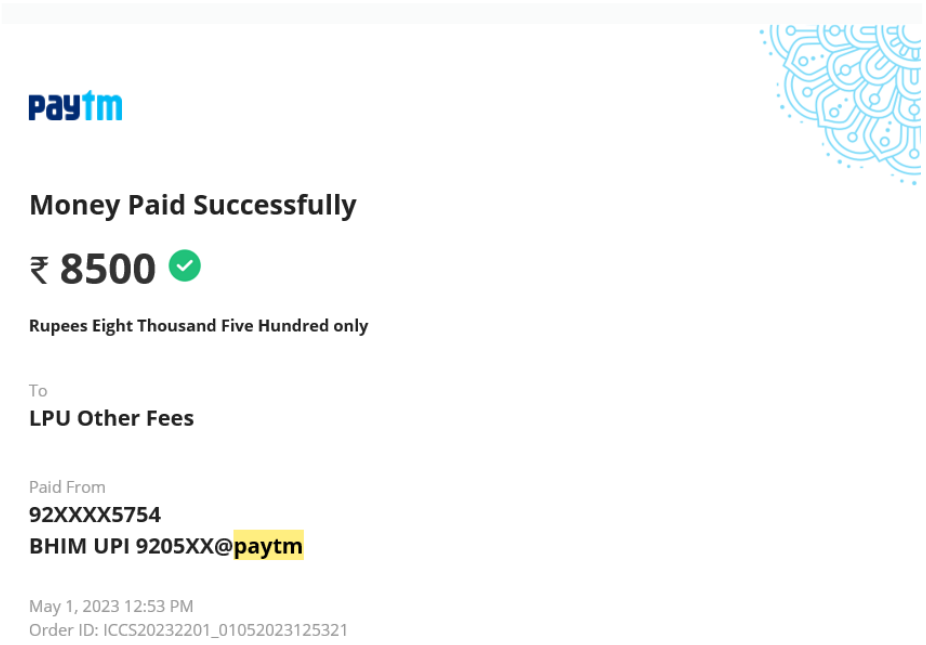

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Submitted Research Paper

Blockchain In Healthcare:Portal For Electronic Health Records

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Abstract. Blockchain is a technology that uses sophisticated algorithms and a digitally distributed ledger to prevent data tampering. It started out in the financial sector, but it is now used in the Internet of Things, banking, supply chain, defense, and healthcare, among other major sectors. Patients, providers, payees, organizations, and intermediaries all require streamlined transactions in a secure, authentic, and transparent environment in healthcare. Blockchain technology, which is based on the internet, has the potential to revolutionize the way healthcare data is used in a decentralized and interoperable manner, without relying on intermediaries. With this technology, it is possible to develop applications that ensure secure, transparent, and unchangeable records, which can help prevent systematic fraud. This study examines previous literature to identify the key challenges of implementing blockchain in healthcare and explores potential solutions to address these issues.
Keywords—blockchain, electronic health record, EHR,healthcare.

I. INTRODUCTION

The rapid adoption of digitalization in the healthcare sector has resulted in the creation of enormous numbers of electronic patient records. Such expansion places a lot of demands on how healthcare data is used and shared, which must be protected. In the healthcare sector, there are significant issues with data privacy, security, and integrity. The inclusion of blockchain technology as a responsible and transparent method of data storage and distribution in different sectors is creating new opportunities for addressing these issues. Over the past few years, blockchain technology has drawn a lot of interest from both the industry and the academic community. In fact, fresh blockchain applications and academic research is published every day. Particularly in the fields of healthcare, medical research, and insurance, blockchain is being hailed as an effective tool for managing sensitive data.

The healthcare system comprises three main components:

- (a) core medical care providers such as doctors, nurses, hospital administrators, and technicians;
- (b) essential medical services including medical research and health insurance; and
- (c) recipients of medical and health-oriented services, which are the patients or the general public.

Over the past three decades, the healthcare industry has undergone a digital transformation, reshaping many crucial functions of healthcare delivery systems [1]. This revolution is expected to bring added value in the form of improved healthcare outcomes in healthcare facilities [1].

In recent years, the healthcare industry has experienced a surge in security and privacy breaches, with over 300 incidents reported in 2017 and an alleged compromise of 37 million medical records between 2010 and 2017. With the increasing digitization of the medical field, the safe and secure management, sharing, and storage of personal health records and medical data have become a significant concern. The rise in articles related to deep learning in healthcare from 2013 to 2016 indicates the growing use of machine learning algorithms to develop predictive models in medicine.

The healthcare sector faces significant issues related to the safe exchange of medical records and adherence to data protection rules. One potential solution that has been proposed to tackle these challenges is the adoption of blockchain technology. Patient data management is one of the most well liked blockchain applications in healthcare. Since health organizations frequently separate medical records, it is impossible to ascertain a patient's medical history without first contacting their previous healthcare provider. This procedure can be time-consuming, and mistakes brought on by human error may frequently occur. A promising opportunity exists for a medical data system that is both more

extensive and more secure given the popularity of blockchain technology and cryptocurrencies like Bitcoin. This is because a blockchain's use of cryptography to guarantee the integrity and accuracy of its ledger is its most important feature.

Data can be stored using blockchain technology in a way that is accessible to all network users, completely mutable, and unalterable. A single, dependable platform would give medical professionals control over the flow of information in electronic health records built on the blockchain technology. The similar information would be accessible to everyone, and any updates that will occur would be immediately provided to everyone on the network. A system like this might be used in hospitals and medical offices all across the world in a variety of ways. However, a vital piece of technology that can enable all of this already exists in the wallets of a large portion of the population: mobile smartphones. Phones and other comparable devices now have the computing capacity and networking capabilities to keep track of a person's vital signs and serve as a hub for entering and retrieving data. Many people already monitor their exercise, caloric consumption, and even mental health with their phones or smart watches, to mention a few.

As a result, blockchain facilitates the development of various services. It is more efficient to combine various types of health monitoring into a single, standardized platform that is available to medical practitioners since it enables better control over the grade of care being delivered. Blockchain data backup ensures that once data is inputted, it cannot be changed or really altered in any manner. In some circumstances, it may even be possible to use a gamified and rewards system to encourage healthy lifestyle choices through blockchain-based electronic health data. Electronic health record (EHR) data do not directly capture information about patients and their physiological conditions, but rather the intricate set of recording processes that are involved in healthcare[4].

II. OBJECTIVE

Blockchain technology is a ledger where data of multiple users is compiled to facilitate our operations of transaction. It offers high transparency. It gives us multiple techniques for authentication and authorization which helps a lot of administrators. Its main objective is to give assurance to customers that their records are safe so that there should not be any stress to anyone about their data, it also increases transparency in the process. It increases customers satisfaction for their end-to-end communication, when data gets collected from a lot of users then Artificial Intelligence is applied for keeping their data safe and dealing with it.

In the field of healthcare, the rate of development is advancing at an ever-increasing rate. High-quality medical facilities backed by an advanced technology are in high demand right now in different sectors. It is widely recognized that protecting the confidentiality of individuals' data is of utmost importance as it can be easily abused. The most significant hurdles in population health management are related to data sharing, privacy, and interoperability. Blockchain technology is a reliable solution to address these challenges, particularly concerning safeguarding privacy. If utilized effectively, blockchain technology can enhance several aspects such as security, data exchange, interoperability, integrity, real-time updates, and accessibility.

Data security is very important from user's point of view and also raises a lot of questions. Data collection, transmission, and analysis over networks must be made simple and secure for both patients and medical professionals. As a result, these problems are fixed with blockchain technology. As we know it is very important to keep privacy of each person's data as it can be used in a wrong way which doesn't keep that person private, so to provide high level of security of data multiple techniques like encryption and decryption are used to provide data from multiple attackers.

III. TECHNOLOGY USED

Blockchain technology has evolved through several stages of development. The initial stage was focused on cryptocurrencies, followed by the use of smart contracts in industries such as finance and real estate. The third stage saw the expansion of blockchain into non-financial fields like politics, healthcare, and culture. Currently, it is believed that blockchain is in its fourth stage of evolution, driven by advancements like data immutability and the integration of artificial intelligence. The wide-ranging applications of blockchain may be attributed to its ability to create decentralized and trustworthy transaction environments.

Blockchain technology is well-suited for the healthcare sector, as it has the potential to effectively tackle pressing issues like automated claim validation and improved public health management. This technology enables patients to maintain control over their data and determine with whom it is shared, which helps to alleviate concerns around data ownership and sharing. By utilizing consensus protocols, it facilitates the consolidation, secure exchange, and rapid access of data records by the appropriate authorities. This is a significant advantage over traditional methods, which require external parties to store the data. Furthermore, blockchain technology can increase transparency in data management processes while reducing the likelihood of data being mishandled or misused. Due to concerns around privacy and insecure electronic health record (EHR) systems, patients are hesitant to share their health records. Innovative technologies like blockchain provide a secure system that enhances patient privacy protection.

A small task that is stored in public blocks is referred to as a blockchain transaction. A majority of system participants must agree in order for each transaction to be confirmed. When transactions are added to the blockchain in this manner, tamper-proofing is guaranteed. According to blockchain immutability, each member replicates, hosts, and maintains the exact identical copy of the ledger.

The integration of blockchain technology with other enabling technologies is expected to bring about a significant transformation in the Internet of Things (IoT). As a matter of fact, most IoT devices are only capable of directly supporting blockchain technology, which can offer a secure and user friendly platform for distributing reliable data and information in the IoT ecosystem. This indicates that blockchain technology has the potential to revolutionize the way IoT devices function. [6].

Using smart contracts, a self-executing piece of code on the blockchain architecture that enables straight-through processing, the business logic is encoded regardless of the type of blockchain. Because nothing can be changed once it has been encoded, smart contracts contained in the blockchain become permanently tamper-proof. They also become self-verifying due to automated possibilities and self enforcing when the rules are followed at all times.

Among the key characteristics of blockchain are decentralization, which makes the ledger available to all participants, immutability, which makes the blockchain resistant to censorship, availability, which gives all peers access to a copy of the blockchain so they can access all time stamped transaction records, and anonymity, which allows each user to interact with the blockchain using a generated address that hides their true identities.

Blockchain may take some time to achieve the anticipated levels of business transformation due to social, organizational, and implementation challenges like governance and security. This is in part because the general public and individual users, like doctors or patients, are not familiar with the technical aspects and benefits of this technology for data management. In addition, the general lack of trust in the legal compliance and governmental regulations associated with the application of blockchain technology may make the situation even worse. By tackling these issues, current research is geared toward assisting blockchain's operational evolution and boosting its adoption.

IV. SYSTEM DESIGN AND ARCHITECTURE

To design a blockchain-based healthcare system, we need to consider the following aspects:

Architecture and Components: The blockchain-based healthcare system can have the following components:

- Blockchain network:A decentralized network that stores and shares healthcare data.
- Smart contracts: Self-executing digital contracts that enforce rules and automate processes.
- Cryptography: Algorithms that ensure data privacy and security.
- User interface: An intuitive and user-friendly interface that allows patients, doctors, and healthcare providers to interact with the system.
- Data Storage and Security: The healthcare data is sensitive and needs to be stored securely. In a blockchain-based system, the data is stored in a distributed ledger that is tamper-proof and transparent. The cryptography algorithms ensure the privacy and security of the data. Only authorized users with the right keys can access the data.

- Interoperability: The healthcare system needs to be interoperable with different healthcare providers, hospitals, and clinics. The blockchain-based system can achieve interoperability by creating a standard format for healthcare data and using smart contracts to automate the data exchange between different parties.
- Patient Control: Patients should have full autonomy and control over their healthcare data, including the ability to grant or revoke access to different healthcare providers. A blockchain-based system has the potential to empower patients in managing their data by utilizing smart contracts to enforce access control policies.
- Regulatory Compliance: The healthcare system needs to comply with various regulatory requirements, such as HIPAA, GDPR, and others. The blockchain-based system can ensure regulatory compliance by using smart contracts to enforce rules and automate compliance processes.
- Use Cases: The blockchain-based healthcare system can have various use cases, such as: Electronic health records (EHRs): Storing and sharing patient health records securely.
- Clinical trials: Recording and sharing data from clinical trials. Supply chain management: Tracking the supply chain of medical devices and drugs.
- Health insurance: Enabling fast and secure claims processing. Overall, the architecture of a blockchain-based healthcare system should be designed to ensure data privacy, security, and interoperability while complying with regulatory requirements. The system should also be scalable, efficient, and easy to use for patients and healthcare providers.

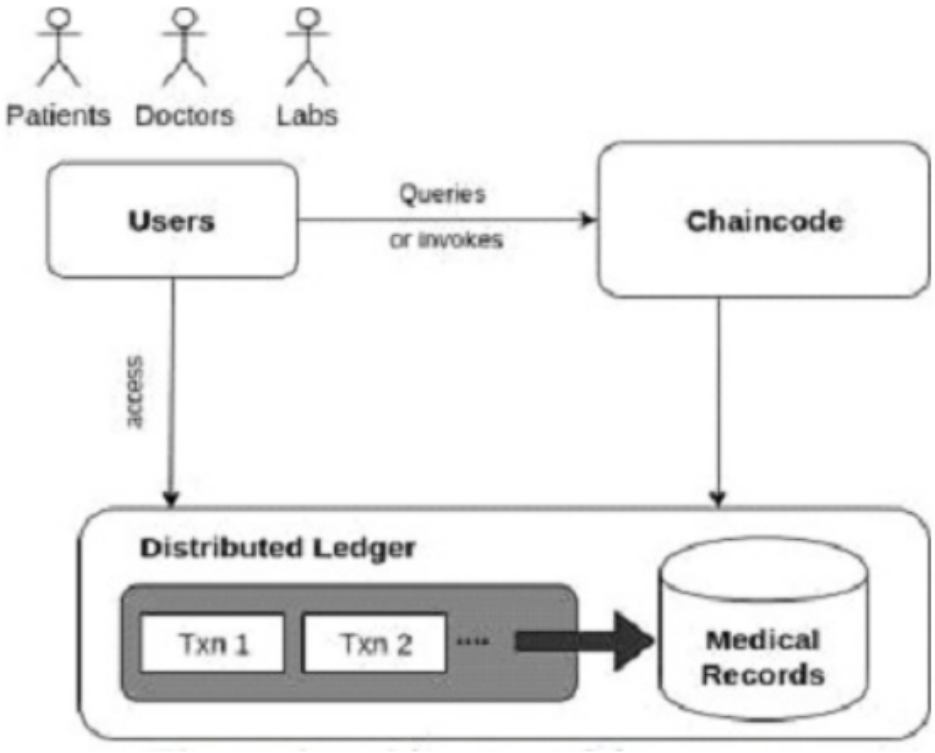

FIGURE 1. System Architecture

V. LIMITATIONS AND FUTURE SCOPE

Definitely blockchain has a future scope in field of healthcare. Blockchain could change the whole process of sharing and exchanging data from multiple clients. It also increases communication between receiver and sender at the level of payments.

The honesty of the data entered into the medical documents would also be guaranteed by the unchangeable nature of blockchain technology. The potential for more precise documentation of any medical mistakes and the capacity to track the effects of a specific treatment. The authors of the study, Yue et al., created an application called Healthcare Data Gateway (HDG) that utilizes blockchain technology and a secure computation technique known as MPC. This system allows for encrypted data to be processed on a private blockchain cloud without revealing the raw data, and produces computation results in a secure manner.[8]

Blockchain is simpler to use in creating and updating documents and records of different providers in healthcare sector but it is still in early stage and needs some more inventions to improve health sector. It also uses concepts like asymmetric key cryptography which involves use of both public and private keys to encrypt and decrypt data. One biggest problem in this people using this need should understand this completely and have enough knowledge where to apply this concept and it also uses power to run these types of applications which can affect scalability. Patient records, breach of data, consistent results, procedural rationalization, decreasing the use of drugs and supply chain tracking are all expected to be addressed by this technology. Healthcare is expected to be a huge success for blockchain technology.

VI. CONCLUSION

An overview of blockchain applications in healthcare was given in this study. Blockchain is being used in many sectors to improve the automation of medical services due to its exponential expansion. Based on our analysis, the majority of research on blockchain in the healthcare industry is primarily centered around the exchange and management of Electronic Health Records (EHRs). Blockchain applications in biological research, pharmaceutical supply chains, and insurance should be takeninto consideration by researchers.

In our research, we noticed a lack of discussion in papers regarding the implementation details of blockchain technology. Although this technology has potential benefits, further research is necessary to fully comprehend, develop, and evaluate it in a secure and effective manner. To encourage the adoption of blockchain technology among stakeholders, it is important to address its scalability, security, and privacy issues.

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