

Blockchain for Giving Patients Control Over Their Healthcare Records

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Abstract: *The research project explores the potential of Blockchain in the healthcare industry. The current solution to the health care storage and sharing of medical records is the most sensitive Electronic Health Record (EHR). Electronic health records (EHRs) are not digital patient information stored on a network. Various opportunities to improve patient care, performance measurements in clinical practice and to contribute to future clinical research are provided by EHRs. The schemes used to maintain EHRs were not yet very secure in the current era of smart cities and homes. Data can be easily broken by unauthorized hackers and outsiders. Also, the data is not accessible to patients and caregivers. These applications cannot create a balance between data security and data access. But block chain can solve these problems. Most EHR data sharing is still done by post due to the lack of a reliable and reliable health data sharing system. This leads to significant delays in patient treatment. Blockchain has the potential to improve health care by placing the patient in a centralized system and improving health data protection and collaboration. Blockchain is a spatial division that provides cryptographic assurance of data integrity, security, privacy and access to data. Patients fully control their medical knowledge and authorize physicians who can review medical information through grant funding and withdraw access methods and outline the challenges they face, and the problems that need to be addressed.*

Keywords: (EHR)Electronic Health Record, (EMR)Electronic Medical Record, (HL7) Health Level 7, (FHIR)Fast Healthcare Interoperability Resources, (PoW) Proof of Work, (PoS) Proof of Stake, (RSM) Replicated state machine, (Tps) Transactions Per Second, (SDK) Software Development Kit;

I. INTRODUCTION

The traditional system of keeping medical records in particular based on manuscripts they have many problems such as random sequence of events, information, insufficient data, broken record, data repetition, inconsistency with handwriting also sometimes it does not work well. In modern times, victory this shortcoming the healthcare industry is changing about the electronic system based on the electronic and currently known better known as Electrical Health Records (EHR)[1]. Major projects in the health care sector can be considered with an EHR program that starts in a patient medical record, doctor appointments and appointments, clinical and laboratory tests report, doctor's note, payment and accounts and future patient follow-up. The main purpose of the EHR is to provide order, sufficient without restriction, not required medical, consistent and effective medical record participants. The advantage of the system is that it is better efficiency, accuracy, security and low cost. Blockchain technology has greatly improved upgrade to the digital age. Technology in particular based on the built-in appendix data structure and is composed of a set of notes in which members of the peers do not trust all other participants. Notes can be found on chain be order order set of blocks contain a number of tasks and as a result blockchain is considered a chronological text order process.

Key features of the blockchain The technology is as follows:

- Corrected: job records when updated it cannot be changed and the data is stored permanently
- Separation: a copy of the data is kept on all nodes in a network that separates data.
- Consistency: each block is verified by the miner network member.
- Delete: all network members have access or view data.



In a blockchain each block has two parts to the title and liability to pay. Block ID; current hash value block and previous block and timestamp. In the second part jobs are saved. In addition to the various benefits of Current blockchain challenges are also huge. Main the challenges of blockchain technology in health care The categories are: data expansion; data types; accessibility and data privacy and security and privacy. Therefore, the main purpose of the proposed program is to build blockchain-based framework for the Electronic Health System. Technological advances in the last few decades have affected several aspects of human life. It has benefited us in many areas of life especially health care. There has been significant progress in the healthcare industry in recent years. We can now keep our medical records online. Doctors were able to diagnose patients better, communication between doctors and patients was easier and doctors were more readily available to patients in emergencies. With electronic records, patients were able to communicate with their physicians even in remote areas. The health care services available at various hospitals and clinics are becoming increasingly popular, due to the unique increase in health services and patient mobility. Physicians with knowledge of a patient's medical history can make informed decisions about their patient's health. The biggest problem is the health care services currently facing, how to share clinical information with various health care facilities while ensuring confidentiality, data integrity, and patient privacy.

II. DESCRIPTION OF THE PROBLEM

Statement of Problem

Taking control of health records and making an EHR system are two individual systems. Considering this in mind we understood the gap of technology.

III. LITERATURE REVIEW

Smart healthcare realizes the interaction between patients and medical staff, medical institutions, and medical devices by building a health archives regional medical information platform and using the most advanced Internet of things technology, so that the medical industry gradually achieves information. Sharing medical data is an important step to make the medical system more intelligent and improve the quality of medical service. However, the sharing of patient data among institutions is not yet fully realized [16], and the blockchain is a great way to solve this problem right now. Blockchain is distributed data systems involving multiple independent nodes, which is an emerging technology for decentralized and transactional data sharing among large networks of untrusted participants. It features decentralization, timestamps, collective maintenance, programmability, and tamper-proofing. Blockchain has relatively few applications in medical treatment, and the existing research mainly focuses on combining blockchain 2 Journal of Healthcare Engineering with a certain information technology to build a single application platform, such as using blockchain technology to build a medical transaction sheet verification system; using etheric blockchain to build a medical information sharing platform MedRec which combines blockchain with big data; and using blockchain technology. However, the application of blockchain technology in the whole intelligent medical industry lacks systematic research. Based on this, the study will build a customer-centered blockchain smart healthcare application system based on stakeholder theory to explore its development path. After sorting out and analyzing all the stakeholders of the system, we get the application system based on ten aspects including 22 criteria.

IV. SYSTEM DESIGN AND FLOW

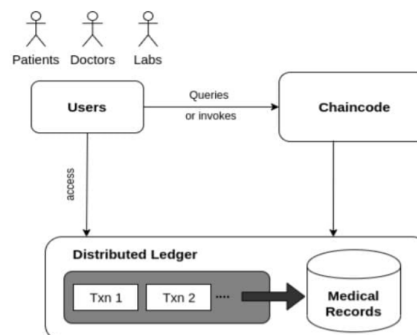


Fig. System Architecture

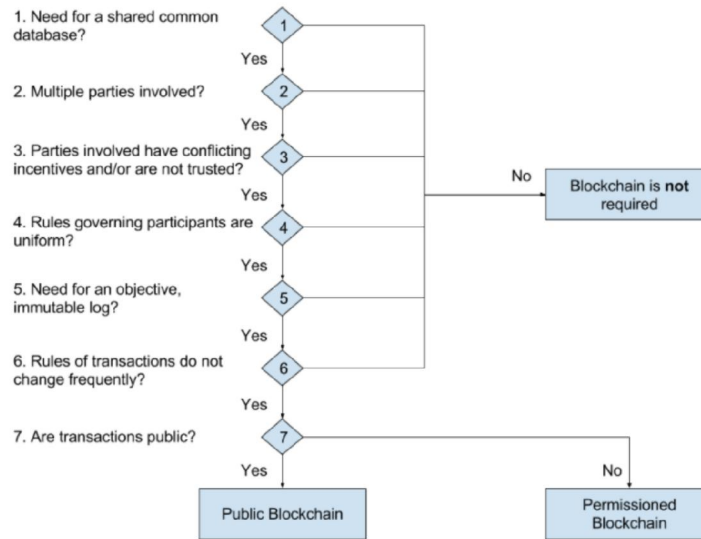


Fig. Blockchain decision Flow Diagram - Level 0

4.1 Consensus Algorithm

A consensus algorithm is a protocol through which all the parties of the blockchain network come to a common agreement (consensus) on the present data state of the ledger and be able to trust unknown peers in a distributed computing environment. Each block that is added on the chain would need to follow some consensus rules for it to be added on the blockchain. For this purpose blockchain technology uses consensus algorithms. The most common consensus algorithm used is Proof of Work (PoW) algorithm and it was used by Nakamoto, in bitcoin network. The basic working of this algorithm is that there are number of nodes or participants on a Blockchain network so when a transaction is requested to be added on the network by any participating node it needs to be calculated. This process is called mining and the nodes that are performing these calculations are miners.

We know that Blockchain is a distributed decentralized network that provides immutability, privacy, security, and transparency. There is no central authority present to validate and verify the transactions, yet every transaction in the Blockchain is considered to be completely secured and verified. This is possible only because of the presence of the consensus protocol which is a core part of any Blockchain network.

The Blockchain consensus protocol consists of some specific objectives such as coming to an agreement, collaboration, cooperation, equal rights to every node, and mandatory participation of each node in the consensus process. Thus, a consensus algorithm aims at finding a common agreement that is a win for the entire network.

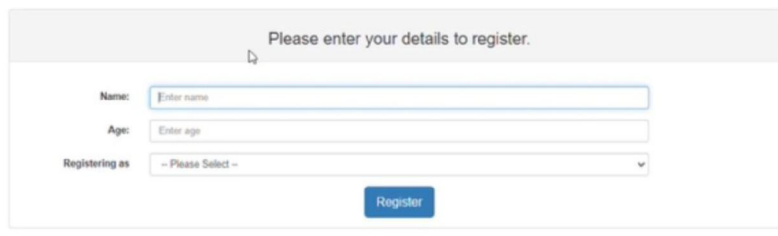
4.2 PBFT Algorithm

The PBFT algorithm is used as the consensus algorithm in the medical blockchain because the PBFT algorithm is a consensus algorithm suitable for the alliance chain. Its advantages and disadvantages are:

1. The PBFT algorithm does not need to rely on a large amount of computing power to avoid the 51 percent attack like the POW algorithm, nor does it need to rely on tokens as a standard to measure voting rights like the POS algorithm or DPOS algorithm. In the case of $(n-1)/3$ nodes error (data loss, nonoperation, etc.).
2. As a kind of Byzantine fault tolerance (BFT) algorithm, PBFT algorithm can guarantee the normal execution of a distributed consensus process when there are less than or equal to $(n-1)/3$ faults or malicious nodes in the system. [20] This requires that the nodes in the network using the PBFT algorithm have at least $(2n+1)/3$ normal nodes in each consensus process, so the environment in which these nodes operate must be relatively safe and stable.

3. The medical blockchain is an alliance chain. The entities participating in the medicalblockchain are endorsed by the government, have certain credibility, and are strictly supervisedby the health management department. The occurrence of malicious behavior is far less than thatin areas such as Bitcoin. At the same time, after years of information development, each hospitalhas a relatively complete network, server, and database system. Therefore, the existing medicalsystem can provide a relatively safe and stable operating environment for the regular operation ofthe PBFT algorithm. At the same time, each node in the cluster running the PBFT algorithmis equal in status, there are no high or low voting rights, and it avoids the centralization of themedical blockchain system when verifying transaction orders or the blockchain.

VI. PROJECT IMPLEMENTATION



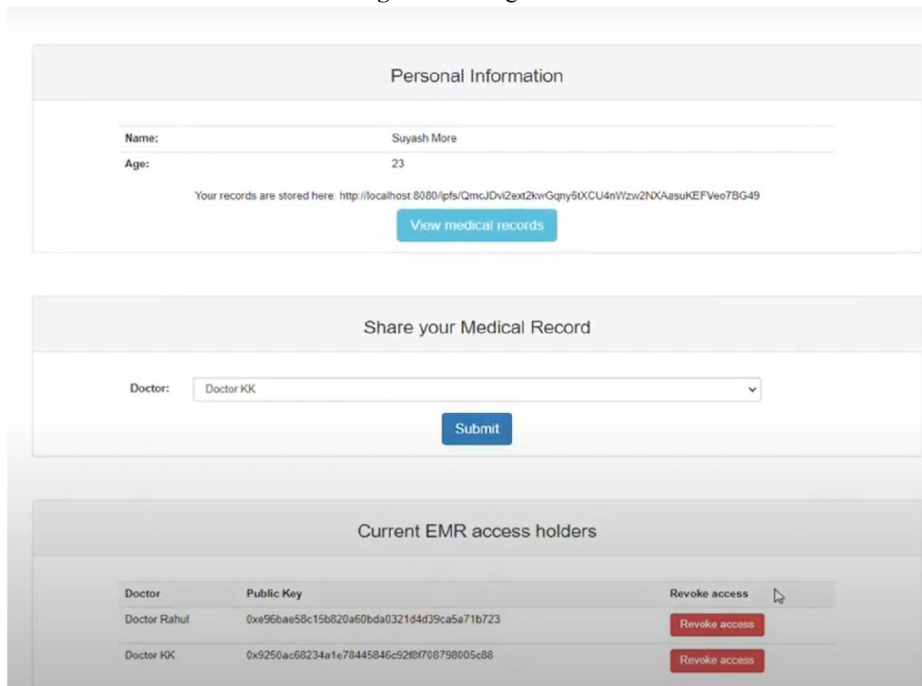
Please enter your details to register.

Name:

Age:

Registering as:

Fig. Admin Login GUI



Personal Information

Name:

Age:

Your records are stored here: <http://localhost:8080/ips/CmcJDvi2ext2kwGqny50XCUCU4nWzvw2NXAasuKEFVeo7BG49>

Share your Medical Record

Doctor:

Current EMR access holders

Doctor	Public Key	Revoke access
Doctor Rahul	0xe96bae58c15b820a50bda032164d39ca5a71b723	<input type="button" value="Revoke access"/>
Doctor KK	0x9250ac68234a1e78445846c52f87f08798005c88	<input type="button" value="Revoke access"/>

Fig. Admin Dashboard GUI

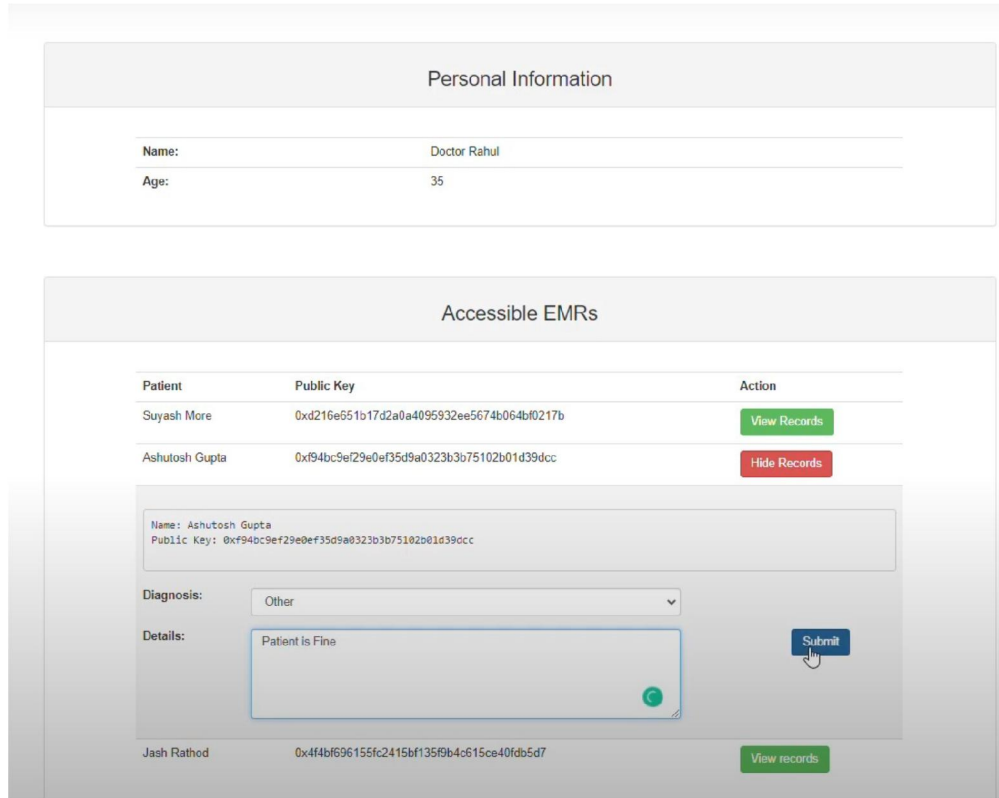


Fig. New patient dashboard GUI

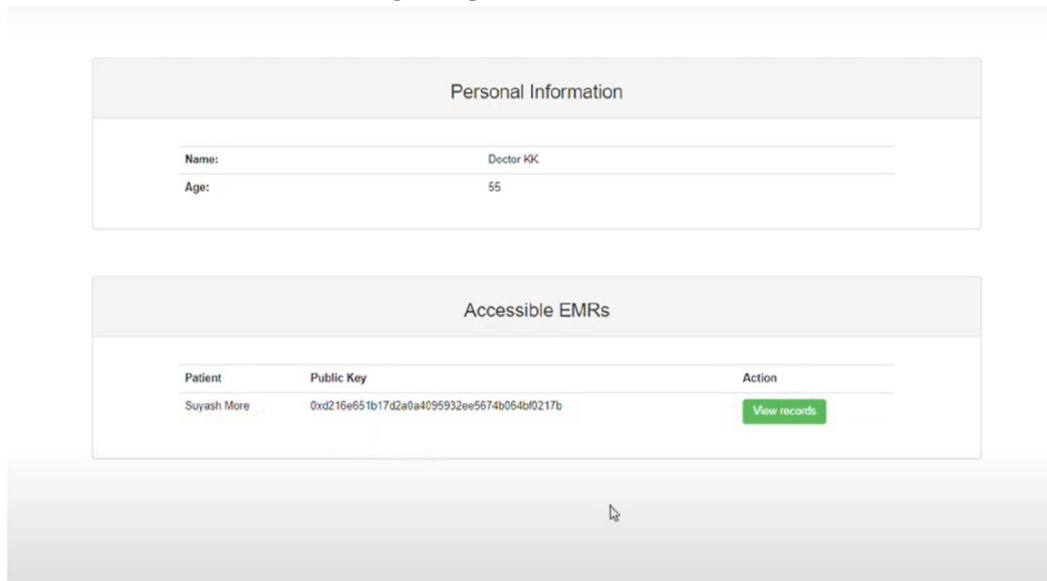


Fig. Doctor's dashboard GUI

VII. DISCUSSION AND RESULTS

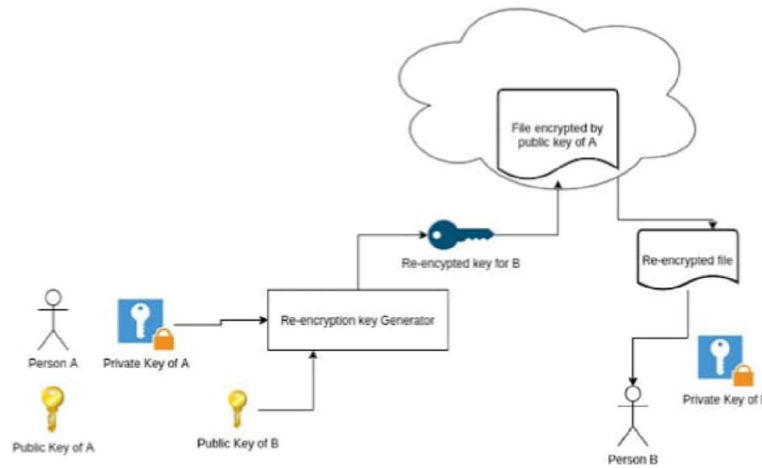


Fig. Security Mechanism

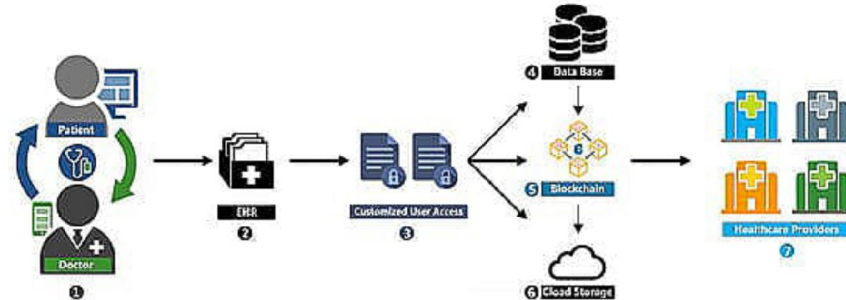


Fig. Deployment Diagram

VIII. ADVANTAGES & DISADVANTAGES

8.1 Advantages

- **High Level Data Quality:** Blockchain Technology offers a superior level of data quality. In reality, it is a distributed ledgersystem where it stores data. But how does it provide high-quality data. Anyhow, this distributedledger offers a consensus process that allows you to filter out any bad data with useful data. Itmeans that no one can just add any kind of information on the ledger or even manipulate the existing ones.
- **Data Security:** Since the blockchain is Immutable and traceable, patients can easily send records to anyone without the fear of data corruption or tampering. Similarly, a medical record that has been generated and added to the blockchain will be completely secure.
- **Information Confidentiality:** The patient can have some control over how their medical data gets used and shared by the institutes. Any party which is looking to get the medical data about a patient could check with the blockchain to get the necessary permission.
- **User Friendly:** This Project has UI designed with maximum features and is Flexible to use. The UI is designed in such a way that any user can use the system easily which helps him in managing things. So this is a User-Friendly Project.
- **Data Transparency:** Pharma companies need to have an extremely secure supply chain because of the kind of product they carry. Pharma drugs are consistently stolen from the supply chain to be sold illegally to various consumers. Also, counterfeit drugs alone cost these companies, nearly 200 billion dollars annually. A transparent

blockchain will help these companies to enable close tracking of drugs to their point of origin and thus help eliminate falsified medication.

- **Unified Database:** Various medical institutes around the world conduct their own research and clinical trials on various new drugs and medications. A blockchain will help create a single global database to collect all this data and put them in one place.

8.2 Disadvantages

- Electronic Health Records (EHRs) are a vital component of most medical practices in today's digital age. Making the transition from a paper-based system to a digital can improve not only the quality of work for your employees but the experience of your patients.
- However, EHRs are not always perfect. If you are currently using EHR software, it is likely that you have experienced problems or issues along the way. These problems could include data bottlenecks, a need for additional staff training, and skills mismatches.

8.3 Application

- Blockchain can provide proof-of-existence for any document and allow anyone to verify the authenticity of said document.
- In order to add new data in the form of transactions, the majority of nodes have to agree that it is valid and coherent with the blockchain history.
- Indeed, as mentioned above, data is often altered or modified because there is currently no system that prevents it. The public key proves that a certain document was registered on the blockchain at a certain time.

IX. CONCLUSION & FUTURE WORK

In this paper, we have proposed a blockchain-based approach to give patients control over their medical records in a decentralized, traceable, reliable, trustful, and secure manner. We have created an architecture for the Electronic Health Record using blockchain technology and we have proposed a framework for the blockchain and create a block to store the patients data in a decentralized healthcare network for secure sharing. We were able to deploy a blockchain-based EHR network and implement basic functionalities in the network. We successfully achieved the main objective of this research by using the primary features of blockchain that is hashing and decentralization. We conclude that blockchain technology is an innovative technology for implementing EHRs and also it has the potential to help in the research and progress of healthcare in the near future.

The idea and implementation can be further extended in the future by implementing various features to handle the advanced functionality of the EHR system. Various sectors like billing, transportation, etc can be added to the network to implement a full-fledged healthcare management system. To make it interactive it can be integrated with a web application. EHRs can be made helpful for pharmacists in monitoring medical sales by adding them to the system as another participant. Thus far, blockchain applications have focused primarily on physician credentialing and chain logistics. There are companies working on technologies that will allow blockchain to be used in the management of electronic health records, but regulations are making it difficult to move forward. In countries like the U.S., which have a "zero risk tolerance," the government may need to work with these companies to get things moving and become a part of the initiative. Despite challenges on the regulatory front, blockchain appears to be the most practical solution for managing data that's tamper-proof and anonymous. The technology could solve the health industry's interoperability issues. One of the primary benefits of using blockchain is that it will allow patients to connect electronic medical records and seamlessly share their record across all healthcare providers. In this way, the technology could improve the quality of patient care. It will be years before we see blockchain become an integral part of the healthcare industry. Broad adoption is a long way off, but the technology is already being implemented in some areas of healthcare.

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