A Blockchain Based EHR Management Using Smart Contract

T.Kalaiselvi(ASP/CSE)[1], R.Janakrishnamoorthy[2], M.Jibin[3] and S.Sanjay[4]

[1]Dept of CSE, Erode Sengunthar Engineering College, Erode, Tamilnadu.
tkalaiselvi1281@gmail.com
[2]Dept of CSE, Erode Sengunthar Engineering College, Erode, Tamilnadu.
janakrishnan3580@gmail.com
[3]Dept of CSE, Erode Sengunthar Engineering College, Erode, Tamilnadu.
jibinmadhu@gmail.com
[4]Dept of CSE, Erode Sengunthar Engineering College, Erode, Tamilnadu.
ssanjay0036@gmail.com

Abstract

Blockchain is developing into a safe and trustworthy platform for secure data exchange in industries including finance, food, the internet of things, supply chain management, and healthcare. By linking nodes on the Ethereum Blockchain platform, we leverage Blockchain technology in this research to secure medical records. This also entails handling a sizable volume of medical data.The proposed model is a multilayer architecture model consists of multiple entities. The entities are doctors,patients, admin, clinic or hospitals, medical records etc. One of the key aspects of this endeavour is the efficient exchange of medical data. The system is to deliver quality medical services with optimized cost.

Keywords:

Blockchain technology, Ethereum, smart contracts, healthcare, data exchange, secure.

1. INTRODUCTION

Recently, Blockchain has emerged a technology that is very promising, attracting the attention of both academic research and industry. Satoshi Nakamoto first introduced this concept in a white paper in 2008[19]. It is described as a decentralized, appropriated, permanent record that is used to securely save communications across many PCs in a common organization, without the help of others.

Blockchain 1.0, the first generation, is built on Bitcoin [19], the major deployment of blockchain for cryptocurrency applications. The concept of smart contract that it is seen as a code fragments that is described, executed, and preserved in the distributed record gave rise to the concept of Blockchain 2.0. In Blockchain 3.0, the third iteration of Blockchain innovation, controls non-financial applications such those related to government, energy, health, and so forth. A few organizations have embraced this innovation and used it in the sector of medical treatment for extended periods of time. Decentralization, protection, and security are the most fascinating features of Blockchain technology that are advantageous to medical care applications because they may offer, protected access to healthcare information for patients and other partners (insurance agency, emergency clinics, specialists, and etc).

In this paper, we go through the most relevant studies on blockchain use in the healthcare industry. Medical data misuses are increasing day by day and it becomes a data leaking business. The objective of this paper is to share medical records safely and secured manner. First, the paper extends the understanding of blockchain and healthcare importance on person's life. Second it specifies the interaction between a doctor and patient. Second, the medical records are stored in a secured chain of network . Third, these records can only be accessed by health care providers with patients permission. A variety of purpose instances, including Electronic Healthcare Records (EHRs) [2, 6–8, 16], Smart contract for healthcare and health protection claims [10] are used to rank the focused techniques.

2. KEY CONCEPTS ON BLOCKCHAIN

In this section, we will analyze the central innovations of the Blockchain technology.

2.1 Overview of Blockchain

Blockchain, which was introduced in 2008 as a proposition for Bitcoin [19], is essentially a shared organization that sits on top of the web [13]. The BlockchainTechnology is a grouping of squares that serves as a public record and contains a complete history of exchange data that took place within the organization. Basically, a square is made up of a header and a body. The header of each square contains a hash address that refers to the previous square.As a result, each square's design is dependent on the previous one, forming a chain or connected list.

Block headers also contain a timestamp indicating the hour that the node was transmitted and a nonce, an erratic number that miners would change as frequently as possible to obtain a certain hash value in sequence to solve a mathematical puzzle.

Additionally, there is a Merkle tree that, at its most fundamental level, minimises the effort required to validate Exchanges inside a square.

A Blockchain exchange may be thought of as a little unit of work that is stored within open blocks. Every trade is verified with the consent of the majority of the Framework members. In this way, once exchanges are pressed into the blockchain, sealing is assured. Regarding Blockchain permanence, a duplicate of the record is replicated, assisted, and maintained.

In this way, once exchanges are pressed into the blockchain, sealing is assured. Considering Blockchain permanence, each participant copies, facilitates, and maintains a duplicate of the record[13].

Decentralization by making the Record accessible to everyusers, changelessness, which makes the Blockchain virtually impossible to alter and secure, accessibility by providing a copy of the Blockchain to each friend so they can access all time-stamped exchange records, and secrecy are some of the key features of the Blockchain. Each user can communicate with the Blockchain using a generated address, which hides the user's true identity.

3. HEALTHCARE BLOCKCHAIN USE CASES

The healthcare sector is regarded as one of the industries with great potential for blockchain technology. The Office of the National Coordinator for Health Information Technology (ONC) issued an ideation challenge in 2016 for proposing white papers on the likely utilize of Blockchain in medical services for better understand the relevance and significance of this Blockchain technology. In this part, we focus on the key studies organized by a select number of use cases, such as electronic healthcare records, remote patient checking, pharmaceutical store networks, and medical coverage claims.

3.1 Electronic Medical Records(EMR)

To alter medical treatment, emphasis should be placed on the management of healthcare information, which might be enhanced by the potential to link disparate systems and increase Electronic Health Records (EHRs) accuracy. Although the words Electronic Health Records (EHRs) andElectronic Medical Records (EMRs) are used interchangeably, they have different meanings. The phrase electronic medical records (EMRs), a digitalized paper graphs at the clinician's office, appeared initially. The clinical and treatment histories of patients in a single practice are both contained in an EMR. However, EHRs are focused on a patient's overall soundness, going beyond the usual clinical data acquired in the provider's office and inclusive of a more comprehensive picture on a patient's consideration [1].

On the basis of planning research, Blockchain technology supports the management of EHRs. Ekblaw et al, provide [7] MedRec, an EHR relavent execution that suggests a decentralized method of handling supervise permission, consents, and information splitting across medical services partners in this particular circumstance. In order to give patients access to information about who may access their medical information, MedRec uses the Ethereum platform. FHIRChain (Fast Health Interoperability Records + Blockchain), another solution that integrates EHR, is available [15]. It is a Blockchain technology based platform that uses Ethereum to share healthcare data with a focus on CEO’s healthcare records. For patients who fulfill the ONC necessity, FHIRChain provides solutions.

For systems that struggle with a lack of coordinated effort for splitting information among cloud administrations due to the hostile risks towards showing the items in private information, Xia et al. offer Medshare [24] an Ethereum application. For the exchange of clinical information in cloud vaults, Medshare provides information provenance, examining, and control amongst sizable information organizations.

OmniPHR is a communicated paradigm that maintains an Interoperable single-perspective on personal health records, according to Roehrs et al. (PHR). The suggested method relies on the engineering of PHR data to be flexible, interoperable, and adaptive. The segmentation of PHR into information Hinders and its delivery in a steering overlay organization might also be guaranteed by PHR evaluation.

3.2 Remote Patient Monitoring

Remote patient monitoring refers to the gathering of Healthcare data using IoT (Internet of Things), mobile devices and body area sensors devices that are suitable to remotely monitor the patient's condition. Blockchain technology is crucial for the storage, exchange, and retrieval of remotely gathered biological data. Ichikawa et al. [14] offer an application where Healthcare records are sent from mobile devices to a Blockchain-based application on Hyper-Ledger Fabric.

By providing instantaneous patient monitoring applications, Griggs et al. [11] show how Ethereum smart contracts may allow automated responses in a safe setting. Other suggested ways highlight the enormous potential of the Internet of Things (IoT) in various fields, particularly how it is being widely utilized in e-health. IoB Health [21], a data-flow architecture that integrates the IoT with Blockchain and may be used for retrieving, storing, and handling e-health data, is a suggestion made in this area by Ray et al.

3.3 Pharmaceutical Supply Chain

The pharmaceutical industry is another well-known application of blockchain technology. Patients may experience serious effects if false or insufficient medications are delivered. It has been acknowledged that blockchain innovation has the power to find a solution to this problem.

Modum.io AG is a firm that utilizes Blockchain to obtain information changelessness, according to Bocek et al. [4]. This company keeps the records of medication products throughout their transportation publicly available to validate the conformity to quality management. Additionally, [5,12,20] addresses the supply of fake pharmaceuticals by providing a security, enduring, and recognizable pharmaceutical production network based on Blockchain technology.

3.4 Health Insurance Claims

One of the medical services handled, insurance claims, can have advantage from Blockchain's consistency, clarity, and inspection of information stored on it. The management of healthcare protection guarantees is a crucial place where blockchain technology offers potential [10]. However, the model executions of such frameworks are very constrained. A Blockchain-based medication classification framework called Medical Insurance Store [26] may be found. It provides clinical protection industry-encoded and permanently stored clinical protection information.

4. IMPLEMENTATION DETAILS:

4.1 The Procedure for Filling and Issuing Medical Prescriptions

The primary goal is to simplifythe clinical medication maintaining process by getting rid of the lengthy procedure, getting rid of the extortion element from the system, and lowering the error rate caused by expert misunderstandings. An expert develops a treatment plan for the patient and adds it, cleverly, to the patient's medical records. The pharmacy then gains access to this medication through a clever arrangement on the Ethereum Blockchain with approval was given by a patient and an important specialist.After arriving at the answer, the pharmacy then, via clever agreements, delivers the medicine together with its expiration date and measurement use provided on the patient's medical care records, and after that, the patient can now choose their medicine. The digital agreement contains generally coordinated drug fulfillment between doctors and pharmacies. In order to comprehend medication requirements or, for the most part, to communicate with pharmacies after a patient visit, specialists use less efforts.

As shown in Figure 1, the information pipeline for administering a clinical medicine involves the patient, a necessary specialist (GP), and a pharmacy. It also includes the specifics of the medicine, include the pharmaceutical ID, expiration date, patient ID, and so on.

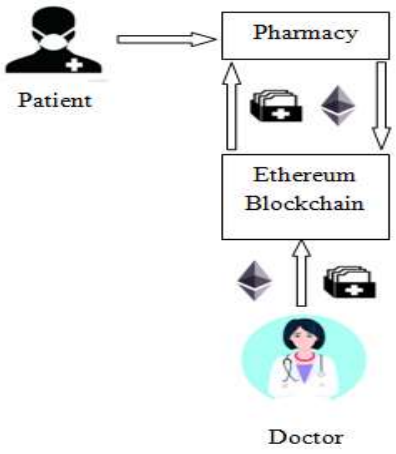

Fig 1. Medical prescription issuance and filing using smart contract.

4.2 Sharing Medical Records

The primary objective is to exchange information using smart contracts that enable labs, experts, crisis facilities, and other partners to successfully access and distribute a patient's beneficial data across partners, as shown in Figure 2.

Think of a scenario when a patient goes to the laboratory for a blood test. The patient receives these notifications through Ethereum Blockchain, is informed that the handled test results are available, and has the option of allowing the laboratory to encrypt the data and place it in Ethereum Blockchain after the results have been handled by the lab and entered into the patient's records. The consent to put the data on theEthereum Blockchain is granted by the patient. If the patient is experiencing a crisis and is drowsy, the crisis department would have the opportunity to quickly access patient data via the Ethereum Blockchain and would have the choice to change the course of treatment.

Patients can avoid traveling alone to the research center or organize for records to be sent to other care providers by allowing their clinical datas to be put on the medical services Blockchain. Additionally, ensure that every medical service providers are equipped with the necessary knowledge to deliver the best care.

Additionally, laboratories and patients have the ability to access the healthcare Blockchain, where they may get sections from insurance companies that advise the transferred data to handle claims or drug associations that choose the data for consideration. Subject matter specialists and crisis centers are given free access to all relevant data on their patients, which reduces costs and work.

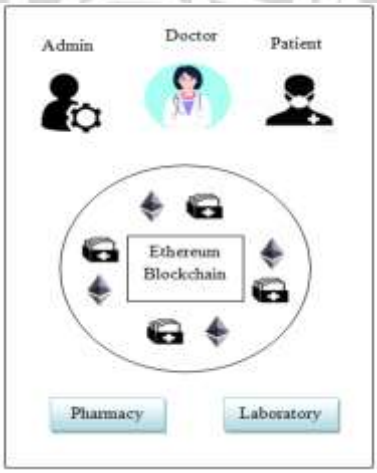

Fig 2. Sharing Laboratory Test/Results Info using Smart Contract

4.3 Facilitating efficient communication between service providers and Patients

In this instance, as shown in Figure 3, the patient offers a petition for a condition. Naturally, it uses a clever contract structure to transmit this request to a crucial professional. A specialist should analyze the request, respond with a suggestion, and, as necessary, refer the patients to the expert for further consideration. Any unspoken information regarding the treatment's past should be recorded in the EHR. Please take notice that the patient recordsis maintained by a local database, where there are clear rules on who may access the data and how much, and these rules are managed by clever smart contracts on the Blockchain.

Another scenario when a patient requests a specific clinical therapy is shown. After that, it uses the understanding's strict design to deliver this application to the appropriate expert. Where patient are essentially swapped for more attention with the educated expert, a specialist determines the interest and replies with a recommendation. Any relevant data on the treatment's historical context should be included in the EHR. Keep in mind that a neighboring information base maintains patient data with explicit regulations that might affect how much is recorded. These instructions are controlled through learning agreements on the Ethereum Blockchain.

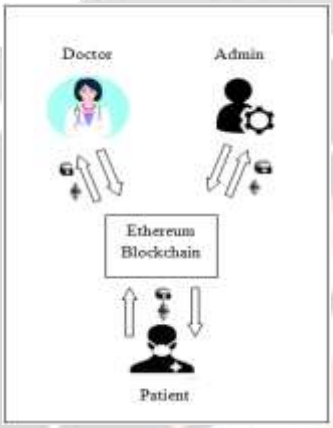

Fig 3. Smart contract for facilitating interaction between patient and service provider.

4.4 Healthcare Reimbursement Data Flow

The primary objective is to quicken the process of medical care framework repayment. In this case, clinicians will actually prefer to proceed quickly with care rather than demanding that it be delayed while relying on the payer to respond.

Medical insurance Company uploads its agreements using Blockchain smart contracts that detail the methods utilized to determine approval. At that point, a provider files a request for early approval of an expert arrangement, therapy, or cure to the Blockchain. The clever agreement for a clinical arrangement of the payer determines approval naturally using the patient's clinical data stored on the Ethereum Blockchain and the information in the solicitation. The supplier will then get approval information immediately. Additionally, the patient may continually review the protection permission together with any research facilities, pharmacies, subject matter experts, and other partners that the patient has chosen for admission.

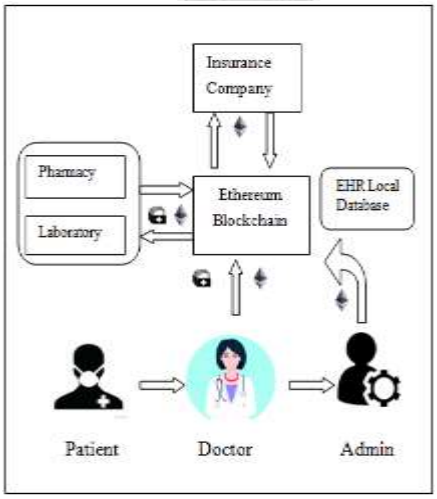

Fig 4. Healthcare reimbursement through smart contracts.

The automated process of early approval would result in large expenditure investment funds for payers, who now spend a lot of money physically studying and responding to solicitations. Instead than pausing patient care while they wait for the payer's response, specialists will actually want to move quickly with therapy. Additionally, patients won't have to worry about whether their insurance would pay for the PCP-recommended treatment. Specialists and patients may work together efficiently to develop a consideration plan that is specifically tailored to the patient's needs and the appropriate protection inclusion when they have quick access to prior approval data.

Our approach entails developing a prototype, then assessing the performance of the integration of medical information from various production. In addition to evaluating the unified view of records, our evaluation criteria also focused on non-functional performance requirements, such as response time, CPU usage, memory occupation, disk, and network usage.

5. ARCHITECTURE DIAGRAM

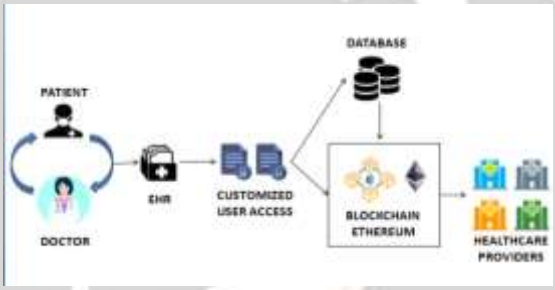

Fig 5. Architecture Diagram

6. MODULE DESCRIPTION

6.1 Admin

- Admin can able to login using login id and password.
- Admin only have the rights to add a doctor

Fig 6. Admin Login

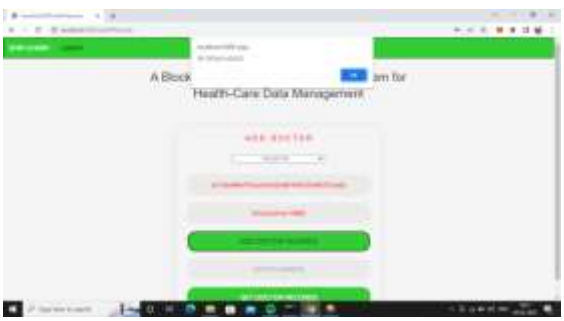

Fig 7. Doctor Registration

6.2 Doctor

- Doctor's can able to login using login id and password.
- The Doctor's can able to add patient's details
- The Doctor's can able to view patient's record with their permission.

Fig 8. Doctor Login

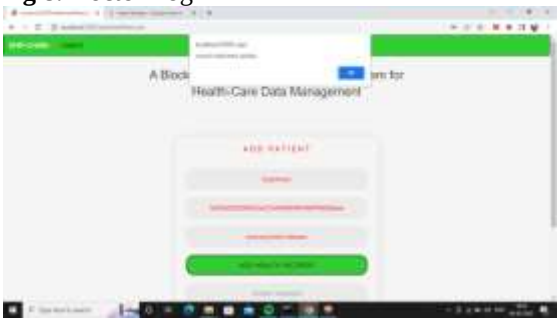

Fig 9. Patient Registration

6.3 Patient

- Patient's can able to login using login id and password.
- The Patient's can able to view their details
- The Patient's can able to give access for doctor's.
- The Patient can able to revoke access for doctor's.

Fig10. Patient Login

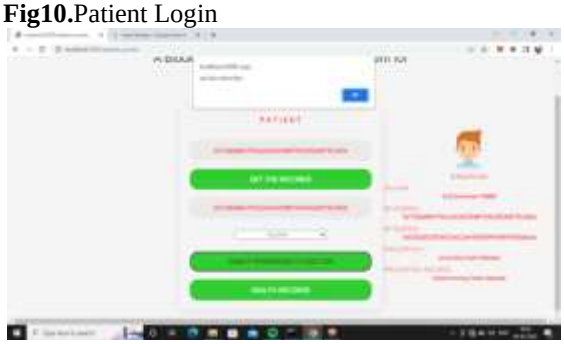

Fig 11. Doctor Access

Fig 12. Patient Details

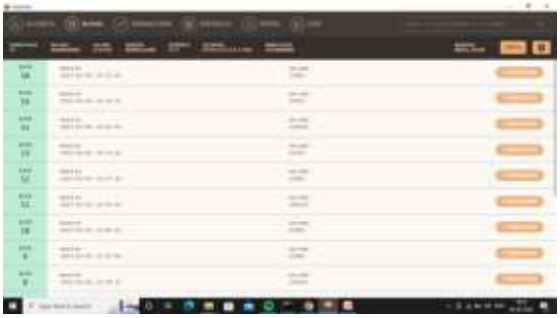

Fig 13. List of Blocks

7. CONCLUSION

In conclusion, using Blockchain for Electronic Health Records (EHR) has the potential to improve the security, accessibility and privacy of patient's data. By using a decentralized and immutable ledger, patients can have greater control over their data, while healthcare providers can ensure that records are accurate, up-to-date, and tamper-proof. However, implementing Blockchain EHRs also comes with its own set of challenges, including issues around interoperability, scalability, and regulatory compliance. The medical records stores are in the form of EHR, so that only the author or the recipient can view the records data . For the working of smart contract, Ethereum is used which can be provided by the Ganache. Ganache is a private Ethereum blockchain environment that allow to emulate the Ethereum blockchain. MetaMask can be used as Ethereum based Wallet that allows users to store, buy, send, convert and swap crypto tokens.

In order to fully realize the benefits of Blockchain EHRs, it will be necessary to address these challenges and ensure that the technology is implemented in a way that is user-friendly, cost-effective, and aligned with the needs of all stakeholders involved. Overall, Blockchain EHRs have the ability to revolutionize the way that healthcare data is managed, stored, and shared, but careful consideration and planning is needed to make sure that the technology is used effectively and responsibly. Our study also showed how implementing an EHR model may combine scattered data into a single view of medical information.

8. FUTURE SCOPE:

The future scope of Ethereum Blockchain Technology in medical healthcare management is vast, and it's had capability to improve patient care, reduce costs, and enhance data security makes it a promising technology for the healthcare industry. In addition to this we can add Pharmacy, Insurer, Bill Management for better data management.

REFERENCES:

[1] Asma Khatoon : A Blockchain-Based Smart Contract System for Healthcare Management Article, MDPI(2020)

[2] Sargolzaei, A.,Ahram, T., Sargolzaei A.,Amaba, B., Sargolzaei, S.,Daniels,J. : "Blockchain Technology Innovations". In: IEEE Engineering & Technology Management Conference (TEMSCON), pp. 137–141.IEEE(2017)

[3] Sartipi, K., Bender, D.,: "HL7 FHIR: an agile and restful approach to healthcare information exchange". In: Proceedings of the 26th IEEE International Symposium on Computer-based Medical Systems, pp. 326–331.IEEE(2013)

[4] Bocek, T., Rodrigues,B.,Stiller, B., B., Strasser, T.,: "Blockchains everywhere - a use case of Blockchains in the pharma supplychain".In: IEEE/IFIP Symposium on Integrated Network and Service Management (IM), pp.772–777,(2017)

[5] Borodinov, A., Bryatov, S., : "Blockchain technology in the pharmaceutical supply chain: researching a business model based on hyperledger fabric". In: International Conference on Information Technology and Nanotechnology (ITNT), Samara, Russia (2019)

[6] Milojkovic, M., Dagher, G.G., Mohler, J.,Marella, P.B., : "Ancile: privacy-preserving framework for access control and Interoperability of electronic health records using Blockchain technology". Sustain. Cities Soc. 39, 283–297 (2018)

[7] Lippman, A., Ekblaw, A., Halamka, J.D., Azaria, A.,: "A case study for Blockchain in healthcare: 'MedRec' prototype for electronic health records and medical research data". In Proceedings of IEEE Open & Big Data Conference, vol. 13, p. 13 (2016)

[8] Yang,Y. Fan, K., Ren, Y., Li, H.,, Wang, S., : "Medblock: efficient and secure medical data sharing via Blockchain". J. Med. Syst. 42(8), 136 (2018)

[9] Fernando, E., et al.: "Success factor of implementation Blockchain technology in pharmaceutical industry": a literature review. In: 6th International Conference on Information Technology, Computer and Electrical Engineering (ICITACEE), pp. 1–5. IEEE (2019)

[10] Gatteschi, V., Lamberti, F., Claudio, D., Vıctor, S.: "Blockchain and smart contracts for insurance: Is the technology mature enough?",February (2018)

[11] Howson, E.A., Griggs, K.N., Kohlios, C.P., Ossipova, O.,Baccarini, A.N., Hayajneh, T.: "Healthcare Blockchain system using smart contracts for secure automated remote patient monitoring". J. Med. Syst. 42(7), 130 (2018)

[12] Haq, I., Esuka, O.M.: "Blockchain technology in pharmaceutical industry to prevent counterfeit drugs". Int. J. Comput. Appl. 975, 8887 (2018)

[13] Lakhani, K.R.,Iansiti, M., : "The truth about Blockchain". Harv. Bus. Rev. 95(1), 118–127 (2017)

[14] Kashiyama, M., Ueno, T., Ichikawa, D., :"Tamper-resistant mobile health using Blockchain technology". JMIR mHealth uHealth 5(7), e111 (2017)

[15] Kim, D.,Jamil, F., Kim, K., Kim, D.,Hang, L.,: "A novel medical Blockchain model for drug supply chain integrity management in a smart hospital". Electronics 8(5), 505 (2019)

[16] Yang, Y., Jiang, S., Cao, J., Wu, H., Ma, M., He, J.: "BlocHIE: a Blockchain-based platform for healthcare information exchange". In: IEEE International Conference on Smart Computing (SMARTCOMP), pp. 49–56. IEEE(2018)

[17] Nayyar, G., Mackey, T.K.,.: "A review of existing and emerging digital technologies to combat the global trade in fake medicines". Expert Opin. Drug Saf. 16(5), 587–602 (2017)

[18] Mazlan, A.A.,Rasid, S.Z.A., Daud, S.M., Yusof, M.F.,Sam, S.M.,Abas, H., : "Scalability challenges in healthcare Blockchain system"-a systematic review. IEEE Access 8, 23663–23673 (2020)

[19] Nakamoto, S., et al.: "Bitcoin: A Peer-topeer Electronic Cash System" (2008)

[20] Raj, R., Agarwal, S., Rai, N.,: "Anticounterfeiting in pharmaceutical supply chain by establishing proof of ownership". In: TENCON 2019–2019 IEEE Region 10 Conference (TENCON), pp. 1572–1577. IEEE (2019)