SECUREMEDS: BLOCKCHAIN PROTECTIONFOR DRUG CHANNELS

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***Abstract*—. The World Health Organisation (WHO) highlights the global threat of medicine counterfeiting, particularly in low- and middle-income countries where 10% of drugs may be counterfeit or of inferior quality, hence creating serious health hazards to the general public. Because there are shortages of necessary medications during illness outbreaks, this problem gets worse. Fighting this issue requires increased public awareness campaigns, improved pharmaceutical accessibility, and international cooperation Our goal is to create a strong framework for monitoring pharmaceuticals at every stage of the supply chain—manufacturers, distributors, retailers, and government agencies such as the FDA. A tamper-proof and easily traceable supply chain can be ensured by implementing blockchain technology and using transparent contractual arrangements. Furthermore, cutting-edge techniques like smart contracts made possible by Ganache and Ethereum improve supply chain integrity. Verification codes are sent via email to strengthen authentication processes and provide an additional degree of protection. Moreover, batch number hashing is secured by SHA encryption, guaranteeing complete protection during the distribution process. Global pharmaceutical safety and efficacy are guaranteed by this all-encompassing strategy.**

***Keywords*— *Pharmaceutical Supply Chain Counterfeit Medications Blockchain Technology FDA (Food and Drug Administration)*.**

I. INTRODUCTION

The pharmaceutical industry's supply chain is antiquated and opaque, which contributes to the growth of fake medications. Drug counterfeiting is a significant global business issue for pharmaceutical businesses. The worldwide market for fake medications is thought to be worth up to $200 billion, making it the biggest fraud industry globally. This is especially true in lower- and middle-income nations, where there are reports of 10.5% of pharmaceuticals being counterfeit, seriously endangering public health. India is the world's biggest producer of generic medications, and between 12 and 25 percent of all medications given worldwide are likely tainted, subpar, or counterfeit.

With the potential for fatality, counterfeit pharmaceuticals can cause great harm and have detrimental effects on the human body. This emphasizes how urgently the medication supply network has to be improved and monitored more closely in order to safeguard public health everywhere. For reducing the risk of counterfeit medications, we offer a blockchain-based methodology to track the transfer of drugs from the FDA (Food and Drug Administration) to producers, wholesalers, and retailers. Our method makes the usage of blockchain technology, which is renowned for its immutability and effective entity tracking .The invention of a blockchain- based architecture for the pharmaceutical supply chain tackles a serious and widespread problem: the spread of fake medications.

With the estimated $200 billion global market for counterfeit drugs, fighting this issue is really important. Because of outdated procedures and a lack of transparency, the pharmaceutical business, which is important for public health, has significant hurdles, especially in developing countries where frequency of counterfeit medications is startlingly high. By using technology to produce an unchangeable and transparent record of drug movements and guarantee responsibility throughout the supply chain, the suggested blockchain approach adds significance.

This protects not just the monetary interests of pharmaceutical corporations, but above all, safeguards people's health and welfare everywhere. Working together with regulatory agencies, especially administrator, gives the proposed system morelegitimacy by highlighting its significance on a global basis. The suggested blockchain-based approach aimsto lessen the significant business risk that counterfeit medications present to the pharmaceutical supply chain.

There are two main goals: First, reduce the monetary losses suffered by pharmaceutical firms because of dishonest practices, and secondly, to protect public health by stopping the entry of potentially fatal counterfeitdrugs on to the market. Through developing an irreversiblerecord of every drug's trip, the system seeks to improve security, accountability, and transparency across the

whole supply chain. Beyond financial concerns, the goalis to highlight the crucial part innovation plays addressing a complex danger to public health worldwide and individual well-being. The suggested solution emphasizes the need to safeguard vulnerable populations in developing countries where the hazards are especially acute, in line with the World Health Organization's acknowledgment of medicine counterfeiting as a widespread global concern.

II. LITERATURE SURVEY

This article suggested a blockchain-based system for transparent and safe drug traceability that makes use of encrypted QR codes. It talked about the problems with the distribution network for fake medications. By using decentralized verification to stop the production of counterfeit medications, the approach sought to improve patient safety. The system's shortcomings included possible vulnerabilities, scalability issues, and difficulties guaranteeing participant authorization for this blockchain-based system. Other problems were the assumption of participant reliability and the preventionof unlawful QR code reproduction.[1]

In this research, a blockchain-based solution for traditional medicine's medical supply chain security was presented. It quickly identified fraud and counterfeit medications by using a unique drug identification system. The prototype optimized data storage for stability while guaranteeing security, authenticity, and real-time tracking. The Blockchain-Based Authentication System's limitations included scalability issues and participant authorization reliance. Other problems included exorbitant implementation expenses, etc [2]

Medication traceability was transformed by blockchain, assuring efficiency and transparency in medicinal distribution network. This method reduced energy consumption while optimizing consensus, traceability, and anti- counterfeiting measures. Subsequent investigations seek to optimize blockchain's potential for pharmaceutical security in several fields. The system's shortcomings included the following: while the suggested blockchain approach addresses medication fraud, accountability, and traceability, it has issues with trust and storage. IPFS and double blockchain architecture are examples of solutions that could improve efficacy. Clustering deployment for better testing and blockchain environment development should be investigated in future study.[3]

Blockchain technology was used in this proposed medicine suspicion system to provide transparent and unchangeable information management. Because blockchain is immutable, integrity is ensured and data manipulation is prevented. improved traceability and security features in the medicine suspicion system to enable quick resolution of problems such as recalled pharmaceuticals or counterfeit goods. One of the system's shortcomings was that its experimental implementation ran into resource constraints. Issues with scalability arose for larger-scale implementation. It was necessary to overcome testing hurdles and performance issues. Resource limitations placed restrictions on the test drug inquiry system.[4]

[2] With a cheap transaction fee, this article introduced a working blockchain anti-product forgery system, increasing user confidence against fake goods. It gave producers access to clear sales data for prompt vendor- side validation. The anti-counterfeiting threshold was decreased for businesses with insufficient resources. Among system's shortcomings was that an Ethereum application's execution cost depended on how simple its code was. Subsequent efforts will focus on demonstrating the simplicity of the code and preserving client confidence by reducing redundancy and extra usage in the distributed application.[5]

This study highlighted the lack of consideration for node reputation and data privacy in the pharmaceutical blockchain technologies now in use. Zero- knowledge proof is used in this proposed prototype. The Markov model addressed these problems and improved system reliability. Among system's shortcomings was that the suggested blockchain approach for pharmaceutical distribution's scalability and practical implementation issues were not sufficiently covered in this study. Furthermore, it is yet unknown how well this prototype works in a variety of dynamic settings.[6]

A blockchain driven traceability solution to address the problems of counterfeit pharmaceuticals and the intricacy of healthcare supply chains. This was accomplished with the goal of improving security and lowering financial losses at medical field sector by leveraging IPFS for decentralized and transparent trackingand Ethereum smart contracts. Among system's shortcomings included the requirement for industry-wide standards and system acceptance, including difficulties with regulatory compliance and integrating blockchain technology into already-existing healthcare systems. As the solution grew, scalability problems also surfaced.[7]

The study emphasized the serious problems that counterfeit medications and unsecure electronic health information present in medicinal field. It suggested a blockchain-based approach that ensures medicine traceability, information consistency , privacy by using Keyless Signature Infrastructure for authentication. The system's shortcomings included the need for regulatory

compliance and industry-wide adoption of blockchain, including possible implementation issues with integrating blockchain into current healthcare systems.[8]

The study used a permissioned blockchain for data integrity and a safe medicine tracking system to address duplicate medicine at developing nations. It covered issues with patient monitoring, recalls, regulatory control, and data sharing at medicinal supply network. The system's shortcomings included issues with scalability, stakeholder acceptability, regulatory compliance ,and privacy of patient data when implementing blockchain in medicinal supply network. One major challenge was persuading the drug industry to embrace this transformation.[9]

Using Ethereum and Hyper Ledger Fabric, this project developed a blockchain depended medicinal monitoring system that simulated critical nodes for functional testing. The emphasis was on improving information exchange about drug distribution for fighting global problem of duplicate medicines . The blockchain pharmaco-surveillance system's shortcomings included difficulties with adoption, integration, and scalability including worries about data privacy and regulatory compliance. The intricacies of the real world and the resource needs for development were not well reflected in simulation testing, necessitating more thought.[10]

III. METHODOLOGY

With a modest transaction price, this article established a working blockchain anti-product forgery system, increasing user confidence against counterfeit goods. It gave producers clear sales information for instant vendor- side confirmation. The anti-counterfeiting threshold was decreased for businesses with insufficient resources. Among the system's shortcomings was that an Ethereum application's execution cost depended on how simple its code was. Subsequent efforts will focus on demonstrating the simplicity of the code and preserving client confidence by reducing redundancy and extra usage in the distributed application.

Verify that all participants have reviewed it carefully before signing to ensure that there is a mutualunderstanding. The manufacturer and store can start doing business after the contract is signed, and the verification adds an extra degree of support of assurance regarding the genuineness of the merchandise. By taking these careful steps, you can create a contract that is clear and complete, meets the unique needs of both parties, and lays the groundwork for a reliable and safe working relationship

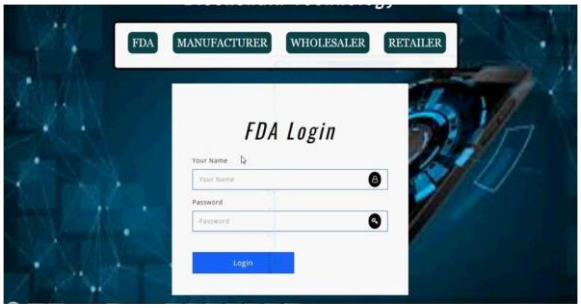

Figure 1 : FDA login

Within distribution network, the FDA account acts as the central authority and issues verification codes in order to full-filling of authenticating other accounts. Bycomparing batch numbers between wholesaler and retailer , these codes protect the integrity within distribution network and validate the authenticity and undisturbed state of medications. When differences in batch numbers are found at the wholesaler level, they are immediatelyreported as possible instances of counterfeiting, which enables rapid action and stops propagation of counterfeit or inferior drugs. The FDA account protects hygiene of people and upholding the integrity of the medicinaldestruction network because of this strong authentication procedure.

In the distribution network, the Manufacturer account is essential to guaranteeing the legitimacy and traceability of pharmaceutical items. Manufacturers access their account to start different processes when they receive the FDA's verification code. The signing of contracts with wholesalers is one important task.

Figure 2 : Manufacturer login

Manufacturers enter into the contract important information including headliner of distributor, the batch number, the brand name, the form, the dosage, and the units. The contract key is sent securely after a wholesaler shows inquisitiveness in agreement and requests it from the manufacturer. By guaranteeing that only verified parties enter into contracts, process transactions more

visible and responsible but also fortifies medicinal distribution network 's overall integrity.

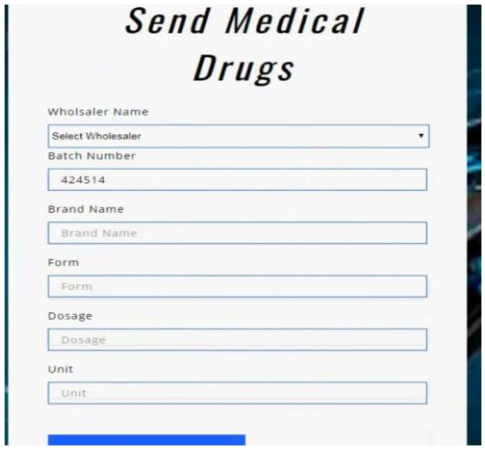

Figure 3 : Contract form

IV. RESULTS

A strict batch number verification mechanism has been implemented by the FDA to assure the safety and authenticity of pharmaceutical items. This system is predicated on wholesalers and merchants matching batch numbers, as essential sign of the drug's authentic and pure state. At the wholesaler level, any differences in batch numbers are reported right away as possible instances of counterfeiting.

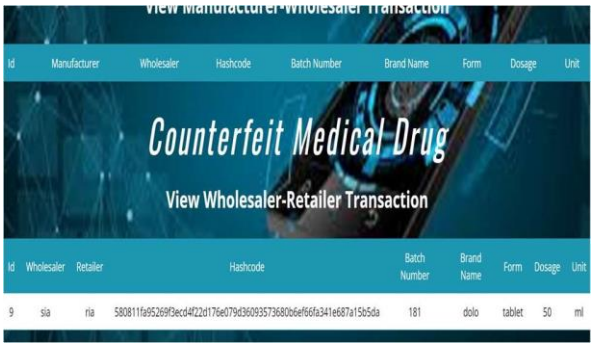

Figure 4 : Counterfeit activity detected

When the FDA enters the batch number to check if it is fake drug or not , if the batch numbers match it displaysthe batch number and the contract details on both the wholesaler and retailer side ,which shows the untampered nature of the drug. But if the batch numbers don't match in these situations, the system clearly alerts FDA likelihood for counterfeit goods in the distribution network by prominently displaying the label "Counterfeit Medical Drug" in the wholesaler area. This lets The FDA wants to safeguard integrity and safety standards of pharmaceutical products, which is why it has put in place such a strict authentication procedure. Additionally shielding customers from potentially dangerous fake drugs, this promotes consumer confidence on medicinal distribution network industry. Preserving the public's health and welfare requires ensuring the legitimacy of pharmaceuticals at every stage of the supply chain. As a result, this strong verification systemis essential to maintaining the effectiveness and quality of pharmaceuticals, which eventually supports the integrity ofthe healthcare system as a whole.

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CONCLUSION

The intended approach is limited to monitoring drug movements within formal distribution chains that are acknowledged , tracked by regulatory agencies. Nevertheless, it is unable to keep track of duplicate drugs that are sold through unapproved channels. Because of this restriction, it is difficult to fight counterfeit pharmaceuticals effectively because the system fails in detect activity occurring outside of approved networks. Furthermore, results from the system's assessment in a controlled, simulated network is not able to reflect precisely how well it performs in real life. The intricacies and subtleties inherent in real-world pharmaceutical distribution scenarios might be ignored by these simulations, which could overestimate the system's effectiveness or fail to foresee important difficulties. In order to overcome these constraints, methods for identifying and stopping the dispersal of medicines outside of authorized channels must be taken into account. Thorough real-world testing must also be implemented for guaranteeing the efficacy and flexibility of the system.

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