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Original Article

Blockchain-Based Fake Medicine Prevention

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Abstract *- Falsified and substandard drugs could contain inactive ingredients, active ingredients but in the wrong dosage or potential contaminants that could be lethal. The use of antimicrobials of low quality may result in treatment failures and may increase antibiotic resistance in individuals resulting in the spread of highly-resistant pathogens. It can also cause allergic reactions and adverse drug reactions. When a drug package changes ownership from manufacturer to wholesaler or from wholesaler to retailer, no information is exchanged between parties that enable parties to track the drugs. Thus there exist a lack of transparency about the original source of drugs. The problem can be solved by tracking and tracing drug products and reagents and fake medicine detection through information verification of supply chain participants using blockchain. This option will be helpful when medications are distributed and become sensitive to outer attacks. Drugs move across a distribution chain that involves several participants. These usually include a manufacturer, a wholesaler, a retailer, a regulatory body and the end-user. The regulating authority monitors quality standards. End-user can view the drug distribution history.*

Keywords *- Blockchain, fake drug, Ethereum, Smart Contracts.*

I. INTRODUCTION

Counterfeit drugs are products that are deliberately made or labelled to look like a genuine products. The number of counterfeit medications has been increasing subsequently over the years, and the World Health Organization (WHO) estimates that 10 percent of global pharmaceutical commerce is counterfeit drugs. Patients suffering from various diseases intake these medicines in the hope they will cure their illness. But on the contrary, tens of thousands of deaths occur in developing countries due to fake drugs, and many of the victims are children. Individuals, families and health systems are staggering every year due to fake medicines.

A blockchain solution can make a significant difference to the pharmaceutical supply chain. It is a decentralized network that shares information in real-time with participants. And can be used as a solution to tracking and tracing the products by the pharmaceutical industry, making sure there's verifiable provenance of what is delivered to the users. Attaching a unique code to each product, they manufacture and registering the same in the blockchain would help to make this whole process transparent and secure. At each stage, stakeholders could check the authenticity of the product they have with them.

II. LITERATURE REVIEW

A. Blockchain

Blockchain is a decentralized ledger that is shared by all network participants [2]. The concept is to store digital data about transactions. The data structure is a list of data blocks chained together that are timestamped, immutable, and in strict order. Modifying an existing item from the blocks is not possible. The information stored on the blockchain cannot be deleted or altered. Instead, a new block needs to be added to the blockchain to update the information. Hence it is tamper-proof. This characteristic of immutability is implemented using a cryptographic hash, a digital fingerprint of data. Each block in the chain includes its hash value and the hash value of the previous block. Thus every block has a reference to a previous block's hash and thus gives a strict order to the blockchain. A blockchain is said to be decentralized as the data is not stored in one place. Instead, the data saved in the blockchain is distributed across many different computers, called nodes.

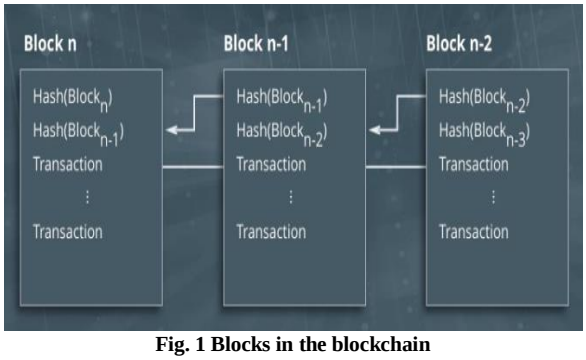

Fig. 1 Blocks in the blockchain

No single entity has control over the data, which allows the substitution of a single master database. In a blockchain, a requested transaction is broadcasted to a peer

to peer network, which consists of computers called nodes. The network of nodes validates the transaction and the users' status using known algorithms. A verified transaction can involve contracts, cryptocurrencies, records or other information. Once verified, the transaction is combined with other transactions to create a new block of data for the ledger. The new block is then added to the existing blockchain in a way that is permanent and unalterable.

A. Ethereum

Based on blockchain technology, ethereum[5] is an open software platform that enables developers to build and deploy decentralized applications. By decentralized, it means that it runs on a network of nodes distributed across the world. Hence it is almost impossible to halt or stop its operations. The transactions, as well as the data stored, are permanent once it is in it.

On the ethereum blockchain, ether is the cryptocurrency that fuels the network. It is also used to pay for transaction fees and services on the ethereum network. Metamask is a bridge that allows one to visit the distributed web of tomorrow in a browser today. It is a browser extension that allows running dApps without being part of the ethereum network as an ethereum node. A smart contract is a phrase used to describe an ethereum application.

B. Smart Contracts

Smart contracts are preset conditions that are agreed upon across all nodes, making blockchain immutable and tamper-resistant. The most prominent smart contract framework, created and designed especially to support smart contracts, is ethereum. Smart contracts help to exchange money, property, or anything of value in a transparent and conflict-free way. Smart contracts inherit properties of underlying blockchains, which include an immutable record of data and the ability to mitigate single points of failure [4]. It avoids the services of a middleman when establishing business relations.

Smart contracts are written as code and is committed to the blockchain. The parties of the smart contract agree to interact with each other upon the code containing a set of rules. The agreement is automatically enforced if and when the predefined rules are met. It provides autonomy, trust, backup, safety, accuracy.

III. DESIGN

A. Implementation

Ethereum blockchain platform, currently one of the largest public blockchain networks, is the development platform used. Smart contracts are coded in solidity. A Distributed File System (DFS) is included as a native base layer service in Ethereum. Ropsten test network is used, which uses [3]Proof of Work consensus algorithm.

The drug distribution chain involves several participants, which include supplier, manufacturer, wholesaler, distributor, retailer, end-user and so on. A regulating body is also involved, which regulates the overall permissions. Fake drug products can be prevented from entering the distribution chain by involving the distribution chain participants in tracking the drugs with the help of a blockchain-based system. The end-user can track the drug product's origin and verify the authenticity of the product.

A unique identification number will be used as identifiers to track each unit of medicine. The process is initiated when a manufacturer creates a drug product and assigns a unique identification number to each physical unit of the drug product. Data will be distributed across the DFS. A blockchain network consists of a growing chain of incorruptible blocks, which are linked together using hash numbers. Each block contains its own hash, the hash of the previous block and drug supply chain data like individual transactions, timestamps, sender and receiver, etc. A decentralized ledger could be used for creating a smart contract, stored in the form of codes in the blockchain and executed only when a certain criterion is met. Smart contracts are implemented to further secure the supply chain and make it more efficient.

B. Workflow

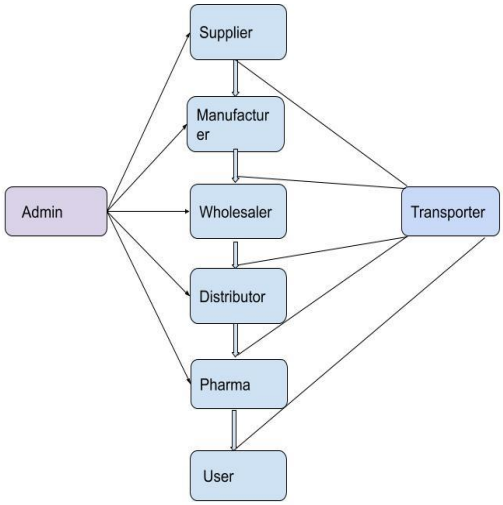

Fig. 2 Drug supply chain

The proposed blockchain-based solution maintains transactional records of all the participants involved in the drug supply chain. The supply chain participants request their corresponding roles as a manufacturer, supplier, wholesaler, distributor to the admin by providing relevant documents to prove and support it. The admin verifies the documents and assigns roles to the requested supply chain participants. The admin has the privilege to revoke the role assigned to the involved participants in case of fraudulent activities.

The supplier provides the manufacturer with raw materials required to manufacture the medicines and provide the description of raw materials, location, farmer name, etc. The manufacturer will manufacture the drug with details such as drug name, location, timestamp,

ingredients, usage of the drug, etc. and get authorized by the regulatory authority. The Shipper is associated with the supplier, and the manufacturer ships the raw materials to the required location. When the smart contract between supplier and manufacturer is deployed, the ethereum addresses of the involved supplier, manufacturer, and Shipper is given. These addresses cannot be changed once the smart contract gets deployed. Thus ensuring that a fraudulent node cannot perform transactions as their ethereum network addresses are different.

When the manufacturer adds the information, it gets stored to the blockchain, making it possible to trace the drugs' supply chain transparently for other stakeholders. A hash ID is produced that can be used for tracking back the transactions once the information is added to the blockchain. Once the shipper service providers deliver the drugs to wholesalers, they can verify the origin of medicines with the help of a unique ID stored on the blockchain. The manufacturer provides the wholesaler with the medicines.

The distributor gets the medicines from the wholesaler, who in turn supplies them to the pharmacies. Pickup can be done only by an associated transporter and is involved with the transactions of wholesalers, distributors, and pharmacies. Illegitimate users cannot access the blockchain, and only associated legitimate users can participate in transactions.

C. Benefits of Blockchain Implementation

- End-to-end traceability of products.
- Reduced losses related to counterfeiting
- Transparency to enhance accountability
- Information verification at each stage
- Immutability of verified data
- It uses protected cryptography to secure the data ledgers.
- Decentralised information handling and storage

IV. CONCLUSION

The rise of Internet pharmacies has made it more difficult to standardize drug safety. In this paper, a blockchain-based solution is proposed to overcome the counterfeit problem in the drug supply chain. It is difficult to detect fake drug products because these drugs pass through different complex distributed networks. The proposed method using Blockchain technology has huge potential. It makes the transactions transparent and provides traceability of drugs by creating an audit. Drug journeys can become more secure.

It enhances security, integrity, data provenance, and the functionality of the supply chains with its transparent, immutable and auditable nature.

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