Electronic Health Records Maintenance Using Blockchain

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Abstract - *The world is experiencing innovations every day in every industry. Even the medical field is not an exception to this. Many revolutionary instruments help to save the life of the patient in a critical time. Still, there is not an effective method that could store this data securely as well as conveniently. Medical organisations are experiencing data breaches on medical health records more often than ever. This paper considers the above aspects and tries to provide the implementation of a robust system that could withstand the attack on security effectively.*

This paper highlights the benefits that can be achieved by using Blockchain in storing the electronic health record. Being a decentralised system, Blockchain can work as a prominent solution to the problems aroused by a centralised system. Implementation of smart contracts simplifies things and makes record creation and validation less complicated.

1. INTRODUCTION

In the Healthcare sector, medical record management and interoperability have always been institute-driven; however, privacy and security have always been a significant question for this system as patients have no control over their medical data. This has given rise to a new concept of a patient-centred interoperability system where the operation, possession, and utilisation of medical data should be allowed for data subjects other than medical institutions. This transition from institution-driven to patient-centred interoperability can be achieved using Blockchain technology. Data immutability, decentralised process, peer-to-peer network, and consensus mechanism are vital aspects of Blockchain technology and can improve medical record management and insurance claim process.

Blockchain technology can guarantee the security and integrity of medical data by ensuring authorised access. The reliance of this technology on public-key cryptography and hashing techniques as a medium to keep track of medical and transaction history concerned with patients' records will ensure protection against loss or modification of records, falsification, or accession by unauthorised users. Blockchain only supports data to be appended to the database; removal of data is not permitted.

Cryptographic hashing is used to link new information to previous records securely. Medical records follow a consensus mechanism prior to their addition to the network. The purpose of the consensus mechanism is to allow a group of separate nodes to distribute the right to update the system according to a specific set of rules, amongst a set of participants, and in a secure way. There are different consensus mechanisms like Proof of Work, Proof of Stake, Leased proof of stake, Delegated proof of stake, and Proof of Importance.

In this paper, we have presented a Blockchain-based health record management web-app that overcomes the shortcomings present in other available apps that use traditional databases in terms of privacy, security, and confidentiality.

2. LITERATURE SURVEY

In this section, we address the various attempts made to eradicate security issues with health record management, its challenges, and the possible solutions.

In 2018, a paper titled "BlocHIE: a Blockchain-based platform for Healthcare Information Exchange" was published in IEEE International Conference by authors of Hong Kong Polytechnic University on a Blockchain-based health information exchange application designed by them [9]. In this paper, they have illustrated a solution to the storage and sharing of medical information by dividing healthcare records into two types electronic medical records and personal healthcare data for analysing their requirements to meet the needs as mentioned earlier. Based on those analyses, they designed BlocHIE on two loosely integrated Blockchains where EMR-Chain was for electronic medical records and PHD-Chain for personal healthcare data. The EMR-Chain was built by combining off-chain storage and on-chain verification to counter privacy, confidentiality, and authenticity issue. They have illustrated a system of three copy storage where the first two copies will include only the medical information related to the patient and will be sent to the hospital and patient, respectively. While the third copy will consist of a timestamp, medical record hash value, signatories of the hospital and patient, which will be stored in the Blockchain network.

In the paper titled," BHEEM: A Blockchain-based Framework for Securing Electronic Health Records," the authors have focused on some loopholes and their possible solution used in the app. In this paper, they have proposed the usage of cipher manager to nullify unauthorised access to the records by incorporating encryption techniques prior to sending and receiving records over the Blockchain network. This app was built on top of Ethereum Blockchain, where the use of its address and identifier will make identification difficult for unauthorised users. The paper also illustrated that total

privacy cannot be achieved but can be minimized to a much greater extent as with the use of technology makes it easier to know specific nodes visits a provider and also the frequency visits making it possible to gather some part of personal information. For this, they have proposed a solution of adding noise to the transaction in the Blockchain. It has also addressed high storage problems occurring due to redundancy by the use of hashes and small EHRs only for storage. This will eventually minimize the storage space and cost of mining.

3. PROBLEM STATEMENT AND OBJECTIVES

A. Problem Statement

Interoperability, accessibility, security, and management of patient data has been a significant problem of the healthcare ecosystem. By some estimations, in the United States, around 30% of the visits report the loss of medical charts. According to HIPAA, in 2019, healthcare data breaches at a rate of 1.4 per day were reported.

Blockchain technology can be a possible solution quickly bring specific changes in the health records management of the patient and to address the problems mentioned above. Due to this technology, the responsibility of sharing the data and authorising access to the data will be in the hands of the patient itself.

B. Objective

The main objectives are the following:
- To create a platform dedicated to storing medical data and patient's history secured.
- To give the owner the right to access and share medical data without anyone's acknowledgement.
- To produce confidentiality to patient medical records victimisation. Patient information secrecy or confidentiality is one amongst the foremost necessary pillars of healthcare.
- To facilitate the transition from an institution driven to patient-centered interoperability.

4. PROPOSED WORK

A large number of institutions and developers are now recognising Blockchain as a mechanism that could help solve problems prevailing in the healthcare industry for a decade or two that have resulted in prodigal spending and higher costs for patients, providers, and insurers. They foresee it as a key that can unlock obstacles to medical data sharing and ultimately empower industry-wide transposition to value-based care. Our solution is an attempt to:
- Increase efficiency
- Improve decision making
- Less time consumption
- Transparent system
- The Secured and decentralised network

4.1 Applications

Administrative Management:
According to some statistics in the U.S around 86% of mistakes are administrative of which most are related to loss of medical data or misplacements in the healthcare industry resulting in 400,000 deaths each year. Immutability and distributed data across each node in the network can substantially eliminate these mistakes.

Insurance Claims and Bill Management:
Malpractices and fraudulent claims can be easily detected as well as management of bill can be eased down with the use of Blockchain technology with the use of smart contract tool and its tamper-proof environment. This can help in cutting many intermediaries associated with collecting and verifying information that can be solely done by the Blockchain itself.

Clinical Research:
Currently, medical research is conducted on localised systems, which is an inefficacious way of sharing research, affecting the outputs of researches, thereby hampering the development of the field. The decentralised system can be a fix to this problem which will increase the productivity of conducting the research.

Securing Patient's Data:
Medical identity theft has been a major concern of the healthcare industry. On an average 17,000 patient records breaches are found every year according to a report. Blockchain can be a promising answer to the constant rise in data breaches. The use of a cryptographic hash mechanism for storing the data in the network can safeguard medical data from data breaches.

Patient's Statistics:
Machine learning technology can be integrated with Blockchain technology to track patients' progress and biological changes which can help prevent future health risks and adversaries.

Drug Supply Chain:
Medical institutions and pharmaceutical companies can keep track of their drug delivery and verification of drugs to prevent counterfeiting incidents. Efficient patient results can help them analyse an area of improvement in the production of drugs for more effective results.

Patient Access Control:
Blockchain will enable the rights of access and control permissions in the hands of the patient. Individuals will be responsible for granting permission to access their medical records. They can also set a particular timeline for the access granted to the individual. This will eliminate the incidents of medical record hoarding.

5. TECHNOLOGIES USED

Bootstrap: Bootstrap is a framework used for the development of web apps as well as websites. It is built on top of HTML, CSS, and JavaScript. It is generally used for developing interactive mobile-first applications. Bootstrap is

widely popular because it is free to use and also an open-source framework.

Bootstrap is a web framework that bases on improving the progression of edifying pages. The fundamental job of adding it to a web adventure is to apply Bootstrap's choices of concealing, size, literary style, and plan to that adventure. In that limit, the primary factor is whether the designers in control find those choices precisely as they would like. Once added to an assignment, Bootstrap gives basic style definitions to all HTML segments. The result is a uniform appearance for articles, tables, and structure parts across web programs.

The Bootstrap is executed in the system as it encourages the user to associate with the information in a hassle freeway. The client can get to information effectively with the assistance of an intuitive user interface.

Node.js: Nodejs is an open-source, cross-platform, JavaScript runtime environment built on Chrome's V8 JavaScript engine. The main motive behind using Nodejs is it provides a powerful API to interact with the environment. It acts as an interface between the client and the data stored in the ledger. Knowledge of JavaScript is required to work with Nodejs.

Its modular construction gives application developers the liberty to plug in alternative implementations of key functions such as crypto suites, state persistence stores, and logging utility. On the contrary, it can be used for developing front-end for projects.

6. IMPLEMENTATION

- **Secure Google Login:**

Our application uses a secure Google Login, i.e. users can use the application with their Google accounts. The applications use firebase to provide secure and simple login process.

- **User Profile:**

Every user will have a profile assigned which will display user details like id, full name, address, phone number, etc.

- **Feedback Page:**

Users can submit feedback from within the app which will be received by the administrators. This can be used to make the app even better in the future.

- **Main Interface:**

The main interface contains a top navigation bar which gives access to the following prominent features of the application:

Patient Information: This feature consists of all the necessary information related to the user's health. The personal information is displayed along with the user's medical information like blood group or allergies.

Document Upload: This feature allows the user to upload the medical documents. These documents are generally the prescriptions provided by doctors, the x-rays and tests that patient have done throughout the illness.

Treatment History: If a patient decides to change the hospital for better treatment, then a patient can update the information regarding treatment history in this section. Every history from the data fed to the app will be stored. This stored history is used in future cases related to patients' health.

Current Status: This feature allows the patient to remain up to date with the current treatment process. This section will display the current prescriptions and the measures to take care of during the illness.

- **Adding New Blocks:**

The genesis block is already created during implementation. Then each block gets mined dynamically. The blocks are added after the information pool has reached a certain level. The mined block is distributed to the entire network. This tackles the problem of a ransomware attack. The ledger keeps record if the data is changed from the block.

- **Creating New Records:**

Once the patient updates the records on the application, the data is fetched, and a new record is created. These records are added to the newly mined block. The records are editable, but the log of editing is maintained in the ledger, and this ledger gets updated from time to time. Each entity in the Blockchain has this ledger and any malfunction can be traced through this ledger.
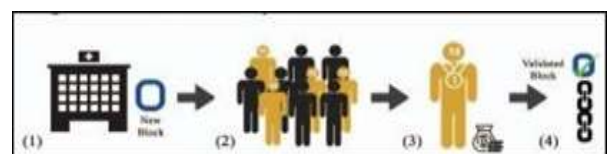
- **The Flow of Data in Block:**

Fig -1: Flow of Data in Block

The patient visits the hospital with an issue regarding health. The hospital performs necessary tests and provides prescriptions. The doctors from the hospital can access data with the consent of the patient [5]. The data is updated throughout the duration of the patient's illness in the respected hospital. This data block is then sent to miners for the mining process. After the mining of the block is completed, the miner gets rewards as shown in the third step, and the verified block is added to the Blockchain.

7. RESULT ANALYSIS

The use of this application will have a great impact on the health care industry. It will keep users up-to-date with the data, and users can also keep track of the history of data regarding health. This tracking of the data benefits the healthcare sector to act as immediately as possible in case of an emergency. The health care insurance sector also gets benefitted as the claims of insurance can be satisfied with fewer hassles in the process.

Though the security issues are always present the system will help to mitigate the risk and minimalisation of the damage is

possible. Threats such as ransomware attacks are completely eliminated as everyone holds the copy. The decentralisation of the authority makes DDoS attacks on the system nearly impossible. User-based wallet attacks are aimed directly at the user's credentials, and these attacks might create problems in the blockchain network, but the risk is very low [7].

The patients have always remained concerned about the security and compromise of personal data. This system provides a robust solution for this problem by providing authority of the data entirely to the patient.

8. CONCLUSION

This system provides an efficient and robust solution for the aforementioned problems. The world is slowly adapting the changes in the healthcare sector. Once the Blockchain is established concretely in this sector then the healthcare sector, will pose few risks regarding the security and authenticity of the data. Though the Blockchain is prone to attack the risk of the attack is minimalised [7]. The storage of the data might create problems, and we are focused on how to mitigate the problem of storage of the data.

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