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Pre Settlement in Insurance for Hospital Treatment Using Cryptocurrency and Blockchain Technology

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***Abstract*: Security and privacy of patients' data is a major concern in the healthcare industry. In this paper, we propose a system that activates robust security and privacy of patients' medical records as well as enables interoperability and data exchange between the different healthcare providers. The work proposes the shift from patient's electronic health records being managed and controlled by the healthcare industry to a patient-centric application where patients are in control of their data. The aim of this research is to build an Electronic Healthcare Record (EHR) system that is layered on the Ethereum blockchain platform and smart contract in order to eliminate the need of third party system. With this system healthcare provider can search for patient data and request the patient consents to access it. Patients manage their data which enables the expedited data exchange across HER systems. Each patient data are stored on the peer to peer node ledger. The proposed patient centric HER platform is cross platform compliant, as it can be accessed via personal computers and mobile device and facilitates interoperability across healthcare providers as patient's medical record are gathered from different healthcare providers and stored in a unified format.**

***Keywords*: Blockchain, Smart contracts, Cryptocurrency.**

1. Introduction

Blockchain technology has emerged as a key technology recently in the digital revolution of the healthcare sector and several research studies have identified blockchain potential for the healthcare ecosystem. It is ready to transform the way traditional medical systems and businesses have been engaged in the healthcare sector for the last several decades. Information and Communication Technologies (ICTs) and blockchain are key enabling technologies for the decentralization and digitalization of healthcare institutions and provides modern and digitilized healthcare ecosystem to patients as well as service providers. Blockchain applications for healthcare data management create utilities for patient, doctors and healthcare institutes in the directions of patient record access and control, claims and payments management, management of medical IoT security and research data verification and exchange for financial auditing and transparency. In these applications, real-time updates to an encrypted, decentralized blockchain ledger are done to understand, monitor, and control medical information. This also facilitates the healthcare institutions to restrict the unauthorized Healthcare

Management involves many processes such as managing finances, patients, billing, logistics, inventory, etc. Medical workflows often involve repetitive tasks related to the actual patient treatment that can be plotted out as a series of conditional steps. These are designed to provide better internal controls and improved efficiency, compliance, productivity, and reduce risk, work cycles and overhead within hospitals and other healthcare service providers. In this study, multiple medical workflows are designed for different healthcare service providers.

Security and privacy of patients' data is a major concern in the healthcare industry. In this paper, we propose a system that activates robust security and privacy of patients' medical records as well as enables interoperability and data exchange between the different healthcare providers. The work proposes the shift from patient's electronic health records being managed and controlled by the healthcare industry to a patient-centric application where patients are in control of their data. The aim of this research is to build an Electronic Healthcare Record (EHR) system that is layered on the Ethereum blockchain platform and smart contract in order to eliminate the need for third-party systems. With this system, the healthcare provider can search for patient's data and request the patients' consent to access it. Patients manage their data which enables an expedited data exchange across EHR systems. Each patient's data are stored on the peer-to-peer node ledger. The proposed patient-centric EHR platform is cross-platform compliant, as it can be accessed via personal computers and mobile devices and facilitates interoperability across healthcare providers as patients' medical records are gathered from different healthcare providers and stored in a unified format. The proposed framework is tested on a private Ethereum network using Ganache. The results show the effectiveness of the system with respect to security, privacy, performance and interoperability.

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2. Problem Statement

Healthcare data is scattered across different systems and sharing it is influential for establishing an effective healthcare system. Storing data at a centralized location can be a single point of security attack. Lack of coordination in health data management and exchange needs a cohesive health care system to keep patients' medical history up-to-date. It also needs to establish trust so that patients do not have to worry about the confidentiality of their records because patients may sometimes avoid treatment fearing privacy of their information.

The rise of blockchain technology provides a path way in developing a ledger - shared, immutable, and transparent history of all the actions that have happened in the medical network (such as a doctor accessing or uploading patient's data, or sharing the medical data for research) to overcome the issues presented above. While designing this ledger based cohesive healthcare system, patients should get major benefit in taking medical treatment without delay and viewing a holistic, transparent picture of their medical history. The key benefits of applying the block chain technology in healthcare system is developing a solution to ensure integrated medical data security, data control and healthcare data management between patients and connected medical experts in the network. To overcome the security issues in the existing system, the objective of our paper are to develop a secure Blockchain based Healthcare system to provide patient medical record access to doctors and researchers in a blockchain network.

A. Categories in Blockchain

1) Permission less Blockchain or Public Blockchain

In permission less blockchain every user is allowed to create his own address and begin to interact with the network, by submitting transactions and adding entries to the ledger. Any node in the network can employ the mining protocols to verify the transactions by mining operations, in exchange for mining fees and block rewards. permission less blockchain uses proof of work where mining is done by solving complex mathematical equations which in return validate the transactions that to be added to the ledger. Digital currencies like Ethereum, the blockchain network also support smart contracts, which are automated transactions that self-execute when some criteria are met.

2) Permissioned Blockchain

Permissioned blockchains are like a closed ecosystem, where users are not freely able to join the network, see the recorded history, or issue transactions of their own. Permissioned blockchains are preferred by centralized organizations, which leverage the power of the network for their own, internal business operations. Permissioned blockchains have a set of trusted parties to carry out verification, and additional verifiers can be added with the agreement of the current members or a central authority. Permissioned blockchains are intended to compatibility with existing applications. They can be fully private or consortium blockchains. Because the actors on the network are named, the intention is that they are also legally accountable for their activity. An advantage of a permissioned blockchain is scalability. In a permission less block chain, each node verifies all the transactions and the data is stored on every computer in the network. It is sure that once the number of transactions increases substantially, the users that are able to perform this processing and verification will decrease, resulting in more centralisation. In a permissioned blockchain, only a smaller number of selected participants as miners, and in large institutions, they will be able to scale their computing power to meet the increase in the number of transactions. As there will be preselected participants it will be easy to alter the results and can reject the transaction easily.

3) Hybrid blockchain

hybrid blockchain is best defined as the blockchain that attempts to use the best part of both private and public blockchain solutions. In an ideal world, a hybrid blockchain will mean controlled access and freedom at the same time.

The hybrid blockchain architecture is distinguishable from the fact that they are not open to everyone but still offers blockchain features such as integrity, transparency, and security.

As usual, Hybrid blockchain architecture is entirely customizable. The hybrid blockchain members can decide who can participate in the blockchain or which transactions are made public. This brings the best of both worlds and ensures that a company can work with its stakeholders in the best possible way.

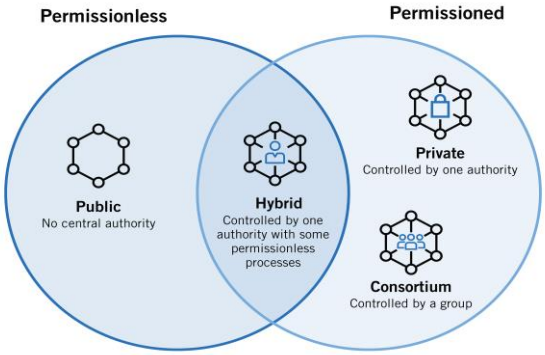

Fig. 1. Different types of blockchain

3. Smart Contract

A smart contract is a type of agreement that uses blockchain to automatically and securely execute obligations when certain conditions are met. Like other blockchain-based technologies, the smart contract is designed to function unlike a centralized authority. A smart contract is both self-executing and self-enforcing. Smart contracts operate on straight forward 'if this, then that' Boolean logic. In this approach, an asset or currency is transferred into a program and program runs this code to validate automatically to determine whether the asset should go to one person or back to the other person or be refunded. Ethereum is a platform for deployment of internet services, for which the smart contracts are building blocks.

Smart contracts work by following simple "if/when…then…" statements that are written into code on a blockchain. A network of computers executes the actions when predetermined conditions have been met and verified. These actions could include releasing funds to the appropriate parties,

registering a vehicle, sending notifications, or issuing a ticket. The blockchain is then updated when the transaction is completed. That means the transaction cannot be changed, and only parties who have been granted permission can see the results.

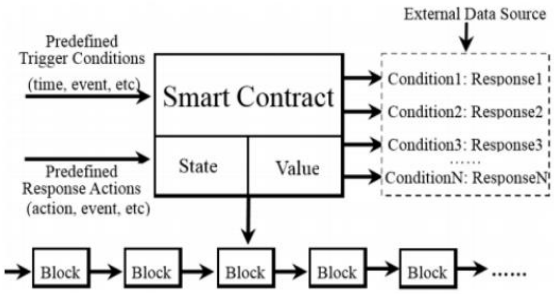

Fig. 2. Smart contract

Within a smart contract, there can be as many stipulations as needed to satisfy the participants that the task will be completed satisfactorily. To establish the terms, participants must determine how transactions and their data are represented on the blockchain, agree on the "if/when...then…" rules that govern those transactions, explore all possible exceptions, and define a framework for resolving disputes.

Then the smart contract can be programmed by a developer – although increasingly, organizations that use blockchain for business provide templates, web interfaces, and other online tools to simplify structuring smart contracts.

4. Cryptocurrency

It all began in the 1990s when American cryptographer, David Chaum, created what was considered as the first kind of online money in the Netherlands: DigiCash. He created DigiCash as an extension of an encryption algorithm that was considered popular during those times, which was RSA. The technology he created, together with its eCash product, was able to generate a huge amount of attention from the media. It became so popular that Microsoft Corporation tried to buy DigiCash for $180 million with the intention of placing DigiCash on every computer in the world that ran on the Windows operating system.

Future of Cryptocurrency:

One of the main motivations that fuel the development of cryptocurrencies is the breaking down of existing financial and technological barriers and borders, particularly in the realm of trade and finance. More than 1,000 altcoins are vying with each other in terms of early blockchain developmental stages. As a result, we can reasonably expect to see only a couple of successful.

5. Implementation

This require softwares like Ganache, truffle or remix to be installed in system first. Once installed Ganache platform provides us with 10 wallet address which we can link to our entities created in network, along with wallet address this platform also provides 100 Ethereum for each address to carry out transactions. In step1, open command line and write "truffle console –network healthcare" this will make us switch to blockchain network after that write "truffle migrate –all" this will migrate our smart contracts in blockchain network and compile it after that write "web3.eth.getAccounts()" this function invocation will provide the 10 number of wallet address from ganache. We can open ganache and check. In ganache we can see which wallet address has how much amount of ether fig. Every wallet has private key, also shows index number and total transactions occurred on that address.

Fig. 3. Smart contract deployment by command line

We have already registered doctors, and patients. Doctor sends the bill amount with details directly to insurance company of that patient. Now insurance company has all the details and now anyone can't provide false bills to take undue advantages from insurance company, all the information will be stored in block in blockchain network which can't be modified. In fig 2, shows the doctor's login panel, here doctor can login himself by using login credentials.

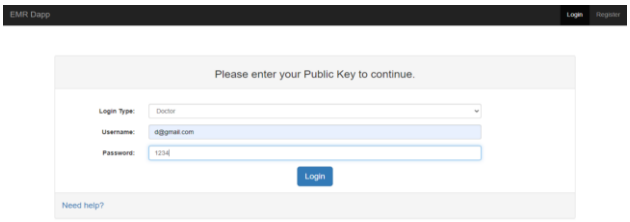

Fig. 4. Doctor's login page

By entering the patient details we can register a new patient by assigning one of the ganache wallets.

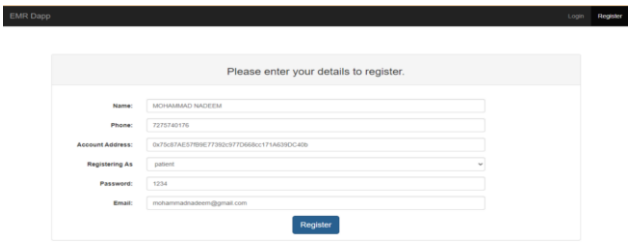

Fig. 5. Patient registration

Now we will check the database as we have registered a new patient. The database contains patients' ID, Patient Name, E-Mail, Ganache wallet address (Account) assigned to patients, Password & Contact Number.

A doctor login himself to check the patient's admission details, to give them a prescription, to generate a bill for their

expenses in treatment. The login page of a doctor contains Home Button, Add Prescription Tab, Patient Tab (Where doctor can see list of patients), Bill Tab (For bill generation) and log out button.

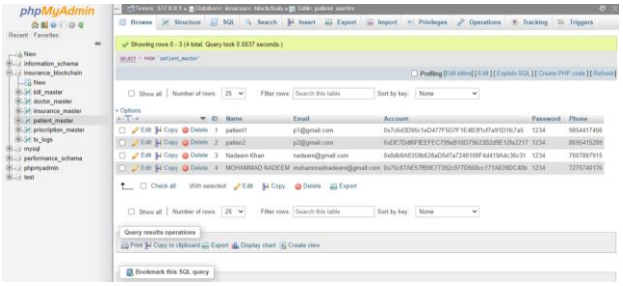

Fig. 6. Database

Fig. 7. Patient's list

The doctor can choose one of the patients listed on the page and can add a prescription. Doctor will choose one of the listed patient and by clicking on details tab the patient details appears like, patient name, email, phone number, select file (where doctor can add prescription file in jpg/jpeg/pdf/png format) and description.

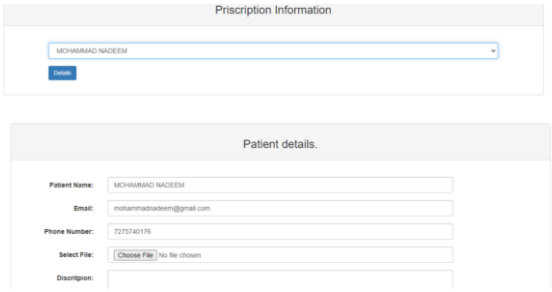

Fig. 8. Patient details and prescription information

A doctor can also generate a bill/invoice for the patient, and can send it to the insurer.

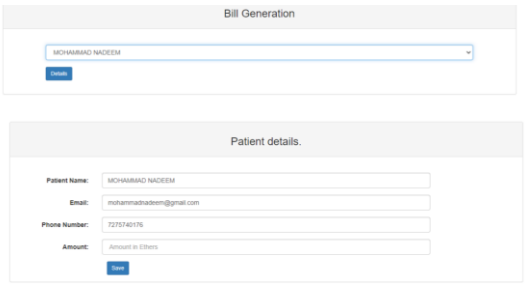

Fig. 9. Bill generation

The admin of an insurance company will login and check the bill sent by the hospital, after verification he approve the bill and the amount will be automatically transfer into the patients' wallet.

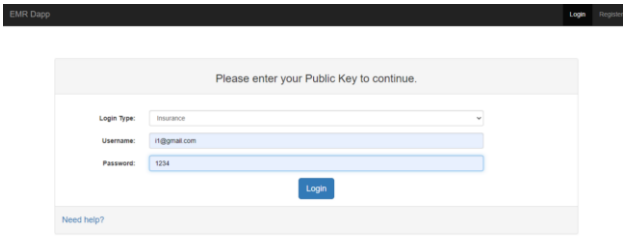

Fig. 10. Login gateway of insurance company

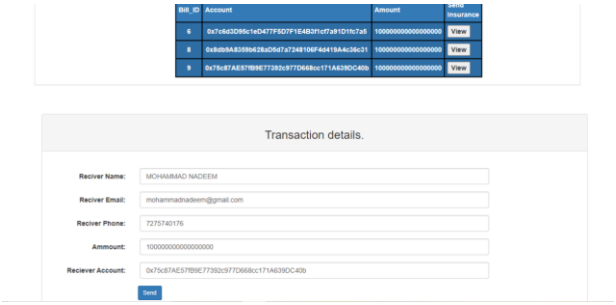

Fig. 11. Bill approval by insurance company

In following figure, we will verify the patient wallet by opening the ganache. We can see it has been credited with 0.10 ETH accordingly.

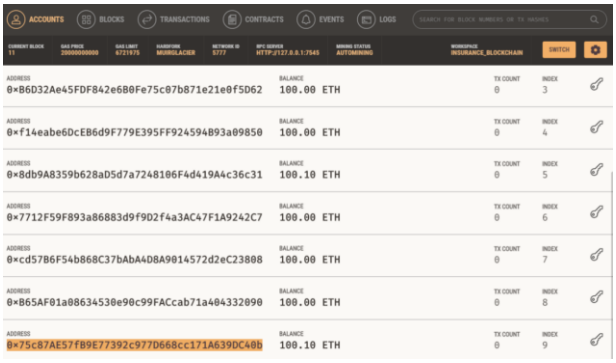

Fig. 12. Ganache wallets

6. Blockchain Applications

Basically, blockchain was designed for its implementation in the field of economics and crypto currencies, but today this technology is at the center of many current developments in the healthcare and medicine industry, we will discuss some areas of these domain that uses blockchain.

1) Drug discovery and pharmaceutical research

Drug discovery and research take a significant cost on the operations of any pharmaceutical company. With increasing costs of healthcare, together with the need to innovate faster on new medicinal treatments, it is imperative that multiple pharmaceutical companies find an approach to collaborate competitively. Blockchain can enable the technological

platform to facilitate the transfer of trusted information and knowledge among multiple parties. The usage of blockchain for robust digital proof of Intellectual Property (IP) through immutable records and time-stamping is one fitting proposition for the collaboration. Blockchain- based solutions also can provide mechanisms to share clinical and trial data competitively. Even under a non-collaborative research and drug development scenario, blockchain provides benefits for effectively tracking and managing various aspects of clinical trials like data management, consent management, tracking side effects of drugs usage, etc. Also, it's not uncommon for a pharmaceutical research company to outsource their clinical research projects. In this case, blockchain could provide a feasible mechanism to assure data integrity and proper outcome validation. In the current system, the pharmaceutical companies might have incentives to misrepresent results, e.g. in disclosing the side- effect of new drugs.

2) Clinical trials

Blockchain also has use cases within the management of the clinical test process for pharmaceutical research. Recently, IEEE Standard Association organized a forum on Blockchain for Clinical Trial with the aim to use blockchain to make innovations in patient recruitment, ensure data integrity, and make rapid advances in drug development. Scribe, a blockchain project presented in the forum, enables an efficient and trusted mechanism to expedite the clinical trials and research process. Of others, it allows an easy and transparent framework for legal and ethical validations of the trial process by the auditors. The work in [14] shows how blockchain can be used to manage the consent, data, and outcome from a clinical trial in a trustful and open manner. Such innovations in clinical trial rollout and management are crucial for advancements in pharmaceutical research. A lot of clinical trials run over the budget and timelines. Competitive sharing of clinical and trial data can accelerate research and discovery. Further, the research aspect of pharmaceuticals is quite broad that pervades the drug discovery process to device manufacturers and clinical trial outcomes. A solution across this spectrum is provided by BlockRX using so- called Advanced Digital Ledger Technology (ADLT). The overarching goal is to inter-connect the currently disconnected parties in silos.

3) Medical fraud detection

One huge application of blockchains in medical industry includes medicine supply chain management. Supply management may be a crucial issue to safeguard altogether sectors, but it's a greater importance in healthcare, thanks to its increasing complexity. This is because any compromise to the healthcare supply chain affects the wellbeing of a patient. Supply chains are vulnerable, and consist of holes for fraudulent attacks as they involve a number of moving parts and people. Blockchains provide a secure and secure platform to eliminate this problem and, in some cases, prevent fraud occurrence also, by introducing higher data transparency and improved product traceability. Since a record in blockchain can only be validated and updated through a smart contract, manipulating the blockchain is not easy.

4) Billing claim management

Financial aspects of medical care are inherently important in the healthcare landscape. This area of financing aspect in healthcare is rife with inefficiencies, mostly related to the trust and transparency, which can potentially be optimized by the use of blockchain. Blockchain provides a mechanism for direct links between patients (one who makes claims) with the bearers (one who clears the claim), as there is trust inbuilt. Smart contracts can be used in the premium negotiating phases. Data regarding the current health status, medication usage, lifestyle, etc. tied through blockchain to evolving premiums, through smart contracts. When many parties or intermediaries are involved in the claim handling, there might be a lot of repetitive tasks and checks involved which might be burdensome for the end customer.

7. Conclusion

In this paper, the presented Blockchain Based Healthcare System aims to provide secure medical data sharing between doctors, patients and researchers for the quality of medical and healthcare services. There are numerous shortcomings in the current healthcare system that seeks solutions based on disturbed and decentralized approaches. In the context, blockchain technology can play a leading role in providing the solutions that are decentralized and can ensure the security and integrity of the medical information. Blockchain based healthcare system is an open decentralized platform that is dedicated to real-time management of patient healthcare information in a secure manner using access control rules in smart contracts. The access control rules used in smart contracts prevent any unauthorized actions from taking place ensuring security of system. BBHCS provides secure medical records to different doctors and researchers. It is designed to enable authorized doctors to access medical history of patients so that they can treat the patients effectively and authorized researchers to discover new drugs and techniques by using the medical information stored in the system. The presented results would encourage researchers to extend this prototype in mobile compatible view and able to store image based lab reports.

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