Applications and Deterrents of Blockchain Technology in Logistics Management

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Abstract

Logistics management is a very complex yet unavoidable part of any organization. The complex network of products, people and processes involved in logistics make traceability and verification of anything involved very difficult and very expensive. Till date, centralized approaches to logistics management are cost-ineffective and complex, while decentralized approaches have the problem of providing consistent and relevant data. However, the new blockchain technology has the potential to provide consistent and relevant data and it is cost-effective and yet, it avoids the complex central control structure. We provide an insight into the different applications of blockchain technology to logistics management. Currently, there is a considerable amount of research in this sphere with corporates all over the world investing in pilot projects or full-scale applications of blockchain technology to logistics. In our paper we examine such applications. In addition, we identify different deterrents of applying blockchain technology to logistics management based on our research.

Keywords: *Logistics, Blockchain, Information, Traceability, Deterrents*

Introduction

Logistics Management is a complex process which involves a lot of processes including materials, packaging, transportation, storage, security among others. In industry, flow of information/services/goods from origin to consumption is considered to be part of logistics management (Figure 1). The aim of logistics management is to maximize the quality of operations involved and to minimize time and cost.

Another definition of logistics is "Logistics is about getting the right product, to the right customer, in the right quantity, in the right condition, at the right place, at the right time, and at the right cost (the 7 Rs)" - John J. Coyle et al.

Logistics management is a nascent area in terms of automation in organization management. The reason is that it generally involves complex operations, lot of people and lot of processes at distributed locations which vary from organization to organization which is difficult to standardize. Though efforts have been made to optimize individual components in logistics in some organizations, a lot remains to be done.

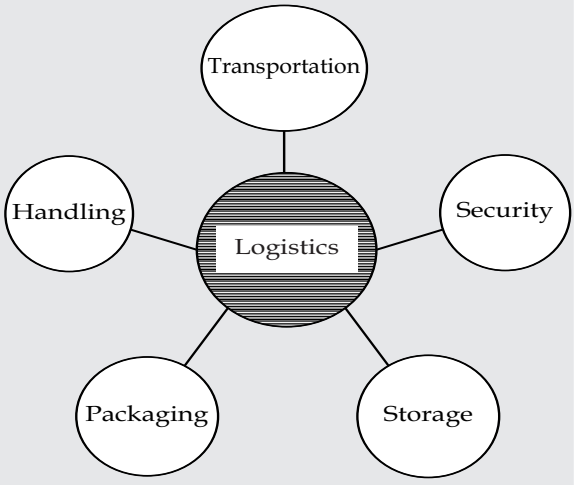

Fig. :1 Logistics Components

In Section 2, we discuss the problems with logistics management. Section 3 explains blockchain technology. In Section 4, we discuss various applications of blockchain technology to logistics management and its deterrents. Section 5 contains the conclusions and references are given in Section 6.

Issues in Logistics Management

Technology has been applied to logistics management over considerable period in time. Whether it is databases for storing transportation details, inventory, etc, RFID tags for tracking products, networks for transmitting data, software for generating reports and so on, technology has been at the forefront of logistics management. However, it is difficult to integrate the information from all the technologies to generate consistent and cohesive data without maximizing the expenses involved in a prohibitive manner.

We illustrate the problem using a simple example in logistics management. An organization is producing a brand of washing powder. The washing powder ingredients have to be brought from suppliers to the factory. The factory produces washing powder, packages and sends it to the distribution warehouse. The distribution warehouse sends the packets to the retailers who we assume to be the customers in this case (Figure 2).

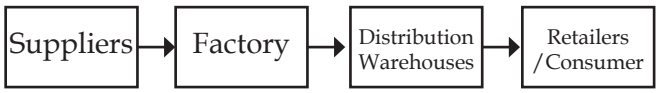

Figure 2: Example of Logistics in a Washing Powder Manufacturing Company

Let us see how technology is applied to the above at present to improve the logistics management. Databases and software systems are extensively used to store data and process data at various stages show in Figure 2. For example, there may be Material Management Software Systems, Transportation Management Software Systems and Regulatory Management Software Systems to process material handling, transportation handling and regulatory compliance processing. RFID tags and barcodes may be used to track materials and so on. However, as the different stages are likely to be in different geographic locations especially in today's era of globalization and ownership/handlers at different stages may vary to a large extent, hence it is difficult to create a single uniform repository for storing and tracking data which is fail-proof and not prohibitively expensive.

Different systems at different locations complicate logistics management and make it cumbersome. Payments and transfer of goods take a lot of time and manpower. Middlemen take advantage of the complicated system and get involved further complicating matters. A lot of other professionals are also involved including but not limited to lawyers, bankers, accountants and so on. What appears on paper to be a series of simple transactions in reality is a complex maze of payments, goods and services which is inevitably difficult to fathom and hence, control.

Digitization of logistics management systems had started a long while ago with the advent of RFID tracking, enterprise resource systems and supply-chain management systems among others. However, due to different geographic locations, different software systems, different ownerships of processes/people/organizations, etc, the IT-enabled systems are rarely integrated resulting in loss/redundancy of data. This in turn prevents smooth information flow and hence, error-free functioning in logistics.

We demonstrate how technology incorporation is yet to provide consistent coherent information with an example below. A manufacturer sends a stack of shipment to a shipment provider. The manufacturer and the shipment provider are two different organizations with their own IT systems. Both do not attempt to build a consistent and coherent IT system because it would be prohibitively expensive, the manufacturer may choose a different shipment provider for his next shipment and in addition, the shipment provider may have other customers besides the manufacturer.

Now the shipment provider receives some info from the manufacturer but keeps only that it considers relevant and tracks the products using its own system with information that it considers relevant which may be difficult to match with that of the manufacturer (Figure 3). Thus there are islands of useful information in logistics but they are rarely consistent and coherent with each other.

MId	Product	Lngth	Width
A1	Steering wheel	…	…
B3	Steering shaft	….	….
C1	Universal Joint	….	….
D2	Steering gearbox	….	……

Shipping ID	Item	Pkg Dimensions
S1	Steering Wheel components	10 x 20 x9

Blockchain technology has the potential to provide the coherence lacking in the digital infrastructure created for logistics management so far. It will provide every detail involved in the logistics of a product/service/information provided by an organization to its customers from the beginning till the end.

In the next section, we explain the basics of blockchain technology.

Basics Of Blockchain Technology

A blockchain is a distributed digital ledger which keeps records of transactions. Each transaction in the ledger is called a block. Copies of the ledger exist at multiple computers called nodes and are updated simultaneously. There is no central point of control. The distributed ledger can be modified/ updated only by simultaneous collaboration of the nodes involved. This prevents the possibility of falsifying records in the ledger.

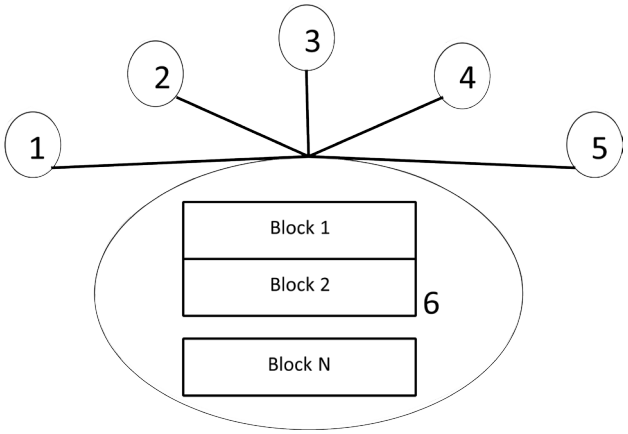

Figure 4: A Blockchain Ledger

We illustrate the working of blockchain technology with a simple example illustrated in Figure 4. Six computer nodes store the distributed blockchain ledger. A total of N blocks or transactions are stored in each block. The N blocks in each node are exact copies of each other. If any block is to be modified in any one node, say node 6, it cannot be done without the consent of all the remaining 5 nodes. If any block N+1 is to be added to block N in node 6, it cannot be done without the consent of remaining 5 nodes. If we consider a large network where a huge number of nodes are involved in the blockchain ledger, then modifying/changing anything requires consent of all nodes falsifying which is next to impossible.

In logistics, blockchain satisfies the need for a distributed model. From a manufacturer to a shipment provider, all can use the same blockchain with a copy at their respective nodes. The information (whether it is of inventory, warehousing conditions, delivery times and dates, and so on) is stored in the same format with all entities involved in the logistics ecosystem and information cannot be falsified without each and every entity's approval which is next to impossible. Thus blockchain satisfies the need for reliability and integrity in logistics management.

Applications of Blockchain Technology to Logistics Management

Blockchain has increasingly been applied to logistics management by different organizations via startups and pilot programs. We have given examples of some below.

Global retailer Walmart uses blockchain to track sales of pork meat in China. Its system lets the company see where each piece of meat comes from, its processing and storage, and sell-by date. In the event of product recall, the company can also see which batches are concerned and who bought them. Food and pharmaceutical products often need special storage. Sensors on such products can record temperature, humidity, vibration, among others. These readings can then be stored on blockchain. They are permanent and tamperproof. If a storage condition deviates from what has been agreed, each member of the blockchain will see it. A smart contract can trigger an action to correct the situation. Depending on the size of the deviation, this action may be to simply adjust the storage. However, it could also extend to changing "use-by" dates, declaring products unfit, or applying penalties. [1]

Provenance, a U.K. software startup, looks to use blockchain technology to establish the authenticity of food. Provenance is testing the technology to authenticate tuna caught in Indonesia delivered to Japanese restaurants. Provenance takes information from sensors or RFID tags and records it on the blockchain to track the fish from "hook to fork." IBM is also interested in food traceability, and has announced a consortium with several major food producers and retailers.[2]

At the Watson IoT Center, Capgemini and IBM have developed a prototype for Smart Container Management based on Blockchain technology. Based on the use case, every container is equipped with sensors which transmit all quality related data (e.g. temperature, pressure, vibrations) to an integrated IoT-Platform. The collected data is visible in real-time to all affected members of the Supply Chain through this platform which guarantees data availability and manipulation security. The monitoring of real-time quality data enables companies to minimize their response time to events. If a quality affecting temperature decrease below a given threshold is noticed during transport, a shipment of replacement products can be triggered in real-time. Furthermore, the destination can be aligned or additional quality checks can be assigned. It is imaginable to automate this processes with Smart Contracts. A change in temperature which poses a breach of contract can trigger automated processes like an insurance proposal, a contractual penalty for the forwarder and a reorder at the supplier. At every point in time, the product's history and its place of origin are uniquely identifiable, and additional information (e.g. on compliance with the required cool chain of goods) can be secured. In this concept it is imaginable that reactive processes are automated by Smart Contracts. If there is a negative effect on the goods, posing a breach of contract, processes like an insurance proposal or a contractual penalty for the forwarder can be triggered automatically.[7]

Blockchain can also be used for transport traceability and organization in logistics. The practical setup is as follows. RFID tags for cartons or pallets store information on delivery location and date. Logistics partners run applications to look for these tags and bid for delivery contract. The partner offering optimal price and service gets the business. A smart contract then tracks status and final delivery performance.[1]

In one projected pilot by a company called T-Mining, the blockchain will give clearance for personnel – like a truck driver – to pick up a load. One of the key advantages of blockchain is that it is much, much more secure than traditional IT solutions. A relatively recent trend in logistics is fictitious pickups. These occur when con artists show up at a shipper's dock, provide fabricated insurance documents, DOT numbers for trucks, and pickup documentation. It is argued that blockchain could help prevent these kinds of thefts. On organization called Kouvala Innovation has an even more audacious vision. Pallets with RFID tags would communicate their need to get from point A to point B by a certain date. Carrier "mining" applications would bid for the right to move that load. The RFID tag would award the business to the carrier that bests meets a shipper's price and service needs. Then as the move progresses, the blockchain would continue to track the shipment.[2]

In logistics, the best known blockchain pilot program involved Maersk and IBM. It centered on creating a digital distributed ledger to create a single electronic place where all the myriad documents related to a shipment could be housed.[2]

Blockchain can also improve the smoothness of logistics operations by reducing middlemen involvement like those of bankers. Blockchain allows the transfer of funds anywhere in the world. Traditional banking methods are not needed. Transfer is direct between payer and payee. It is also secure and rapid – in minutes, compared to days for automated clearing house payments, Australian vehicle manufacturer Tomcar uses bitcoin to pay suppliers. Currently, three partners in Israel and Taiwan accept this. Tomcar's supplier agreements use standard terms. The Transactive Grid is an application running on blockchain to monitor and redistribute energy in a neighbourhood microgrid. The program automates the buying and selling of green energy to save costs and pollution. The technology for running the program is the Ethereum platform, designed for building smart contracts of any kind.[1]

Organizations have made huge investments in digital infrastructure and yet, they have limited control and visibility over their overall logistics. Blockchain looks to be a promising solution to this problem. However, there are still challenges to be met.

While blockchain technology is reliable, it is not tamper proof. There have been instances when cryptocurrencies based on blockchain technology were hacked and stolen. Hence, it is important to use and implement blockchain technology in way that there is minimum information theft and mismanagement in the system.

In addition, blockchain technology requires a set of complex technological and business skills which needed skilled personnel. Recruiting and training personnel with such skills is an important issue in implementing blockchains. Last but not the least the mindset of organizations partners and employees have to be changed so that they can accept a distributed control system. This is the most difficult part of all. Human nature is prefers centralized control and to switch over to distributed control requires a considerable change in mindset which organizations need to overcome.

Conclusions

The findings above are just the tip of an iceberg. Profitability of organizations depend a lot on logistics management. It has proved to be a complicated and expensive process in spite of in corporation of technology in the same. Blockchain provides a solution which provides the possibility of transparency, integrity and cohesiveness without prohibitively increasing expenses. A lot more organizations will further implement blockchain in their logisitics management in the near future. They need to be studied in more detail to understand the impact of blockchain in logistics and its deterrents.

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