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Supply Chain of Pharmaceutical Industry Using Blockchain Technology

Dr. Mallikarjun S B Ph. D^[1], Sumana CMTech^[2], Annam Reddy Sai Harshitha^[3], Gowthami B A^[4],
Indushree B Y^[5], Kruthika S S^[6]

Dept. Computer Science and Engineering, Bapuji Institute of Engineering and Technology, Davangere,
Karnataka, India

Dept. Computer Science and Engineering, Bapuji Institute of Engineering and Technology, Davangere,
Karnataka, India

Dept. Computer Science and Engineering, Bapuji Institute of Engineering and Technology, Davangere,
Karnataka, India

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Dept. Computer Science and Engineering, Bapuji Institute of Engineering and Technology, Davangere,
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Karnataka, India

ABSTRACT: Currently, counterfeit medicines pose a serious threat because there is no transparency in the current system which makes it difficult for people to know the authenticity of the medicines they buy. Also, it is difficult to detect tampering in the supply chain when it is suspected to be illegal or unfair. The challenge to be addressed is the need to track the actual product from the start of production to the point of use. The project aims to use blockchain to securely record transactions between two parties and integrate it into medical devices to provide users with interactive design interactions.

KEYWORDS: Blockchain Technology, SHA Algorithm, Smart Contract, Django, Wamp Server.

I. INTRODUCTION

The pharmacy supply chain is the process by which medicines are manufactured and distributed to patients. However, this chain is complex and consists of many stages that will last for months or longer and span many regions around the world. The chain's sales offices, manufacturers, shippers, wholesalers, distributors, retailers, etc. It has many sections. Therefore, tracing each drug along the supply chain and tracing its source becomes a difficult task. Counterfeit drug use is a global problem. Health research organizations report that approximately 10-30% of medicines in developing countries are counterfeit. Counterfeit products are a big concern as they can have different side effects on people's health. According to the World Health Organization, about 30 percent of all medicines sold in Africa, Asia and Latin America are counterfeit. The real problem is not counterfeit medicines, counterfeit medicines are different from real medicines and counterfeit medicines have different effects on human health.

It is very difficult for customers or buyers to understand the value of the product as there is no transparency in the current system. Investigating supply chain tampering is still very difficult when it is suspected to be illegal or unethical. Thus, such a supply chain consists of suppliers, manufacturers, etc. try to connect places and decide who needs what, when and how. Due to the lack of clarity in the current system, consumers and buyers can no longer determine the

authenticity of the product. This type of tampering in the supply chain is very difficult to investigate when there is evidence of wrongdoing or fraud. In addition, retailers and manufacturers can be unreliable when trying to figure out who wants what, when, why and how.

Blockchain is an evolving solution. Blockchain provides a distributed hyper ledger with no centralized authority over the system. Each transaction into the Blockchain is immutable, which means there is no way sensitive data like Drug/Customer information can be tampered with. Blockchain provides complete transparency, which also brings trust between the various main entities of the Supply Chain, such as, Manufacturers, intermediaries like Distributors and Suppliers, and the end-users like Customers/Retailers/Hospitals. Each product within the chain can be transferred between different authenticated entities of the chain using an event request-response mechanism. All transactions between the different entities are recorded into the Blockchain using smart contracts.

Blockchain is a distributed ledger technology (DLT) that contains a growing list of data called blocks that are securely linked together using cryptography. Each block contains the cryptographic summary of the previous block, its time and transaction data (usually seen as a Merkle tree with leaves to represent the data). The timer proves that the updated data exists when the block is created. Since each block contains information about the previous block, they form a chain (similar to a linked file) where each additional block is linked to the previous block. Therefore, blockchain transactions cannot be undone because once recorded, information in a block cannot be changed back without modifying all subsequent blocks.

A blockchain is usually managed by a peer-to-peer (P2P) computer network and operates as a public distributed ledger where nodes collectively act according to the added approved algorithm protocol and valid new business blocks. Although blockchain data is immutable, blockchains can be considered secure in terms of design and distributed computing instances with high Byzantine fault tolerance, as blockchain forks are possible.

1.2 Blockchain Features

Several characteristics are associated with the blockchain: peer-to-peer network, decentralized, transparency, distributed consensus, inefaceable, distributed structure, resilience, autonomy, security and trust. All these characteristics constitute the innovative potential and modern possibilities of the blockchain. The most important characteristics of the Blockchain are:

- **Peer-to-Peer Network:** The peer-to-peer is a group of independent computers called nodes which are interconnected with each other to share data without use of the centralized computer. In blockchain network, transactions take place directly between two nodes in the network, meaning no third party is required. It is verified by all other nodes in the blockchain. This is known as the Peer-to-Peer network.
- **Decentralization:** Blockchain system is a distributed and decentralized system. That is, there is no central authority that controls and manages the blockchain, but network nodes can access and control all transactions because each of them has a copy of the data civil document. This is an advantage that makes the blockchain more secure.
- **Smart Contracts:** Smart contracts are self-signed contracts where the agreement between the buyer and seller is written directly into the line of code. This ensures the success of the business and eliminates the need for intermediaries.
- **Consensus mechanisms:** In order to add a new block to the blockchain, a consensus mechanism must be used to verify the validity of the transaction. This ensures that all participants in the network agree on the state of the blockchain.

II. LITERATURE SURVEY

G. Perboli et al [1] describes the standard methodology for developing and validating the overall Blockchain solution and designing a strategy for integrating it into Business Strategy. They also highlight how Blockchain can tackle security challenges in IoT, such as identifying different devices and managing trust, information tracking, authentication and access control, and accountability in IoT-based applications.



Jamil and L. Kim et al. [2] proposed an application as a user service that uses smart contracts and distributes data as a middleware. The proposed system is based on blockchain permission and distinguishes it from other blockchain-based systems by only allowing users to join and register with the blockchain network. The smart contract-based application uses the job and executes multiple queries and updates the status data by continuing the process and sending the updated results as a response to the application.

Q. Zhu and M. Kouhizadeh et al. [3] focused on combining the decision-making process with blockchain technology to remove products and all related information from the company's product copy, which is the process of removing products. Four main phases of the removal process are proposed: identification, identification and support, evaluation and decision-making, and implementation. Blockchain technology improves communication and collaboration between various organizations in the supply chain, increasing information efficiency, efficiency and reducing conflicts.

Prachi Shrikant et al [4] focuses on the importance of Blockchain technology to trace and detect counterfeit products in the supply chain. Every time the medicinal drug moves from one entity to another, the information stored in the Blockchain makes it easy to track the drug, and thus the threat of counterfeit products is reduced. Blockchain technology helps solve the main issues, as each new transaction is time-stamped, enabling companies to track their products in the supply chain. Allowing stakeholders to take actions in case of any issues by identifying the exact location of the drug.

K. Toyoda et al [5] proposed the need to develop anti-counterfeit systems that will work when the RFID tag's information will be cloned in the post supply chain. Hence through the paper, they proposed The Possession of Products scheme. The counterfeits can be detected if any entity is unable to prove the possession of the particular product. They have suggested Blockchain, as Bitcoin allows users to prove their ownership without the need for any authentication and centralized authority.

Huang and Yan et al [6] narrate the importance of Drug ledger, a fully scenario-oriented Blockchain system for drug traceability and regulation. Drug ledger uses the UTXO-based transaction model combined with the supply chain to construct the entire workflow that includes drug packaging, repackaging, unpackaging and drug transaction cancellation, the arrival and exit of the drug supply chain, and so on. Thus, the Drug ledger manages to separate the drug traceability service from data modification, ensuring data authenticity and privacy.

J. Ma et al [7] describe the need for a fully-functional Blockchain system to prevent product counterfeiting to ensure that the products can be identified and traced in the supply chain. They propose using Ethereum, a Blockchain platform and suggest that users write smart contracts using Solidity and deploy them on the network. Through the proposed anti-counterfeit system, the users do not have to be concerned regarding acquiring counterfeit products.

Leng Kaijun et al [8] proposed a public Blockchain with a double chain architecture to enhance agricultural supply chain systems' efficiency. They showed that their solution provides adaptive rent-seeking and matching mechanisms for public service platforms. It guarantees the security and transparency of transaction privacy and information of enterprise information. The main drawbacks are the size of the underlying Blockchain network and the related performance issues.

Mao et al [9] proposed a Blockchain-based credit their method, but they do not consider the overall system costs and benefits explicitly. Evaluation system to strengthen management and effectiveness in the food supply chain. In particular, they gather credit evaluation text from traders by smart contracts on the Blockchain. Further, the text is analyzed by a deep learning method named Long Short-Term Memory (LSTM). The system's drawback is that they show the effectiveness of their method, but they do not consider the overall system costs and benefits explicitly.

R. Kumar and R. Tripathi et al. [10] proposed a framework that represents a blockchain-based medical supply chain security infrastructure between partners and original companies that can provide safe medicines. It relies on PKI and digital signatures to prevent duplication and man-in-the-middle attacks.

III. EXISTING SYSTEM

The supply chain now includes the movement of medicines from the manufacturer to the seller and to the consumer. Generally, wholesalers place orders with manufacturers [5]. They take orders and deliver the goods. The wholesaler then takes the product and deliver directly to pharmacies, hospitals and retailers. They usually deliver products to exporters, to distribution centers where they process them. These centers then deliver the drug to the patient.

IV. PROBLEM STATEMENT

The Pharmaceutical Supply Chain (PSC) is a main component of the Healthcare Cyber Physical System (H-CPS) which ensures the access of essential medicines with the right amount and quality to reach the consumer in need, on time. But associations between these entities change from time- to-time based on the need and usage patterns. Hence, we create a Full-fledged web application which manages the supply chain using Blockchain instead of traditional centralized network.

V. PROPOSED SYSTEM

The proposed system consists of many entities like suppliers, transporters, manufacturers, wholesalers, distributors, and customers/retailers and is connected through a decentralized network as shown in the **Figure 1**. Each of the above entities of the supply chain is a node on the public Blockchain. Each of these nodes has its own Ethereum account, which is used for representing its identity. This proposed solution eliminates the need for a foundation of trust, intermediaries, and provides a high level of integrity, trust and security, and business insights to increase efficiency and security[9]. The solution focuses on the use of smart contracts to control and manage all interactions and transactions between all participants in the product ecosystem.

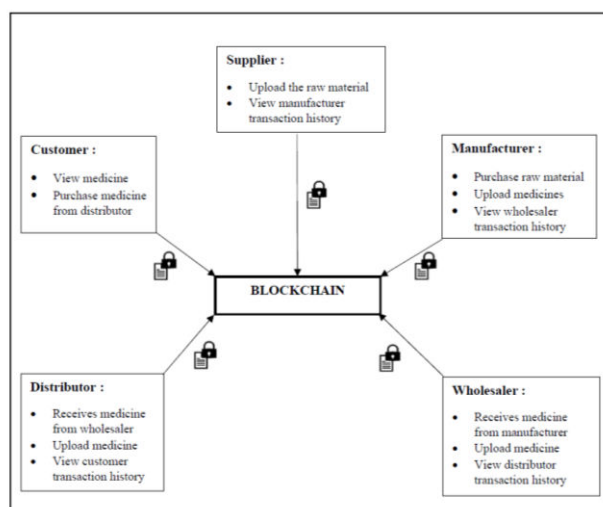


Figure 1: Proposed system

All transactions are recorded and stored in blockchain data connected to the immutable and decentralized system, thus



providing a high level of transparency and traceability for the entire chain ecosystem in a security-minded, reliable, reliable and efficient manner. Test results show that our solutions are viable and safer than existing systems.

VI. OBJECTIVES

- To provide User Interface Design (UID) interactions between concerned users involved in the supply chain of pharmaceutical producers, intermediate participants, consumers.
- To make use of Blockchain Architecture by providing intermediate secured transaction of data.
- To create secured database using Blockchain technology through which significant data can be stored and also providing secure access to the concerned users.

VII. METHODOLOGY

User Interface: The user interacts with the system through the user interface, which allows them to input data and view the results of various operations.

Backend: The backend receives input from the user interface and processes it according to the rules of the smart contract. It communicates with the blockchain network using the Wamp protocol.

Smart Contract: The smart contract contains the business logic of the system and is executed on the Ethereum blockchain. It is responsible for managing the lifecycle of the pharmaceutical products and validating the authenticity of transactions.

Ethereum Blockchain: The Ethereum blockchain serves as the underlying infrastructure for the system. It is a decentralized, distributed ledger that allows for secure and transparent storage and transfer of data.

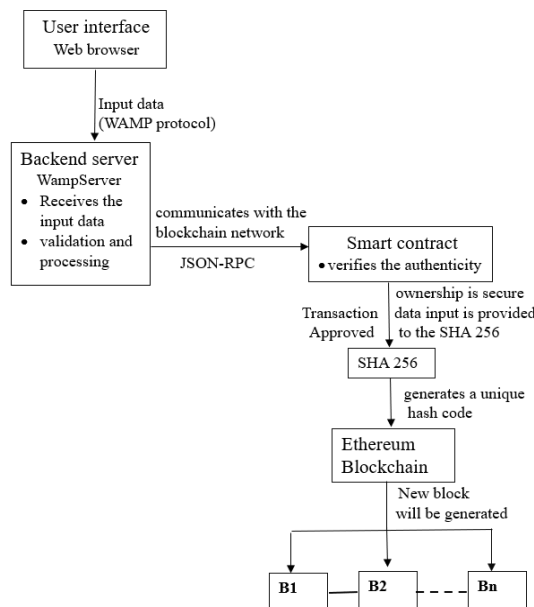


Figure 2: Methodology

MySQL Database: The MySQL database is used to store information about the pharmaceutical products and their supply chain. It is used by the backend to manage the state of the system and to provide data to the user interface.

WAMP Server: The WAMP server is used to establish communication between the backend and the user interface. It

allows for real-time communication using the WebSocket protocol.

VIII. RESULT

In this paper, we have developed a web-based Supply chain management system that relies on Blockchain technology. The supplier can upload the raw materials in which authenticated manufacturers can purchase and make use of raw materials to manufacture medicines. Further, authenticated users will continue the process of purchasing medicines. During the process of purchasing medicines using smart contract Ethereum Blockchain a hash code will be generated which will give secure payment transaction between the concerned users.

We didn't use the cloud in this because the main agenda behind this project is to store data in a highly secured area as leakage of data from cloud storage is common and we prefer a decentralized data storage facility. Instead, we used IPFS based storage model. Only the hash of the file is stored in the blockchain and the files of the certificate are stored in IPFS. Calculation of block header hash is mainly based on IPFS hash. Once a fraudulent node wants to tamper with the data which has already been entered its IPFS hash also changes. Thus, an invalid block won't be validated by Blockchain. In this storage space is also optimized because of the use of hash itself.



Figure 3: Supplier uploading raw materials

Supplier with proper login credentials can upload the raw materials by providing details of the raw materials like name of the raw material, number of pieces, brand name, price and image file can be chosen as shown in the **Figure3**.



Figure 4: Supplier transaction details

The self-executed smart contracts will be verifying the authentication of the user, if the user is authenticated then the transaction is approved in which the hash code will be generated for the related information and new block will be created in the blockchain. The above **Figure 4** indicates the supplier transaction details with unaltered hash code and timestamp.



IX. CONCLUSION

In this project, we focused on improving the transparency and security of the pharmaceutical supply chain using blockchain technology. We developed a system that allows for the tracking and tracing of pharmaceutical products from the manufacturer to the consumer. We began by gathering requirements and designing the system architecture. The technologies such as Ethereum blockchain, Django web framework, WAMP server, and MySQL database are used to build the system. We also conducted testing at various stages of development to ensure that the system was working as intended. The system operates by allowing users to input information about pharmaceutical products into the system, which is then verified and stored on the blockchain. The information is then accessible to all authorized parties in the supply chain, providing a transparent view of the entire process.

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