



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Complete Review on Advantages of Blockchain and IoT In Supply Chain Compared to Traditional Systems

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Abstract— Blockchain is emerging as a technology with multiple benefits in all possible sectors and domains. Supply chain is not exception of it. Trust, integrity, security all this can be introduced in supply chain using blockchain. Trust based traditional supply chain has many disadvantages and difficult to manage all stakeholders. IoT and blockchain together can help industries to establish secure, immutable, transparent supply chains. All stakeholders can track the records and no-one will own the data. Even list of benefits is still growing but implementation rate is quite less. This is because of less understanding of technology and not knowing what difference it will create after implementation. In this paper we will discuss multiple approaches to manage transparency in supply chain. From traditional to blockchain based solutions, how it can impact in sectors like healthcare, agriculture, eCommerce, food-processing. We will check problems in current supply chain and possible solutions using technologies like blockchain and IoT. This article will help people from various sectors to understand how technology can change overall system by keeping functioning same and how it can improve the efficiency.

Keywords— Blockchain, Supply-Chain, IoT, Traceability

I. INTRODUCTION

Supply chain is backbone of every product-based industry. Stronger is the supply chain more is the business. Supply chain ensures timely delivery, quality and correct product to the customer. Some entities in supply chain take advantage of loopholes of current supply chain techniques and introduce faulty products in market. Due to this end users as well as industries affects. Some sensitive issues with supply chains like healthcare may have impact on end users lives[12][13].

Blockchain technology allows to store data in distributed ledger where no one owns the data. Every transaction gets validated before adding it to node and once stored its permanent. No one can change the data. [1][2]. Internet of Things (IoT) have potential to generate all required data to manage supply chain and use it for tracking and tracing. All stakeholders can check that data to make chain more trustful [3]. On top of this all advantages of IoT, there are some challenges in it. Those can be overcome by blockchain. Both together can form better system. Some features are listed below[4]:

- Decentralization: It ensures that data is not at one place and not owned by single stakeholder. Decentralization provides fault tolerance and greater availability ratio than centralized systems. Blockchain ledgers are decentralized copy of transaction data.
- Secure and anonymous: Data is kept secure and user identity cannot be hacked. To give best example of it;

people are still guessing “Santoshi Nakamoto”, founder of Bitcoin. Also Bitcoin is still not being attacked by anyone.

In this paper we will discuss benefits of integrating traditional supply chain with IoT and blockchain. Traditional supply chain is shown in Fig. 1. It consists of Raw material supplier, manufacturer, distributor and consumer.

Challenges faced by traditional supply chain are [5]:

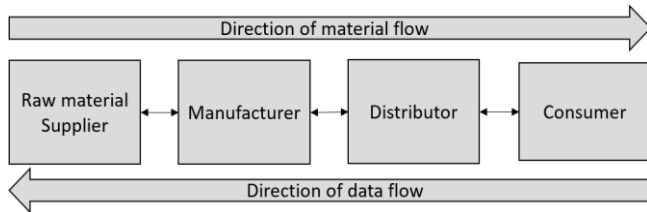


Fig. 1. Material and data flow in traditional supply chain

- Transparency- Multiple stakeholders have to trust on each other. End user may not get to know if someone in between introduces faulty product in supply chain.
- Poor management of demand and supply- Due to data flows reverse than product, manufacturers get difficulty to understand proper demand and create supply according to demand.
- Risk management- Traditional supply chain has poor risk management. Risk prediction and management is difficult in traditional supply chain.
- Technology Integration- Due to change in user need technologies need to be integrated in system. This is difficult as old supply chain is difficult to modify as per change.

Benefits using IoT and Blockchain together in supply chain are as follows [5]:

- Trackability- Data flow is uniform within all stakeholders and can be traced by any stakeholder. Blockchain provides this benefit and reduces counterfeiting issue from supply chain.
- Security- Blockchain provides data security and high availability
- Data and material flow- IoT enables real time data and material flow. Product location, environmental parameters, demand this data is useful for manufacturer to act before risk.

II. LITERATURE SURVEY

Supply chain with traditional approach just contains common agreement between all stakeholders. Even after decades; most of the supply chain runs on the same principle [6]. The entity having more power in supply chain can have power to inject counterfeit products. Here just information is stored on

the web rest functionalities and other aspects like transparency, security is not taken into consideration.

Existing solutions have some IoT based prototypes. One of them is RFID tags. RFID tag store product data and attached with product package. It is used as identifier and tracking in supply chain. In this solution cost of tags and data stored in centralized server are major problem. Apart from traditional system it has benefit of easy tracking using RFID tags [10].

An NFC based consumer-level counterfeit detection framework solution suggests one approach with NFC technology and reduces issue of centralized data storage issue [7]. Semi offline solution based on public key cryptography and public key Infrastructure. This solution allows user authentication without accessing central database. Here it is assumed that NFC is all available thing in mobile. But most of the supply chain consumers are not having NFC readers.

QR code-based supply chain trackability solutions present in market are most simple to use. Food, grocery and vegetable supply chain are commonly using this solution currently. When product gets packaged, it is linked with unique Id and that Id is mapped with QR code. At every stage of supply chain respective stakeholder add its entry. End user can scan the code and traceability code mapped with that QR code is sent to server for fetching the data. Here database is centralized and commonly accessible between all stakeholders. First argument in traceability code is (Tread item id) manufacture code, second is (batch Id) Timestamp and third is (Id Identifier) Vegetable Id. [8]

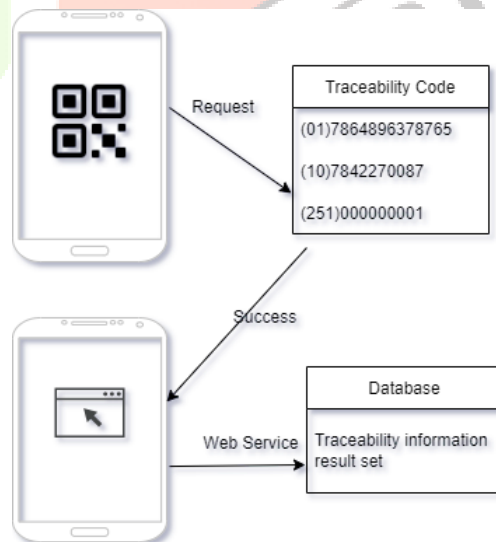


Fig. 2. Traceability procedure

Similar implementation in healthcare medicine supply chain is available namely Smart-Track[11]. GS1 standard barcodes are used to identify product, lot and expiry date. Information is collected while product flow from supply chain from manufacturer to distributor and from distributor to pharmacy.

End user can check for authenticity of that medicine by simply scanning the QR code.

Some recent solutions have blockchain based solutions for tracing of product[9]. Each product is mapped with unique code. User have to manually enter the code and system will check product entry in blockchain database. If it is available, it means product is authenticated.

III. ANALYSIS AND PROPOSED SOLUTION

By analyzing multiple approaches to detect fake products in supply chain, traditional approaches alone are not useful. Technologies like IoT, blockchain and AI all together can form better solution. To protect data and make system transparent blockchain is one and only solution till date. To map products with unique id and make applications user friendly QR code have its impact. Apart from that to manage demand and supply AI can work together with blockchain. Multiple IoT based sensors can solve problems arising in supply chain, from manufacturing to consumption by end user especially in food related supply chains.

From Fig. 3. One who want to verify product will flow flowchart 1. User will use his account and scan QR code. That QR code contain information of product. This information is verified into blockchain ledger.

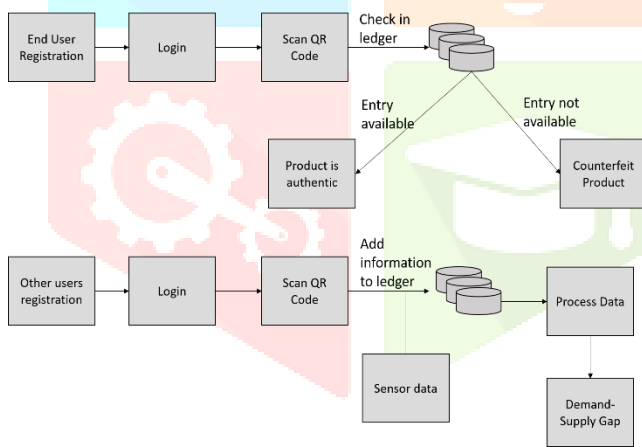


Fig. 3. Proposed system from analysis

If that data doesn't match, product for which user is enquiring is fake. At every point of supply chain stakeholders will add amount of information. For example, manufacturer add manufacturing details like batch number, manufacturing date, expiry date etc. Distributor will add product transportation related data. This data will be available to end user when he scans QR code. Also, IoT based sensors continuously generate data and real-time tracking of product can be made. This is solution where all stakeholders from supply chain come under one umbrella resulting transparency in the system. Data flow will be uniform and demand and supply can be managed easily.

IV. USE CASE USING ANALYSIS

Supply chain in healthcare for counterfeit medicine traceability:

Counterfeiting in medicine can be done by changing proportion of substituents, changing complete medicine or bringing expired medicines into supply chain. It has very adverse effect on lives of users. To solve this issue solution with above mentioned analysis suggested below.

As shown in Fig. 4. All stakeholder has frontend DApp which allows to upload and fetch data on blockchain network. All files are stored on IPFS and hash of stored data kept in blockchain to reduce data on network. Web3 js is used to enable interaction with metamask. Metamask is a wallet holding crypto and used to provide gas fees. It uses blockchain like Ethereum or ganache to test on local environment. Every transaction is stored into smart contract that cannot be modified once recorded.

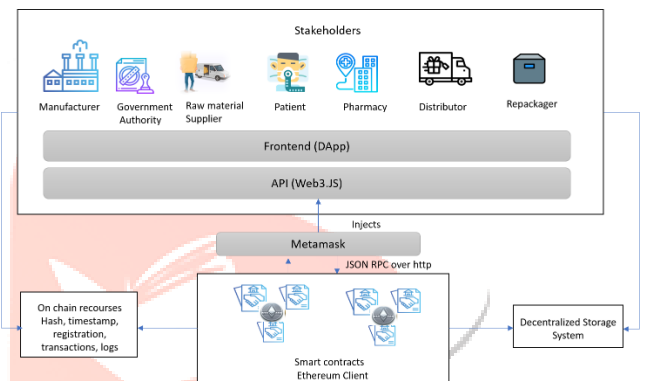


Fig. 4. Blockchain based healthcare supply chain

V. CONCLUSION

This paper shows clear difference between traditional supply chain and Blockchain and IoT based supply chains. In this article one can understand problems faced by food processing, automotive, agriculture and healthcare industries. By using conventional methods together with technology like blockchain can solve counterfeiting, traceability and security problems. Finally one use case is given to show how proposed solution could work to integrate blockchain in supply chain.

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