



Secured Supply Chain Management for Medical Companies using Blockchain

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Abstract

Supply chain management in pharmaceutical industry is a complex process which comprises of managing tasks like manufacturing, storage, and sales of medical drugs. Though supply chain management is a challenge on every industry, in health care, compromised supply chain adds risk to consumers' safety. Increased adoption of technology, globalization and industry populated with multiple stakeholders in various jurisdictions has given rise to a complicated health supply chain. In this operation process, due to imbalance and asymmetry of information among the stakeholders arises a fraud problem such as compromising the consumer drug information. In such cases, in order to improve the security and reliability of drug information we suggest blockchain based data storage technology. In this paper we discuss about how fraudulent drug information problem can be resolved using blockchain and by the way presenting reliable information to the concerning consumers. We discuss about smart contract based on Consensus algorithm. Blockchain in pharmaceutical supply chain not only reduces the risk of counterfeiting and theft, but also allows efficient inventory management.

Keywords: Supply chain, blockchain, pharmaceutical industry, proof of work, medical drug information, drug counterfeiting.

1.Introduction

In production enterprises and business, supply chain may be a network of individuals or organizations involved in moving a product or service from manufacturing to delivering to the customer. A basic supply chain management includes the subsequent components: Planning, information, source, inventory, production, location, transportation and return of products. Supply management plays a serious role in pharmaceutical industry also.[1] Pharmaceutical supply chain should provide medicines in right quantity, with acceptable quality, to the proper place and customers. It includes all of the logistical activities, manufacturing operations, marketing, sales, product fabrication and managing information. during this process, an outsized amount of drug information is handled among various stakeholders, which results in major challenges like lack of coordination among stakeholders, inventory management, expiration, temperature control and warehouse management.

Blockchain can be described as a data structure that holds transactional records and while ensuring security, scalability, transparency and decentralization.

Blockchain technology has shown its considerable adaptability in recent years in various sectors. Blockchain was proposed by Satoshi Nakamoto [2] in January 9, 2009 with bitcoin, is an open distributed ledger that can record transactions between two parties efficiently and in verifiable and permanent way.

[3] Numerous starting points for blockchain in healthcare includes public health care management, user-oriented medical research and drug counterfeiting. When it comes to the supply chain of pharmaceutical sector, there is danger of [4] information's "asymmetry" and "incompleteness", due to the lack of management for information openness and transparency in the supply chain and lack of supervision, and also one subject in the supply chain do not care about the other subjects.

This paper focusses on the risk due to tampering of drug information which includes drug ingredients, composition, date of manufacturing and expiry, storage parameters like temperature humidity, and dosage. These information are produced and maintained by various stake holders individually. This leads to imbalance of information and the subjects may involve in fraud activities like producing false information for personal benefits.

In the point of avoiding this fraud, the drug information can be made transparent and verifiable to everyone. At the same instance, tampering of information must be taken into account which causes serious problem. Block chain can serve as the best solution for this problem since tampering is hardly or never possible in block chain information.

The applications of blockchain can be divide into three categories: 1. Digital currency 2. Intelligent contract 3. Different area applications. Presently we are in the second category, which uses Consensus authentication mechanism. We focus on "proof of work" Consensus mechanism, for generating valid blocks of data and also making it protective against tampering. This mechanism generates chronologically-ordered blocks linked and secured by making use of hash algorithm, timestamp, cryptography in a peer-to-peer network.

2.Literature Survey

Yonggui Fu and Jianming Zhu [5] has proposed a system structure and intelligent contract operation mechanism in big production enterprises supply chain. This proposal adds blockchain based data storage and data access mechanism to the classical blockchain technology. This paper is general to all enterprises including pharmaceutical industry which is taken as a case study. This paper focuses on managing endogenous risk in supply chain.

Gregor Blossey *et al* [6] presents an application perspective of blockchain in Supply Chain Management (SCM). This paper

mainly focused on issues of manufacturing and logistics in SCM. This paper provides a general application view without providing system structure.

Vishal Naidu *et al* [7] has proposed decentralization of supply chain details among various stakeholders by blockchain and also suggest IOT to ensure there is no inconsistencies.

Benhe Gao *et al* [8] proposed blockchain technology for controlling Supply Chain Financing (SCF) pledge risk and a strategy for Real Time Stare in Market (RTSM) to mitigate risk pressure.

Mitsuaki Nakasumi [9] says double marginalization and information asymmetry as a serious problem in supply chain management and proposed blockchain in as a solution. The process of information sharing between manufacturers, suppliers and customers leads to the risk of asymmetrical information.

Lei Xu *et al* [10] proposes a security mechanism to prevent unauthorized access to the data stored on the public lecture. This paper proposed Chain of Custody (CoC) technique for managing supply chain based on hybrid decentralized ledger.

3.Proposed System

The system proposed is used for securing various drug information which is produced by various subjects of supply chain like supplier, manufacturer, warehouse, and retailer, using blockchain and presenting reliable and trustable information to the consumers through an authority like Department of drug administration. Our system consists of the following modules:

A. Admin module:

The admin module consists of an application to which every subject in the supply chain has to register in and provide their details which is stored in the Server. The admin (say, Department of Drug Administration), sign in is available. The admin can add supplier, manufacturer and retailer details, authenticate and manage them based on the terms and conditions.

1. Manage Supplier and raw materials:

The admin creates an entry list, each entry has supplier-item or supplier-category ordering attributes specified on the procurement or ship-to organization levels. The tasks include: manage a list of suppliers, supplier sites, manufacturers, distributors that are either authorized or

restricted from supplying critical items or categories, setting up dates and maintain approved supplier list entries to reflect the current business state with the suppliers.

2. Manage product information:

Product information comes from various subjects which is maintained in their own cloud storage. The Bill of Materials (BOM) is produced by the manufacturer, which can be understood as the recipe and list of ingredients for creating a final product say, drug. The information includes composition of ingredients, dosage, caution and date of manufacturing and expiry, price for each specified drug, and warehouse-oriented information like temperature and other storage parameters.

B. Consumer Application:

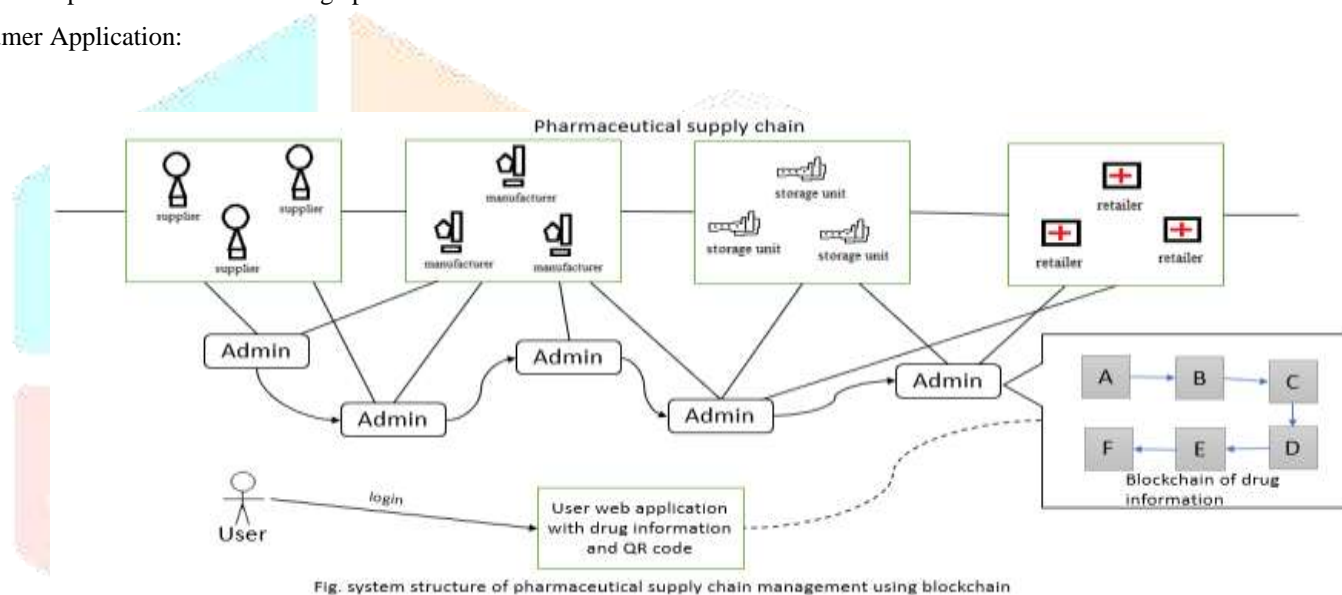


Fig. system structure of pharmaceutical supply chain management using blockchain

The drug-related information from various subjects which is available in the server is encrypted using SHA-256 hash function. The hash function is applied for each block, here a block is defined as the information per drug. The information of a single drug is analyzed and hash function is performed on it. The input bytes can be of variable length, on performing SHA-256 a hash of fixed length (256 bits). After computing hash values for the blocks, the chaining mechanism is handled.

D. Blockchain creation:

Whenever a new drug information is added, the admin validates the information and the blocks are generated. Basically a block has the following information: Index, timestamp to store the creation date of

This module consists of a user web application, to which the user can login and view the dash board containing the drug information. All the consumer drug information which is maintained in the admin server is made available to the registered user, along with the QR code which generated to every drug by the system.

C. Cryptographic hash function:

Hashing is the fundamental in the creation of blockchain. Cryptography hash function is a special class of hash function possessing various properties: Deterministic, Quick computation and Pre-image resistance; Thus making it ideal for cryptography. SHA-256 is the hash function we use in the creation of blockchain.

the block, hash of the previous block, data about the drug, hash of the current block. The blockchain is generated in the admin server, where each block stores the hash value of the previous block in the chain,

thus guaranteeing the integrity of the block data. Finally a blockchain is valid and the integrity of its data is preserved when the first block is valid and each block that precedes it contain the hash of the previous block.

4. Algorithm and methodology

A consensus algorithm is a mechanism by which all the peers of the blockchain attain a common agreement about the present state of the distributed ledger. In short, consensus mechanisms are protocols that make sure all nodes are synchronized with each other and agree on which data are legitimate and are added to the

blockchain (fig.). There are a number of consensus mechanisms, we jump on to "Proof of work" mechanism. This term was coined by Markus Jakobsson and Ari Juels [11].

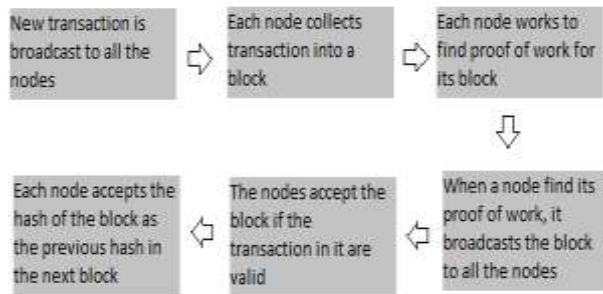


fig. Consensus mechanism

In the context of crypto currencies like bitcoin, the transactions are taken as the input to hashing. In the case of pharmaceutical supply chain, information per drug is taken as the input to hashing function. In this case we have to consider two terms into consideration: Nonce, which is a random number which is used only once. Hash, which is a complicated algorithm which converts a string to a fixed length hash id. We use SHA-256 cryptographic hash function for encryption.

Every block in blockchain has its hash (id). When next block is added, we will take that hash of the previous block and add the current block of transactions. The next step would be to take nonce – a random number, and add it to the end of that block of text. Now we have a big block of text which contains a hash of the previous block, new transactions, and a random number, which is taken as the input to the algorithm to generate hash id of the current block (fig). This process is repeated at the instance of adding a new block

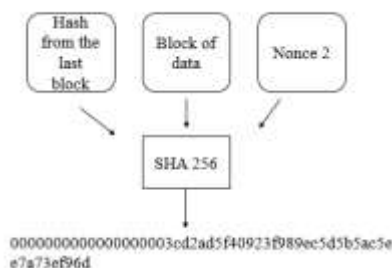


Fig. hash id generation for each block

5. Analysis

Consensus algorithm is a guaranteeing protocol for stable functioning of blockchain. The use of proof of work consensus mechanism results in additional computational power, but it remains the effective mechanism for implementing blockchain and prevents denial of service attacks. SHA-256 is the presently used hashing algorithm for blockchain, being an effective algorithm and produces unique hash results for the input. In the existing environment, there is a process of acceptance of any new technology, that makes the pharmaceutical industry as the core, to convince the authority, management and specific users.

6. Conclusion

This paper proposes a secured way of managing pharmaceutical supply chain using blockchain. The system is proposed to prevent the risk of tampering consumer drug information by the supply chain stakeholders, thereby reducing counterfeiting, theft and improving the quality of inventory management. This system also aims at presenting the necessary drug information to the concerning consumers.

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