

## Blockchain Enabled Pharmaceutical Supply Chain

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**Abstract** - In the pharmaceutical industry, counterfeit medicines cause a serious threat to society. Counterfeit drugs affect patients' health directly or indirectly causing serious health issues and sometimes even death. This counterfeiting is due to improper supply chain management in the pharmaceutical industry which not only endangers patients' health but also tarnishes the company's image. In the traditional supply chain, drugs pass through various stakeholders from manufacturers to retailers. Manufacturers and various authorities have no visibility of the system, which leads to counterfeit drugs. Blockchain technology can be used in this supply chain management and will provide security, safety, traceability, and transparency to the supply chain by providing visibility and immutability of each step in the supply chain. Any counterfeit drugs can be found, tracked, traced, and sorted efficiently providing safe medicines to the customers.

**Key Words:** Blockchain, Supply Chain, Counterfeit drugs detection, Drugs Supply Chain

### 1. INTRODUCTION

In the pharmaceutical industry, counterfeit medicines cause a severe threat to society. Counterfeit drugs affect patients' health directly or indirectly causing severe health issues and sometimes even death. The major effect of counterfeit medicines is the adverse effect on the health of the people. The legitimate medicine manufacturing organizations also face major revenue loss and a tarnished company image. There is a need to identify and distinguish between genuine and counterfeit medicine. The counterfeiting of medicines is due to improper supply chain management in the pharmaceutical industry which not only endangers patients' health but also tarnishes the company's image. In the traditional supply chain, drugs pass through various stakeholders from manufacturers to retailers. Manufacturers and

various authorities have no visibility of the system, which leads to counterfeit drugs. The main reason why counterfeit drugs reach customers is either because a third party mimics a trusted company and sells counterfeit drugs or because of middlemen who tamper with the genuine goods to earn profits. These compromised products go undetected since there is no way to check whether the product is genuine or not. There is a need to identify and distinguish between genuine and counterfeit medicine right when it enters the supply chain.

In today's pharmaceutical supply chain, each transacting party typically manages its own database systems. These private databases allow each party to minimize external security threats while maximizing internal data consistency. These participants may or may not carry out malicious edits of data in their system of record to their own benefit. Manufacturers and various authorities have no visibility of the system, which leads to counterfeit drugs. It is difficult to trace back exactly when and how the counterfeit medicine got mixed with the genuine products. All these problems can be solved through Blockchain technology. Blockchain technology can be used in supply chain management and it will provide security, safety, traceability, and transparency to the supply chain by providing visibility and immutability of each step in the supply chain. Any counterfeit drugs can be traced and sorted efficiently providing safe medicines to the customers. Blockchain is a technology that enables peer-to-peer transactions in a decentralized network. This decentralized network of blockchain makes it highly secure. It establishes trust among unknown peers. It records all the transactions in an immutable digital ledger. The changes made even in the single block of the blockchain will reflect in all ledgers of respective peers. In the Pharmaceutical supply chain, there are many stakeholders from raw material suppliers to customers and this increases the risk of malpractices.

Therefore to achieve security and trust among different stakeholders, blockchain will help with its various features. Every participant of the chain will get to know whenever some action is performed on the blockchain. Hence transparency and visibility can be achieved in the supply chain using blockchain technology.

## 2. Related Work

Blockchain offers a secure interoperable IT system that with its distributed ledger structure can have distributors, buyers and other stakeholders collaborate on the same platform. This eliminates the difficulty in transfer of data between different databases due to many different actors with different databases in the supply chain. Using a shared distributed ledger, it is possible for all relevant parties to securely track the product throughout the supply chain while still ensuring that sensitive information is not shared with any unwanted parties. [1] proposes a framework that represents blockchain-based secure infrastructure for medical chain supply among valid participants. It aims to address the issue of drug safety using Blockchain and encrypted QR code security. In [2] the focus is on *modem.ip*, a start-up that uses IoT (Internet of Things) sensor devices leveraging blockchain technology to assert data immutability and public accessibility of temperature records, while reducing operational costs in the pharmaceutical supply chain. [3] points out the issues in current pharmaceutical supply chain management, and explains how blockchain can be used to add traceability and visibility to drug supply and overcome the issue of counterfeiting. [4] proposes the role of blockchain as a certification entity that guarantees the origin, authenticity, and integrity of data stored off-chain. In the paper, a supply chain simulation model is studied to understand the benefits that companies can achieve in a blockchain-enabled supply chain. [5] provides an industry-focused insight into the practicality and feasibility of permissioned blockchains in real-world applications. It also discusses some non-trivial challenges that should be addressed in making the permissioned blockchain practically deployable in

enterprises. In [6] the adoption of blockchain technology in supply chain networks is discussed. The barriers and obstacles in the adoption of Blockchain for supply chain are also discussed. [7] sheds light on blockchain adoption behavior in the supply chain management field, while taking into account the behavior of the adopters from India and the USA. [8] is focused on semi-structured interviews that were conducted with various experts in the pharmaceutical industry including project managers from a case company. It provides detailed knowledge of the Blockchain's potential within procurement and supply chain and its potential for the pharmaceutical industry. [9] outlines the requirements focal businesses have of any traceability system, including meeting stakeholders' needs as well as the factors critical to the success of any supply-chain-wide implementation. [10] proposes a solution that focuses on the utilization of smart contracts to govern and control all interactions and transactions among all the participants involved within the supply chain ecosystem.

## 3. Proposed Architecture

All the supply chain members will access an official website where they can upload the drug details which they are handling. The web server (in the center) will form a bridge between the users and the Blockchain network. This server will interact with the users directly and perform the fetching and delivery of data. It will be connected to a database that will store the login and registration details of the user base. It will also maintain a record of the current node server which will be handling the creation of blocks.

The Blockchain network will contain numerous node servers which will be handling their own copies of the blockchain ledger. Each node server will get a chance to gather & store data in the ledger in a round-robin fashion. Once enough drug details are collected, the node server will add the collection of drug details called a block in terms of blockchain technology to its ledger and then send the data to every other blockchain in the network. This will allow all node servers to have their copy of the data and any manipulation done on the data can be easily recognized by cross-checking with other node servers.

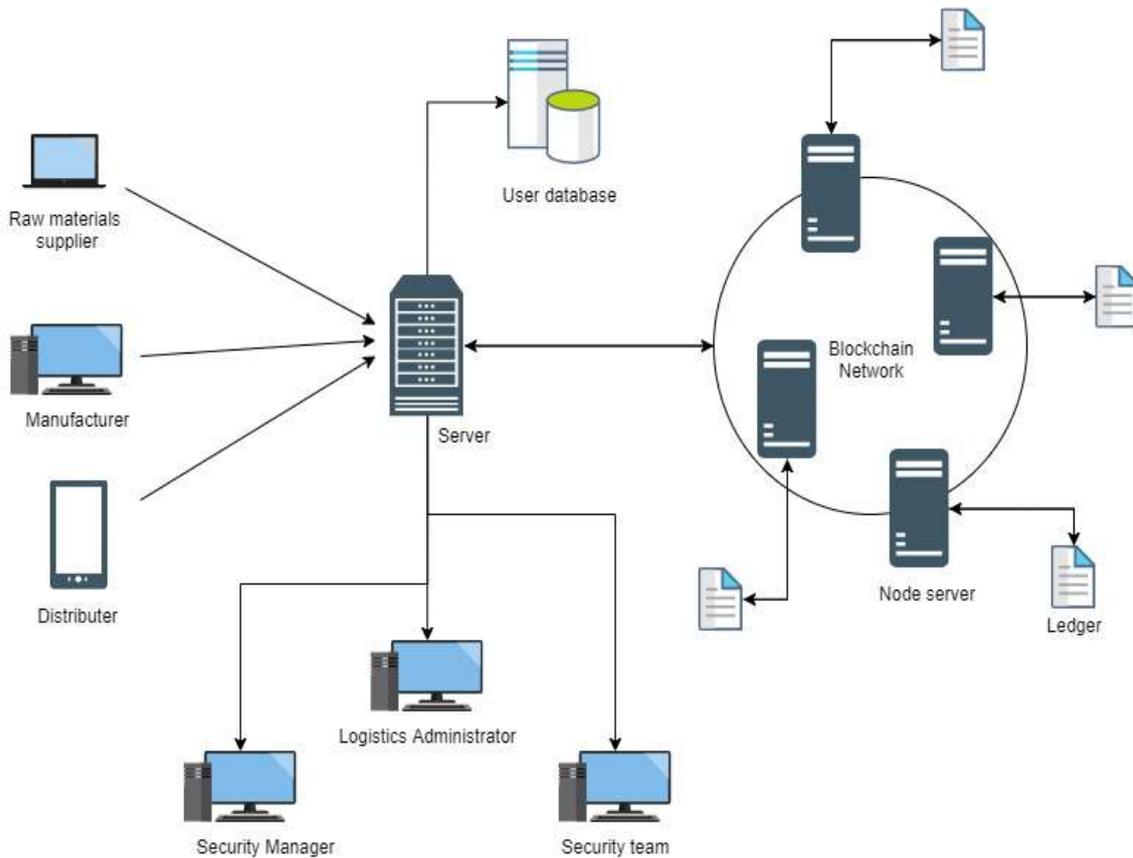


Figure 1: Architecture Design

#### 4. Proposed System Design

The regular members of the supply chain include the raw material supplier, manufacturer, supplier, distributor, and pharmacist. The other major participants that keep an eye on the supply chain like the Audit Manager, Supervisor, etc.

The regular members create transactions and send them to the server. The server then stores these transactions in a buffer. These transactions are then bundled into a block after all transactions are validated and added to the chain. These actions are done by the node which has the current authority to add blocks.

In case during validation any data is found erroneous or invalid, then all the necessary members are alerted and notified. The main authorities have complete access to the blockchain and can access it to trace back the culprit.

#### 5. Conclusion

This proposed framework represents blockchain-based pharmaceutical supply chain management where the transaction of medical drugs can be traced from raw material suppliers to end-users. This framework will achieve security by tracing the counterfeit drugs and ensuring trust among all the stakeholders.

#### 6. Future Work

Blockchain based supply chain needs more research before it gets adopted. Further features can be added to improve efficiency, security & ease of use. Adding additional alert features, using QRcode to keep track of goods, adding more security to the data. This system can also be used for other products which need monitoring and traceability throughout its lifecycle.

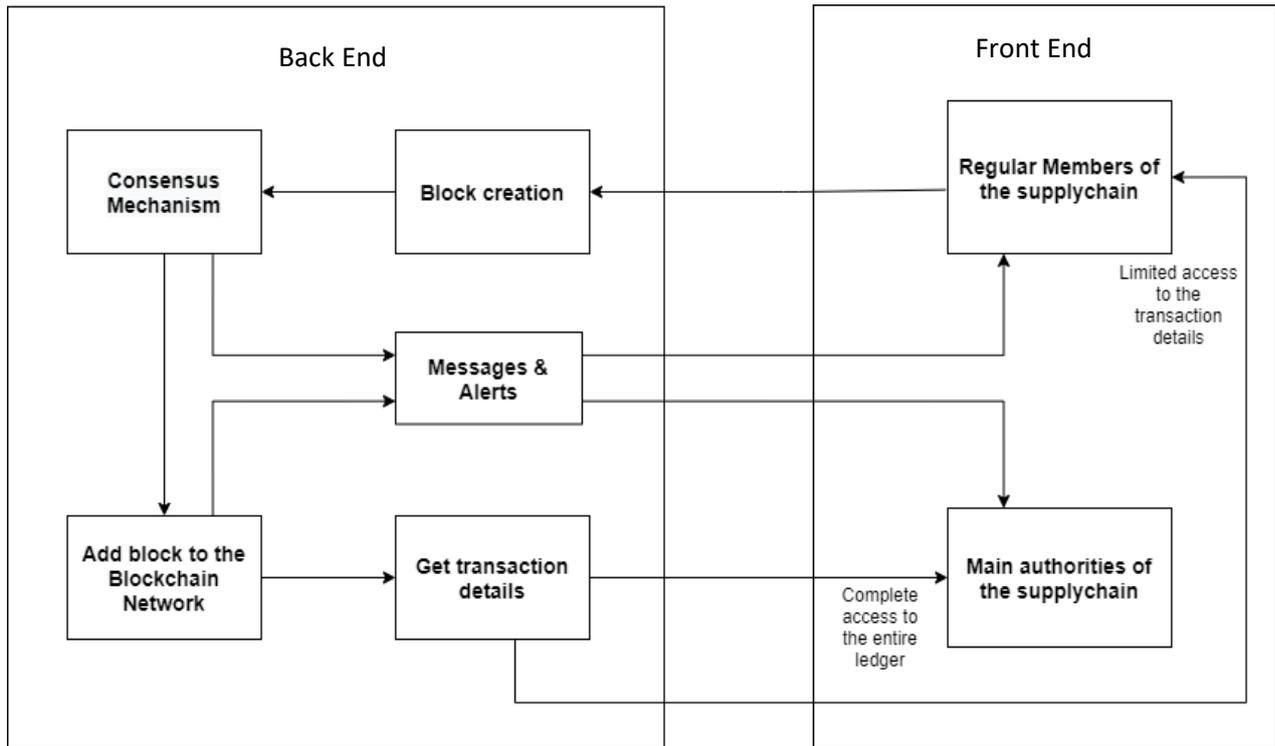


Figure 2: System Design

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