ETHEREUM BLOCKCHAIN FRAMEWORK FOR HEALTHCARE APPLICATIONS

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Abstract- *Block chain technology (BT) is an evolving technology with reliable and protective measured for sharing data in various applications. This work concentrates on healthcare based BT over Ethereum platform for data management. The medical applications include complex medical procedures with clinical and surgical trials. It includes managing and accessing of huge medical data. With the execution of medical applications factors like system cost are estimated for providing feasibility. This works provide multiple flows of healthcare BT over Ethereum platform. The performance of this model is analyzed with multiple flows. The data management, security, identity, and autonomy are considered as an essential factor.*

Keywords- *Block chain, Ethereum, multiple flow, reliability, feasibility*

1. Introduction

Blockchain Technology (BT) is an upcoming technology that evolves over the digital healthcare revolution with extensive studies. It is identified as a potential platform for healthcare sectors [1]. The flow or functionality of the healthcare sectors are changed drastically with the involvement of BT. This technology is key facilitating technology for digitalization and decentralization of healthcare sectors and offers digital and modern healthcare system to physicians and patients [2]. The application relies over the data management for providing utilities to doctors, patients and others to maintain patients' record and manage their payment details. The data verification and exchange towards transparency and financial audit is done through BT. In real-time, data is encrypted,

and decentralized to have better insight towards understanding, monitoring, and controlling medical information [3]. It facilitates restriction of non-authorized individuals to have access towards the sensitive data.

The healthcare sector based data management includes various processes like inventory, logistics, legal factors, staffs, patients and finance management [4]. These are considered as multiple

workflows with successive tasks over treatment process. It is modeled to offer better control and enhanced production, efficiency, compliance and to decrease the risk factors and overheads encountered in healthcare sectors. This work concentrates on analyzing the workflows in healthcare data management with Ethereum platform.
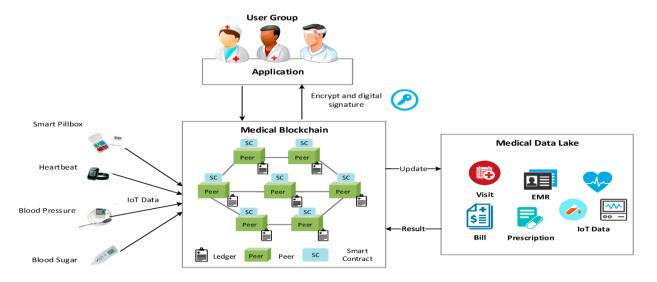
This investigation offers a smart healthcare system for managing data and to reduce the complexity over the process. Various existing approaches are analyzed and investigated with ethereum based healthcare management for providing better results [5]. The objective is to provide a potential utilization of blockchain and to resolve the challenges encountered by previous investigations. The analysis is done with generation of newer solutions, methodology, algorithm, and various architectures. With real-time database analyze, the applicability of ethereum platform over medical applications are also examined. There are diverse feasible adoptions of application over blockchain technology.
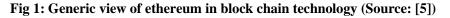
The BT network provides de-centralized information system that holds various transactions and works with diverse protocols that determines the flow of transaction validation and entire

network functionality. This network model is considered as a distributed registry when data is stored on the nodes for operating the individual networks [6]. The BT network is integrated with transaction blocks which is connected with various records. Thus, immutability property is determined to be a preliminary security process for blockchain features. The data over the network is protected with the changes over there. When an attacker pretends to modify the keys, the registry will immediately ceases as the hash value over block headers are changed based on hash function mechanisms. The generic view of blockchain technology usage in healthcare sector is given in Fig 1.

This paper is structured as: Section 2 demonstrates the backdrops concepts. Section 3 is research methodology with potential benefits. Section 4 is discussion part with conclusion at section 5.

2. Related works

The legal system shares healthcare information internally and not compatible with other external systems. The benefits during integration of network connectivity and healthcare, connection among various healthcare organizations are considered by researchers. The crucial crisis is identified in organizational data sharing that requires information from healthcare providers and shares it to organizations like research institutes and researchers.

Fig 1: Generic view of ethereum in block chain technology (Source: [5])

In various applications, the BT defines the governance and data processing. This is performed to acquire segmentation, sharing and secure medical services. In healthcare industries, this BT is currently a developing technology. With major advancements in health care data, cloud based storage and regulations gives opportunities for managing healthcare data and provides easier way to access data. The data transaction, security, management, and storage have to be fulfilled with integration of huge valuable data-driven process. The BT has the ability to resolve various crises in

an effectual and robust manner. The investigators concentrates on data management, sharing, EHR, and storage. The innovations towards BT technology holds BT technology, sources, stakeholders, and application that are partitioned into various measured.

Author in [7], explains about the sources, healthcare application, and stakeholders. This technology facilitates patient-centric control towards data sharing in institutions by enabling identification, digital access rights, and dealing with huge amount of data and immutability. Some investigators

concentrates on ledger based BT platform for transmitting data towards the ledger of BT networks. This information is collected from smart phones. The investigators have to provide a proper statement towards the transfer of data to BT. Author in [8], manages healthcare information more effectually. There are diverse studies and they provide potential benefits over limitations devoid of providing an appropriate proof for computation. It gives better proof for validating the healthcare records over cloud by maintaining data privacy and security. Author in [9] discusses about the limitations of authentic and non-authentic blockchain. For this analysis, the author applied hyperledger source for collecting patient's healthcare data. Author in [10], reviewed about the healthcare management systems and two different algorithms used for offering network security.

Author in [11], anticipated data sharing approaches in BT and P2P network model termed as MedChain. The system has been modeled for generating healthcare data through medical examination and patients can get data from mobile applications or through other IoT devices. Author in [12] analyzed diverse crises related to healthcare management system and resolves diverse issues associated with it. The author gives a research insight towards healthcare technology with probable use of process evaluation. The author anticipates an effectual delivery system with protocol usage. Author in [13] analyzed various crises that are related to data security and privacy to get rid of healthcare based issues. Author in [14] explained about information breaching like address, name and so on. This model deals with health care records. The ultimate objective is to examine system performance to deal with patients' data, third party users and doctors.

Author in [15] explained about the smart contracts and blockchain technology for gaining potential benefits over process streamlines. The author manages the patient's record and has the efficiency to diminish the loss and to eliminate data fabrication by securing data over the ledgers. The author in [16], discusses about the drug processing and the standardization process for dealing block chain. The

complexities are highlighted to identify false drugs and to anticipate block chain to predict counterfeits. Author in [17], performs systematic analysis over the present research process in healthcare sectors. This study concentrates on cases involved in healthcare records like supply chain, drugs, bio-medical research and record management. The author analyzed these factors and still requires a better understanding towards the BT and to determine how the process is fit with healthcare based challenges [18].

Table I: Issues in blockchain technologies [19]-[20]

S.No	Issues	Activities
1	Data interchange	Data is used among the healthcare providers to certain third parties and patients during the fulfillment of protection regulation in healthcare sectors.
2	Interoperability	Providing standards for data exchange facilitates data passing among healthcare providers. However, legacy system does not provide it.

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3	Device tracking	The tracking among the supply chain facilitates retrieval among the devices and eliminates unnecessary purchase and fraudulent.
4	Drug tracking	The medical device provides the ability to track the custody from patients and provides frictionless outcomes and to eliminates forge drugs.

3. Methodology

This work concentrates on Ethereum in healthcare sectors and to store those records over the network. The data accessibility, integrity, ownership and metadata are considered for construction of contracts as in Fig 2. The BT transactions are performed with signature instruction signed cryptographically. The transition function is performed with legitimate transactions over data alterations. The regulations are modeled based on medical records that are computationally specified. The policy is based on transactions of data with healthcare professionals by acquiring third party permission. This leads to a complex workflow. The model has to be designed based on concentrating towards various workflows and to acquire data

access permission among entities over healthcare systems. The anticipated model is designed for dealing with the complex workflows.
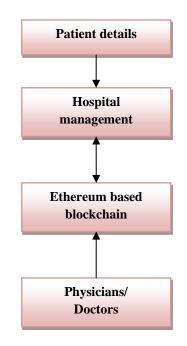

Fig 2: Use of ethereum in healthcare sectors

This model establishes management of access permission among the entities of the system. This generates interaction among the patients and the doctors. The authorization is embedded with contracts. The activities are tracked with ID from the source. Various scenarios are provided and functionalities are measured with the contract establishment. There is no proper centralization of entities to deal and approve the operation functionality which is directly managed via contracts. This may drastically reduce the process administration. The records are stored in local database to preserve the viability with hashing element to maintain commitment to chains.

These transactions are done by signing the private keys. The system content maintains ownership and acquires access from the member of P2P network. This technology assists contracts to automate and to track the state transitions. The relationship among the Ethereum and contracts are related with the records and to permission and to acquire data from

server to fulfill the tampering and hash records of BT. It helps to improve data integrity. The access providers include records of patients to maintain sharing providers. The data from automated notification can validate record data for acceptance and rejection. This maintains evolution of records and to manage them. The system is prioritized with usable information and to add the patient's detail. These provide point of references to validate data updation.

Here, cryptography based keys are used to deal with verification and implementation for accessing data with ID number to ethereum. After confirming validation through authentication, the algorithms are provided to 'off-chain' for exchanging data among the providers and patients. The workflow uses medical procedures to execute and to implement contracting system. The treatment process and maintains of records for surgery is included for validation. The design model facilitates doctors, patients and organization to get rid of inefficiency. The system assists in retrieval process, management and analysis of complex data and procedures.

a. Ethereum block chain

Generally, ethereum blockchain is considered as a distributed transition system where the states include state transition and accounts for performing direct value transfer and data among the account. There are two diverse types that prevail over ethereum. They are: 1) External account owner and 2) smart contract accounts. The former is to manage the ethereum based value tokens and private keys. The latter is related to the contract based code and triggers the transaction among the contract function calls. To secure the blockchain from various malicious attackers and to predict the mistreating factors related to network attacks are based on payment protocol. The fee is collected to use the data storage and to carry out every process over the contract. The fees are generally collected by the miners to carry out verification, execution, propagation, and block transactions.

The mining is rewarded by the intensive users to provide effectual electricity and hardware to ethereum network. Transactions have to give gas limits to certain amount of gas that senders pretend to pay. When the gas utilized during transactions exceeds the limit provided, the execution has to be stopped. However, the sender needs to pay fee for execution. This protocol secures the sender when there is a short in funds.

i) Smart contracts

There are some blockchain infrastructures such as Ethereum based smart contracts. These agreements are pre-agreed using formal provision from source code. These contracts are provided automatically without the interventions of any intermediates and third party. These functions are awoken by blockchain transaction and functional utilities by appealing towards health care domain.

b. Analyzing medical records with Ethereum

The manufacturers are provided with simple alternative and to provide trails over the treatment process. Cost is higher to get the patients data from independent data providers and to carry out marketing campaigns. The ultimate objective is to facilitate users with clinical trials based on ethereum network that gives protected medicines and to improve interest towards the research. This work handles meta-data that includes registration, medical details, enrollment and screening process. The metadata is more essential as it assists in predicting registration process, analysis, screening and enrollment process. The blockchain predicts the ability of patients for including the clinical trials. It transfers data to chosen patients that include application to read access medical record, appropriate results and process it through contracts, fee, and lab reports with appropriate patient results. It deals with the patient directly to diminish the purchase of data and marketing factors. The patients have compensation trails and acquire access to newer treatment process.

The ultimate target is to improve the speed for system reimbursement. The doctors have the ability to process the data quickly and hold the treatment process until the payer responds to it. The automated execution is done to monitor the entire process. The process of eliminating errors that are made by humans and to response to the authority by triggering interpretation forms. The policies are posted by blockchain technology by determining the authorization. The supplier has to give appropriate authentication for treatment purpose. The policies hold information regarding the patients' through ethereum BT and information request. The authentication is returned to providers. The patients with laboratory information, specialists, pharmacies, and stakeholders are also having delegation towards the access and validate the authentication. The entire process is shown in figure [3].

The automation process with authentication saves payers from reducing the substantial expenses manually and responds to the request. The physicians initiate the process and waits for response. The patients concerned with insurance are covered with doctor recommendation. With immediate availability for authentication purpose, the patients can plan for insurance coverage. The process is related to workflow and addresses the complex flow in constant manner. This is merged through ethereum blockchain process. The administrators, billing section and front desk performs entire task to assist workflow from patient management. The details are seamlessly attained from the patient's record. The workflow comprises of diverse functionalities through patient process. It includes approval, clearance, scheduling, testing and recording. The process is recorded to give review when surgery is cancelled.
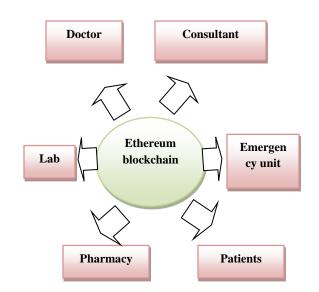

Fig 3: Ethereum blockchain functionalities

This process also relies over the cost estimation for deploying the healthcare system. The target idea is to provide feasibility over the system for benefitting ethereum based BT. The computation with ethereum platform helps to eliminate network abusing and to overcome various issues. The cost is to make successful transaction with ethereum BT. the entire operation, computation, deployment, creation, and calls are used to store data over virtual ethereum and to carry out certain specific tasks.

The ethereum network makes use of consensus mechanisms to analyze the transactions executed among the block chain network. This process has to resolve mathematical functions for processing and verification of transactions. These computations require higher energy to power systems and to be resolved at appropriate time. As well, to make the system to cool some more energy is needed. Similarly, huge energy is needed to maintain blockchains over certain organization. As well, the use of higher energy is not acceptable as changes over the climatic condition are measured to be crucial concern. However, ethereum is attempting to model a certain novel approaches with consensus approaches and to diminish energy consumption. This is measured to be highly advantageous for real-time application depending on ethereum platform.

4. Discussions

The patients' details are stored in over healthcare systems in different format as it holds the results of lab, drug details, and payers and so on. It leads to infringements to exchange data. The poor data sharing infrastructures are considered for drug discovery and to hold the public information. Some efforts are taken to deal with the issues and to concentrate on newer standards. Sometimes these efforts fail to address the issue due to rejection. The lack of data processing is avoided by general practice towards the attributes and patients' expectations. The precision is computed with prediction of future care, industrial functionalities and substantial resources for development of health care and by modernizing the current system.

Here, the basic requirements needed for healthcare sectors are discusses and the shortcomings are analyzed with ethereum health care management. It provides an extensive overview towards the functions of ethereum model in BT. The hindrance towards the execution of healthcare system is addressed with entereum platform. The practical cost deployment is also examined with this platform and the expenses are reduced for the patients.
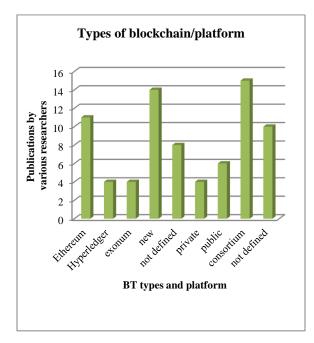

Fig 4: Use of ethereum over healthcare sectors

For this reason, the departments with higher cost are considered and deployment is performed over that. The quantitative analysis is done (See fig 4) with cost deployment which is extremely accountable and the ethereum based system maintenance is recorded with patients' details. This is considered to be more feasible in realistic circumstances. It is obvious from the analysis that healthcare management based cost analysis is extremely lower. The cost computation should be economical and every patient pretends to pay lesser fee to gain access over the data processing.

5. Conclusion

With the advancements in blockchain technology, this work concentrates in healthcare management system over ethereum platform. This can be applied to large-scale environment for processing data and to reduce the complexity encountered in it. This model gives an innovative idea towards the analysis of cost and functionality with multiple workflows. The data is handled effectually with accessibility, reliability and interoperability. The feasibility of the model is measured with cost computation and to reduce the overall cost. The cost is lesser while sharing the patients' information and to help the doctors. This model is used for data management. The execution of this process is performed effectually with diverse perspectives. This BT technology gives higher insights towards availability, and security of the system. The ultimate objective is to provide an outline to enhance the healthcare systems and related outcomes. This may resolve the healthcare issues and to achieve unstructured data modeling, legacy and data security lack and unresolved privacy factors. In future, this is applied with other applications.

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