Pharma-chain: Pharmaceutical Supply Chain WebApp Using Blockchain

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Abstract – **In India counterfeit drugs is the serious expanding issue associated with the healthcare industry. United States Trade Representative (USTR) has warned IHO (Indian Health Organization) for its growing problem of counterfeit or spurious drugs. USTR report said almost 20 per cent of all pharmaceutical goods sold in the Indian market are counterfeit which harms the decades-old reputation of being the "pharmacy to the world". The traditional supply chain of drugs used by pharmaceutical industry is outdated and offers limited transparency. As a result, the production of counterfeit drugs has increased exponentially. Keeping an eye on this increment that was observed in USTR report, we propose a blockchain based model which helps in countering falsified drug records which were claimed by exploiters. The reasons for using blockchain technology includes its immutable property and effortless tracking of a drug in the blockchain. It ensures the data integrity and authentication. Moreover, with the proposed model, we can also track the movement of the drug beginning from the manufacturer right up to the pharmacy.**

Keywords: Blockchain, Counterfeit drugs, Tracking, Healthcare.

I. INTRODUCTION

Counterfeit Drugs can cause a public health hazard, as falsified and substandard drugs may contain harmful doses of dangerous chemicals and give rise to massive debilitation. Counterfeiting of drugs is a practice of manufacturing and selling of pharmaceutical products with the purpose to defraud the customers. Falsified medicines can contain inaccurate ingredients and proportion or show no presence of active ingredients. Hence there is a need to develop a well-built model to get through the issue of counterfeiting drugs. Moreover, the ongoing industry lacks clear visibility over the distribution of drugs from pharmaceutical companies to patients. This is due to a complex supply network, augmented by a lack of visibility of the medicines all through journey. The consequences of falsified and counterfeit drugs are probable to cause destructive outcomes.

Various companies are involved in the supply network and due to that drugs ownership keeps changing between manufactures to dealers, repackages and wholesalers or suppliers before reaching the patient. There is negligible visibility between the nodes involved in the supply network in order to keep check of the authenticity of the drug. This is skeptic for patients and pharmacologist concerning the legitimacy of the item sold at the end of the chain.

Counterfeits are a huge commercial burden for particulars, healthcare systems and in some cases can give on to further financial stress on the healthcare system. Considering current Scenario, Number of solutions are available but due to increased technology exposure, the sophistication of counterfeit items and packaging are rapidly improving and no room for detection is being left. There are few Central systems to track these counterfeiting but Central system are also prone to failure. Keeping these challenges in mind we aim to develop a blockchain based system that can restrain drug counterfeiting and keep track of drug movement from manufacturer to patients.

Blockchain there is no central party, since all data is distributed , immutable and completely transparent which leads to less failure . Blockchain technology helps in overcoming the security problems in healthcare. Features which make blockchain reliable for use in combating counterfeit drugs are: -

1. **Decentralized:** Decentralized signifies, storing data in all the systems so that no central unit could modify the information and will. The

communication is node-to-node no central node is involved.

2. **Distributed Database:** Any modification in data will reflect in all other nodes, therefore any malpractice could be caught due to presence of distributed database.

maintains authenticity of product.

3. **Immutable:** Modification of data is not permitted to any node involved in the chain which makes it Immutable.

4. **Transparent:** Transparency of data is maintained as any changes done by any node is immediately visible to all node which
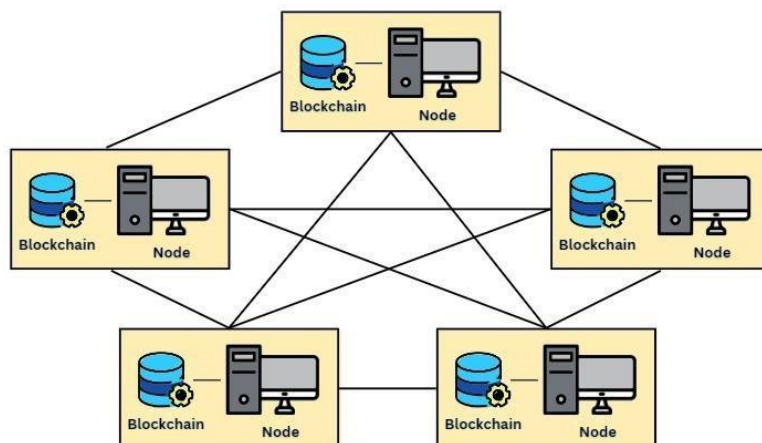
Figure 1: Peer-to-peer network in blockchain

II. LITERATURE REVIEW

Over the years, many scholars and entrepreneurs have made many discussions and research on how to combine blockchain technology to improve and manage the current situation

Zhang et al. [1] proposed smart parking based on a decentralized approach which was reliable and the privacy was protected. Parking vehicles in big cities can be a big challenge. Many savvy parking applications tend to solve these problems however, a large number people experience the ill effects of protection issues or they work in a centralized environment. Using the concept of smart contracts, they were able to accomplish fairness.

The study conducted in [2] proposed an approach based on a decentralized solution which is blockchain to creating a DT (Digital Twin) which ensured the data traceability, data authenticity, and immutability of information. They utilized the decentralized IPFS stockpiling workers to store the information identified with DT.

Lin et al. [3] designed a secure and efficient remote user confirmation system based on a blockchain model. They incorporated this decentralized method, group benchmark, and subject matter validation to give solid evaluation of the user's entrance history.

Yang et al. [4] proposed a protocol for election which is based on decentralized approach i.e. blockchain-technology. Their model does not need a committee to count the votes. They successfully created an encryption system that guarantees that no one can decode the votes but each one of us can ensure the legitimacy of the votes.

Siyal et al. [5] reviewed the work that is already existed in the medical sector. They also highlighted the recent research in this sector that is using a decentralized model such as blockchain.

They highlighted the usability of a decentralized model for neural system. They have successfully stored a

virtual digital brain on the decentralized network like blockchain.. They also highlighted some impactful factors that are creating hurdles of the blockchain in the medical sector. Every blockchain based model runs according to the smart contract.

Dwivedi et al. [6] pointed out the issues related with privacy and security associated with data sharing and storing. They used blockchain to ensure secure handling of data within the network. They also tried to solve the problems associated with integrating blockchain with IoT devices and proposed a new structure of blockchain that can be integrated with IoT devices.

McGhin et al. [7] addressed the future research side of the medical sector . They also addressed some of the unique requirements that are not addressed in earlier conducted blockchain experiments. Apart from that, they addressed research areas like scalability, block withholding attack, and blockchain mining incentives in which blockchain might lack for the healthcare sector

The authors in [8] addressed the use cases of blockchain and reviewed, assessed various publications and consequently proposed a methodology which is to integrate blockchain with the processes involved in the current healthcare system. They found that EHR (Electronic Health Records) and PHR (Personal Health Records) are the areas where blockchain is mainly used and Ethereum and Hyperledger fabric are the most preferred open-source frameworks for developing a blockchain based application.

Haq et al. [9] specified the problems that are present in the current pharma supply chain and explained how blockchain can be used instead of the current supply chain to ensure traceability and transparency while transferring a particular entity from one level to another. They suggested a permissioned blockchain for storing all the data involved within the network and since it is a permissioned blockchain

so it ensured that only trusted parties are becoming a part of the network.

III SYSTEM OVERVIEW

1. Supplier:

   i. Create a Raw Material ii. Assign the Ethereum addresses to raw material

2. Manufacture:

   i. Processes the raw material

   ii. Authorize the source of the received product

3. Distributor:

   i. Confirm the source of the received product.

   ii. Transfer the ownership of the medicine.

4. Retailers:

   i. Confirm the source of the received product ii. Sell the medicine to the pharmacy.

Module Description-

User Interfaces
Registration();
Order Medicine();
Control Panel();
Track Medicine();
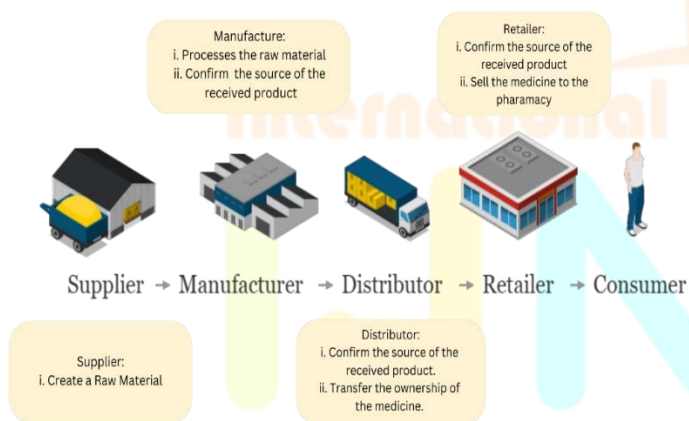
Figure 2: System Architecture and flow.

IV. PROPOSED METHODOLOGY

4.1 Blockchain implementation

Blockchain is a progressing technology that is becoming more commonly acknowledged with the mounting fascination of digital fiscal systems such as Bitcoin. At its core, it is a decentralized ledger database. By dividing up the network and making it possible to be managed and held by several nodes not situated in the same area, blockchain finally constructed a logical means to address this issue. In spite of this, in the consented blockchain, the choice to construct a fresh block is made by some reliable nodes. It has been employed for copyright management, identity validation, and data storage facilities.

The Truffle framework helps improve compilation and deployment of smart contracts. Truffle is an improvement tool for Ethereum's Solidity language and furnishes an assessment system, making DApp production simpler. We compile and move our contracts which presents us with a build version of our agreements that incorporates the contract abstraction into the script so we can take advantage of the abstracted contract provided by truffle straightaway in JavaScript code. The secret behind DApp development lies in penning down smart contracts and connecting with them via front-end webpages where users can communicate with contracts.

4.2 Smart Contract

Once certain terms and conditions have been agreed upon between a buyer and seller, a code stored on the blockchain will automatically activate, known as a 'smart contract'. This typically enables both parties to be fully aware of the outcome without having to involve any outside intermediaries or wait for any additional time. The smart contract is established by the proprietor of the blockchain, encompassing many players of the supply chain including suppliers, fabricators, distributors and retailers. Additionally, various Solidity events are used to communicate with the front end in real-time.

4.2.1 Migration Contract

It is the smart contract where the proprietor of the blockchain is designated as the moderator. The proprietor of the blockchain has exclusive authority to add and register members to the chain, giving them particular roles. This power is solely retained by the blockchain owner.

4.2.2 Supplychain Contract

The blockchain proprietor is the only individual who can regulate supply chain, though each node in the system (such as manufacturer, retailers, distributors and so on) can update its delivery status. This smartcontract contains declarations of various phases of medicine delivery within the pharmaceutical supply chain. Functions to introduce each node, to check if it exists, and to purchase or sell medicines are all defined in this contract.
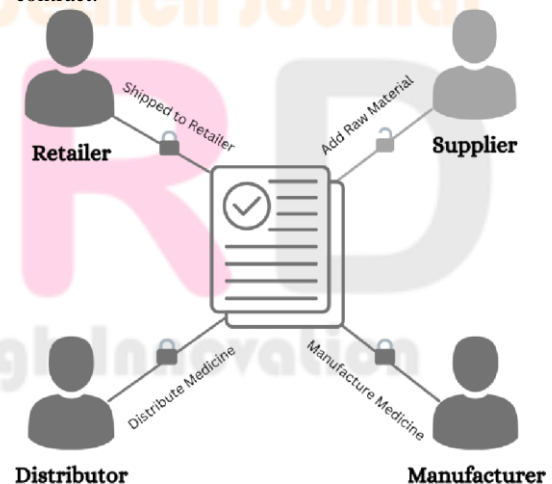

Figure 3: Working of Supplychain smart contract

4.3 Design Flow

The design flow for the proposed architecture is given below. Entities involved in the supply chain process are as follows: · Raw Material Supplier
· Manufacturers
· Distributors
· Retailers
· Sold to Patients/Customers

The participants in the supply chain can be found in figure 1. Each blockchain member except patients/customers is registered on the blockchain by the blockchain owner. The blockchain owner provides Ethereum addresses to every entity and registers them on the network. This will make sure that only trusted members exist on the network.

As the first link in the supply chain, the raw material supplier initiates the process. Each batch of medicines supplied by the Raw Material Supplier will have its own Medicine ID. Whenever a medicine batch is ordered, it is assigned this unique ID. Following the batch purchase from the Raw Material Supplier, ownership of the commodity will be transferred to the manufacturer. Only commodities that are able to sell or supply in the chain are registered on the blockchain, which preserves the authenticity of the commodity.

Blockchain Owners are the only ones authorized to register medicines on the blockchain. If an unwarranted entity attempts to supply, manufacture, distribute, or sell falsified medicine, the owner can keep an eye on it and cease them from contaminating the chain.

Every member who purchases the medicine can uncover its origin and will inherit ownership of the medicine. Consumers will be able to track down the source of the medicine utilizing the unique Medicine ID. This will make sure that the drug they are purchasing is genuine.

The subsequent steps are necessary to obtain the soughtafter results.

1. The blockchain Operator signs up every entity in the blockchain. In the given example, the Raw material Provider, Manufacturer, Distributor, and Retailer are the essential entities.
2. The blockchain proprietor puts in an order for medication and includes its characterization along with it.
3. The supply chain can be controlled through a "Control Panel" from where each entity in the blockchain can perform the cycles which they are intended to do. For instance, a Manufacturer can embed the medication id in the information field to refresh the field to the manufacturing stage after it has acquired the crude materials.
4. No other account can refresh some other stage other than the enlisted hubs for the pertinent forms or else a very high gas expense will be charged.
5. Any individual on the system can follow the progress of any medication by utilizing the "Track Medicines" choice accessible on the main page.
6. The individual must enter the medication Id and all applicable data will show up on the screen alongside the progression of supply for the medication Id given by the user.

Figure 4: Process flow of ownership of medicine in the supply chain.

V. RESULT

The web application developed using react for tracing the medicine supply has a home page which has a dashboard.
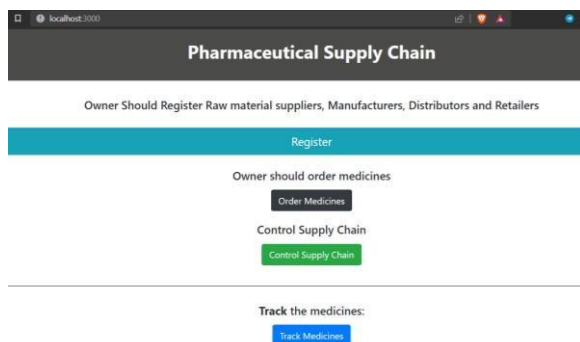
.

Figure 5: Home page of web application.

The blockchain owner registers every entity in the
Figure 6: Registration panel blockchain with their Ethereum account addresses and location.

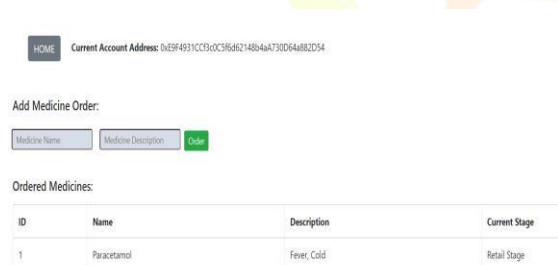The blockchain owner puts up an order for a medicine adding its name and description.

Figure 6: Window to order a medicine

After adding the description and the name of medicine and clicking order, a payment window will pop up which will ask for gas fees that is needed to order the drug.
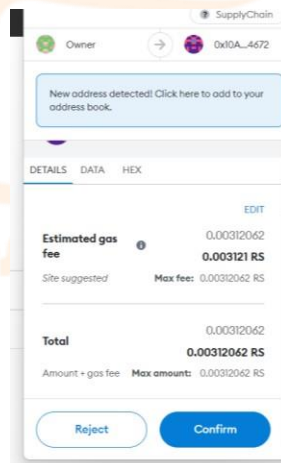
Figure 7: Payment window popped up through meta mask which is used to pay the fees to order the medicine.
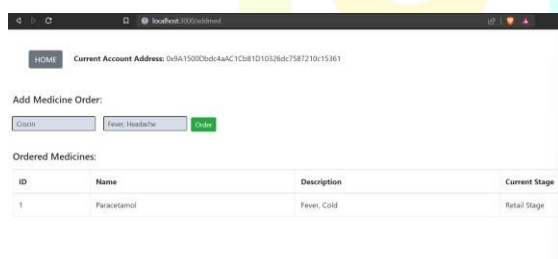
Figure 8: Outcome after the blockchain has paid the gas fees and hence medicine is ordered.

Supply chain is controlled by Control panel from which every entity in the blockchain can update the supply chain on their part.

Figure 9:Portrays Control panel for the supply chain

For example, a Manufacturer can input the medicine id in the input field to update the field to Manufacturing stage after it has brought the raw materials from Raw Material Supplier by paying gas fees through metamask.

Figure 10: Shows the transaction window of metamask between

Manufacturer and Raw Material Supplier.

Figure 11: Result of transaction between the Raw Material Supplier and Manufacturer.

Figure 12: Illustrates the supply chain of the medicine which is tracked by the medicine ID assigned automatically to the medicine when it was inserted on the blockchain by the owner of the blockchain

VI. CONCLUSION

Healthcare is major concern in today's growing world.

Major health loss can occur if consumed counterfeit drugs. Research has shown that counterfeiting of drugs is sown in large scale in markets of lower- or middle-income countries. Hence, it has became matter of concern in current scenario and solving this large-scale problem is task and common approaches of security is not effective enough. Keeping the challenges of brute force approach, we came up with a solution which is Blockchain based model to detect such fake drugs in complete supply chain network. The model aims to keep track of complete supply chain which includes Raw material supplier followed by Manufacturer then Distributor and Retailer. In this Blockchain model, the blockchain owner creates all the entities and provides Ethereum address to all the nodes of chain. Further, every medicine will have unique id or QR and in chain every node will update the node, if found any interruption in chain the Blockchain owner will cease the medicine and therefore contaminated medicine will not reach the customer or consumer.

Since, Entire model is implemented in Blockchain, therefore it is not possible to interrupt the chain and practice counterfeiting of drug/medicine. Blockchain possess property like Immutable which implies the nodes cannot make changes in blockchain. Transparency, it is said since in blockchain any action of entity reflects in chain to all nodes or entities. These features of blockchain will prevent pharma industry and consumers from taking contaminated medicines. Blockchain Technology is technology model we have used in the to solve a very large underlying problem which is needed to solve in order to save large amount of life of citizens.

VII. FUTURE SCOPE

A new structure for the supply chain for medications that need special handling procedures .A system for preventing medicine counterfeiting utilizing blockchain technology .Using blockchain and IPFS (InterPlanetary File System) to provide decentralised storage that secures supply chains. It might be suggested to simulate or construct any medicine anticounterfeiting system using Hyper-ledger in order to create a business model.

REFERENCES

[1] C. Zhang et al., "BSFP: Blockchain-Enabled Smart Parking With Fairness, Reliability and Privacy Protection," IEEE Transactions on Vehicular Technology, vol. 69, no. 6, pp. 65786591, 2020.

[2] Hasan et al. , "A Blockchain-Based Approach for the Creation of Digital Twins", IEEE Access, vol. 8, pp. 34113-34126, 2020.

[3] C. Lin, D. He, N. Kumar, X. Huang, P.

Vijayakumar and K. R. Choo, "HomeChain: A Blockchain-Based Secure Mutual Authentication System for Smart Homes," IEEE Internet of Things Journal, vol. 7, no. 2, pp. 818-829, 2020.

[4] X. Yang, X. Yi, S. Nepal, A. Kelarev and F. Han, "Blockchain voting: Publicly verifiable online voting protocol without trusted tallying authorities", Future Generation Computer System, vol. 112, pp. 859-874, 2020.

[5] A. A. Siyal et al., "Applications of Blockchain Technology in Medicine and Healthcare: Challenges and Future Perspectives", Cryptography, vol. 3, no.1, article no. 3, 2019.

[6] A. Dwivedi, G. Srivastava, S. Dhar, and R. Singh, "A Decentralized Privacy-Preserving Healthcare Blockchain for IoT", Sensors, vol. 19, no. 2, article no. 326, 2019.

[7] T. McGhin, K. R. Choo, C. Z. Liu, and D. He, "Blockchain in healthcare applications: Research challenges and opportunities", Journal of Network and Computer Applications, vol. 135, pp. 62-75, 2019.

[8] A. Hasselgren, K. Kralevska, D. Gligoroski, S. A. Pedersen, and A. Faxvaag, "Blockchain in healthcare and health sciences—A scoping review", International Journal of Medical Informatics, vol. 134, article no. 104040, 2020

[9] R. Kumar and R. Tripathi, "Traceability of counterfeit medicine supply chain through Blockchain," 11th International Conference on Communication Systems & Networks, pp. 568570, India, 2019.