

Medical Record Maintenance Application Using Blockchain

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ABSTRACT: In today's digital age, the vulnerability of personal information, particularly sensitive medical data, is a growing concern. Safeguarding the utmost privacy of an individual's medical records is quite important. The main goal of this project is to develop a resilient and secure application dedicated to storing medical records on the Ethereum blockchain. The core architecture involves the creation and maintenance of smart contracts for executing specific operations on medical data, ensuring its robust security on the internet.

The smart contracts, meticulously crafted and sustained within the Ethereum blockchain network, form the backbone of this application. The initial step involves the registration of hospitals, designating them as authorized users empowered to input and access medical details. Only duly registered hospitals possess the privilege to contribute medical information and retrieve it when necessary. This stringent access control mechanism significantly enhances the security of stored medical records, fostering a safeguarded environment for sensitive healthcare data.

Keywords: Smart contracts, Blockchain, Ethereum, Solidity programming, Meta Mask, Ganache, NFT, De-centralized application, Ethereum Virtual Machine, Ether, Remix IDE, Gas fee, Web3.

I. INTRODUCTION

Nowadays, ensuring the security of information has become a neglected aspect in various fields. Information security is crucial because the misuse of data can lead to significant problems and chaotic situations. Protecting information is important as it holds value for many individuals in society. Hackers often attempt to obtain data by breaching databases and servers of social media platforms or other applications. The intention is to misuse this data for personal gain. Therefore, it is essential to secure data to prevent any misuse.

Information security goes beyond just preventing unauthorized access; it also involves securely storing, accessing, and managing data without it being corrupted or modified by unauthorized parties. It encompasses aspects such as disclosure, disruption, inspection, and recording of data.

Among the various types of personal data, health data is particularly crucial. Many individuals prefer to keep their health data confidential. This data may include personal information about the patient, along with diagnosis and treatment details, which should be kept secure and unmodified. Ensuring the integrity and confidentiality of medical data is crucial.

Typically, hospitals, both government and private, collect and maintain medical data of patients in independent databases. However, traditional methods of storing and accessing data have vulnerabilities. Storing data on regular hard disks and tapes poses a risk of theft and misuse. Third-party servers and databases also do not provide sufficient security, as evidenced by past security breaches. While cloud technology offers large storage space and other necessary facilities, it is a third-party service with associated costs.

In response to these challenges, blockchain technology emerges as an alternative. Blockchain provides a secure and decentralized approach to storing and managing data. It addresses concerns related to data security, integrity, and confidentiality. This makes it a promising solution, especially considering the limitations and risks associated with traditional storage methods and third-party service.

II. LITERATURE REVIEW

The research centered on a thorough investigation into the effectiveness of various methodologies within the domain. By scrutinizing pertinent research papers, the aim was to assess a multitude of approaches and techniques employed

in these areas. This process sought to reveal the nuanced intricacies and advancements within the field.

Ayesha Shahnaz, Dr. Ayesha Khalid [1]- “Using blockchain for electronic health records”:

The extensive research on blockchain technology has underscored its manifold benefits across different industries, with particular attention to the healthcare sector. Here, its potential contributions to security, privacy, confidentiality, and decentralization present promising avenues for advancement. However, despite these advantages, Electronic Health Record (EHR) systems encounter persistent challenges concerning data security, integrity, and effective management. This paper delves into the transformative capacity of blockchain technology in mitigating these issues within EHR systems. The authors present a comprehensive framework tailored for the seamless integration of blockchain technology into the healthcare sector's EHR infrastructure. The framework's primary objectives encompass the incorporation of blockchain within EHR systems and the establishment of a robust electronic record storage system, ensuring heightened security and confidentiality. Achieving this involves defining granular access rules to regulate user interaction within the proposed framework. Additionally, the framework delves into addressing the general scalability concerns associated with blockchain technology by incorporating off-chain storage mechanisms for records. In essence, this proposed framework not only presents a scalable and secure solution but also underscores the integral role of blockchain in enhancing EHR systems within the healthcare domain.

William J. Gordon Christian Catalin [2] – “Blockchain technology for Health care”: In this paper titled "Facilitating the transition to patient-driven interoperability," the authors explore a notable shift in healthcare interoperability from institution-centric data exchange to a patient-driven model. Traditionally, compatibility has focused on data integration among different organizations like healthcare systems entities. The recent emphasis on patient-driven interoperability introduces new challenges related to security, privacy, technology, incentives, and governance. The paper investigates the potential role of blockchain technology in facilitating this transition through five key mechanisms: (1) digital access rules, (2) data aggregation, (3) data liquidity, (4) patient identity, and (5) data immutability. The authors examine obstacles to blockchain-facilitated patient-centric interoperability, encompassing issues such as the

volume of clinical data transactions, privacy and security apprehensions, patient involvement, and incentive structures. Despite the exciting trend toward patient-centric data sharing in healthcare, the paper acknowledges the uncertainties surrounding whether blockchain can effectively address these challenges and successfully drive the shift from institution-centric to patient-centric interoperability.

Gulara Muradova [3]- “Protecting And Securing Medical Records Using Blockchain Technology”:

This paper elucidates the escalating integration of technology in the healthcare industry and the widespread digitalization occurring globally within the healthcare domain. It underscores the significance of blockchain as a prominent technology offering heightened security measures to safeguard data against digital theft and cyber attacks. The term "blockchain" originates from the fusion of "block" and "chain," representing a sequential arrangement of blocks. Functioning as a decentralized information and reporting system, blockchain enables the entry and recording of diverse information within its blocks. These blocks are intricately linked, forming an immutable chain of information. Blockchain essentially operates as a distributed database, open for scrutiny by anyone participating in the network. In the healthcare landscape, where information spans electronic medical records, patient registries, and histories, the existing systems often evolve organically, lacking uniform standards or protocols. The paper underscores the immense value of healthcare data repositories, which, if accessed comprehensively, can unveil correlations between patient behaviors, seemingly unrelated conditions, and demographic factors. The challenge lies in securely accessing diverse data sources. Blockchain's unique feature lies in its shared information storage across the network, making it nearly impervious to tampering and deletion through encryption. The paper illustrates this by conceptualizing a blockchain where each block represents a clinic recording patient names and records. Any attempt to modify information triggers a chain reaction, altering subsequent blocks and ensuring data integrity—a defining characteristic of blockchain technology.

Zhijie Sun, Dezhi Han [4] – “A blockchain-based secure storage scheme for medical information” This paper underscores the paramount importance of medical data and the critical need for preserving its privacy within the public sector. It delves into the application of

blockchain technology in the management of medical information, emphasizing decentralized control and secure storage facilitated by distributed consensus and authentication mechanisms. Given the sensitivity of medical information, comprising personal and diagnostic data, ensuring its confidentiality is imperative. The ongoing technological advancements have significantly impacted various facets of human life, reshaping our perceptions and utilization of resources. In parallel, the healthcare sector is undergoing transformative changes, leveraging technology to enhance security, user experience, and overall efficiency.

Historically, medical records were maintained using paper-based systems, relying on handwritten mechanisms. This antiquated approach proved to be inefficient, insecure, and disorganized, lacking tamper-proof features. Issues such as data duplication, redundancy, and the lack of a centralized system resulted in multiple institutions possessing varied copies of a patient's medical records. In response to these challenges, blockchain technology presents a decentralized solution, enabling the distribution of information with shared ownership.

The decentralized approach ensures that each piece of information, or data, is distributed, mitigating issues related to data duplication and enhancing overall organization. Blockchain, as the underlying technology, secures batches of transactions through hashing and manages them within peer-to-peer networks. Noteworthy benefits of blockchain include enhanced security, anonymity, and data integrity, all achieved without third-party intervention. These attributes position blockchain as a viable solution for storing patient medical records, aligning with the contemporary healthcare industry's emphasis on securing sensitive patient data. Despite technological innovations in Electronic Health Record (EHR) systems, blockchain addresses persisting issues, offering a robust solution to enhance the security and efficiency of medical data management in the healthcare sector.

Cornelius

C.Agbo,QusayH.Mahmoud,J.MikaelEklund [5] –“Blockchain Technology in Healthcare: A Systematic Review”.

This paper explores the ongoing research endeavors aimed at extending the applications of blockchain technology beyond its original context in Bitcoin, with a particular focus on its potential impact on non-financial sectors, notably healthcare. Acknowledging the relatively recent but rapidly

expanding nature of research in this domain, health informatics researchers and practitioners find themselves grappling to keep abreast of the evolving landscape. The paper contributes to this discourse by presenting a comprehensive evaluation of existing research regarding the utilization of blockchain technology in the healthcare sector.

In accordance with the guidelines established in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), this study utilizes a systematic mapping study process. The research methodology involves a meticulous search across four scientific databases. The objective is to identify, extract, and analyze all pertinent publications to provide a comprehensive overview of the ongoing efforts in this area. The findings of the review reveal a multitude of studies proposing diverse use cases for integrating blockchain into healthcare practices. However, a notable gap is identified concerning the scarcity of tangible cases.

This paper underscores the imperative for further research to address this gap and enhance the understanding, characterization, and evaluation of the utility of blockchain in healthcare. Despite the promising potential, the current state of blockchain applications for healthcare is illuminated, with an emphasis on existing limitations and areas ripe for future exploration. The conclusion drawn is that continued research efforts are essential to bridge the divide between theoretical propositions and the practical realization of blockchain's impact on improving healthcare processes.

Mohammad Moussa Madine, Ammar Ayman Battah ,Ibbar Yaqoob, Khaled Salah,RajaJayaraman,Yousuf AL-Hammadi [6]-"Blockchain for Giving Patients Control Over Their Medical Records".

Personal health records (PHRs) serve as invaluable tools for individuals, empowering them to integrate and manage their medical information. These electronic applications offer patients a means to take control of their health data, reshaping the traditional doctor-patient dynamic. However, current PHR management systems exhibit shortcomings in providing reliable, traceable, and secure control over patients' medical data, raising concerns about authenticity and accuracy. Compounding the issue, many existing approaches rely on centralized systems, hindering seamless medical data sharing and introducing the potential for a sole point of failure.

This paper introduces an innovative solution utilizing Ethereum blockchain-based smart

contracts to distribute and safeguard patients' management of their medical information. The objective is to guarantee decentralization, immutability, transparency, traceability, reliability, and security. By employing decentralized storage via the InterPlanetary File Systems (IPFS) and reputable reputation-based re-encryption oracles, the proposed system securely acquires, stores, and exchanges patients' medical data. The paper includes thorough algorithms and their detailed implementation, alongside an assessment of the smart contracts based on crucial performance metrics such as expenditure and precision.

A security evaluation is performed, and the paper discusses the generalizability aspects of the solution. Transparently outlines the limitations of the proposed approach, fostering a comprehensive understanding of its scope and constraints. In a commitment to openness, the source code for the smart contract is made accessible to the public on Github, encouraging collaboration and scrutiny from the broader community. Ultimately, the paper presents a robust and decentralized solution leveraging blockchain technology to address existing challenges in PHR management systems, laying the groundwork for

improved control and security in patient-centric health data management.

Harshini V M, Shreevani Danai, Usha H R, Manjunath R Kounte[7]-“Health Record Management through blockchain”.

The pursuit of global progress hinges on a healthy population, with health records serving as vital indicators of individual well-being. However, centralized record-keeping systems are prone to breaches, resulting in significant financial losses and compromised privacy. Despite the shift towards institution-driven approaches, patient data remains vulnerable to misuse due to lack of control. A patient-centric, decentralized model is imperative to mitigate data theft and manipulation while empowering individuals. Blockchain technology offers a robust solution, leveraging decentralized ledgers to enhance security and enable patient-controlled access. Moreover, the integration of smart contracts streamlines processes and facilitates secure data exchange. This paper advocates for a patient-driven approach to health record maintenance using blockchain and smart contracts, anticipating further research and practical implementation in the field.

Paper	Month and Year	Technique/Methodology	Pros	Cons
[1]	June, 2018.	Blockchain technology for Healthcare: “Facilitating the transition to patient-driven interoperability”	Blockchain technology supports patient-initiated interoperability by employing methods such as digital access regulations, data consolidation, liquidity, patient identification, and data permanence.	Obstacles encompass clinical data transaction volume, privacy and security apprehensions, patient involvement, and uncertainties regarding incentives, casting doubt on the viability of transitioning from institution-focused to patient-driven data sharing.
[2]	Oct, 2019.	Using blockchain for electronic health records	Enhanced security, privacy, and data integrity for electronic health records.	Complex implementation, regulatory compliance challenges, resource-intensive transactions, interoperability issues, and initial high costs.

[3]	November 29, 2019.	ProtectingAndSecuring Medical Records Using BlockchainTechnology	Blockchain technology provides maximum security to healthcare data, preventing digital thefts and cyber attacks through its decentralized and immutable nature. It ensures a distributed database accessible to anyone, enhancing transparency and data integrity.	The challenge lies in transitioning from legacy healthcare systems to blockchain, especially when dealing with diverse sources of healthcare data. The need for secure access to various data points while maintaining privacy poses implementation and interoperability challenges.
[4]	November2019.	Ablockchain-basedsecure storagescheme formeicalinformation	Blockchain ensures secure, decentralized, and tamper-proof storage of highly sensitive medical information, improved security, and data integrity.	Challenges may arise during the transition from traditional paper-based systems, including issues of data duplication, redundancy and interoperability.
[5]	2019	Blockchain Technology in Healthcare: A Systematic Review	The systematic review highlights the potential impacts of blockchain in healthcare, with numerous proposed use cases, showing promise for improved data management, security, and efficiency in the industry.	Despite increasing interest, there is presently a scarcity of sufficient prototype implementations and studies to verify the efficacy of proposed blockchain applications in healthcare, highlighting the necessity for additional research and development in this domain.
[6]	2019	Health Record Management through blockchain	Security and Privacy through decentralized ledgers. Empowerment of individuals	Implementation challenges and investment requirements. Potential scalability issues and regulatory hurdles.

			with control over their health data	
[7]	Oct,2020	Blockchain for Giving Patients Control Over Their Medical Records	The proposed Ethereum blockchain-based smart contracts offer decentralized, secure control over personal health records, enhancing patient autonomy and data security.	Despite the innovative approach, potential limitations include scalability challenges of blockchain technology and the need for widespread adoption to realize its full potential in transforming PHR management.

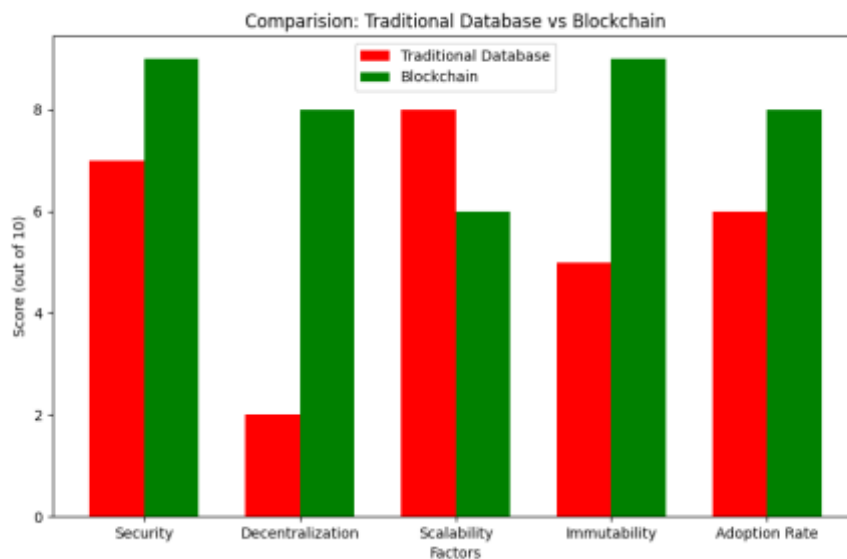


Fig.1.Comparision of Traditional Database and Blockchain.

III CONCLUSION

A medical record maintenance application utilizing blockchain technology emerges as a sophisticated and secure solution for the effective management of patient data. Functioning as a web application, it ensures seamless accessibility for all users. Blockchain's distinctive features, including immutability and decentralization, significantly enhance the security of medical records by preventing unauthorized modifications and reinforcing data integrity. Patient privacy is a priority, allowing individuals to exercise

decentralized control over access permissions. The application incorporates smart contracts to automate various operations, such as updating records and verifying insurance information, streamlining processes and minimizing errors. Standardized data formats on the blockchain contribute to improved interoperability between different healthcare systems, facilitating smooth data exchange. The transparent and auditable nature of blockchain enables easy tracking of changes in medical records, a crucial aspect for regulatory compliance and audit purposes.

Deployment of smart contracts on a test network ensures thorough testing of functionality and security, minimizing risks before full implementation on the main network. While the advantages are significant, addressing challenges like scalability and regulatory compliance remains imperative for the successful integration of this technology into existing healthcare infrastructures.

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