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Smart Contracts in E-Health records using Blockchain

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Abstract - The fact that organizations are now storing various and fragmented patient health data is one of the major issues in the field of health care. All companies that charge for health insurance keep records of their customers' health data. In some cases, information may even need to be shared across medical facilities. This might result in a number of problems, including data sharing between organizations, which could result in data abuse and a loss of privacy. Due to the participation of all interested parties, the Electronic Health Record (EHR) structure on blockchain uses smart contracts to address such difficulties. By placing medical record transactions on the blockchain, EHR creates a smart health care e-care system and addresses the issue. To provide time-limited access to the patient's electronic health records whenever the data is needed, an EHR smart contract is established. Smart contracts allow for the recoding of all transactions into a single system, preserving data privacy.

Key Words: Ethereum, EHR, Hyperledger Fabric, Merkle Tree, Blockchain.

1. INTRODUCTION

Doctors can enter comments, scans, and lab results into this system, all of which are logged as transactions. In addition to dispensing medication, the pharmacy also logs the transactions on the blockchain. To guarantee the verification of therapy and payment settlement, the patient is granted access for a certain period of time. Patients' doctors can remotely examine medical issues using smart contracts. In order for insurers to immediately access a patient's health characteristics and provide the appropriate insurance, patients can provide their health information to insurers. Patients get rewards for granting time-limited access to their health records to research organizations for use in clinical trials. The suggested system can even be advanced by being able to differentiate between the individuals involved in various transactions.

2. Literature Survey

In [1], Alaa Haddad, Mohamed Hadi Habaebi and Md. Rafiqul Islam propose a system in which EHRs are preserved digitally, contain data about a person's health. Combining AI with blockchain technology can effectively overcome some of the drawbacks of these two technical ecosystems. To enhance the efficiency of AI algorithms, data from a data repository or other reliable, credible platform is employed. Since all health-related data will be securely saved and reviewed, doctors, healthcare workers, and payers will be able to get updates immediately. Cons of this approach include a capacity problem with blockchain that needs significant consideration. Their tactics should focus on interactions between just those network participants who have a need to know, or on a need-to-know basis.

In [2], Abdullah Al Mamun, Sami Azam and Clementine Gritti, According to this system, Hyperledger Fabric and Ethereum (private) are the two most often used blockchain systems for managing EHRs since they mostly meet all the requirements. They also discovered that using blockchain to manage large-scale big EHR data has drawbacks, including constrained storage capacity, high computing costs, and high communication costs. However, technologies like edge computing, IoMT, and artificial intelligence provide possible remedies to these constraints. Potential researchers can create a new architecture or model by compiling all relevant publications, their contributions, and their limits. Furthermore, new routes in blockchain research may suggest more intriguing answers to the issues at hand. Cons of the system include the inability to address the situation when a patient has to have access to his EHRs while he is in a coma, unconscious, or illiterate.

In [3], Vardhini B, Shreyas N Dass, Sahana R and R. Chinnaiyan propose a system to solve the current problems the healthcare industry is currently experiencing, this paper suggests putting medical record transactions on the Blockchain in order to create a smart ecosystem. They want to make patient data accessible securely so that unauthorized third parties cannot access it. Blockchain technology is used by EHR Framework to store records securely and uphold a single source of truth. To commit the transaction to the distributed ledger and gain access to a patient's medical history, the stakeholders will need to ask for approval. A blockchain-based solution can promote widespread accessibility, data privacy, financial efficiency, and confidence in the information system. Cons: This method might be made better by enabling rapid access to medical records in case of crises. Its structure might be adjusted to match a particular condition or be based on pre-existing guidelines.

In [4], Mrs. Usharani Chelladurai, Dr. Seetha lakshmi Pandian and Dr. Krishna moorthy Ramasamy proposed a system which offers safe, open access to health data and the full life cycle of individual health information for patients, doctors, caregivers, and service providers,. In addition to privacy, it is intended to achieve transparency and security. The suggested

method introduces a Merkle Tree as a significant advancement for hashing input data to guarantee content integrity. The outcomes of testing this strategy on a live hospital built on the blockchain Hyperledger Fabric are promising. By using fewer resources, it increases the system's throughput and performance while reducing network latency. Cons in system is they didn't consider more about privacy and scalability.

In [5] , Asma Khatoon, Blockchain is becoming into a safe and reliable platform for secure data exchange in application industries including the financial sector, supply chain management, food industry, energy sector, internet of things, and healthcare. A number of medical processes, including challenging surgical and clinical trial procedures, have been developed and implemented using the Ethereum blockchain platform. The associated cost for this system has been assessed in terms of a feasibility study, which has been thoroughly covered in this article. Many members of the healthcare system will find it simpler thanks to this effort to provide better healthcare while spending less. In addition to giving patients and service providers access to a contemporary and digitalized healthcare environment, blockchain and information and communication technologies (ICTs) are significant enabling technologies for the decentralisation and digitalization of healthcare organisations.

In [6], Andre Henrique Mayer, Cristiano Andre da Costa and Rodrigo Da Rosa Righi, In this study, a thorough assessment of the literature on EHRs inside a Blockchain was conducted in order to pinpoint and assess the main issues, challenges, and possible benefits of blockchain adoption in the healthcare sector. After conducting their analysis, they came to the conclusion that Blockchain technology might, in the future, be a good solution for problems in healthcare, such as EHR interoperability, fostering trust between healthcare providers, auditability, privacy, and allowing patients to manage access to their health data. They would then be able to choose who they want to trust and with whom they want to share their medical records. However, they also made it clear that additional study, testing, and experiments are necessary before deploying Blockchain technology on a broad scale in healthcare because a patient's health data are private, very sensitive, and important information. Cons in this system are restricted to EHR and blockchain-related issues and do not cover other healthcare related blockchain applications, such supply chain and medication access management. This is to say that the review was solely concerned with papers that addressed the fundamental EHR and Blockchain principles.

In [7], Santosh T. Jagtap, Chetan M. Thakar and Ouail El imrani, This system-made intelligent contractual healthcare management framework demonstrated the extension of decentralisation concepts for large-scale data administration to medical ecosystems as well as the simplification of intricate medical procedures. In order to provide auditability, interoperability, and usability, they provide a novel approach to maintaining medical records that takes use of smart contracts. This system, which is made to show flexibility and granularity, streamlines the medical testing process and permits the sharing of patient data. Storage is another drawback of this technology.

In [8], Usharani Chelladurai, Seethalakshmi Pandian: In this system Blockchain smart contracts were developed in order to satisfy the requirements of patients, physicians, and other healthcare specialists. Tree data structure for updating medical records, transferring health information between many providers, seeing contracts on the peer-to-peer blockchain network, and securely storing and easily retrieving health records. A practical way for exchanging healthcare data [EHR] on the blockchain is provided by the MedRec platform. Patients are granted access to their medical information in order to track health improvement and lower healthcare charges. In the proposed system, the patient is in control of sending the system their own personal health data and is the data sender. Instantaneously saved in a database server are blocks with hashes generated by the system. A transaction identification is given to each blockchain user. This makes it easier for consumers to obtain the data. The system's drawback is that it requires expanding the body of research based on the Merkle Tree data format. For the extended work to ensure content integrity, a new Modified Merkle Tree data structure should be adopted.

In [9], Harshini V M, Shreevani Danai, Usha H R and Manjunath, In this system, forecasts of a person's health through time are included in their health records. Data breaches occur as a result of the centralized management of health records. 27,314,647 patient data were impacted in 2016. The use of smart contracts in the healthcare industry might further simplify things. Around the world, patientdriven interoperability—in which patients consent to ondemand access to their medical records—is starting to catch on. They used a strategy smart contracts, which are pieces of code that run on their own when both parties accept a set of protocols. Here, the patient and hospital administration are seen as two different parties. The smart contract can be executed in three steps: invoking, creating records, and validation. According to their analysis, blockchain technology is one of the potential solutions for the efficient maintenance of medical records. Additional study may aid in the adoption of blockchain technology across all industries, making life easier.

In [10], Sergey P, Novikov and Oleg D. Kazakov:The article gives an example of the decentralised design of the healthcare system. In this situation, an electronic environment that enables seamless communication between all healthcare providers and patients is required. The construction of such an environment enables the use of integrated electronic medical records to create medical information storages (IEMC). The IEMC's main duty is to gather as much practical electronic medical data on a particular patient. One of

blockchain's fundamental benefits over alternative distributed database models is the integration of data processing, preserving consistency and security in a single protocol, done algorithmically and with the least amount of human involvement. As a result of its extensive deployment and irreversibility, it enables you to retain the highest level of security. The main difficulty in using blockchain technology to healthcare is finding a balance between defending the interests of system members and catering to society's more general needs and desires.

In [11], Ayesha Shanaz, Dr Usman Qamar and Dr Ayesha Khalid, The Ethereum platform and its dependencies were used to construct this system. The following contracts are a part of this framework: Roles and patient records. Their suggested approach combines granular access controls for records with secure record storage. They didn't list all the parties the patient will deal with. Certain laws and regulations that adhere to the standards of the healthcare industry weren't defined.

In [12], Hegui Zhu, Yujia Guo and Libo Zhang: To address the drawbacks of the conventional recording system, the usage of electronic medical records (EMR) has dramatically expanded. The revelation of personal information, however, poses a possible risk during the transmission of EMR. The primary goal of this study is to improve the Merkle tree-based blockchain EMR storage strategy by using it to increase the system's security and efficiency. In the suggested convolution Merkle tree, the original binary tree structure is replaced with a convolutional layer structure, which can significantly increase efficiency. Using the same amount of input data, experiments demonstrate that the number of stored nodes has fallen greatly, and the number of layers in the modified convolution Merkle tree and the hash calculation amount have both been drastically reduced. The use of an upgraded Merkle tree structure ensured data storage simplicity and security, which improved the EMR record and query application's speed. Merkle trees have higher CPU and memory footprints than other forms of trees, which is their biggest drawback. When compared to the Merkle tree, the root generation of a binary search tree is extremely simple.

In [13], Yonggang Xiao, Bin Xu, Wenhao Jiang and Yunjun Wu : In this study, the enterprise-grade approved distributed ledger technology Hyperledger Fabric v1.4.1 is used to implement the HealthChain prototype. It is installed on a computer running Ubuntu 16.04.1 LTS and powered by an Intel Xeon E5-26xx v4 2.4 GHz CPU with 2 GB of RAM. All servers are constructed using Docker 18.06.1-ce, which virtualizes peers and orderers into containers that share hardware and the kernel of the operating system. Docker Compose, a programme for configuring and managing multi-container Docker applications, creates the HealthChain network. First, there is a single point of failure due to the lone order. The entire system will crash if the orderer fails since EHR transactions cannot be ordered into a block. Second, as the ledger grows, the read latency gets longer.

In [14], Suzanna Schmeelk, Megha Kanabar, Kevin Peterson and Jyotishman Pathak: Their analysis explores the possibilities, difficulties, and unanswered issues associated with the adoption and integration of blockchain technology inside EHR systems. For solutions to open practitioner questions in the healthcare sector, they aggregated and evaluated data. Future research should focus on issues with patient matching and adequate semantic analysis of blockchain data transfer, among other issues with historical health informatics obstacles. Other Blockchain applications in the healthcare sector, such as pharmaceutical apps, are not covered in this research because it is restricted to studies involving EHRs and Blockchain.

3. CONCLUSION

Every option now in use has certain limitations, according to research across numerous studies. Physicians should be able to safely access the patient's records if they need to read the electronic health information when the patient is unconscious, in a coma, or illiterate. It is necessary to distinguish between transactions conducted by different people. The system must be effective, scalable, and provide the aforementioned features.

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