Journal of Smart Internet of Things (JSIoT)
VOL 2023, No.01 | 36-45 | 2023
DOI: 10.2478/jsiot-2023-0004

Article

Design and Development of Healthcare System Using Blockchain

Myasar Mundher Adnan [1,*]

[1] School of Computing, Universiti Teknologi Malaysia, Johor Bahru 81310, Malaysia
*Corresponding author: Myasar Mundher Adnan (email: myasar.adnan@gmail.com)

Received xx March 2023; Accepted x July 2023; Published xx July 2023

Abstract: This entire system stands upon blockchain technology. The system is initially broken down in sections like different modules for patient, doctor, pharmacy and insurance agent. It is completed utilising a personal blockchain from Corda and Ethereum called Ganache as well as a private blockchain. This supports the development, testing, and general deployment of dApps. An Ethereum development framework is called Truffle Suite. Completely control the lifetime of modern contracts that includes bespoke installations, linking with different libraries and intricate applications on Ethereum. In dApps, Meta Mask is usefull for account creation, login and bitcoin transcations. The storage of all huge files and documents is done using the IPFS technology. Because IPFS is a P2P network circuit for decentralised data storage and the produced hash is simple to store on the blockchain, it is used. ReactJS was used to build the system's front end. The Remix online compiler for Solidity is used to build and test smart and modern contracts that are written in the Solidity blockchain programming language.

Keywords: Blockchain Technology, Healthcare System, Distributed ledger technology, Distributed systems, Exchange of Health history and information.

1. Introduction

The COVID-19 pandemic put the world under a lot of stress, making it incredibly challenging for healthcare institutions to keep track of coronavirus victims and their medical histories. After performing some investigation, we discovered that the virus had a significant impact on those who had high blood pressure, diabetes, and other illnesses. Furthermore, it becomes quite challenging for medical professionals and hospital facilities to carry out these tests effectively without losing a lot of time and money. Another problem preventing efficiency in this case is the present system's lack of openness.

Patients who have been to more than one hospital almost always have had the same physical examinations at previous hospitals. This is because medical data is always centrally stored at the healthcare facility and is primarily managed by the healthcare facility itself. Traditional data

management systems do not ensure data integrity and patient data reliability. Due to this vulnerability, difficulties with privacy and data security might arise, including deliberate tampering, hacking, and natural catastrophes. Health insurance fraud, which some patients commit to avoid paying, is another issue that affects healthcare institutions. Since patients and medical facilities/doctors do not interact on a peer-to-peer basis.

Agencies and insurance companies, dealing with these situations is very difficult.

According to a report in the UK's Daily Telegraph, the Bondi Junction Cosmetics Laboratory exposed patient data and privacy by publishing information on patients' names, residences, health insurance numbers, and medical records online in June 2017. A database on Amazon unintentionally exposed roughly 47 GB of medical information in October 2017, potentially affecting at least 160,000 patients. Decentralization, verifiability, and immutability are characteristics of blockchain that are crucial for the preservation of medical history of patient.

The introduction of blockchain technology brought new ideas and methods to undertake these problems and provide efficient solution. Blockchain can provide a decentralized framework to simplify and support the incorporation of health details across various applications and stakeholders. The systematic exchange of data between health care providers increases the likelihood of correct medical examinations and effective and punctual treatment. Accurate and complete medical records are valuable assets for patients. In this research, we developed a healthcare system network to securely manage personal medical details in a blockchain distributed storage system. The major contributions of this product are as follows. [1] A healthcare system based on blockchain network technology was proposed for providing a platform to secure storage and interaction between medical institutions, patients, pharmacies and insurance companies. [2] Some modules are introduced to help you manage your data. [3] The projected system does not rely on reliable outside sources.

2. Existing System

Given the current situational implications and all the practised methods of the healthcare system, as soon as a person visits a hospital, all basic steps should be taken, such as: For example, make an appointment, fill out a form, and take some initial tests followed by consultation with the doctor and prescription is issued containing all the medicines necessary for the patient's specific problem. The next step is payment for all consultations and medications. If the patient has health insurance, the amount will be covered by the health insurance company. However, integrating this entire process would be very time consuming and inefficient. Also, seeing a new doctor means detailing previous illnesses, but forgetting to mention some minor medications and allergies. Writing down all the information on paper is inefficient and cumbersome.

Traditionally, payment processes work across all sectors by accepting help from outside parties. Independent applications such as Google Pay, PhonePe Paytm and Amazon Pay now dominate his UPI ecosystem and control the majority of transactions. Even in the medical field, certain amounts are deducted from banks and other online payment systems when paying for certain appointments and medicines. In this case, the use of blockchain completely avoids the involvement of these third parties. Transaction amounts are minimized, and processes are efficient. Another problem that occurs in traditional systems is transaction time. It is resolved by blockchain adoption as blockchain is a P2P system that makes all transactions easier and faster.

3. Literature Survey

3.1. lockchain-Based Medical Records Secure Storage and Medical:

Medical data [1] is distributed among medical institutions, and the data standards are different

for each medical institution, so the interoperability of medical information between medical institutions is low. All of this makes exchanging and sharing medical data very difficult.

Medical information [1] is distributed among medicinal institutions, and the data structure is dynamic for each medical institution, so the interoperability of medical information between medical institutions is low. All of this makes exchanging and sharing medical data very difficult. essential in medical history.

3.2. Service Framework Opportunities for Use of Blockchain Technology in Medicine:

T Blockchain [2] is a brand-new, emergent technology that is still in its infancy. Blockchain has a lot of potential for healthcare systems since its key benefit is data security. In an HSBC poll, 59% of customers stated they had never heard of the word "blockchain," and even among those who had, 80% didn't know what it truly was.

3.3. A systematic review of blockchain:

Five themes—economic gain, blockchain technology, initial coin offerings, fintech revolution, and sharing economy—are the foundation of this article [3]. Additionally, it describes the numerous ways in which blockchain has changed throughout time. This essay also illustrates how using blockchain technology may assist businesses and how it might work to their favour. Paper also offers us a sense of the numerous industries in which blockchain technology may be used and how it can outperform current technologies.

3.4. Towards Using Blockchain Technology for eHealth Data Access Management:

This paper [4] focuses on finding a safe, decentralised approach to store the vast volume of vital patient data. It is the benefit of employing this technology to avoid counterfeit and fraud, the simplicity with which medical data may be accessed through blockchain, and some other factors. Uses of blockchain in healthcare. To safeguard doctor-patient relationships, they have devised a method that would use a smart contract implemented on blockchain. Patients have the authority to decide who can read their data in order to protect data security. As the data from real-time monitoring equipment, such as heart rate monitors and ECG sensors, cannot be directly integrated with blockchain, it is kept in the IPFS system, a robust decentralised database system. The hash created once the sensor data is saved in IPFS may be utilised to access the data. This technology can be used in conjunction with cloud computing to address the mining industry's high processing power issue.

3.5. Applications of Blockchain towards Medical Sector:

Several problems in medicine arise from the complex partners of intermediaries and the need for traceability of replacement. To name a few, health information is scattered across several silos, negatively impacting research and management. About half of the medicinal trials are not documented. The impact of silent disclosure continues to increase, and non-standard bogus solutions remain a major problem. Blockchain could shed light on these issues because it inspires trust without intermediaries, has traceability as a standard highlight, and ensures untapped trading models by enabling new incentive structures. Blockchain has built a notable appeal in the healthcare industry due to its potential [5].

Patient information is spread across different pieces of the healthcare industry value chain, known as information silos, and information sharing tends toward multi-layered consent management. Because of this, central information cannot be accessed, and it cannot be accessed when it matters most. By acting as a prerequisite for a trustworthy, decentralized database, blockchain can bring this matter to light with the Wellbeing Data Exchange (HIE). One-stop access to complete medical histories for obstinate healthcare providers. Built using blockchain beliefs, her

Get-to-Control framework puts patients in control of their information. They can give consent to external parties, such as analysts, to gain access to all or part of the remediation record. Luckily, this includes patient-centric healthcare shows, where blockchain can act as a catalyst to advance belief. Data stored on the blockchain cannot be changed or deleted. On a financial level, blockchain could save the pharmaceutical industry hundreds of billions of dollars by defining a chain of custody within the supply chain.

Blockchain can therefore facilitate healthcare agreements and, as a driving force, facilitate innovative commerce models that can result in a lack of energy among various healthcare parties, such as patients and suppliers. A patient-centred healthcare programme and a global HIE, for instance, may be made possible by the morality of blockchain-enabled decentralised trust and driving force structures. Furthermore, blockchain-based decentralized network/services may minimize merchant lock- in problems in healthcare.

3.6. Use of Blockchain Technology in Healthcare:

Despite its youth, blockchain technology is already being used in a variety of fields, most notably the finance and business industry.

Blockchain [6] reduces the need for a centralised expert to validate data judgement and ownership, intervening exchanges, and trade of digital resources while enabling safe and pseudo-anonymous exchanges with open communication between collaborative partners. It offers important characteristics like constancy, decentralisation, and simplicity that may help with pressing difficulties in healthcare like insufficient documentation at the point of service and difficult access to patients with health information. Interoperability is necessary for a competent and productive healthcare system since it enables applications and innovation platforms to exchange information over health organisations and app developers in a secure and reliable manner.

Smart contracts are additions to blockchain, as they are implemented in the Ethereum Blockchain, that provide code to specifically control the exchanges or redistributions of digital resources between two or more parties who agree to a set of rules or ascension already established between included members. To enable the development of DApps to be connected to Blockchains and provide dependable services to the application users, keen contracts can store information objects and characterise activities on the information. In the area of healthcare, clever contracts may be linked to create strong and persuasive specialised foundations that enhance care coordination and quality, advancing the prosperity of individuals and communities. In a perfect world, health organisations and app manufacturers would be able to safely connect with computer programme applications and innovation stages in an interoperable healthcare environment, exchange information, and use the exchanged information [7].

Many healthcare use cases that face similar information sharing and communication issues would undoubtedly benefit greatly from an interoperable architecture. From a more specialised perspective, much research is needed to adhere to the most sensible strategy planned in creating an interoperable biological system using Blockchain technology while addressing fundamental security and privacy issues in healthcare. Creating decentralised apps that utilise already-existing blockchains like Ethereum [8]. A contemporary blockchain network could in some circumstances be preferable than an existing blockchain. Then you can consider taking another course that involves building a healthcare system or expanding an existing Blockchain.

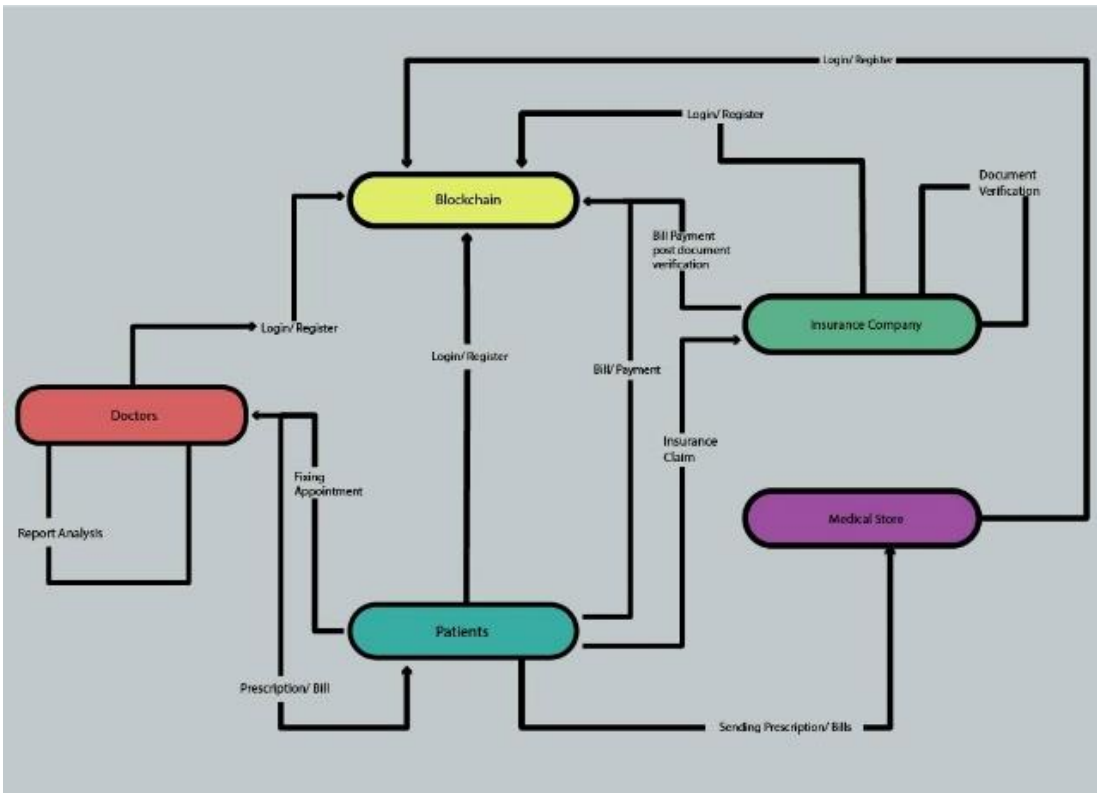

Figure 1: Diagram of Communication

4. PROPOSED SYSTEM

A Blockchain that only provides healthcare services. The body of the patient is forming and contracting. Additionally, people may pay the bill in the form of this coin, which includes consulting costs and medical store money (no third-party intervention). The issue description states that this resolution primarily focuses on the data safety of particular system entities. A healthcare system can change data storage by utilising the private blockchain idea. Every patient would have access to a private blockchain with all of their interactions with physicians and insurance providers. This will not only link them, but smart contracts will also be used to maintain the medical history, transaction, and insurance information. The system contains modules that need to be addressed independently and then integrated as necessary. These modules are categorised by system stakeholders [9].

The system is described in the first module as a stage for patients (everyone in the nation) to save their confidential details, including health records. As long as the system is in place, patients can add and amend their papers, but not delete them. To ensure individuality, each patient will have a separate account connected to their Aadhar number. Patients can chat with doctors or schedule an appointment in addition to maintaining track of paperwork [10]. Patients can provide a specific doctor their private key so they can help them, review their prior medical records.

The next module details the answer from the perspective of the medical intitutions or medical organization. In this, doctors and professor are given a stage to review (observe only) a patient's health history who has submitted their personal key and conduct an examination if necessary. Doctors will upload prescriptions and medications following a thorough investigation. The company on the patient's block will also provide other information, such blood results, X-ray reports, and MRI reports.

The third segment covers insurance providers. If a patient applies for insurance, they must provide a private key for document verification before the insurance company takes over the rest of the procedure, as is customary today. This will stop any unintentional fraud committed throughout this procedure.

The last module relates to the medical supply warehouse. One can purchase medications from the shop in accordance with the prescribed dosage, and the system will also preserve this information. If this is conducted, it would perform in the form of a distributing chain of drugs and provide an option to easily track all of it [11].

The idea of a private distributed blockchain would transform the operation and data storage of healthcare systems. Every patient would have a private blockchain containing all of their prior interactions with their physicians and insurance providers. Not only would this link them together, but all of the prior medical information would also be stored in the blockchain blocks. When comparing this to the current system, it only contains the medical data of individuals who have been admitted to that specific hospital. Therefore, the system will employ the patient's public document, which will be produced at the moment of initial registration with the system network, together with the UID (Aadhar number) for their final verification upon admission.

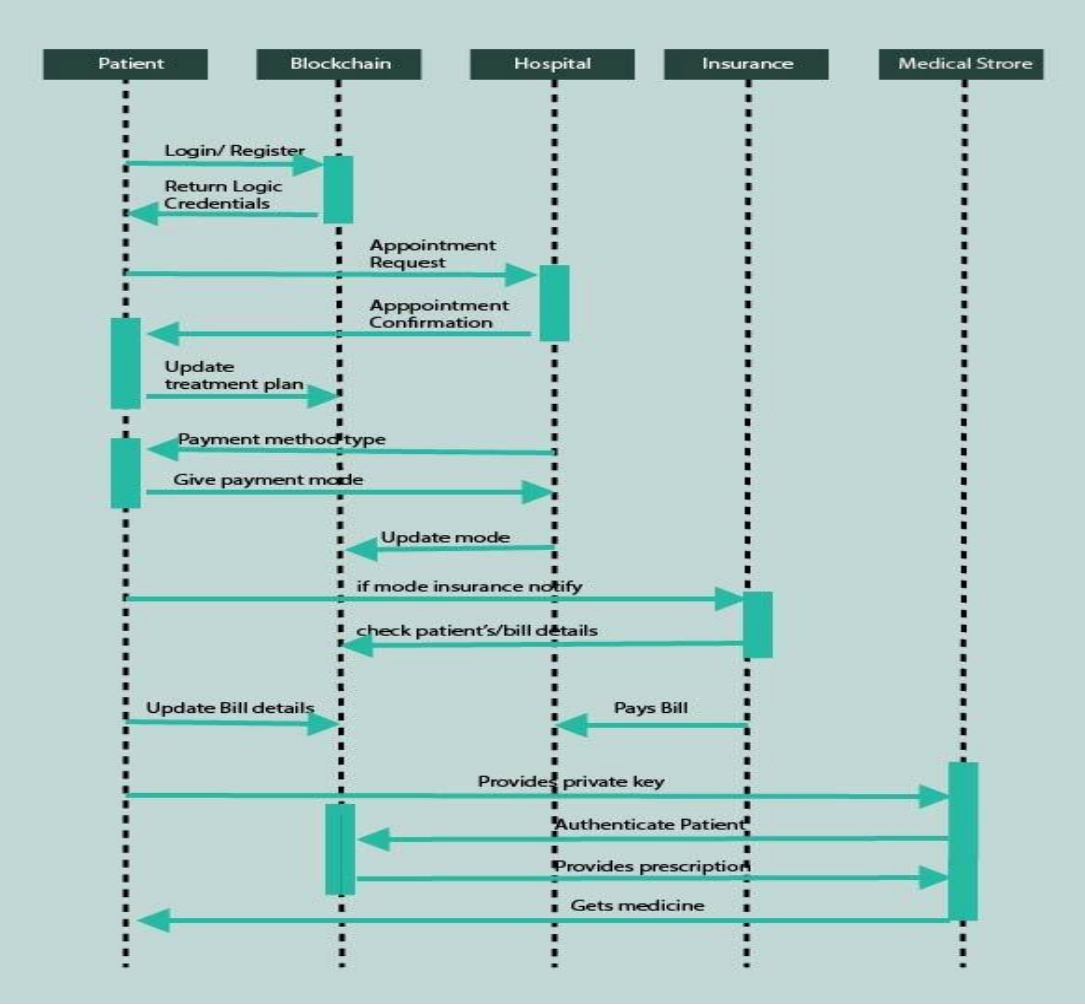

Figure 2: Sequence Diagram Flowchart

Following the procedure, the system will be immediately attached to the created bill. The

primary advantage of this mentioned feature is for transaction because the memo is shown in the blockchain block, making it apparent to insurance payments providers as well. The method of payment is up to the patient. Additionally, patients can pay with Ethereum based ether (which is a prominent cryptocurrency). Ether is just a kind of digital money that employs the blockchain network idea. If a patient qualifies for insurance, they may also choose not to have it. In the existing system, the payments area is where the majority of frauds are often committed. Misconduct of any type cannot take place since the system is transparent [12].

It will also be easier to conduct future study because all the documents and reports are kept in a one block of the network. As all the data is maintained in a database, patients who are willing to do so can share a portion of their records that will be useful for research projects. centralized pattern (i.e., every previous health records are maintained in a single block of the network).

The system's total data chain is depicted in the flowchart above. Observe this as a case study. Say we already have some characters. Dr. Shyam, his ABC insurance business, and Ram are all patients. Ram signs up, giving his UID number for verification along with other basic information. To view the physicians, you wish to schedule and their availability, you must first enter into the system. Let's say Ram schedules a consultation with Dr. Shyam, who gives Ram the secret key to see his medical records. The doctor will give a thorough prescription and charge after the diagnosis and treatment are complete. Ram must now submit a claim for ABC's insurance on his own. If he decides to get insurance, he will submit an application and all required paperwork. If everything is in order, ABC reviews the paperwork, the insurance is accepted, and ABC sends the doctor an invoice. Give Shyam some Ether. Ram may also choose to pay his debt in full in ether [13] if he doesn't wish to utilise insurance. Medical supply stores are subject to similar regulations. Once more, Ram is in charge of deciding which recipes to divulge to the pharmacy, and in order to do so, she must provide the pharmacy her confidential key. Using blockchain, a medical shop owner may also verify Rams, and after their Rams are validated, they can start receiving their prescribed medications.

5. MATHEMATICAL MODEL

The technology behind blockchain underpins the whole system. The system is primarily broken down into modules like the patient, doctor, medical supply, and insurance agency modules. The implementation is carried out utilizing a personal blockchain for Ethereum called Ganache as well as Corda, a platform for developing distributed applications. Overall dApp development, deployment, and testing are aided by this. An Ethereum development framework is called Truffle Suite. The whole lifespan of smart modern contracts, which includes customized installations, linking with library, and sophisticated Ethereum applications, is entirely managed by it. In the dApp, Meta Mask is utilized for initial signup, account registration, and bitcoin digital transactions. . The IPFS technology is used to store all of the huge files and documents. The peer-to-peer network IPFS is used because it allows for widespread data storage and makes it simple to store blockchain hashes. ReactJS is used to build the system's front end [14]. The Solidity language is used to write the Smart Contracts, and the online Solidity compiler is used to build and test them.

S = {I, O, Q0, T, Qn, Success, Failure} Where

I – System Input I = {I1, I2}

I1 = {I1`, I2`}

I1` = It contains all of the patient's earlier medical records.

I2 = Key for insurance companies to enter to start billing.

I2` = Key that will be input on the hospital's website to admit patients.

O – System Output. O = {O1, O2}

O1 = All the patient's earlier health data.

O2 = The system's result, or the billed sum, will be integrated to the patient's block in the network and the insurance company's block.

Q0 - The initial data stage, which involves patient, hospital, and insurance company registration.

Qn - The system in its final form, which entails updating each block that was used from the moment a patient was admitted until they were discharged.

Success equals S1, S2.

S1: If the patient receives the right information from the system. All prior medical history and test results must be included in the material.

S2: If the network is successful in processing transactional data made in ether without the need of intermediaries.

A notice stating "Failure - Accessing Invalid Document/block" will appear.

Function T: Transition

T = {F1, F2, F3, F4}

F1 stands for verifying the portal's public key.

Storage and retrieval of all medical records is F2.

F3: After the procedure, upload all bills and paperwork to the network.

F4 = Beginning the payment process (Only if done using Ether).

6. RESULT

The system draws attention to a few of the distinctive ideas that are emphasized in this section.

Since the entire sector is transitioning to digitalization, everyone needs a unique account as well as authentication and verification. Every account will be connected to a UID to offer a singular account (Aadhar Number). There hasn't been a system that unifies the majority of the medical department's subsystems up until this point. travelling from the patient to the assigned doctor to a hospital for insurance to perform research to the supply chain of a drug [15]. Every component of the healthcare system is included in a single system. Figure 3 shows the dataflow diagram of the proposed model.

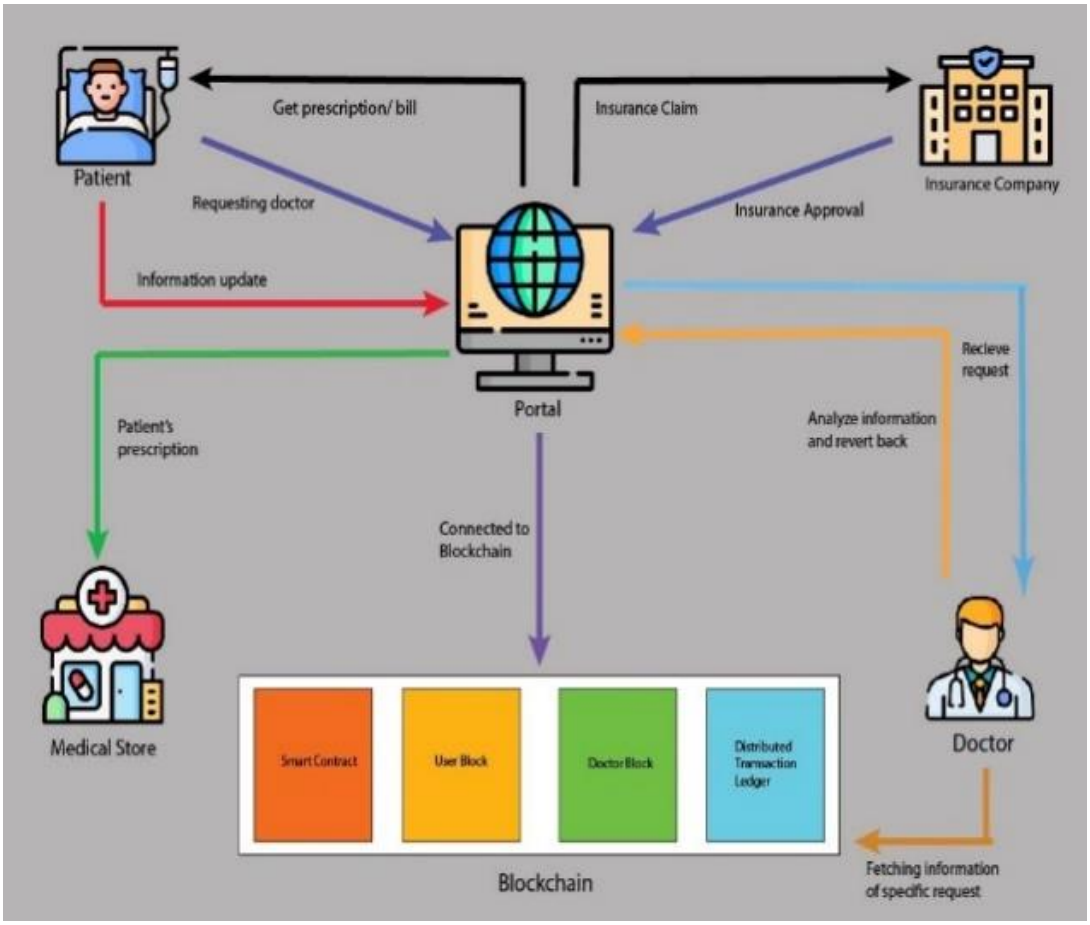

Figure 3: Dataflow Diagram of the proposed system.

7. FUTURE WORK

The suggested approach aims in incorporating all forms of medically associated labour that takes place on a daily basis. There are several further, more complex stages of procedure that may be incorporated into the system after that. These extra features will improve the system and expand its marketability.

Included in the features are distributing chain techniques for tracking the deleivery of the pharmaceuticals. The government body will be able to monitor medications and pharmaceuticals from the place of manufacture to the farthest end point, i.e., till it reaches the patient, thanks to this. Additionally, it is simple to track a product's (or a medicine's) expiration date, allowing widespread fraud to be prevented.

Concern for research work is another characteristic that might be incorporated into the suggested approach. Medical organizations/institutions may ask a specific patient's consent before using their data for without revealing anyone's name, do research. The patient is required to supply a private key in order to grant access to certain documents.

8. RESULT

One of the most intricate systems, the healthcare system has several interwoven components. For the sharing and dissemination of information in healthcare, there are significant obstacles.

Combining safe data sharing technologies is necessary for doctors, service providers, and clients. By decreasing insurance fraud and incorrect information, digitalizing medical data would also make it possible to analyse medical trends and assess the quality of service. The suggested solution would also speed up patient admission and eliminate the need for patients to carry physical copies of prior medical records. The patient won't need to take paper copies of their prescriptions with them when they visit pharmacies or medical supply stores [16].

Records that have been digitally preserved are simple to maintain, impossible to delete or change, and only available to certain individuals on a private blockchain, keeping them secret from others. The patient consent data that has been preserved may be made available to researchers. There will be many changes and a beneficial influence of blockchain on healthcare in the future because this is an area that is quickly expanding.

Funding Statement*:* The authors received no specific funding for this study.

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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