Traceability of counterfeit medicine supply chain through Blockchain

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Abstract: - The primary concerns surrounding drug safety within the counterfeit medicine distribution network arise from the initial manufacturing process of these drugs. Ensuring the traceability of correct and active pharmaceutical ingredients during manufacturing presents a significant challenge. Failure to detect drugs lacking the intended active ingredients can result in severe harm or fatalities to end-consumers. Leveraging the advanced capabilities of blockchain technology offers a promising solution for establishing comprehensive traceability of drugs from the manufacturer to the end-consumer, as well as the ability to identify counterfeit drugs. This paper endeavours to tackle the issue of drug safety by employing Blockchain technology alongside encrypted QR (quick response) code security.

Keywords—Blockchain, Drug safety, pharmaceutical supply chain.

I. INTRODUCTION

The World Health Organization (WHO) describes counterfeiting as intentionally and fraudulently incorrect labeling a product with respect to its identity and/or source [1]–[3]. Several manufacturing companies are seriously threatened by this illegal activity, especially the pharmaceutical industry. It puts public health at risk and costs genuine producers a significant amount of money in lost sales. The International Chamber of Commerce in Geneva estimates that the global market for counterfeit goods is worth an astounding $650 billion a year [4].

Numerous techniques have been employed to trace counterfeit drugs within the medical supply chain. In [6], the authors propose the utilization of Smart-Track, which incorporates barcodes or RFID codes on medicine bottles to authenticate their legitimacy. Similarly, [7] introduces the Data-Matrix tracking system, wherein each medicine is assigned a unique Data-Matrix containing essential details such as Manufacturer ID, Product ID, package ID, authentication code, and optional metadata. The article also mentions the Central Verification Register (CVR), designed to store the hash value of Data-Matrix details. Upon purchase, the scanned Data-Matrix (including the hash value) undergoes verification against the manufacturer's CVR.

In [8], the authors suggest employing Near Field Communication (NFC) tags for product authentication. A key exchange technique is proposed to validate medicine details retrieved from its NFC tag.

None of the aforementioned methods incorporate automatic verification of product authenticity and manufacturer legitimacy. When it comes to preventing counterfeit. drugs in the drug supply chain, blockchain technology stands out as a way to ensure an immutable chain of transaction ledger, tracking each step of the supply chain at the individual drug level [5].

II. BACKGROUND STUDY

The counterfeiting of medicines poses a grave threat to society, adversely affecting public health and causing substantial revenue losses for legitimate pharmaceutical manufacturers. Despite numerous anti-counterfeiting techniques proposed in recent years, many existing schemes lack robust security and are susceptible to attacks like replay and man-in-the-middle attacks. Despite the application of conventional technologies such as RFID, barcode scanning,

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and mobile technology for tracking and tracing medicines, counterfeit drug incidents remain alarmingly high.

To address these vulnerabilities and enhance counterfeit drug safety, we propose encrypted QR code techniques accessible only to authorized entities is approved by regulatory authorities of medical supply chain.

III. LITERATURE SURVEY

In this section, we propose the utilization of a permissioned blockchain for Medical Chain Storage and the implementation of a tracking system for counterfeit drugs.

A. Medical Chain Data Storage in Blockchain

The proposed structure for storing transaction data, depicted in Fig-1, bears resemblance to Bitcoin transaction data. As illustrated in Fig-1, each participant shares their public key, hash value of the previous transaction, and an encrypted QR (Quick Response) code provided by the manufacturer. This QR code contains details of the medicine manufactured by the pharmaceutical agency. The transaction within the medical chain is secure and tamper-proof. Illegitimate participants cannot gain access to the transaction block due to participant (recipient) verification via public key and digital means.

The global counterfeit drug trade impacts all stakeholders in the pharmaceutical industry, including hospitals, pharmacies, wholesale distributors, global health programs, and regulatory authorities. The illegal drug market significantly contributes to the proliferation of fake and fraudulent medicines by introducing contaminated, improperly stored, and falsified ingredients. This problem persists due to a lack of technical and business solutions offering sufficient traceability and provenance.

For instance, a substandard version of the anti-cancer drug Avastin® reached thousands of cancer patients in the U.S., potentially causing treatment complications. Regions such as the Asia Pacific, Africa, and Latin America are particularly vulnerable to counterfeit drugs, with nearly 30% of drugs produced and consumed being counterfeit, resulting in approximately 1.5 million deaths annually. In Europe, reported cases of counterfeit drugs have doubled compared to previous years. A recent report from a prominent European research project highlights the counterfeit medication industry's profitability, estimating a revenue loss equivalent to nearly 4.5% of drug sales, totalling €10 billion annually.

In this section, we introduce and analyse two blockchain-based architectures designed to meet essential requirements for drug traceability. The proposed architectures are built on two blockchain platforms: Hyperledger Fabric and Hyperledger Besu. These platforms offer superior levels of trust, decentralization, transparency, privacy, security, data integrity, deployment flexibility, modularity, and scalability compared to other blockchain platforms such as Ethereum, Quorum, and Blockchain.

These architectures serve as pivotal components for establishing private permissioned blockchain ecosystems. In these ecosystems, pharmaceutical stakeholders and their end-users are registered, controlled, and overseen by a regulatory authority or a consortium of stakeholders. The following subsections detail the two proposed architectures and their corresponding transaction flows, followed by an in-depth technical comparison.

IV. DISCUSSION

Blockchain solutions for supply chain and logistics have experienced significant adoption recently due to their provision of an immutable and transparent method for recording transactions among distrustful stakeholders. The primary feature of blockchain technology lies in its capability to track and trace asset transactions through a decentralized distributed ledger containing cryptographically secured timestamped records. This allows for direct digital transfer and storage of transaction records without the need for intermediary service providers. Blockchain facilitates the establishment of an immutable ledger for transaction processing among physically dispersed and untrusted stakeholders throughout the pharmaceutical supply chain. This technology offers an efficient and cost-effective solution supporting various drug traceability functions and procedures to ensure proper authentication.

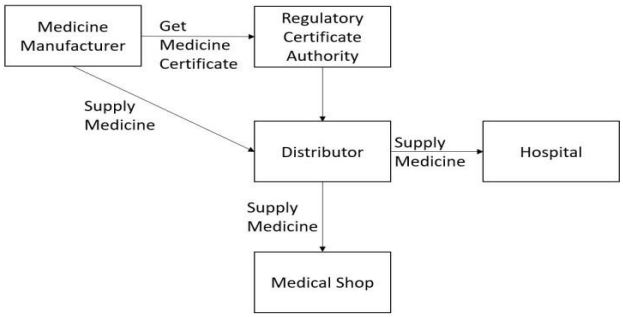
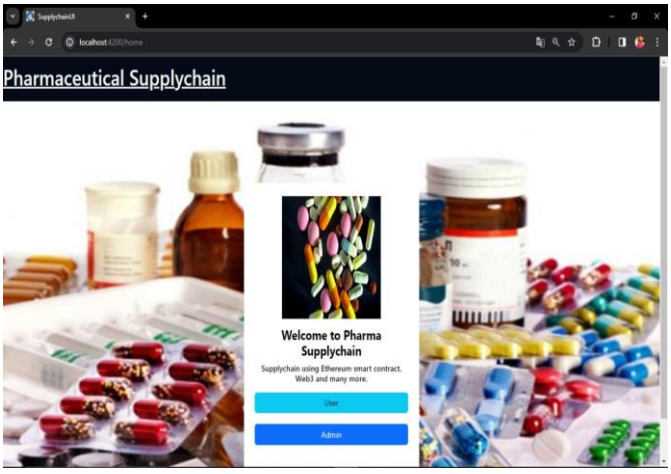


Fig. Workflow of Medicine Supply Chain

V. RESULT



Admins Dashboard –

Fig-1

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Home Page –

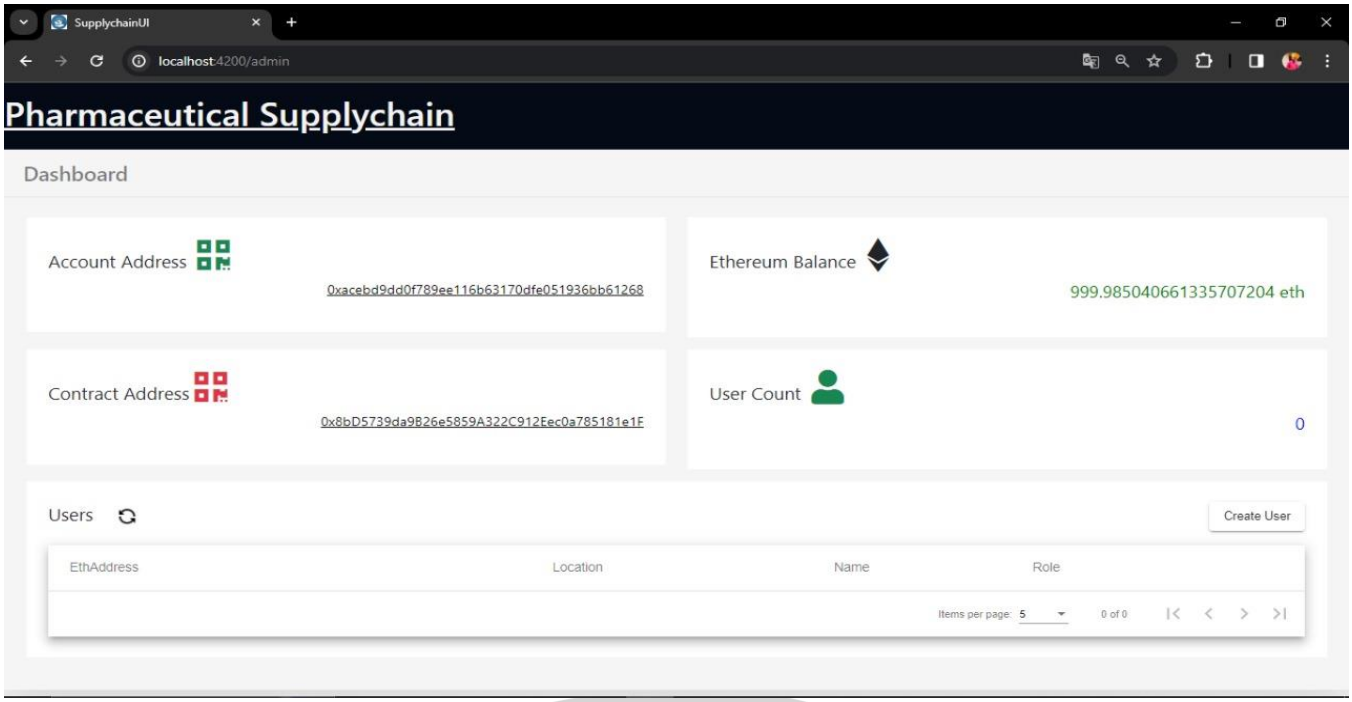

Fig-2

VI. CONCLUSION

The proposed framework represents a blockchain-based secure infrastructure for the medical chain supply among authorized participants. This framework not only ensures the security of drugs but also verifies the authenticity of manufacturers. Unlike the current medical chain framework, which relies on third-party trust, the proposed methodology utilizes Public Key Infrastructure (PKI) and digital signatures, significantly enhancing security measures against replay and man-in-the-middle attacks.

By implementing PKI and digital signatures, the proposed framework establishes a robust system where participants can securely exchange medical chain transaction data without the need for intermediaries. This approach enhances trust among stakeholders while minimizing the risk of fraudulent activities and counterfeit drugs infiltrating the supply chain. Furthermore, the use of blockchain technology ensures transparency and immutability of transaction records, providing a reliable audit trail for tracking the movement of pharmaceuticals from manufacturer to end-user. This not only enhances accountability but also facilitates regulatory compliance and quality assurance measures. In conclusion, the proposed framework offers a comprehensive solution for enhancing drug safety and authenticity within the medical supply chain. By leveraging blockchain technology and cryptographic techniques, it establishes a secure and transparent ecosystem where stakeholders can confidently participate in the exchange of medical goods while mitigating the risks associated with counterfeit drugs and malicious attacks.

VII. REFERENCES

[1] W. Burns, “WHO launches taskforce to fight counterfeit drugs.,” Bull. World Health Organ., vol. 84, no. 9, pp. 689–690, 2006.

[2] H. Kwame Adjei, “Counterfeit Drugs: The Relentless War in Africa,” Pharm. Pharmacal. Int. J., vol. 2, no. 2, pp. 45–47, 2015.

[3] World Health Organization, “Substandard, spurious, falsely labelled, falsified and counterfeit (SSFFC) medical products,” Who, no. January, pp. 2–5, 2016.

[4] H. H. Cheung and S. H. Choi, “Implementation issues in RFID-based anti-counterfeiting systems,” Compute. Ind., vol. 62, no. 7, pp. 708–718, 2011.

[5] Y. Li, T. Marier-Bienvenue, A. Perron-Brault, X. Wang, and “Blockchain Technology in Business Organizations: A Scoping Review,” no. January, 2018.

[6] Paik, Michael, Ashlesh Sharma, Arthur Meacham, Giulio Quarta, Philip

[7] Smith, John Tarhanas, Brian Levine, Mary Ann Hopkins, Barbara

[8] Rapchak, and Lakshminarayanan Subramanian. The case for SmartTrack.” In Information and Communication Technologies and Development (ICTD), 2009 International Conference on, pp. 458-467. IEEE, 2009.

[9] E. Engineering and C. Science, “Reliable Identification of Counterfeit

[10] Medicine Using Camera Equipped Mobile Phones Saif Rehman, Raihan Ur Rasool, M. Sohaib Ayub, Saeed Ullah, Aatif Kamal, Qasim M. Rajpoot, and Zahid Anwar,” pp. 273–279.

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