BLOCKCHAIN ENABLED HEALTH DATA LEDGER FOR MAINTAINING PATIENT INFORMATION AND SECURED ACCESS

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Abstract*— The requirement for safe, open, and effective patient information management is critical given how quickly the healthcare industry is changing. Medical record storage and access through traditional means frequently encounters security, interoperability, and data integrity issues. Blockchain technology provides a decentralized and unchangeable ledger for handling health data, which presents a viable solution to these problems. The creation of a blockchain-enabled health data ledger system with a focus on patient information management is suggested in this study. The solution securely stores patient records using distributed ledger technology from blockchain,guaranteeing data integrity and security and facilitating quick access and sharing among approved healthcare practitioners.

Keywords: Security ,interoperability ,Data integrity , Blockchain and unchangeable ledger.

I. INTRODUCTION

In the contemporary landscape of healthcare, the management of patient information stands as a critical cornerstone in ensuring efficient delivery of care and fostering improved health outcomes. However, traditional approaches to storing and accessing medical records have often been fraught with challenges such as security vulnerabilities, interoperability issues, and concerns regarding data integrity. In light of these limitations, emerging technologies like blockchain offer a compelling solution to address these longstanding impediments .Blockchain technology, renowned for its decentralized and immutable ledger system, holds immense promise in revolutionizing the way health data is managed and maintained. By leveraging cryptographic techniques and distributed consensus mechanisms, blockchain provides a secure and transparent platform for storing sensitive patient information. Moreover, its inherent attributes of decentralization and cryptographic security render it resistant to unauthorized tampering or data breaches[1]. This paper proposes the development and implementation of a blockchain-enabled health data ledger system tailored specifically for the maintenance of patient information. The envisioned system aims to harness the transformative potential of blockchain technology to overcome the shortcomings of traditional data management approaches in healthcare. Key objectives of the proposed system include enhancing data security, fostering interoperability among healthcare systems, ensuring the integrity of patient records, and empowering patients with greater control over their own health information. By establishing a decentralized and transparent framework for managing health data, the proposed system seeks to usher in a new era of efficiency, transparency, and patient-centricity in of the capabilities and implications of blockchain healthcare delivery. Through a comprehensive exploration technology in healthcare, this paper endeavors to provide insights into the potential benefits and challenges associated with the adoption of blockchain-enabled health data ledgers. Additionally, it aims to offer practical recommendations for the implementation and integration of such systems within existing healthcare infrastructures, thereby paving the way for a more secure, interoperable, and patient-centered healthcare ecosystem[2]. In this research, we looked into the potential applications of blockchain technology for electronic health records and the healthcare industry. Even with the technical innovation in EHR systems and the advancements in the healthcare field, there were still some problems that needed to be solved. One such innovation is blockchain technology. We combine granular access controls for such documents with secure record storage in our suggested architecture. It makes the system easy for people to operate and comprehend. Additionally, given the framework makes use of IPFS's off-chain storage feature, it suggests steps to guarantee that the system addresses the issue of data storage. Additionally, the system benefits from role-based access because medical records are only accessible to the patient The decentralized and immutable ledger system of blockchain technology is well-known, and it has the potential to completely transform the management and upkeep of health data. Blockchain offers a transparent and safe platform for the storage of private medical data by utilizing distributed consensus methods and cryptographic tools. Furthermore, it is impervious to unwanted manipulation or data breaches because to its intrinsic decentralization and cryptographic security features. This article suggests creating and implementing a blockchain-enabled health data ledger system designed especially for patient data upkeep. The proposed method seeks to address the drawbacks of conventional data management techniques in the healthcare industry by leveraging the revolutionary potential of blockchain technology. The proposed method seeks to enhance data protection encourage interaction, among healthcare platforms ensure the precision of information and empower individuals with greater authority over their personal health records. The proposed system aims to introduce an era of effectiveness, transparency and patient focused care in healthcare services by establishing an transparent structure, for managing health data. This research aims to shed light on the benefits and challenges associated with implementing blockchain based health data records through an analysis of the features and impacts of blockchain technology, in the healthcare sector[3][5]. Additionally it aims to offer guidance on incorporating and implementing these technologies, within healthcare systems to enhance safety, interoperability and patient focused care.

II .**Literature Survey**

The incorporation of technology, into health records (EHRs) offers a promising solution to bolster security, privacy and interoperability within healthcare systems. Blockchains encryption methods ensure the integrity and confidentiality of data while its decentralized structure enables data sharing among healthcare providers and empowers patients to manage their information.

[1]. Scholars such as Patel paired with Gupta (2018) and Chen et al. (2018) have talked about the advantages of blockchain in healthcare underscoring its role in boosting security, transparency and interoperability. Researchers like Brown teamed with Williams (2020) and Garcia et al. (2020) have delved into use cases of blockchain in healthcare with a focus on managing information and controlling access. Experts, like Smith and colleagues (2015) and Johnson along with Lee (2015) have pointed out the potential of technology in healthcare highlighting its ability to tackle data management challenges. Experts like Kim collaborating with Park (2012) and Wang et al. (2012) have scrutinized security measures and privacy concerns within blockchain based healthcare systems discussing methods and adherence to regulations. Investigations carried out by researchers such, as Li et al.(2018) and Rodriguez and Martinez (2018) have presented real world proof of how blockchain powered health data records can improve access, to data and enhance outcomes.

[2]. Scholars like Garcia Hernandez and Lopez (2012) along with Zhang and Wang (2012) have pointed out hurdles and upcoming paths for technology, in the healthcare sector stressing the importance of tackling scalability and regulatory challenges. Researchers such as Brown and Williams (2022) and Garcia et al. (2022) have explored various use cases of blockchain in healthcare, focusing on patient information management and access control. Scholars such as Kim and Park (2018) and Wang et al. (2018) have examined security and privacy considerations in blockchain-based healthcare systems, discussing cryptographic techniques and regulatory compliance. Authors such as Smith et al. (2008) and Johnson and Lee (2008) have outlined the potential of blockchain technology in healthcare, emphasizing its ability to address challenges in data management. Studies conducted by authors like Li et al. (2014) and Rodriguez and Martinez () have provided empirical evidence of the effectiveness of blockchain-enabled health data ledgers, showcasing their impact on data access and patient outcomes.

[3]. Thilina Ranbaduge, Dinusha Vatasalan, and Ming Ding's work on privacy-preserving record linkage likely focuses on developing techniques to link records across different databases while protecting the privacy of individuals. Here's a detailed description along with potential ideas, algorithms, and shortcomings.Record linkage involves identifying and linking records that correspond to the same individual across multiple databases or datasets. This process is essential for data integration, analysis, and decision-making in various fields, including healthcare, finance, and demographics.Privacy-preserving record linkage techniques aim to enable record linkage while minimizing the disclosure of sensitive information about individuals. This is achieved by employing cryptographic methods, anonymization techniques, and privacy-enhancing protocols.Hash functions are used to transform sensitive identifiers (e.g., names, addresses) into unique cryptographic hashes. Similar hashes from different datasets can then be compared to identify potential matches without revealing the original identifiers.Privacy-preserving record linkage techniques may introduce noise or errors into the matching process, leading to false matches or missed links. Balancing privacy and accuracy remains a challenge, particularly when dealing with noisy or incomplete data.

III. SYSTEM DESIGN

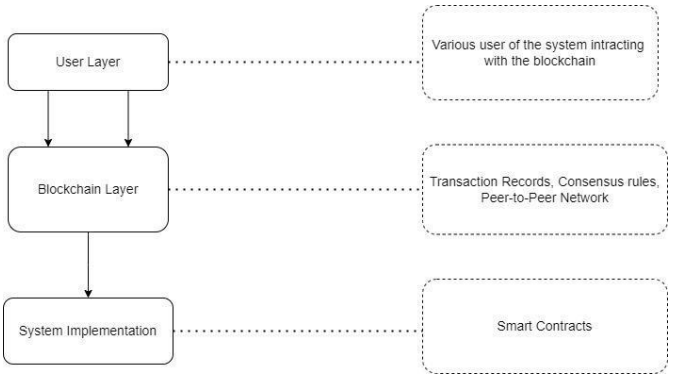

Figure 1. Overview of System

As visible in above figure, the proposed framework or system has three modules. These modules have further concepts that need to be understood they are explained as follows.

1. **USER Layer***:*

A user is defined as an individual who uses of the system and its functions. A user has various roles and features on the system, making him identifiable on the system.

The users of this system should be patient, doctor and administrative staff. The main task of these users would be interact with the system and perform basic task such as create, update, read, and delete the records.

The user is using this system should be accessed by the system's functionality by browser, as it contains the GUI (Graphical User Interface) of the D App, i.e., our proposed framework.

The GUI contains all the function that can be accessed by the user. The user according to the assigned role could use this GUI for interacting with the other layer of the system, i.e., blockchain layer.

2. System layer:

This layer contains the code or mechanism for interaction of user with the D App which is functioning on the blockchain. This layer contains three elements inside it. They are:

Blockchain Assets:

In Ethereum blockchain, transaction is processed by which external user can update the state of a record and information stored in the Ethereum blockchain network. These transactions are treated as *asset* by the Ethereum blockchain as they are pieces of information that user can send to another users or to simply store it for using it later.

Governance Rules:

Ethereum blockchain uses Proof of Work (PoW) consensus algorithm, the reason behind using it is also for ensuring that *governance* of blockchain is maintained in a trusted manner which is through consent from all the trusted nodes attached to the blockchain network.

Network:

Ethereum blockchain uses the peer-to-peer network. In this network all the nodes are connected as *peers*. If no node is acting as a central node then the functions is controlled by central node. The reason behind using this network was because the idea was to create a distributed platform not a centralized.

Transactions

The system includes following transactions

- Add records : would create patient's medical records in the DApp. It contains the fields of ID, name, blood group, and IPFS hash. The basic medical records is stored along with the IPFS hash that contains the file uploaded containing the lab results or other medical records of patient. .
- Update records: would update the medical records of patient. This can only change the basic information of the patient not the IPFS hash. IPFS hash is non-updateable to ensure security of records[1].
- View records: The view records function is used both by doctors and patients. The patient can view his records by the system authenticating that patient views only his own medical records. For this purpose system uses the public account address of the patient to ensure that only the relevant medical records is shown to the patient[3].
- Delete records: would make the user be able to delete record of any patient. The user here would be the doctors they are given this right to delete any patient's record stored on the blockchain[1].
- Grant access: for each of the above mentioned transactions, certain user would need to have access to them, i.e., only the doctor or nursing staff can make change in the report of the patient. But ,patient can view his reports but won't be able to change it[1].

3. System Implementation:

The system is implemented by using the Ethereum and its dependencies.

4. **SMART CONTARCT***:*

smart contracts are an important part of D Apps as they are used for performing basic operations**.**

Following contracts are included in this framework

- Patient Record
- Roles

These contracts are used for giving access to the users on the D App and performing CRUD operations on the records of patient.

The role based access would ensure that there is no third party accessing these functionality and only the authorized users of the system would have access of these functions.

IV. METHODOLOGY

- **Admin :**
  Admin can:-

- Add Doctor to the Network
- Add Patient to the Network
- Delete User(Doctor/Patient)

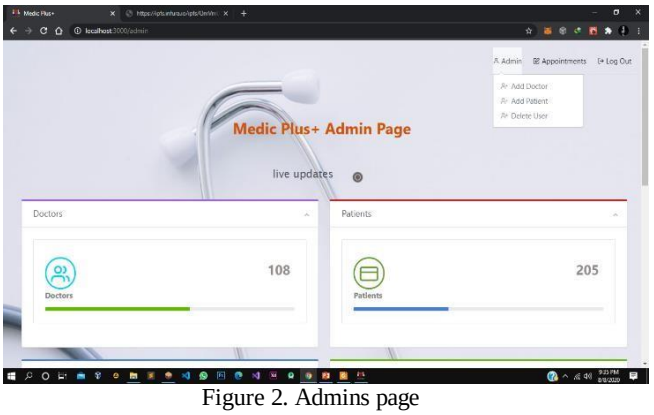

Figure 2. Admins page

- **Doctor:**

Doctors can:-

- Add Patient's Record
- View Patient's Record
- Update Patient's Record
- Delete Patient's Record
- Edit Doctor' s Info

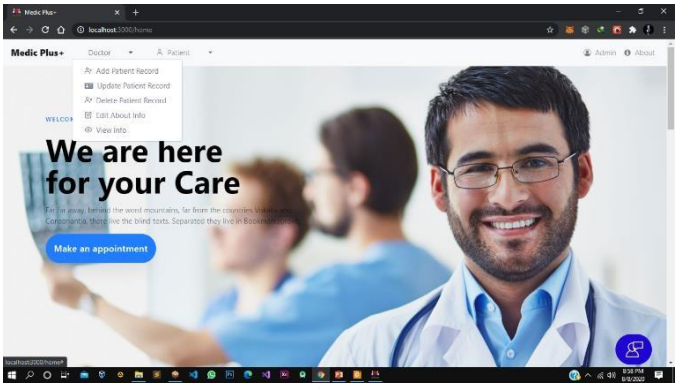

Figure 3.Dcotors page

- **Patient:**

Patient can:-

- View medical info
- Edit About info

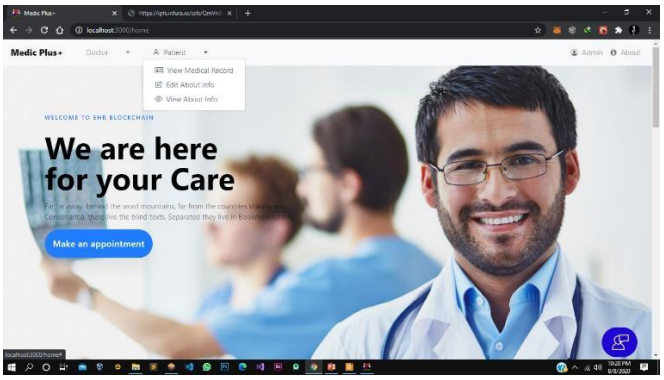

Figure 4. Patient page

V RESULT

As observed in figure 5 ,it is the home page of the Electronic Health record . Home page have 4 options. The User have to choose who is he ADMIN , DOCTOR , PATIENT or MAKE A APPOINTMENT.

Figure 5. Home Page

As observed in figure 6, it is ADMIN Page .Here the ADMIN can see the total number of patients, doctors, transactions. ADMIN can also add Doctor. Admin can view the appointments made by patient and which doctor is assigned to the patient.

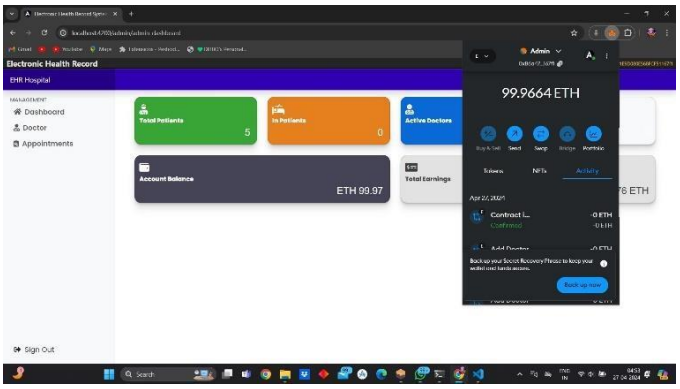

Fig 6 . Admin page

As observed in figure 7,it is the doctor page. It can be opened from the doctor device. Fron here doctor can information, view patient record consult the patient. It also show the doctor about there upcoming appointment.

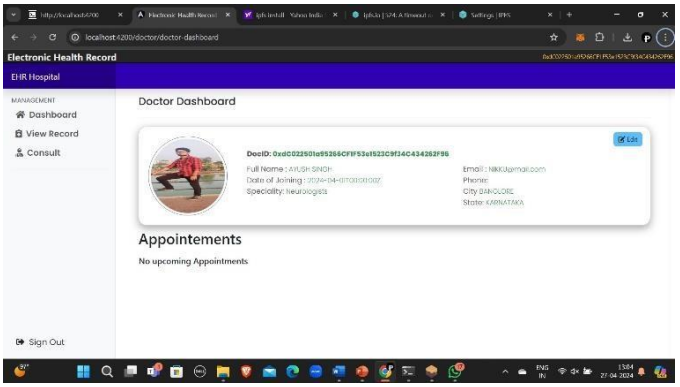

Figure 7. Doctor page

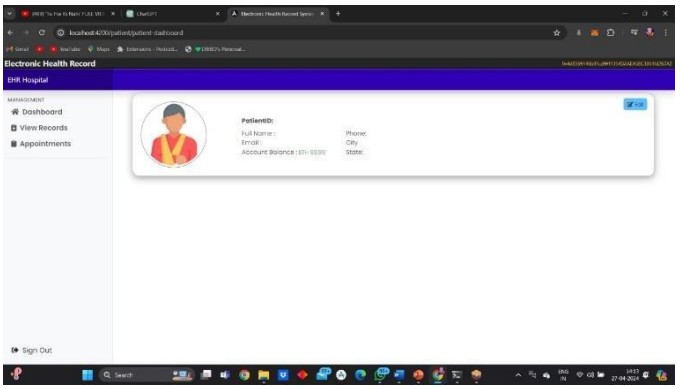

Figure 8. Patient page

As observer in the figure 8, it the the patient module. From the patient module the patient can see his information, view his medical records and the scheduled appointments.

VI. CONCLUSION

In this project we discussed how blockchain technology can be useful for healthcare sector and how can it be used for electronic health records. Despite the advancement in health sector and technological innovation in Electronic Health care system they still faced some issue that was addressed by the novel technology, i.e., blockchain. The proposed framework is the combination of secure storage along with the access rules of the records. It creates such a system that is easier for the users to use and understand. Also, the framework proposed ensure that the system tackles the problem of data storage as it utilizes the off-chain storage mechanism of IPFS. This also solves the problems of the information's asymmetry of EHR system.

VII. FUTURE ENHANCEMENT

For this we need to have certain considerations as we need to decide how much a patient would pay for consultation by the doctor on this decentralized system functioning on the blockchain. We would also need to implement medical insurance module for patients and also a Appointment module , there the patients can take appointments to see the doctors.

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