A Blockchain-Integrated Web Interface for Supply Chain Management in Medicine Industry

Dipta Mukherjee, Subhra Banerjee and Sourav Chakraborty
Assistant Professor, University of Engineering & Management, Jaipur, India

Keywords: Blockchain-Integrated, Tracing, Pharmaceutical Company, Supply Chain Management.

Abstract: The mismanagement of supply chains in pharmaceutical companies has significantly increased the prevalence of counterfeit medicines. There is an urgent need for regular monitoring of drug ownership and the distribution of expired medicines. Blockchain technology offers a reliable remedy to these problems by enhancing transparency within companies. Utilizing a decentralized database, blockchain ensures data integrity. Leveraging the Ethereum Blockchain, it ensures the storage of immutable data through advanced cryptographic algorithms, providing comprehensive security and transparency in the system.

1 INTRODUCTION

In 2004, the term WEB 2.0, also known as the participative social web, highlighted the importance of user-generated content, usability, and interoperability for end users. More recently, the internet has evolved significantly with the advent of Web 3.0, characterized by distributed ledger technology, commonly referred to as Blockchain. Blockchain introduces the concept of data decentralization. Initially, it was closely linked to digital currency, leading to the uprise of Bitcoin. Blockchain has gained substantial acceptance due to its decentralized and transparent nature, enabling the recording of transactions between non-trusting stakeholders. Simply put, Blockchain is a shared information database agreed by distributed network.

This study applies Ethereum-based Blockchain technology to enhance drug traceability in supply chain management. The supply chain consists of interconnected channels and points of control from production to distribution, with corporate and private networks at various levels little data is shared between these systems due to security or system barriers therefore often leaves it unclear and untraceable. Maintaining system reliability is important, as reliance on a centralized server carries the risk of data loss during congestion. Ensuring the authenticity and authenticity of medication quantity and quality is essential to prevent counterfeit medication and ensure patient safety.

Blockchain is emerging as the best solution to achieve decentralization, security, traceability and transparency in the supply chain network. It operates as a peer-to-peer ledger system, using decentralized blocks to store data safely through asymmetric key encryption and hash functions This approach not only ensures the integrity of drug information but maintains confidentiality among manufacturers and between users through smart contracts, which in the former are used to store patient histories in healthcare systems

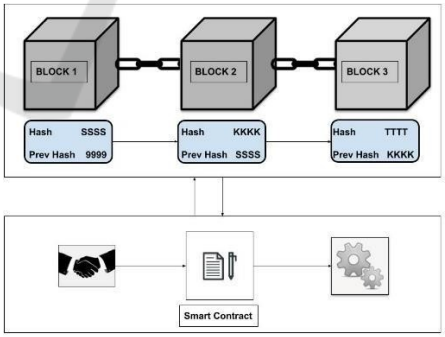

Figure 1: Smart Contract & Hash Function in Blockchain.

Data handling and security are important concerns in medicine, making process integrity of paramount importance. Counterfeit medicines with harmful ingredients pose a serious risk to consumers. The pharmaceutical manufacturing process encompasses end-to-end processes from sourcing active ingredients to manufacturing and delivery of the final product to

Chakraborty, S., Mukherjee, D. and Banerjee, S.
A Blockchain-Integrated Web Interface for Supply Chain Management in Medicine Industry.
DOI: 10.5220/0013280600004646

In *Proceedings of the 1st International Conference on Cognitive & Cloud Computing (IC3Com 2024)*, pages 161-164
ISBN: 978-989-758-739-9

patients to ensure patient safety and medicines timely delivery is the most important aspect of this supply chain.

Our primary approach to dealing with the limitations of centralized data is to detect counterfeits and monitor order flow at every stage of the supply chain using blockchain technology. This ensures maximum security, traceability, and proper authentication. Data from each entity must be entered into the blockchain network to provide a traceable path for end consumers. Each block in the network has a unique hash (private and public keys), a timestamp, and the hash of the previous block. Once entered, data cannot be altered or changed by anyone other than the admin. The primary security requirement is met as the blocks where data is stored are secured by private keys.

2 LITERATURE REVIEW

Lingayat et al. analysed blockchain architectures for pharmaceutical companies, comparing the Ethereum Public Blockchain and Hyperledger Blockchain Framework. They assessed parameters such as transparency, centralization, scalability, security, and privacy. The study found that while platforms like Ethereum and Groin scale effectively, they are unsuitable for identity management systems (IMS). Additionally, Ethereum's proof of work consensus is computationally intensive, whereas Hyperledger offers IMS along with scalability, and improved tracking and tracing systems through its pBFT-Byzantine fault tolerance approach.

Uddin et al. proposed two blockchain-based drug traceability systems using Hyperledger Besu and Hyperledger Fabric architectures. They evaluated these systems based on security, privacy, accessibility, and transparency, and discussed challenges in adopting such technologies in pharmaceutical supply chains.

Zakari et al. conducted a systematic literature review (SLR) on blockchain technology in the pharmaceutical industry, evaluating parameters such as tracking, tracing, counterfeit prevention, distribution, and data security. A meta-analysis was conducted that identified reliability, traceability, transparency, traceability, and real-time data as important success factors. Their review addressed key questions regarding previous studies, major areas of application, limitations, and future research directions.

Zoughalian et al. proposed a blockchain-based solution for transparency in drug delivery systems using Python framework. Their framework ensures data integrity through authentication mechanisms at each node, including timestamps, unique identifiers (UUIDs), and configured connections. It achieves collision, availability, and separation tolerance through the CAP theorem and zero knowledge proofs (ZKPs).

Siby et al. proposed a blockchain and web-based supply chain management systems were introduced to pharmaceutical companies, compared to traditional database systems based on transparency and security Switched to blockchain for increased security and traceability, InterPlanetary File System (used to store cryptographic hashes). IPFS) is integrated.

Another study proposed a collaborative framework integrating blockchain and IoT for drug supply management. It used Ethereum smart contracts for business logic and data encryption, ensuring traceability from sender to recipient using role-based access rules.

Tiwari et al. explored blockchain adoption in third-party logistics (3PL), highlighted shortcomings and proposed digitization strategies for supply chain transactions to address issues of accuracy, security and data quality

Anthony et al. moderated an anti-counterfeit submission system was developed using the Ethereum Solidity language, which ensured that the products were authentic and traceable while transparently scanning the network

Shannan et al. designed a distributed traceability platform using barcodes, RFID tags, and sensors, ensuring supply chain visibility and data privacy through zero-knowledge proofs and an enhanced PBFT algorithm.

Lastly, a proof-of-concept model integrated Hyperledger Fabric with Odoo ERP, employing a three-layer architecture to synchronize communication among manufacturers, consumers, and logistic partners in the supply chain.

3 METHODOLOGY

To implement this solution, we have developed a web interface using Node.js and React, leveraging their capabilities as open-source platforms and front-end libraries respectively. Node.js serves for server-side programming, content generation while React supports smart contract development. Ethereum serves as our decentralized platform for storing data in blocks, with the Metamask wallet enabling connectivity to the local host and managing each account and transaction within the interface.

The proposed pharmaceutical network, depicted in Figure 2, encompasses key roles: Designer, Regulator, Manufacturer, Distributor, Retailer, and Consumer. The flow of medicines commences with the designer creating drug compositions. The regulator validates the drug's composition, after which the manufacturer produces and transports the drug to the distributor. The distributor then distributes the medicines across entities such as pharmacies, hospitals, and retailers, ensuring patients receive the correct medications.

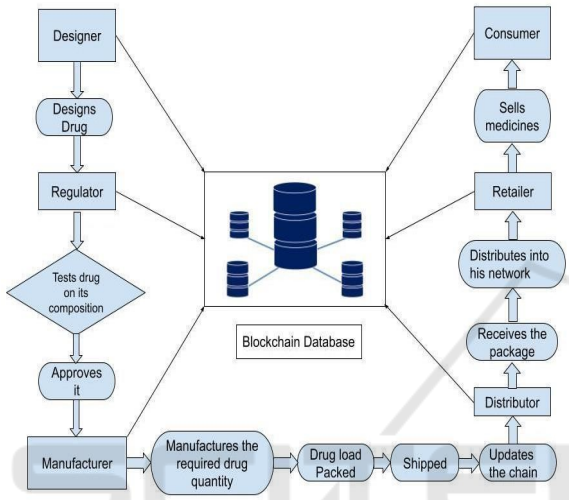

Figure 2: Framework of Supply Chain Management in Pharmaceutical Companies of drug counterfeiting.

4 CONCLUSION

This paper introduces a web-based drug delivery system that uses blockchain technology. Employees assign roles to different nodes such as designer, regulator, manufacturer, distributor, and retailer. Transaction information is stored on the Ethereum blockchain network, allowing customers to trace the entire journey of a product using its unique ID. This approach simplifies the search process and ensures that counterfeit drugs are removed from the network. Data storage on the blockchain network also increases security.

In summary, blockchain technology provides decentralization, transparency, trust, anonymity and stability. Its validation in the pharmaceutical industry represents a strong solution to prevent the distribution of counterfeit drugs

REFERENCES

Lingayat, Vishwesh, Isha Pardikar, Shubham Yewalekar, Shyamal Khachane, and Sachin Pande. "Securing pharmaceutical supply chain using Blockchain technology." In *ITM Web of Conferences*, vol. 37, p. 01013. EDP Sciences, 2021.

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.

Zakari, Nazik, Muna Al-Razgan, Amani Alsaadi, Haya Alshareef, Lamia Alashaikh, Mala Alharbi, Rana Alomar, and Seham Alotaibi. "Blockchain technology in the pharmaceutical industry: a systematic review." *PeerJ Computer Science* 8 (2022): e840.

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. [5]. Siby et. al., "Blockchain based Pharmaceutical Supply Chain Management System", International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, ICCIDT - 2022 Conference Proceedings

Humayun, Mamoona, Noor Zaman Jhanjhi, Mahmood Niazi, Fathi Amsaad, and Isma Masood. "Securing drug distribution systems from tampering using blockchain." *Electronics* 11, no. 8 (2022): 1195.

Jaya, Robert Muliawan, Valentino Dhamma Rakkhitta, Pranata Sembiring, Ivan Sebastian Edbert, and Derwin Suhartono. "Blockchain applications in drug data records." *Procedia Computer Science* 216 (2023): 739-748.

Ashraf, Mateen, and Cathal Heavey. "A Prototype of Supply Chain Traceability using Solana as blockchain and IoT." *Procedia Computer Science* 217 (2023): 948-959.

Tiwari, Sunil, Pankaj Sharma, Tsan-Ming Choi, and Andrew Lim. "Blockchain and third-party logistics for global supply chain operations: Stakeholders' perspectives and decision roadmap." *Transportation Research Part E: Logistics and Transportation Review* 170 (2023): 103012.

Alamsyah, Andry, Sri Widiyanesti, Puspita Wulansari, Eva Nurhazizah, Andrieta Shintia Dewi, Dadan Rahadian, Dian Puteri Ramadhani, Muhammad Naufal Hakim, and Prenzeline Tyasamesi. "Blockchain traceability model in the coffee industry." *Journal of Open Innovation: Technology, Market, and Complexity* 9, no. 1 (2023): 100008.

Teodorescu, Margareta, and Elena Korchagina. "Applying blockchain in the modern supply chain management: Its implication on open innovation." *Journal of Open Innovation: Technology, Market, and Complexity* 7, no. 1 (2021): 80.

Turki, Mariem, Saoussen Cheikhrouhou, Bouthaina DAMMAK, Mouna Baklouti, Rawya Mars, and Afef Dhahbi. "NFT-IoT Pharma Chain: IoT Drug traceability system based on Blockchain and Non

Fungible Tokens (NFTs)." *Journal of King Saud University-Computer and Information Sciences* (2023).

Casella, Giorgia, Barbara Bigliardi, Serena Filippelli, and Eleonora Bottani. "Cases of application of blockchain on the supply chain: a literature review." *Procedia Computer Science* 217 (2023): 1416-1426.

Sunmola, Funlade, and Patrick Burgess. "Transparency by Design for Blockchain-Based Supply Chains." *Procedia Computer Science* 217 (2023): 1256-1265.

Lee, Michael Christian, Rafaelle Richel Pearl, Ivan Sebastian Edbert, and Derwin Suhartono. "Developing an anti-counterfeit system using blockchain technology." *Procedia Computer Science* 216 (2023): 86-95.

Shahaab, Ali, Imtiaz A. Khan, Ross Maude, Chaminda Hewage, and Yingli Wang. "Public service operational efficiency and blockchain– A case study of Companies House, UK." *Government Information Quarterly* 40, no. 1 (2023): 101759.

Liu, Shannan, Ronghua Zhang, Changzheng Liu, and Du Shi. "P-PBFT: An improved blockchain algorithm to support large-scale pharmaceutical traceability." *Computers in Biology and Medicine* 154 (2023): 106590.

Kordestani, Arash, Pejvak Oghazi, and Rana Mostaghel. "Smart contract diffusion in the pharmaceutical blockchain: the battle of counterfeit drugs." *Journal of Business Research* 158 (2023): 113646.

Belhi, Abdelhak, Houssem Gasmi, Abdelaziz Bouras, Belaid Aouni, and Ibrahim Khalil. "Integration of Business Applications with the Blockchain: Odoo and Hyperledger Fabric Open Source Proof of Concept." *IFAC-PapersOnLine* 54, no. 1 (2021): 817-824.