

UTILIZING THE BLOCKCHAIN TECHNOLOGY IN TELEMEDICINE MANAGEMENT SYSTEM

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ABSTRACT: *There are always signs of change in healthcare industries that support new advancements. Telemedicine applications have been widely adopted among patients and telemedicine healthcare providers among which provides control over patients' health records are on increasing recently. Thus security issues much bother during an exchange of health-related data caused the main drawback in the system. For providing patients with borderless integrated service over telemedicine considering security in mind Blockchain has been implemented. For safe and secure health care data sharing in applications Blockchain Since blockchain in management has a nature of decentralization, for telemedicine applications, this serves a suitable driver for data sharing to new insights. Without any central authority peer to peer transaction of data can be recorded and managed by Blockchain technology. In this paper, we discuss real-time patients' data are respect to their medical status has been collected with the help of biosensors and stored on the Internet of Things with Blockchain technology and processed with a three-line processing technique. Also, we discuss on Blockchain technology application and advantages in Telemedicine applications.*

I. INTRODUCTION

For various secure applications, we can see that the fastest growing technology is Blockchain technology. Among stakeholders, blockchain technology is used on various implementations. For secure data sharing and immense potential management of healthcare, banking, supply chain management by utilizing this technology. In telemedicine and healthcare systems this Blockchain plays a major role. In the Telemedicine domain blockchain provides service due to its decentralized nature and distributed system. In human service system block chain deals with sharing secure information among people, partners, speedy charging and information Interoperability.

It also gives a better replacement for widespread digital transformation with the technology which has rapid growth in upcoming future. For Human administrations, there is a markable commitment with IOT, 5G, and 6G. Among various medical services, it is not so secure with current Telemedicine services with a centralized design which has to problems mainly leakage of information and delay in accessing. In the above case, there is a chance of accessing the medical details of a patient without their knowledge. In the current Telemedicine system for distance medical opinions, the major issue is securely accessing data within a network. A promised technology and efficient way is blockchain technology. On distance telemedicine services EHR plays a major role in maintaining and storing data. The patient's information stored as a ledger in blockchain technology that can monitor and access patients and their details. The major reason for the development of blockchain technology is the above methodology. Apart from security and accessibility blockchain also provides some more benefits like privacy, verification, and respectability.

In multiple applications like data management, financial services, IOT, food science, Cybersecurity, and health care Blockchain technology has gained the attention of researchers to work with. For safe and secure delivery of data in secure telemedicine data transmission application of blockchain have become a remarkable interest witnessed. Traditional methods in medical applications have been reformed by Blockchain for safe data transmission for effective diagnosis

and treatment. It's the technology for the future to support an authentic, secure and personalized healthcare application that contains a merged database of all clinical data of a patient with up-to-date data in a secure manner. Telemedicine is the application where a large amount of data has been generated, stored and processed for future applications. Due to some sensitivity nature of data in telemedicine with limitations like privacy and security the process of storing and processing huge data has become a challenging process[1].

Numerical applications besides cryptocurrency are enabled in blockchain to support transactions by Ethereum platform Blockchain [7-10]. Ethereum framework supports the development of many telemedicine applications [9]. For many areas such as public services, IOT, Security services, and reputation systems takes Blockchain as a promising technology[12-15]. For storing records and transactions of values like gold, currency, energy, real estate and intellectual property rights (IPR). High security and decentralized distributed nature are the two major characteristics of blockchain [17]. Intermediate points like agents or brokers are void in Blockchain. In this data assessment economy, it is very important to ensure the manipulation and corruption of data.

Many types of research have been going on through for extending applications of blockchain since it was announced through bitcoin. Blockchain is believed to have significant impacts in the field of telemedicine. Its new but rapidly growing technology of research of Blockchain in Telemedicine.

II. LITERATURE REVIEW

Koosha Mohammad and Mohammad [2019][12]proposed a technology based on blockchain architecture that preserves privacy in access controlling for distance health applications. Advantages are immutability and anonymity of users for IOT application along with some special features by providing some changes in the traditional blockchain model to overcome changes challenges miners of Blockchain are clustered, stored and processed with nearest data available for the patient. Along with that security analysis of the proposed architecture has been progressed.

Thomas K. Dasaklis, Fran Casino [7], analyzed and studied the symbolic relation between smart health and blockchain. Three individual streams of possible synergies are identified and analyzed among others. For implementing blockchain-based applications in the healthcare domain several challenges have been analyzed and discussed with several opportunities for future research.

Ahmet EKIN and Devrim ÜNAY [11], presented a review on various applications of blockchain technology. Applications that selectively utilize Blockchain are analyzed deeply and their pros and cons are evaluated. Also, the Estonian system has been reviewed which is a national level blockchain-based health care system, and its ramification to turkey has been discussed in detail.

Mohamad Kassab, Joanna DeFranco [14], provided preliminary results on the literature survey on enhancing the inherent characteristics of blockchain and hinder particular quality on the health care system. Five essential quality requirements of healthcare have been analyzed and even advances have been achieved.

Wang, Jing , Xiao [23], proposed a framework of parallel healthcare systems that helps for precision diagnosis and increases treatment success with an artificial system that works with PHS its execution with parallel processing. For modeling and representing patients' conditions, diagnosing and treating they used artificial healthcare systems. Various therapeutic regimens are analyzed and evaluated with some computational experiments. And for real-time optimization and decision making support parallel execution has been implemented in both artificial and actual health care system. A consortium blockchain has been constructed by combining emerging blockchain technology with PHS that links all blocks and processes that are included in the medical data sharing and caretaking process. A treatment system is built and deployed with a prototype named parallel gout with that there is an improvement in the overall performance of the complete system.

Ruksudaporn Wutthikarn and Yan Guang Hui [24], focused on healthcare service application and developed an application for a healthcare system that serves as a prototype for dental health management. A transaction id number has been maintained that ensures proper transaction of the data that are accessible only by an authorized participant that is doctor and patients with the help of a Hash number generated by hyper ledger maintained. In this healthcare management system relationship with trust is most important for healthy chain maintenance and for sharing medical equipment and medical records among all authorized participants.

Zheng, Liu, Chuanyu [25], proposed a method that intimates PBFT time response in Continuous Time Markov Chain (CTMC). has been used in the healthcare blockchain network. Delay in redundant nodes and in main nodes are the most influencing factor that is evaluated by the system. The optimization design of the blockchain network is the final contribution of the system.

III. BLOCKCHAIN IN TELEMEDICINE

3.1. Overview

For changing the perspective of digital transaction or to replace them, Blockchain technology based on digital-ledger has been developed. All transaction records related to

participating members are included in a decentralized distributed ledger. without any central records, participants are allowed to track digital assets by creating and storing Blockchain transactions in chronological order [1]. A major key feature of blockchain is a copy of the full blockchain is held in a network of participating nodes[3]. Authorization has been given for the participants only for those are agreed with the agreement. Making any fraudulent transactions are impossible to bypass since all transactions are tractable[3]. Whenever new transactions are going to be done a new block will be created for including the transaction. For verification process, every transaction is broadcasted across the network nodes. A new block is created and updated by other nodes by distributing the blockchain, whenever a new transaction is approved. And the complete process expressed above is given in fig.1.

The complete list of transactions is been stored in a sequence book, and this is shown in figure.2. parent lock refers to every point that has reference to the previous block. Every block is validated by a single value that is the hash value represents the reference. Since the first block of the blockchain has no parents so its hash value is a straight zero and is called a genesis block. Mining more than one block parallel is known as the uncle block proposed by Ethereum blockchain. But in Bitcoin blockchain, one is considered as an official block and other as Stale block it is known as uncle block. The whole block is neglected in Bitcoin whereas uncle block's hashes are stored[5].

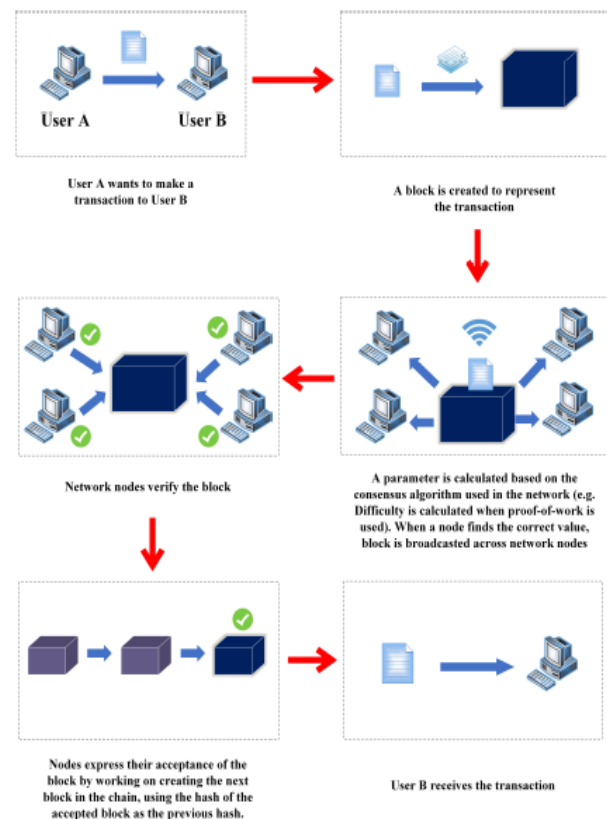


Figure 1. Blockchain process.

There are two categories in network architecture namely centralized and distributed architecture. The central node is responsible for maintaining coordination in centralized architecture and to take control over it. The need for central point is eliminated by connecting all nodes in a distributed architecture. Two primary advantages of the peer-to-peer function of blockchain architecture in distributed network greater computing power compared to centralized architecture and network reliability since every node's computing power has been combined together and there is no single failure point [18].

Precision security in the blockchain network, data integrity has been achieved and maintained in the blockchain. Databases are spread across several computing nodes which is referred to as distributed ledger[15]. Through an identical saved copy of ledger, every device is updated by itself independently. The use of distributed ledger arises blockchain.

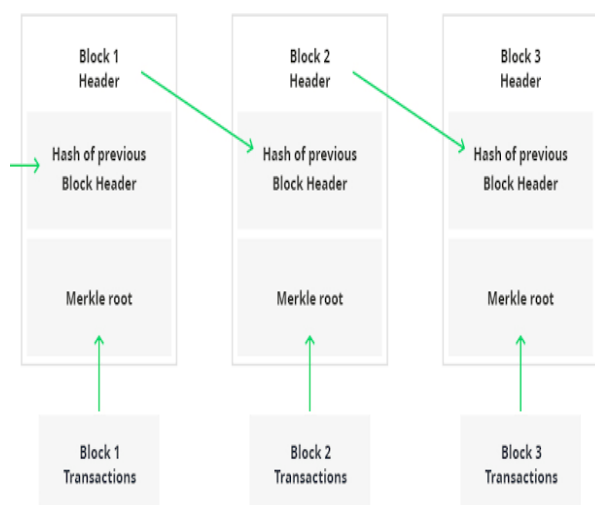


Figure 2. Blockchain architecture

The distributed ledgers of blockchain are not the same exactly. For a record of consensus of the network node both the terminologies can be defined as cryptographically audit trails. This process is not at all reversible. For providing a valid and secure distributed consensus, a chain of blocks is not employed in distributed ledgers.

3.2. Telemedicine system for Artificial health care

In paper[8] an artificial system for diagnosis of disease by a software-defined methodology that consisted in PHS helps for the treatment system. Real doctors and patients are included in this system. And doctors are software-defined and virtual patients are included in an artificial system. There are three different virtual doctors in the case of artificial doctors those are Expressive, Prognostic and Dogmatic.

a) Expressive doctor

- Information on the medical field and experience in the same field with real doctors make an Expressive doctor.

- An intelligent robot possessing adequate skills that owe similar responsibilities of doctors are involved in detecting disease in patients and for treating them.

b) Prognostic Doctor:

- For a Prognostic doctor who is a perfect doctor requires faultless skills in the medical field.
- All processes included in treatment from detecting to treating is done by a Prognostic doctor, then comes observing and analyzing the treatment effectiveness through multiple processes.

c) Dogmatic Doctor

- The dogmatic doctor referred to as a group of efficient artificial doctors with different therapeutic effectiveness's verification.

Similar to above there is an Expressive patient, Prognostic patient, and Dogmatic patient. Simulation of the real-time patient. Simulation with real-life patients that consist of real patients.

a) Expressive patient

- Information regarding real world has been data-driven with their personal identification.

b) Prognostic patient

- The artificial doctor conducts various diagnosis and treatment on Prognostic patients
- An effective treatment scheme and most reasonable diagnosis can be found by this approach.

c) Dogmatic patient

- Here is the final stage where the patient receives optimal treatment
- A pace is maintained with the Dogmatic patient and the real-world patient where the real patient has been monitored.

3.3. Application of Blockchain

3.3. 1. Blockchain in Telemedicine Drug supply chain management

Transparency and security aspect in supply chain management is the main challenge faced by the pharmaceutical industry in telemedicine application. Due to counterfeit drugs supplied they suffer losses in millions every year. Efficacy and safety if the product is paramount for pharma based companies since they are dealing with products that impact the lives of their customers[13]. There are so many stages between manufacturing and consumption like manufacturing, transportation, handling, storage, redistribution, and retail. From simple human mistakes to malicious intent many things can go wrong between these stages. As participants in this supply chain usually will maintain their own records, it is very difficult to identify any problem that occurred still there share their information in just one level up and one level down. It is more prone to errors when the records are paper-based. Further issues in the drug supply chain may further delay in the investigation for identification due to these factors.

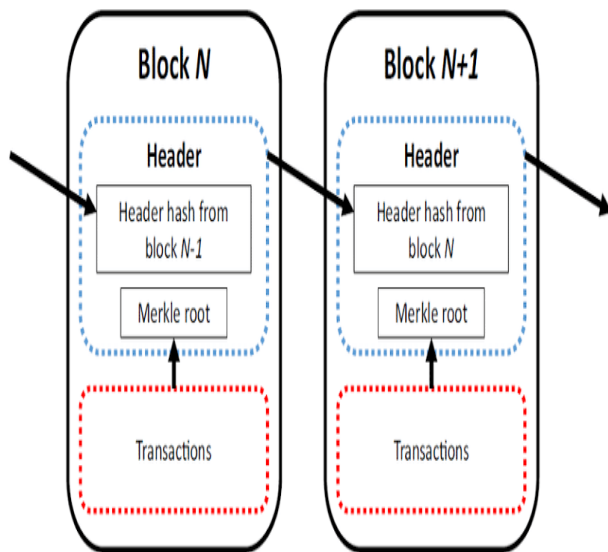


Figure 3. Block header structure.

3.3.2. Blockchain in Telemedicine claim and Billing management

Fraudulent claims and billing is the main loss to be eliminated and avoided in telemedicine applications. In telemedicine space, it is very common for medical billing-related fraud. Misrepresenting non-covered medical services as services, performing unnecessary services for a patient medical condition, overcharging the actual services, claiming charges for the non-performed services by the providers, are some very common telemedicine frauds that cover for obtaining claims money and covering financial losses.

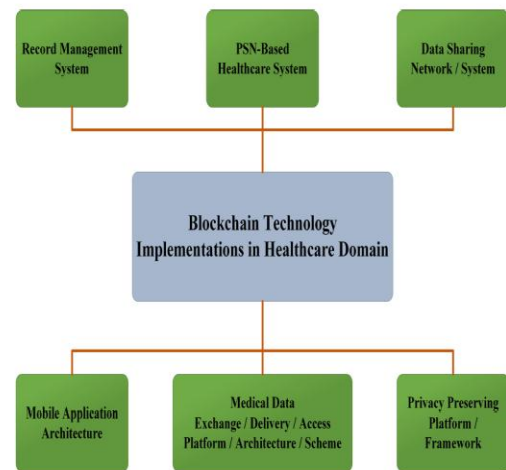


Fig.4. Implementation of blockchain in Telemedicine applications

To verify and adjudicate the claim information, There are many intermediaries involved and there is a lag of time for claiming process and to ensure the process also for reducing providers and payers administrative costs. A lot of back and forth of communication between parties involved in a typical process of claim adjudication for claims processing. Most of these challenges faced during claim adjudication and payment processing activities have been reduced by blockchain. The required workflows can be automated by blockchain and a single copy of the contracts and billing-related information can be shared among all parties involved.

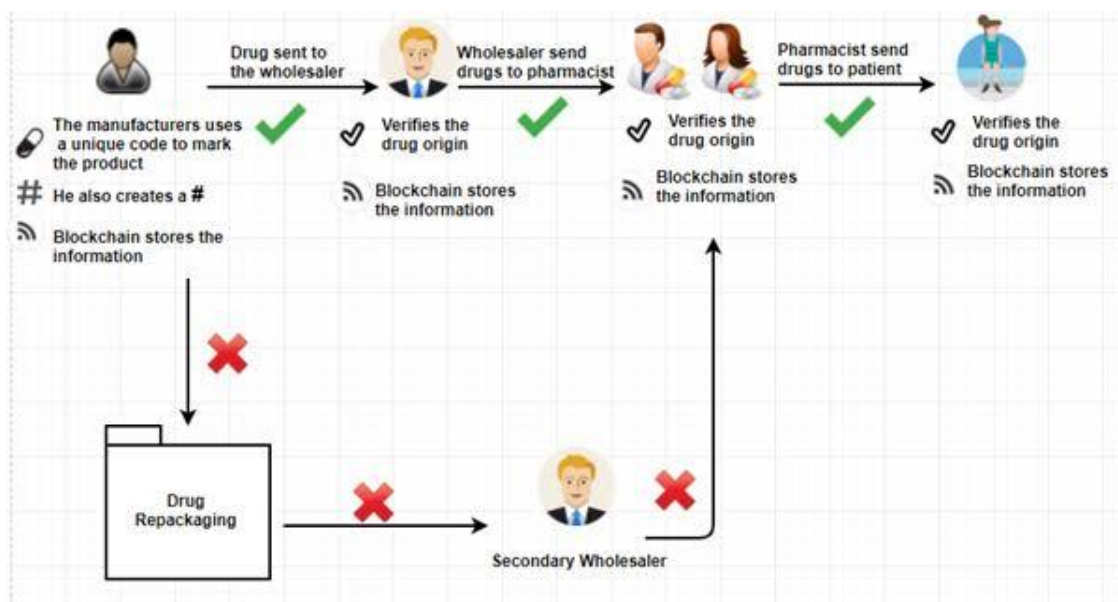


Fig.5. Blockchain in supply chain management for drugs

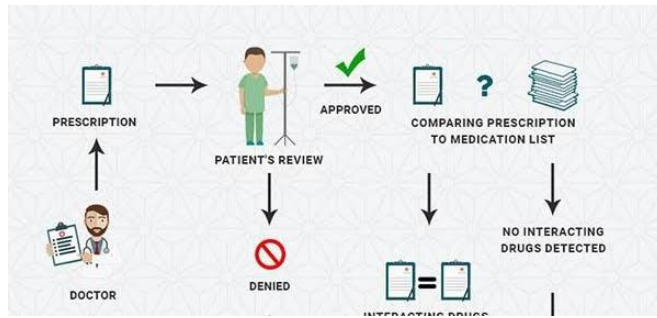


Fig.6.Blockchain solution for drugs interchange

3.3.3. Blockchain application in Telemedicine HIE (Health Information Exchange)

To transfer telemedicine data beyond geographical and institutional boundaries is the primary objective of HIE for providing an effective secure delivery mechanism. A lot of factors need to be considered with a universal sharing mechanism like :

Infrastructure: a centralized data source is required in the traditional way of sharing data where security risk footprints increase and Single centralized authority trust is required [20].

Security: Failure for patients' data security leads to financial as well as legal implications since privacy preservation of data is the ultimate important need.

Interoperability: All the required parties should understand the meaning and structure and that is the way for data sharing.



Fig.7. Blockchain application in Telemedicine HIE

Table 1. Survey of investment in blockchain technology

Year	Spending in millions U.S.Dollars
2014	30
2015	75
2016	130
2017	210
2018	315
2019	400

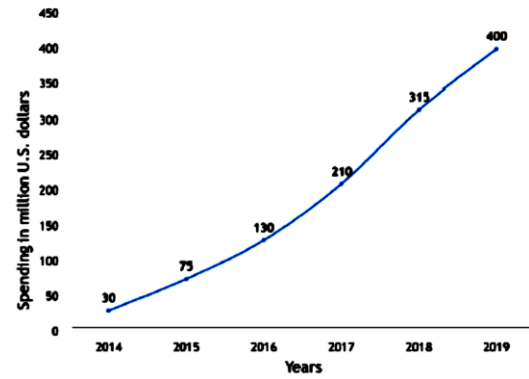


Fig.8. Worldwide Capital market investments into the blockchain, (in million US dollars).

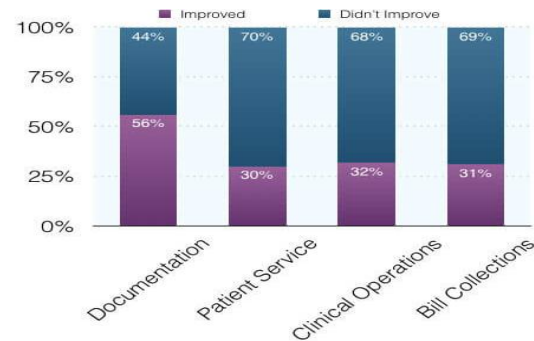


Fig.9. HER effect on the practice of Telemedicine management

Table 2. Effect of HER on practice in Telemedicine management system

Process	Improved %	Un improved %
Documentation	56	44
Patient service	30	70
Clinical operation	32	68
Bill collection	31	69

Table 3. Blockchain technology revenue pool(\$ billion)

year	Business cross border	remittance	Capital maker	Tile insurance
2016	0.1			
2017	0.7	0.3	0.2	
2018	1.7	0.7	0.3	0.1
2019	2.6	1.1	0.4	0.3
2020	3.5	1.5	0.7	0.6
2021	4.4	1.8	1.1	0.7
2022	5.2	2.1	1.4	0.8
2023	6.1	2.4	1.6	0.9
2024	7.0	2.7	1.7	1.1
2025	7.9	3.0	1.9	1.2
2026	8.7	3.2	2.0	1.3
2027	9.6	3.4	2.2	1.5
2028	10.5	3.6	2.3	1.6
2029	11.3	3.7	2.4	1.7
2030	12.2	3.8	2.5	1.9

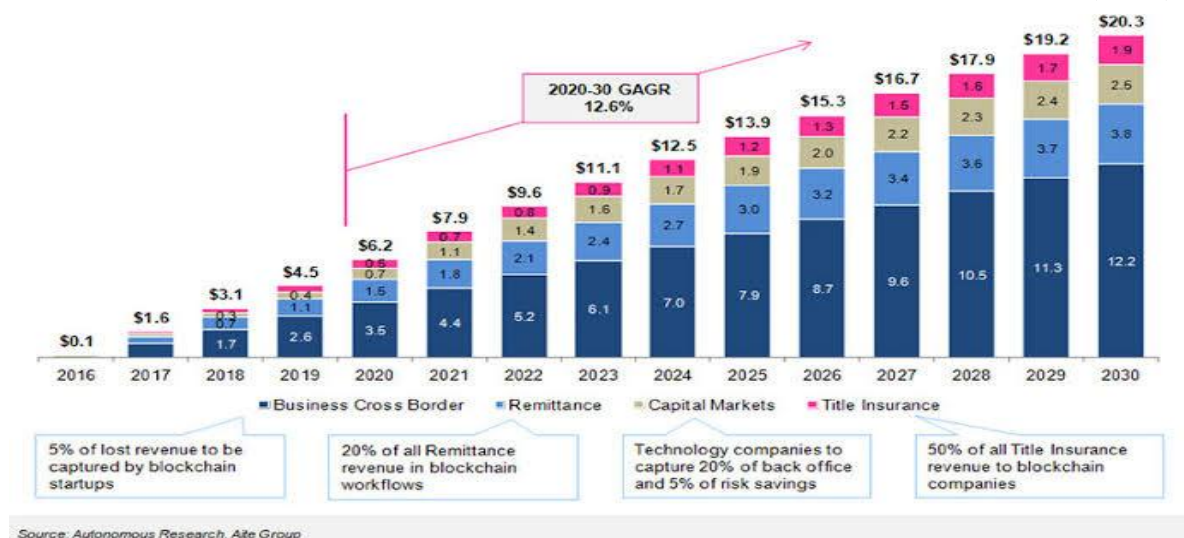


Fig.10. Blockchain technology revenue pool(\$ billion)

4. CONCLUSION

Thus, a three-line focusing based approach for telemedicine application for distance medical assistance has been proposed in this paper with Dogmatic, Prognostic and Expressive patients and doctors that make a good field for the artificial telemedicine system. Also, multiple analysis took on to make the system more effective. Followed by some common application of blockchain in healthcare application that can be implemented with the proposed methodology which makes the system performance better.

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