

A Review on Benefits of IoT Integrated Blockchain based Supply Chain Management Implementations across Different Sectors with Case Study

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Abstract— In the current era, blockchain based system getting a lot of attention across different industries especially in the domain of supply chain because of its streamlined nature at the same time keep the privacy intact as well as more efficient than the conventional system. However the traditional supply chain faced lot of challenges these days because of the complex networks. Blockchain integrated with IoT framework has the potential to overcome the challenges faced by the conventional systems across industries. Basically the IoT integrated blockchain system provides enough benefits such as connecting the link between the flows in the supply chain to improve the efficiency of the supply chain network, makes the system transparent that can reduce the code of conduct violation throughout the supply chain networks, the immutable properties helps the stakeholders to trace the products throughout the networks. Even though blockchain based system provides enough benefits across industries, so far the implementation rate is very low because of the lack of knowledge about the benefits of blockchain system as well as lack of understanding about how and why it is needed in their fields. In this paper we will highlight the difference between the conventional supply chain as well as blockchain based supply chain and the benefits of implementing blockchain in different sectors such as automotive, pharmaceutical, food industry, retail. This article will highlights the problems currently facing by the above mentioned industries by using the conventional supply chain as well as the solutions to the problems provide the blockchain based systems in those industries. This articles helps the people across sectors to understand the benefits of the blockchain based system in their respect fields as well as implement it to improve the efficiency of the overall system.

Keywords— Blockchain, IoT, Supply chain, integration, system

I. INTRODUCTION

Blockchain technology is defined as the technology that plays as a role of distributed ledger in which transactions are made in digital manner and at the same time these transactions are recorded, verified, and validated throughout the network

of nodes without the approval of central authority [1, 2]. Internet of Things (IoT) is a system that works over a network with uniquely identified machines, devices, animals, objects, and people, which are interrelated and they have the potential to transmit the data among themselves without any interaction between them [3]. However the IoT has some privacy and security challenges which can be overcome by integrating blockchain technology.

The features that will make it possible are as follows [4]:

- The most important feature is the decentralization, which ensures that there is no individual resource that control the whole system. All participating nodes of the system can use all their resources to prevent the many-to-one traffic flows, which eventually succeed in dealing with problem raised to single point failure and decreases the delay. The decentralized system makes sure that the system is robust and scalable.
- The second feature is the anonymity that is inherent to the blockchain system is usually suitable for most of IOT applications where the main objective is to keep the identity of the user as private.
- The third feature is security which is mostly desirable since IOT is dealing with lots of heterogeneous device with unsecure network from untrusted parties. Blockchain provides a secure network when dealing with this kind of problem.

The above mentioned features has a potential that can be recommended for many application. In this study we have implanted the integration to a traditional supply chain network and highlights the benefits of it so that it can be recommended across the industries. The traditional supply chain network design is shown in the figure 1. The system consist of mainly three elements named as Upstream side(suppliers), producers, downstream side(customers).

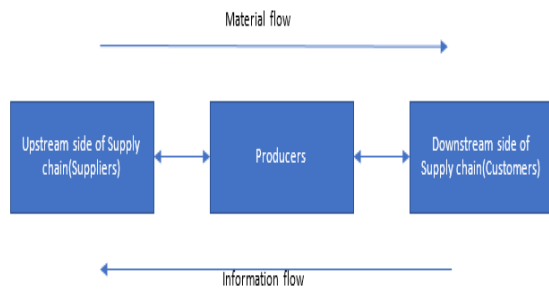


Figure 1. Key elements and flow within a supply chain network

The challenges faced by conventional supply chain are as follows [5]:

- Lack of visibility from the upstream side to downstream side: Lack of visibility from one end to other end create numerous problem such as fraud, violation in code and conduct etc.
- Lack of flexibility to sudden demand changes and control on operation cost: With the effect of globalization, frequently there is change in demand and indirectly increase the operation cost
- Lack of trust on security among stakeholders: Due to the lack of trust there is no proper information flow from one end to other end
- Ineffective supply chain risk management: Ineffective supply chain risk management system does not able to predict risk and also does not able to react according to the situation.
- Lack of advance technologies: Traditional supply chain management does not have advance technology to deal with the problem that raised due to sudden changes happened because of the globalization.

The benefits that blockchain an IOT give to the supply chain are as follows [5]:

- Information continuity and traceability: The irrevocable and immutable properties of blockchain help to share the information among the stakeholders to make sure that the product and the information are traceable without any inherent risk.
- Information accessibility: The transparent nature of blockchain helps to access a huge amount of data generated along the supply chain
- Link between Information flow and material flow. IOT helps in connecting the link between information flow and material flow at different stages of supply chain network to improve the efficiency of supply chain network.

- Decrease in the code of conduct violation and fraud: The transparent and auditable features of blockchain helps in detecting fraud at every stage as well as reduces the code of conduct violation throughout the supply chain

II. BENEFITS OF IMPLEMENTATION OF BLOCKCHAIN BASED SUPPLY CHAIN IN DIFFERENT SECTORS

In this paper we will highlight the benefits of implementing the IoT integrated blockchain for four different industry such as Automotive, food industry, pharmaceutical, and retail industry.

A. IoT INTEGRATED BLOCKCHAIN BASED AUTOMOTIVE SUPPLY CHAIN

Blockchain based automotive supply chain can be implemented in two ways such as incoming logistic service to the plant and outgoing distribution service to the dealers and the importers[6].

- 1) **Incoming Logistic service:** Delivery of parts at right time and maintaining optimum amount of inventory are the main priorities of the manufacturing plant, which is possible if there is an effective coordination among third party logistics, transportation companies, and multiple tiers of the suppliers. This coordination process can be greatly improved by using the IoT integrated blockchain system. The system uses smart IoT sensors and various smart devices that can trace the location of the parts, quantity and other useful information in the real time. This improvement in the system lead to the number of benefits to the manufacturing plant such as a planned production schedule, improvement in material flow as well as information flow, and improvement in the tracking system of goods. At the same time the benefits to the supplier side includes reduction of faulty orders, reduction in warehousing cost, optimization of inventory level, and improvisation in inventory turns
- 2) **Outgoing Distribution service:** In the other side the distribution of outgoing vehicles to the dealers and importers at the right time is the main priority of the manufacturing plant with the effective coordination of multiple third party logistics and transportation companies. This can be effectively achieved by the use of IoT integrated blockchain system, which uses many IoT sensors and smart devices. The system can trace the location of the vehicles, other useful information in the real time. This improvement in the system lead to the number of benefits to the manufacturing plant such as improvement in just-in-time logistics, reduction in damaged vehicles and improvement in inventory controls. At the same time the benefits to the dealer and importer includes the lead time reduction in build to order vehicles and reduction in warehouse cost.

B. IoT INTEGRATED BLOCKCHAIN BASED PHARMACEUTICAL SUPPLY CHAIN

In the traditional pharmaceutical supply chain it is very difficult to track the incidence of drug counterfeit and quality of drugs because the whole system is not transparent. But with the help of IoT integrated blockchain system the product can be identified with global trade item number (GTIN), expiry date, and serial number, which is accessed by everyone connected to the supply chain network. In this system, the drugs is treated as an asset, which is digital in nature that allows the companies to track the digital assets starting from the manufacturer to the end customers [7]. The figure 2 shows how everyone in the network get connected to the blockchain to make the system more transparent.

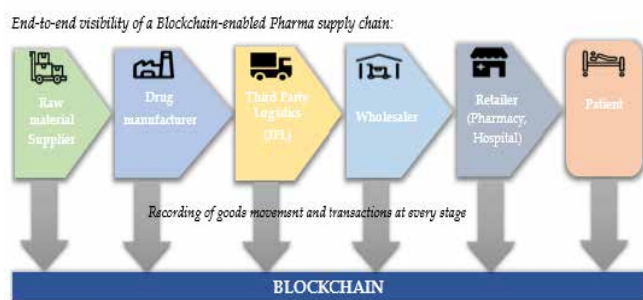


Figure 2. Blockchain based pharma supply chain system (Source: [http://yesinstitute.in/2018/04/a-blockchain-solution-to-the-counterfeit-drug-menace\[8\]](http://yesinstitute.in/2018/04/a-blockchain-solution-to-the-counterfeit-drug-menace[8]))

C. IoT INTEGRATED BLOCKCHAIN BASED FOOD SUPPLY CHAIN

The issue related to food safety and food borne illness are getting worse day by day because of non-available of a proper system for traceability of food. The primary cause of food borne illness is contamination, which is difficult to trace in the traditional food supply chain because the system is not transparent. But the IoT integrated blockchain system would be able to overcome the issue by providing a platform that is neutral in nature and at the same time removed the third party involved in the system. Most of the work done based on the consensus between two parties and they worked on set of rules. Figure 3 shows a typical food supply chain system.



Figure 3. Blockchain based Food supply chain system ([https://hackernoon.com/how-is-blockchain-disrupting-the-supply-chain-industry-f3a1c599daef\[9\]](https://hackernoon.com/how-is-blockchain-disrupting-the-supply-chain-industry-f3a1c599daef[9]))

The blockchain based systems brings a huge benefits to the members in the supply chain network. The food producers would be able to ensure that the quality of their supplies are not getting tampered in the supply chain and the fraud identification would be notified immediately to the retailer because the system is transparent. In the retailer side it would be easier for them to trace the damaged food product without checking the whole supplies. The consumer benefit would be that they will know what quality food they are consuming at the end [9].

D. IoT INTEGRATED BLOCKCHAIN BASED RETAIL SUPPLY CHAIN

In the traditional retail supply chain the consumers have the worries about the quality of the product they are getting and the source of the origin of the product they are buying. The most important point here is building the trust in the consumer, which is difficult to achieve since the system is not transparent. The blockchain based system would be able to remove these problem by building the consumer trust. In this system every product has a digital identification that stores all the information along the life cycle of the product from the point of origin to the end (retail store). Figure 4 shows the working principle of a blockchain based retail supply chain [10].

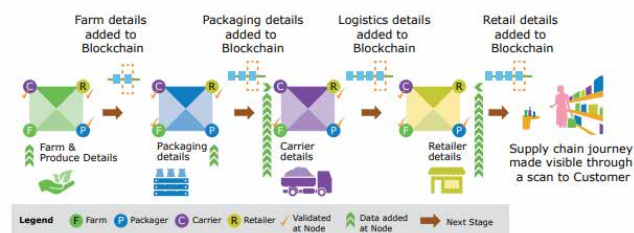


Figure 4. Blockchain based retail supply chain system ([https://www.tcs.com/content/dam/tcs/pdf/Industries/Retail-logistics/Abstract/Unblocking-retail-supply-chain-with-blockchain-1017-1.pdf\[10\]](https://www.tcs.com/content/dam/tcs/pdf/Industries/Retail-logistics/Abstract/Unblocking-retail-supply-chain-with-blockchain-1017-1.pdf[10]))

III. CASE STUDY

The traditional seafood supply chain system has various issues associated with it. The issues are as follow 1) The record keeping was done manually which is tedious and not done in a proper way. 2) The condition of the storage system is not maintained properly since the temperature and humidity are not recorded properly. 3) The fishing practices mostly done in an unregulated manner as well as in an illegal way. 4) Act of frauding by mislabeling the higher valued seafood items. The various issues associated with the traditional supply chain lead to various impacts on the consumers, distributors, and also to the economy are mentioned as follows

- The quality of the food are compromised that affect the health and safety.
- The security with respect to economy of seafood industry are in danger.
- The trust of the consumer and vendor are diminished because of fraud and mislabeling.
- Sustainability of resources are also hampered because of

improper practices. The blockchain based seafood supply chain system shown in the figure 5 would be able to overcome the issues mentioned earlier. The new system will provide transparency throughout the supply chain. It reduces the operating cost and save lot of time. It also increases the trust level among consumers as well as vendors as they know what they are buying

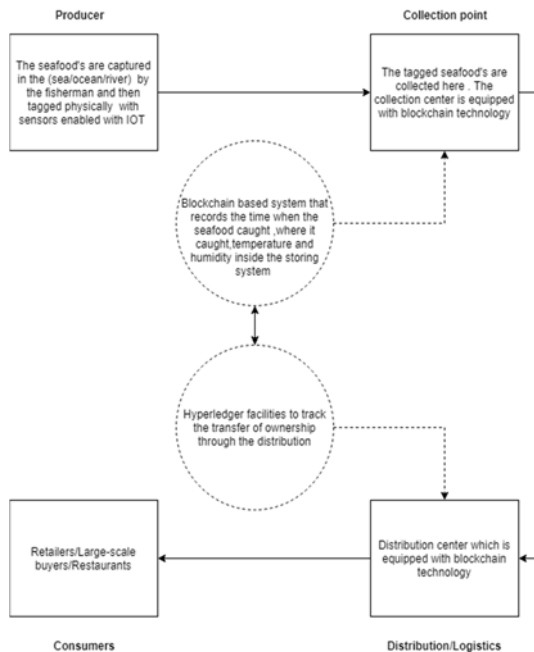


Figure 5. Blockchain based seafood supply chain system

IV. CONCLUSIONS

This paper highlights the difference between the conventional supply chain and IoT integrated blockchain based supply chain. This article pointed out the problems faced by the automotive industries, pharmaceutical industries, food industries, and retail industries by using the conventional supply chain as well as the solutions to the problems provide the blockchain based systems in those industries. It was observed that the IoT integrated blockchain based supply chain system able to remove the problem and make the system more efficient and trustworthy. Finally a case study has been proposed on seafood industry supply chain and the benefits of integrating block chain into the network. This paper will help the industry people to know the benefits of blockchain based supply chain system and try to implement in real life to get better result.

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