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Study of Fake Medicine Detection using Blockchain

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Abstract: ***The healthcare industry has grappled with the challenge of monitoring genuine medicines while counterfeit drugs continue to proliferate, posing significant risks to patient safety. These fraudulent pharmaceuticals not only have detrimental effects on health but also result in substantial financial losses, with reports indicating annual losses of approximately 200 billion dollars for US pharmaceutical companies. Particularly concerning is the World Health Organization's revelation that in underdeveloped nations, one in every ten medicines consumed by patients is counterfeit and of low quality. To address this critical issue, we use blockchain technology to track the supply chain, from the manufacturing stage to the end- user. Leveraging blockchain technology, our system enhances reliability, transparency, and security in healthcare data. This paper focuses on bolstering transaction security, safeguarding medicine quality, and fortifying data protection through the utilization of blockchain technology.***

Index Terms: Counterfeit, Blockchain, Smart contracts, Fake Medicines

I. INTRODUCTION

The proliferation of counterfeit medicines poses a severe threat to public health and creates substantial challenges for pharmaceutical companies worldwide. The consequences of counterfeit drugs extend beyond financial losses to these companies, impacting patient well-being and potentially caus- ing life-threatening complications. With an estimated annual global market of $650 billion in counterfeit products, it becomes imperative to address this pressing issue. Various techniques, including barcoding and RFID (Radio-Frequency Identification). However, these solutions are not without their limitations, such as high implementation costs and lack of transparency.

The pharmaceutical supply chain is intricate, involving numerous entities like suppliers, manufacturers, transporters, wholesalers, distributors, and retailers. Maintaining transparency and traceability throughout this extensive network is a formidable challenge.

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Counterfeit medicines infiltrate the market, particularly affecting developing countries, where the percentage of fake drugs can range from 10% to 30%. These counterfeit drugs not only result in financial losses but also jeopardize human health by causing adverse side effects. The existing supply chain faces inherent inefficiencies, primarily due to a lack of transparency in the supply chain making it difficult to believe in the authenticity of medicines. It becomes even more challenging to investigate suspected un- ethical or illegal practices within the supply chain. This paper advocates the use of blockchain as a solution to address these issues. Blockchain offers a decentralized, immutable ledger with no central authority, ensuring transparency and trust among various supply chain entities. Smart contracts enable secure and transparent transactions between manufacturers, distributors, suppliers, and end-users, leading to improved customer experiences and heightened customer satisfaction. The research aims to enhance transparency, traceability, and security in the pharmaceutical supply chain by leveraging blockchain technology. The amalgamation of blockchain technology and other innovative approaches promises to revolutionize the pharma- ceutical industry, ensuring the safety, quality, and authenticity of medicines while prioritizing the well-being of patients.

II. LITERATURE SURVEY

[1][11][12][13][14][15] The Research paper presents a blockchain-based supply chain to ensure that no counterfeit medicine is added to the supply chain. It uses QR code methodology to avoid counterfeiting of medicines. It involves various participants and utilizes public keys, digital signatures, and encrypted QR codes for secure transactions. Notably, the system incorporates a location tracker to prevent unauthorized transactions. Customers can scan QR codes to verify medicine authenticity. The prototype uses a private blockchain system, and a drug administration authority validates participants. While the implementation uses JavaScript and Angular, it emphasizes the system's security and ability to detect counterfeit medicines within the supply chain, with future work proposed for quantitative assessments. D'souza, S. [2] employs smart contracts and product registration for the permanent and immutable recording of all product transfers, enhancing traceability. Notably, consumers actively participate in maintaining information flows. The system's decentralized features are pivotal, mitigating the risk of unauthorized data manipulation. Customer service and transparency are augmented through integrating a Rasa chatbot, facilitating insight into drug details and order progress along the supply chain.

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Establishing an event request-response mechanism further bolsters security by verifying the authenticity of events and the identity of involved parties. These events are securely logged and stored on the blockchain in real-time. This paper implements a decentralized application using Truffle and tests smart contracts.

[3] Here solution utilizes smart contracts for each type of stakeholder in the supply chain so that only authentic and authorized persons can access the limited information available. The proposed solution achieves protection against malicious attempts. The paper's main purpose is to focus on tamper-proofing the data in the pharmaceutical supply chain. [4] presents an IoT-based authentication scheme to combat counterfeit medicines. The system's architecture involves information, authentication, and database servers, ensuring transparency and security throughout the supply chain. This user-friendly scheme enhances medicine authenticity verification, empowering patients to make informed purchasing decisions.

The research paper [5] discusses challenges in the pharmaceutical supply chain, including ethical issues, weak regulations, and counterfeit medicines' impact. It proposes a blockchain-based solution, "Crypto Pharmacy," to enhance transparency and trust. The system utilizes NEM blockchain, mobile applications, and smart contracts to track medicine from production to distribution. QR codes and immutable blockchain records provide confidence in medicine authenticity. The design and implementation of this system are detailed, emphasizing the importance of blockchain technology and the Proof of Importance algorithm to credit trustworthy participants. The survey highlights the need for improved pharmaceutical supply chain security and integrity [6], highlights the use of blockchain technology to secure the pharmaceutical supply chain. It outlines how blockchain records medication flow, starting with manufacturers assigning QR codes, verification by wholesalers, and ultimately reaching patients. The focus is on ensuring medication authenticity and transaction transparency.

[7] introduces a novel approach to counterfeit medicine detection through the integration of blockchain technology. The paper proposes a decentralized system that utilizes blockchain's immutability and transparency to track the entire pharmaceutical supply chain, from manufacturing to distribution. By recording each transaction on the blockchain, stakeholders can verify the authenticity and origin of medicines in real-time, mitigating the risk of counterfeit products entering the market. This methodology not only enhances traceability but also facilitates swift identification and recall of counterfeit medicines, thereby safeguarding public health.

Building upon the concept of blockchain, [8] presents a comprehensive framework for counterfeit medicine detection leveraging smart contracts. The paper outlines the development of intelligent contracts that autonomously execute predefined rules and regulations within the pharmaceutical supply chain. Through smart contracts, stakeholders can enforce strict au- thentication protocols, verify product legitimacy, and trigger automatic alerts in case of suspicious activities. By automating authentication processes and ensuring tamper-resistant record- keeping, this framework offers enhanced security and reliabil- ity in counterfeit detection efforts.

In contrast, [10] explores the application of machine learn- ing algorithms for counterfeit medicine detection based on image analysis. The study proposes a robust algorithm capable of analyzing microscopic images of medicine samples to identify subtle differences between genuine and counterfeit products. By training the algorithm on a diverse dataset of authentic and counterfeit samples, the model can effectively classify and flag suspicious medicines with high accuracy. This approach not only complements existing authentication methods but also provides a non-invasive and scalable solution for detecting counterfeit medicines across various regions and product types.

[9] The literature discusses the importance of trust and information sharing in supply chain management, particularly in complex, multi-stakeholder environments. Challenges in- clude trust-building, investment costs, technical disagreements, and concerns about data security. Blockchain technology is presented as a solution to enhance transparency, authenticity, and trustworthiness in supply chains. Blockchain's use of a public ledger secured by cryptography, decentralized storage, and smart contracts can improve information sharing, coordi- nation, and efficiency while ensuring data accuracy and trust in multi-party supply chain networks.

III. PROPOSED METHODOLOGY

The existing system, titled" A Comparative Survey Analysis of RFID-Based Anti-Counterfeiting Systems", examines the use of Radio Frequency to identify counterfeit drugs. This system focuses on evaluating the effectiveness of RFID technology in detecting duplicate items. In conjunction with remote sensor networks, RFID has gained prominence in recent years and holds significant potential for future applications. Unlike traditional methods that employ laser technology, RFID relies on low-frequency radio waves to capture and store data about tagged objects. This system finds application in scenarios such as inventory management in warehouses and distribution centers. It functions by having a transceiver emit radio waves that interact with RFID tags. These tags, equipped with microchips, respond by transmitting specific data to the RFID reader. In r e s p o n s e to the issue of counterfeit medications, our so- lution utilizes Blockchain-based Smart Contracts to secure the pharmaceutical supply chain. The suggested system encom- passes various participants, including suppliers, transporters, manufacturers, wholesalers, distributors, and customers or re- tailers, all interconnected via a decentralized network. Within this supply chain network, each of the entities serves as a node operating on the public blockchain. Every node possesses its unique Ethereum account, utilized to identify itself. The particular responsibilities and roles of each participant are shown in Fig.1. design effectively verifies the sender's cryptographic signature, ensuring the data's integrity.

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Unauthorized access to the data storage is effectively thwarted by the combination of public keys, sender-verified digital signatures, and encrypted QR codes, which collectively prevent medicine duplication.

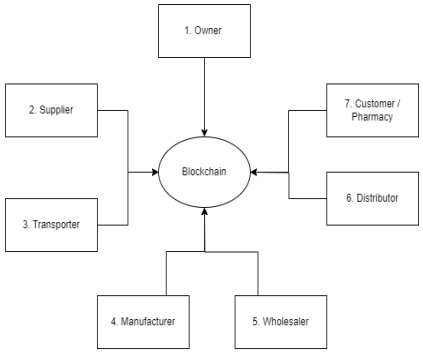

Fig. 1. System Overview

A. Supply Chain in Blockchain

It establishes a supply chain involving drug administration, manufacturers, distributors, and pharmacies. The verification authority, which is the drug administration, authenticates var- ious participants within the blockchain network. The data storage system in the designed framework closely resembles the storage of transaction data in Bitcoin. Each participant within this network possesses a public key. Transactions that occur between these participants involve the sharing of public keys, the hash value from the previous transaction, and an encrypted QR code provided by the manufacturer. Also, Smart Contracts are Designed for the supply chain, for raw materials, and for each transaction.

B. Methodology

Fig. 2. Qr Code Scanning Flowchart

Manufacturers assign QR codes to medicines, encrypting them with hash values generated through a hash function. These QR codes contain comprehensive information regard- ing the medicine, including manufacturer details, ingredients, manufacturing and expiry dates, and quantity. This information is processed using CRC-32. To ensure that each medicine possesses a unique QR code and to prevent any potential reuse by the manufacturer, a hash function is employed. Transactions within this supply chain are characterized by robust security and tamper resistance, thanks to intricate algorithms. This In Fig.3 the event request-response mechanism showing the transaction between sender and receiver [2]. The process begins with the buyer initiating a request. This action triggers the ”buyEvent()” event within the Supply Chain contract. This event provides crucial information, including the Ethereum addresses of the buyer and seller, the specific address of the raw material, a signature, and a timestamp indicating when the request was made. The seller’s addresses are indexed to enable each seller to access their records based on their unique Ethereum Address.

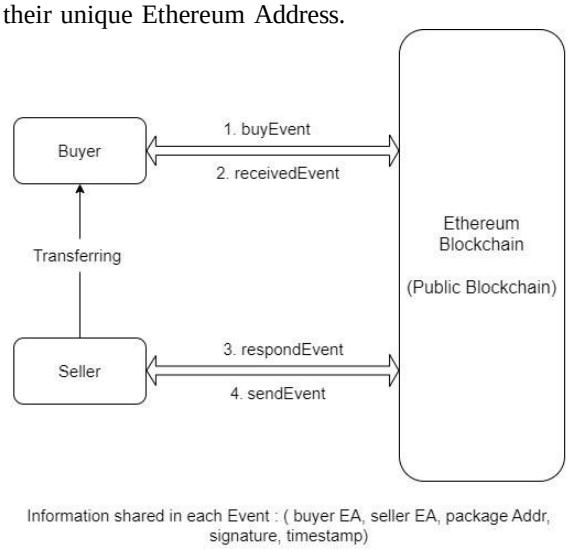

Fig. 3. Event Request-Response Mechanism

Subsequently, the seller retrieves log records relevant to their Ethereum address and proceeds to verify the signature within the events. Successful verification results in the trig- gering of the” respondEvent ()” event, allowing the seller to respond to the buyer’s request. This response has a signature created using the seller’s private key.

Once this step is completed, the seller arranges for the product to be shipped to the buyer through a transporter. This shipment event is recorded through the” sendEvent ()” event, which documents essential details such as the Ethereum addresses of the seller and buyer (Seller EA and Buyer EA), the product’s address, a signature signed with the seller’s private key, and a timestamp reflecting when the product was transferred.

Finally, upon receiving the goods, the buyer triggers the” received Event ()” event to officially acknowledge the receipt of the products.

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For instance, in a scenario where a manu- facturer needs raw materials for producing new medicines, the manufacturer takes on the role of the buyer, while the supplier, providing the required raw materials, acts as the seller. Upon successful completion of the described process, the supplier updates transaction information based on the product address in the corresponding Transaction contract, and the new recipient of the raw material is recorded in the Raw Material contract. It is essential that only after both transaction parties have genuinely activated the events mentioned above will the transaction details be modified. This system operation ensures that the source of the product is deemed trustworthy.

IV. CONCLUSION

In conclusion, our project harnesses the transformative potential of blockchain technology to address the pervasive issue of counterfeit pharmaceuticals. By deploying smart contracts within the pharmaceutical supply chain, we ensure transparency, traceability, and data security. The integration of IoT further enhances real-time monitoring and tracking. Through these innovations, we strive to eradicate counterfeit drugs, promote medication quality, and strengthen the integrity of the pharmaceutical supply chain. This initiative not only safeguards public health but also demonstrates the profound impact of blockchain in revolutionizing industries and ensuring a safer, more reliable future for global healthcare.

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Anthors Contributions	All authors have equal participation in this article.

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