Blockchain-Based Secured Drug Traceability in Health Care Application

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KEYWORDS

Block Chain, Health, Security, Privacy

ABSTRACT

Despite the enormous advancements in technology, fraudsters continue to attack the healthcare industry. Numerous recent healthcare security breaches indicate that attackers are focussing on the electronic health data and the drug supply chain. Additional investigation into security problems in the healthcare sector demonstrates that the primary cause of these incidents is the centralisation of data storage. The healthcare sector also lacks immutability, adaptability, security, and privacy in addition to having insufficient documentation. It has been discovered that blockchain technology may offer a complete solution to the main issues the healthcare industry is now facing. Healthcare issues may be resolved with the aid of blockchain's intrinsic qualities, which include immutability, transparency, privacy, security, and documentation. In this work, an interactive blockchain 2.0 medication supply chain tracking system is created, and Hyperledger Calliper is used to measure the system's performance. This system makes sure that everyone involved in the drug supply chain can follow the drug's journey from the producer to the end user. The members' own inventory management is also aided by it. In addition to providing privacy and transparency, this method offers a viable remedy for the issues associated with counterfeit drugs. With one ordered peer and one endorsed peer, the system can process 25,000 transactions per second.

1. Introduction

Modern times have seen a daily influx of new pharmaceuticals into the market due to the sharp rise in the number of ailments affecting humans. These medications aid in the patient's recovery from sickness, but occasionally they can worsen a person's condition. Drug counterfeiting is primarily to blame for the negative effects of medications [1]. This is due to the profitable drug's frequent transfers of ownership along the supply chain, which makes it easier for counterfeit medications to get onto the market. The process of identifying these fake medications is difficult and costly. Not even the doctor writing the prescription can tell the difference between legal and illegal medications [3]. Humans are profoundly and catastrophically affected by medications that are counterfeit [2]. It may alternatively be described as a product that contains the incorrect substance, an inactive ingredient, or an active ingredient at a high dosage. A World Health Organisation (WHO) study claims that fake or subpar medical products make up one in ten of the goods offered in low- and middle-income countries. The continuously expanding Indian pharmaceutical business has a significant market for fake and bogus medications. From 2021 to 2028, the Indian pharmaceutical market is projected to expand at a compound annual growth rate of 11.34% [11]. According to a different WHO assessment, India is the world's third-largest manufacturer of generic drugs and is a key hub for the production of fake pharmaceuticals. This drug counterfeiting is carried out with consideration for the following factors: minimal investment requirements, lack of public awareness, leakage points in the supply chain, and difficulty in detecting counterfeiting [6].

When a particular drug that is in high demand is unavailable, counterfeit medications also manage to make their way onto the market [4]. Producers of fake drugs use the chance to close the gap between supply and demand. False medications have the potential to be lethal when they are poisonous, fail to treat illnesses, or aid in the development of disease-causing bacteria. Antibiotics and anti-malarial drugs are the most frequently counterfeited medications in low-income nations. Fraudsters are not concerned with the efficacy or quality of the counterfeit medications; instead, they are very interested in producing an exact replica of pricey prescription medications, such as those used to treat cancer, AIDS, or other illnesses. Improving operational efficiency while cutting costs and medication waste is another significant issue facing the pharmaceutical supply chain system [5]. This procedure entails keeping track of stocks, organising the stock according to demand, monitoring medication expiration dates, and other related tasks [9]. If the inventory is not kept up to date, money will be wasted on unnecessary prescriptions, pharmaceuticals will be wasted, and the company's marginal profit will be reduced.

2. Methodology

The suggested blockchain-based medication supply chain is shown in Fig. 1. Manufacturers, distributors, retailers, chemists, and customers are all involved. Each member of the network uses the smart contracts that have been implemented within it to update, validate, and manage the supply chain data. [13].

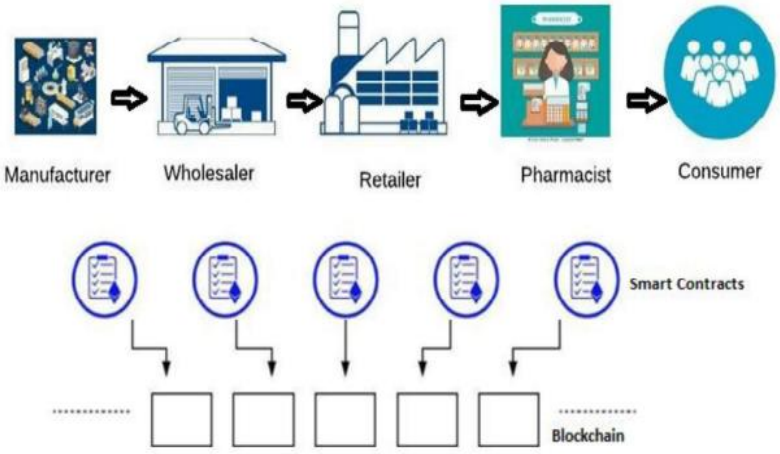

Figure 1: overall proposed framework

Computer programs known as "smart contracts" specify each member of the network's tasks and obligations as well as their relationships with one another. It makes it easier for each network member to communicate with the distributed ledger. It also assists each party in approving the proposed transaction and updating the ledger. After receiving the transaction request, the smart contracts carry it out and reply to the client [7]. It maintains the ledger in the interim by adding transactional data and conducting queries. The hyperledger fabric, a permissioned consortium network, was used in the architecture of the suggested system, which sets it apart from others [8]. Only those who have been authenticated are able to use the network and conduct transactions. The certificate that the certificate authority issued is used to confirm the participants' legitimacy. Drugs are moved through the supply chain from the manufacturing location to the end user, changing hands along the way. The manufacturer, wholesaler, retailer, and chemist are some of the parties involved in this supply chain. Certain characteristics of the medication being produced are linked to it, including the name, form, dosage, date of manufacture, date of expiration, and manufacturer.

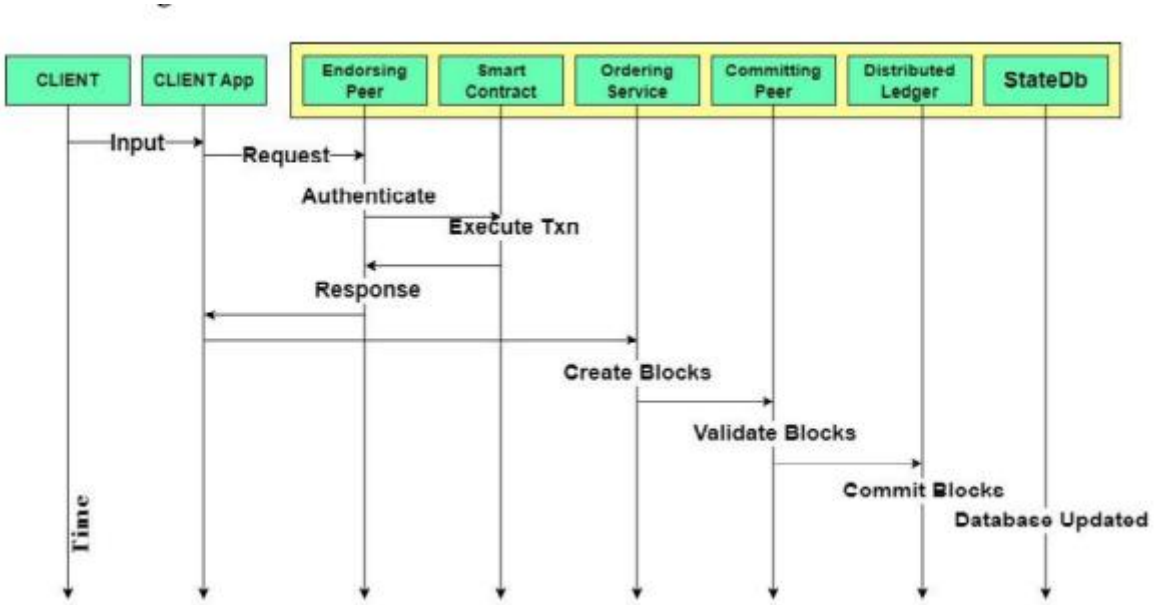

Figure 2: Transaction flow for read and write operations

Nodes in the supply chain carry out read and write transactions when medications are moved. Nodes are permitted to carry out transactions in accordance with the access control policy once they have joined the network by getting a certificate from the certificate authority. The customer node only has access to view permissions; the manufacturer, wholesaler, retailer, and chemist nodes are granted read and write permissions. When a client node submits a transaction proposal via the network, the nodes in the network begin to communicate with one another [12]. Using smart contracts, the endorsing nodes take the transaction proposal and carry out the request. Without changing the ledger, the smart contracts carry out the transaction request and update the global state. The endorsing nodes retrieve the proposal answer from the world state, sign it with their certificate, and provide it back to the client. These answers are gathered by the client node and forwarded to the ordering nodes. These proposal responses from different clients are gathered by the ordering nodes, who then arrange them into blocks. After that, the blocks are sent to the network's committing nodes, who update the ledger and the global state, validate the transaction response, and commit the transaction [10]. In addition, the committing node may produce an event informing the client of the success or failure of the transaction they submitted. Fig. 2 depicts the read and write transaction flow for the suggested medication supply chain.

3. Results and discussion

The suggested prototype implements the business logic of the pharmaceutical medication supply chain system using Hyperledger Fabric, an open source permissioned blockchain technology. With an Intel Core i5 processor and 16 GB of RAM, the suggested system is run on the Ubuntu 18.04 operating system. Version 18.09 of Docker is utilised to run the Docker environment, and version 18.09 of Docker-compose is used.

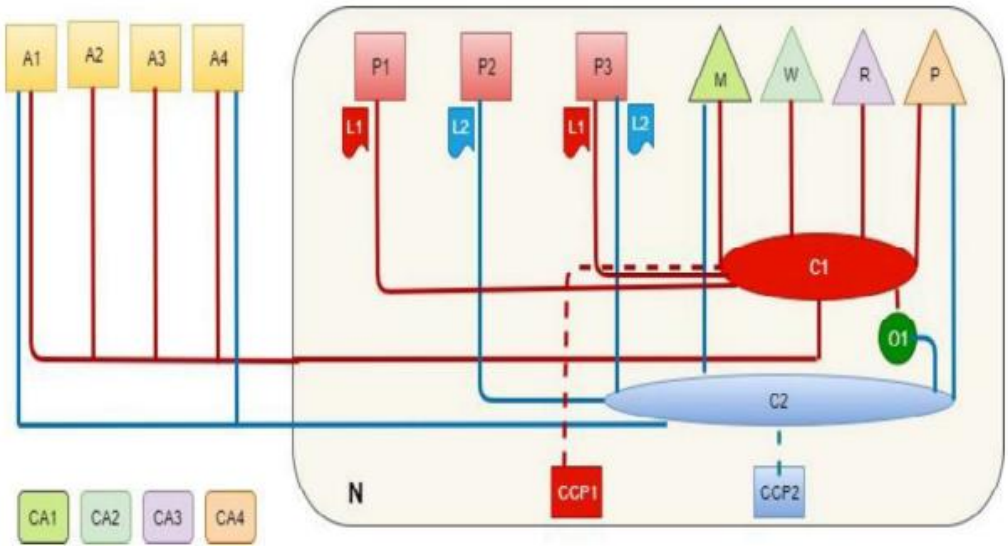

Figure 3: Designed network structure

For a hundred users, the success rate, transaction throughput, and latency are monitored. The success rate, transaction delay, and transaction throughput are measured, and there are now only two endorser peers. The figures 3 to 5 depict it.

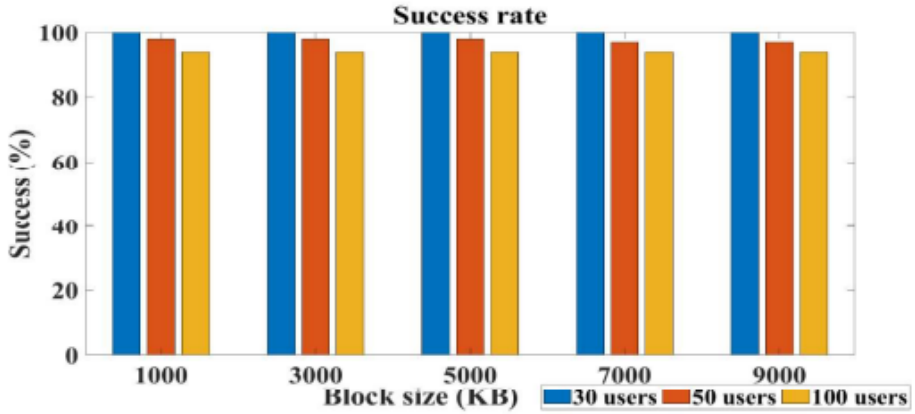

Figure 4: Success rate on varying the block size and the number of users

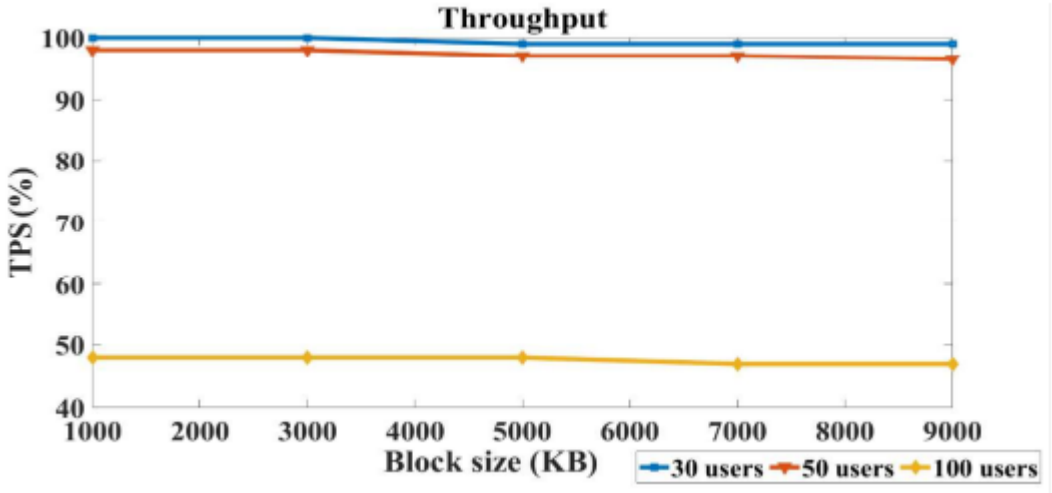

Figure 5: Throughput on varying the block size and the number of users

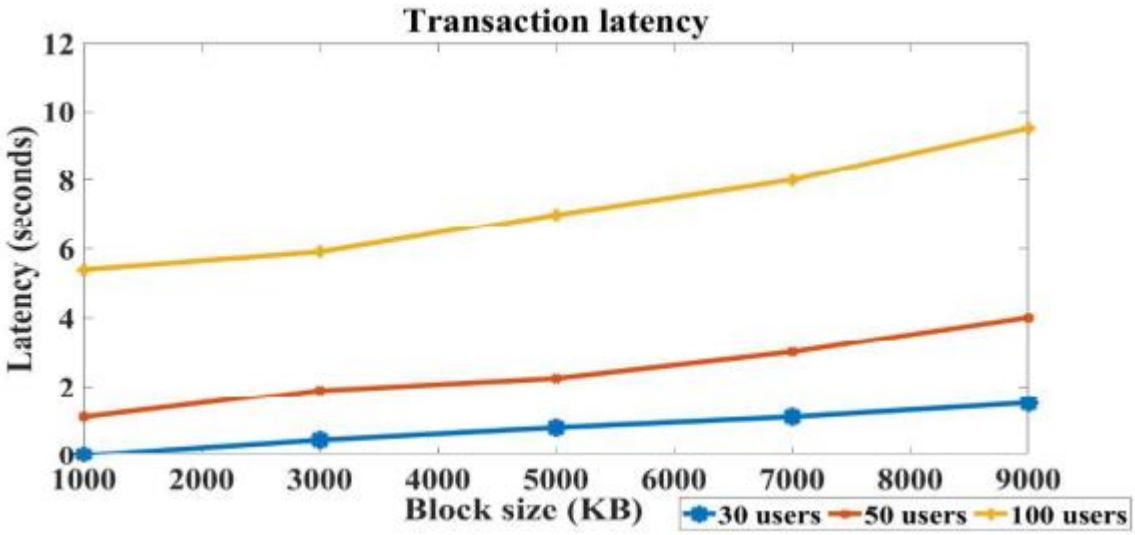

Figure 6: Latency on varying the block size and the number of users

Hyperledger Calliper is a blockchain benchmarking tool that is used to test the performance of the proposed system. Multiple iterations of the system are tested with various user groups and numbers of endorser peers. Metrics including transaction latency, success rate, and transaction volume per second are quantified. In the future, the system might be built to accommodate cross-chain platforms and enhance throughput and success rate in response to a real-time rise in user count.

4. Conclusion and future scope

This study outlined the drawbacks of the present medication supply chain infrastructure and suggested a cutting-edge Hyperledger Fabric blockchain solution. The proof-of-concept application that tracks medications from the point of manufacture to the customer might be the name given to the suggested system. The consumer only has the ability to read the records in this system; the manufacturer, wholesaler, retailer, and chemist are the only ones with the ability to alter information in the database. It is not permitted for the customer to do any update operations. To facilitate communication between the users of the system and the blockchain platform, a web application has been created. Because only members who have registered can access the proposed system, it is deemed trustworthy because digital certificates are used to uphold the system's legality. The suggested blockchain 2.0 drug supply chain system ensures a safe and responsible drug supply.

Reference

[1] Musamih, Ahmad, Raja Jayaraman, Khaled Salah, Haya R. Hasan, Ibrar Yaqoob, and Yousof Al-Hammadi. "Blockchain-based solution for distribution and delivery of COVID-19 vaccines." *Ieee Access* 9 (2021): 71372-71387.

[2] Uddin, Mueen. "Blockchain Medledger: Hyperledger fabric enabled drug traceability system for counterfeit drugs in pharmaceutical industry." International Journal of Pharmaceutics 597 (2021): 120235.

[3] Sindhusaranya, B., Yamini, R., Manimekalai Dr, M. A. P., & Geetha Dr, K. (2023). Federated Learning and Blockchain-Enabled Privacy-Preserving Healthcare 5.0 System: A Comprehensive Approach to Fraud Prevention and Security in IoMT. Journal of Internet Services and Information Security, 13(3), 199-209.

[4] Abbas, Khizar, Muhammad Afaq, Talha Ahmed Khan, and Wang-Cheol Song. "A blockchain and machine learning-based drug supply chain management and recommendation system for smart pharmaceutical industry." Electronics 9, no. 5 (2020): 852.

[5] Cheema, Muhammad Asaad, Rafay Iqbal Ansari, Nouman Ashraf, Syed Ali Hassan, Hassaan Khaliq Qureshi, Ali Kashif Bashir, and Christos Politis. "Blockchain-based secure delivery of medical supplies using drones." Computer Networks 204 (2022): 108706.

[6] Mohamed, K.N.R., Nijaguna, G.S., Pushpa, Dayanand, L.N., Naga, R.M., & Zameer, AA. (2024). A Comprehensive

Approach to a Hybrid Blockchain Framework for Multimedia Data Processing and Analysis in IoT-Healthcare. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications (JoWUA), 15(2), 94-108. https://doi.org/10.58346/JOWUA.2024.I2.007

[7] Zoughalian, Kavyan, Jims Marchang, and Bogdan Ghita. "A blockchain secured pharmaceutical distribution system to fight counterfeiting." International Journal of Environmental Research and Public Health 19, no. 7 (2022): 4091.

[8] Liu, Xinlai, Ali Vatankhah Barenji, Zhi Li, Benoit Montreuil, and George Q. Huang. "Blockchain-based smart tracking and tracing platform for drug supply chain." Computers & Industrial Engineering 161 (2021): 107669.

[9] Ludhiani, Simran, Rajesh Kumar Maheshwari, and . 2022. Novel Application Of Mixed Solvency Concept To Develop And Formulate Liquisolid System Of A Poorly Water Soluble Drug, Furosemide And Their Evaluations. *International Journal of Pharmacy Research & Technology*, 12 (1), 28-57. doi:10.31838/ijprt/12.01.05

[10] S. Neelima, Manoj Govindaraj, Dr.K. Subramani, Ahmed ALkhayyat, & Dr. Chippy Mohan. (2024). Factors Influencing Data Utilization and Performance of Health Management Information Systems: A Case Study. Indian Journal of Information Sources and Services, 14(2), 146–152. https://doi.org/10.51983/ijiss-2024.14.2.21

[11] Rehman, Muhammad, Ibrahim Tariq Javed, Kashif Naseer Qureshi, Tiziana Margaria, and Gwanggil Jeon. "A cyber secure medical management system by using blockchain." IEEE Transactions on Computational Social Systems 10, no. 4 (2022): 2123-2136.

[12] Uddin, Mueen, Khaled Salah, Raja Jayaraman, Sasa Pesic, and Samer Ellahham. "Blockchain for drug traceability: Architectures and open challenges." Health informatics journal 27, no. 2 (2021): 14604582211011228.

[13] Kamath, Vagdevi, Yaparla Lahari, and Kusuma Mohanchandra. "Blockchain based framework for secure data sharing of medicine supply chain in health care system." International Journal of Artificial Intelligence 9, no. 1 (2022): 32-38.

[14] Musamih, Ahmad, Khaled Salah, Raja Jayaraman, Junaid Arshad, Mazin Debe, Yousof Al-Hammadi, and Samer Ellahham. "A blockchain-based approach for drug traceability in healthcare supply chain." IEEE access 9 (2021): 9728-9743.