DOI: 10.48137/23116412_2022_3_87
УДК: 338.47

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APPLICATION AND POTENTIAL IMPACT OF BLOCKCHAIN TECHNOLOGY IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

Annotation

The article provides an overview of the practice of application and potential impact of blockchain technology in the field of logistics and supply chain management. The authors analyzed a number of sources to assess the current state and role of blockchain technology in this area. Possible use cases are considered, including pilot projects of organizations from all over the world. Proposals have been developed for further implementation of the technology in the transport logistics system.

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Keywords: blockchain technology, logistics, supply chain management, innovation, digitalization.

Introduction

Logistics and supply chains have evolved with the passage of time. There have been developments and advancements as per the modern needs and requirements of the time. But at the same time, this evolution and advancement also resulted in increased complexity along with a growing number of intermediaries. This is also affecting companies involved in these sectors and resolving these complexities is proving to be a challenge for such companies in the coming time because of the enormous involvement of human intermediaries in this area. These intermediaries play several important roles such as when it comes to serving as enablers in the network as well as organizing and coordinating different processes and tasks to be performed within the network of participants [1, 2]. There are several kinds of intermediaries. For example, the chatter of cargo ships, port managers, customs officers as well as a provider of logistic services and etc. They are all important intermediaries with important roles in current logistics and supply chain infrastructure. But at the same time, they are also the reason for high costs and sometimes cause failures as well. Since blockchain has disrupted several sectors around the globe, the same way it has great potential to transform the logistic and supply chain sectors. The technology does not only promise to minimize and in some cases eliminate the role of human intermediaries but it will also change the processes such as there would be no requirement of piles of paperwork in the process of cross-border trades and shipments. As a result, this will also eliminate the role of another intermediary which is customs officers [3].

Methodology

The main target of the paper is to find out the true potential of blockchain technology for the logistics and supply chain sector. Does blockchain technology have the capability to disrupt, evolve and transform the logistics and supply chain sector? If yes, what are the possibilities, and what are the current use cases around the globe. For this purpose, the paper analyzes different use cases and pilot projects being implemented around the world in the logistics and supply chain sectors along with how blockchain can resolve some of the major issues in logistics and supply chains such as the issue of traceability, trust, the immutability of the data, real-time information sharing, food safety, counterfeiting, child labor, labor rights, and etc.

Results
Building Transparent Supply Chain

Blockchain is the digital system for record-keeping which was developed for the record-keeping of cryptocurrency networks. But by the time, it has been well established that supply chain management is another area where this emerging technology of blockchain has amongst the most promising applications to offer along with its great potential to help and resolve several issues and challenges being faced by supply chain partners. A complete, tamperproof, and transparent record-keeping ledger can be created which would be immutable and capable to store the track record of the inventory flows along with information flows and financial flows in transactions.

There are many corporations in the United States, which are involved in exploring and adopting the blockchain at its initial phase in order to find out how this technology could help them in their supply chain area and whether it has the potential to improve their supply chain operations or not. Among them, seven large corporations were selected and studied to collect information. These companies include IBM, Emerson, Hayward, Mastercard, Corning, and two other companies which preferred to remain anonymous. These companies are not limited to any one industry. In fact, they belong to different industries including technology, retailing, financial services, and manufacturing.

As per the progress and outcomes which have been achieved by these corporations as a result of their early initiatives in the implementation of this technology, it is obvious that blockchain has the capability to enable more cost-efficient and quicker delivery of products along with creating better traceability across the supply chain by making products more traceable. Not only this, but it is also helpful in streamlining the process of financing along with enhancing coordination and collaboration among partners, buyers as well as banks [4].

Blockchain Advantages

Since the year 1990s, the use of enterprise resource planning (ERP) has contributed to significant progress in the development of information sharing in the supply chain area. The companies leading in this include Procter & Gamble and Walmart. Regardless of this progress and development, one challenge is still being faced by large supply chains of companies that are involved in complex transactions. This challenge is how they can make their supply chains more visible.

If we look into present ERP systems being used by companies in the supply chain area along with financial-ledger entries of the current

world, we find that they still have some limitations to them which could be resolved with the help of blockchain. If we take the example of a scenario where retailer, supplier, and bank are involved in a simple transaction. The retailer is dependent on a supplier to source a product from it whereas a supplier is dependent on the bank in order to get working capital from it which is required to fill the order of the retailer. So if the retailer sources a product from a supplier and the supplier gets the working capital from the bank to fill the order of the retailer, this simple transaction includes three flows which are inventory flows, financial flows and information flows. Now, this is to be noted here that given flow does not result in financial-ledger entries at all three parties involved. At the same time even current ERP systems, inspections, and manual audits are also not able to solve the challenge of connecting these three flows in a reliable and trustworthy manner. As a result, this becomes difficult for corporations to improve their decision-making, eliminate their execution errors, and resolution of conflicts related to their supply chain.

In today's world, supply chains are yet to overcome the challenge related to real-time detection of execution errors. These execution errors include missing of shipments, payment duplication, and data entry mistakes and the realization of these mistakes in real-time is still difficult to identify in most cases. This especially proves to be true when it comes to those companies which have complex supply chains and are involved in thousands of transactions each day across their large network of supply chain products and partners. A usual problem which is faced especially by food companies is when the shelf life of their products reaches the end in a retail store. A study which has been conducted with a major manufacturer of packaged foods shows that even though it is possible to get the information that would reveal the number of expired items in the store, with the help of inspection or audit of the inventory. But it would rather be limited and would not be sufficient to address the root causes of this issue of expiration [4].

There is another approach of inventory marking that has the potential to strengthen the supply chain operations of organizations. In this approach, RFID tags (Radio Frequency Identification) or electronic product codes that comply with GSI standards (globally accepted rules for handling supply chain data) could be utilized for the marking of the inventory. But this approach also has some difficulties when it comes to the integration part of ERP systems. The experience of the companies included in this study shows that when it comes to the integration of ERP systems, the process proves to be quite expensive along with time-consuming. Throughout the life of large organizations, they go through multiple mergers and acquisitions along with organizational changes and as a result, they could end up having even more than 100 ERP systems to be integrated with each other. Usually,

such systems are so different to each other that even the way data fields are defined in these systems may differ to each other. There is also a possibility that such systems are not even capable to communicate easily with each other. We take the example of a large company included in this study which had 17 ledgers in different ERP systems associated with a single activity – trucking – and on top of that, the distributors and suppliers of this company had their own ledgers and ERP systems.

But with the help of blockchain, the complexity of such processes could be eliminated. When blockchain is used for the process of record-keeping, unique identifiers are assigned to assets. These include units of inventory, loans, orders, and bills of lading. In this process, unique identifiers serve the role of digital tokens (similar to bitcoins). Blockchain does not only enable the details capturing of those transactions which are not recorded in the system of the financial ledger, but it also contains such chronological string of blocks which makes it capable to integrate all three types of flows in the transaction. This is one of the many reasons why blockchain has such importance and value in the supply chain. This does not end here, in fact, each block in the blockchain is encrypted and the distribution of these encrypted blocks to each participant allows them to preserve their own copies of the blockchain. It is because of these special characteristics of blockchain which make it capable to provide a complete, immutable, trustworthy, and reliable audit trail of all activities included in these three categories in the supply chain.

Blockchain also provides the opportunity for banks to utilize its potential in order to improve their supply chain financing. Usually, when it comes to lending decisions, there is a series of procedures and processes to be performed by banks that are not only tedious but also vulnerable to errors. These processes include financial reviews as well as physical audits. But with the help of blockchain, transactions between suppliers and retailers can easily be verified by banks without having to perform such processes as they can confirm these transactions by only reviewing them on the blockchain.

Another big plus of blockchain is its capability of automating many of these functions with the help of smart contracts. Smart contracts can execute transactions automatically without any involvement of manual efforts. They are based on lines of computer code that are designed to obtain data from blockchain in which conditions and prerequisites are already defined along with functions to be performed in both scenarios of either fulfilling or failing to fulfill conditions and prerequisites. They are well capable to verify whether contractual obligations are fulfilled or not. If yes, they can automatically issue the payments. And if not, payments can be refused. Smart contracts are programmed to be capable of assessing the status of transaction and on basis of this assessment, they can take predefined actions automatically

such as the reading of ledger entries, releasing of payments, and identifying irregularities needing manual intervention [5].

Applications

There are several needs and requirements of the current time in the supply chain area which existing technologies are unable to address. In this segment, we are going to analyze how various applications of blockchain are being utilized by companies included in our study in order to meet these requirements.

Enhancing Traceability

One of the requirements which current technologies are unable to tackle is traceability across supply chains. In 2013, the Drug Supply Chain Security Act was introduced in the U.S. The purpose of this act is to safeguard consumers of prescription drugs from stolen, harmful, or counterfeit products. As a result, companies are required to enhance traceability so that they are able to monitor and identify such products in their supply chains and then be able to trace them before they reach to customers. As the act mandates compliance, one of the large pharmaceutical companies, which is included in this study, has already started a collaboration with its supply chain partners for the utilization and implementation of blockchain in their processes for the same purpose.

In this process, all the products of the inventory which are drugs are assigned and tagged with electronic codes. As a result, it enhances traceability in the supply chain because this process enables the company to preserve the record on the blockchain-related to each product flow of inventory by scanning the tags assigned to each product along with their movement from one firm to another. This way, it generates a complete track record and history of all products across the entire supply chain from their source to consumer. With the early success of this project in the U.S., the company was encouraged for broad implementation of such pilots and as a result, it initiated further similar projects in Europe and other locations. On the other hand, IBM is another leading organization in this field. It is working in a similar direction and progressing towards the transformation of a safer and reliable supply chain for food products. They are already in partnership with Walmart to implement and utilize blockchain in order to trace and track fresh food products which we have already discussed above in detail.

When it comes to such implementation and utilization of blockchain

technology, it has very clear and obvious advantages. One of the obvious advantages is that it makes it possible for companies to efficiently recall the faulty product in case of any complaint before it's too late. It also enables the company to identify all suppliers along with production and shipment batches of the faulty product. Further, it enables participating firms to automatically monitor the quality of products along with keeping the complete record of temperatures in which products are stored during their flows from one place to another. It is especially useful in the case of perishable food or drug products that are required to be fresh [6]

Reduced Disruptions along with Enhance Efficiency and Increased Speed

Emerson, included in our study, is a multinational firm and is involved in engineering as well as manufacturing activities. As a multinational firm, Emerson deals in thousands of product components with several customers, suppliers, and different locations around the globe. This includes Emerson in the list of firms having complex supply chains.

Emerson President Michael Train said, "When a firm has such a complex supply chain, it usually faces several challenges. These problems are not only limited to the lack of visibility of goods throughout the supply chain, but also include long and unpredictable delivery times of components. And these problems can arise even from the slightest disruption or delay in any part of the supply chain, which will lead to excess inventory and disruptions in other parts."

One approach which could help to tackle and overcome such situations is to form a consensus among such companies so that they agree to share their production and inventory-allocation data on a centralized platform. But this approach would require a huge amount of effort and time, especially when it comes to the process of integration for all such companies. Additionally, they would have to trust other companies with their data which most of the companies usually feel reluctant to do so. Also, such companies will have to agree on centralized decisions regardless of considering the fact the decision is made by their partners or competitors. Such obvious complications in this approach make it unrealistic to be implemented. Considering all these complications of integration, implementation, data sharing and trust deficit, a more realistic and practical approach for participating firms will be to utilize blockchain for sharing required data related to their inventory flows. This will not only allow all companies to utilize complete and accurate information available on a common blockchain database, but they would also be free to make their own decisions. Additionally, when it comes to production man-

agement as well as order placement among participants, utilization of Kanban system would be possible for participating firms to perform such tasks. As a result, all participating firms will enjoy enhanced visibility and access to data related to inventory flows across supply chains. Hence, resolving the problem of unexpected lead times, making them more predictable.

There are many more companies who also believe in the potential of this technology. One of these companies is Hayward, which is a multinational firm and manufactures equipment for swimming pools. Another entity that has already begun the implementation process of blockchain in its supply chain processes is Walmart Canada. In this phase, trucking companies that are responsible for supply chain operations including transport of its inventory are utilizing shared blockchain with Walmart.

Improvement in Contracting, Financing and International Transactions

Companies implementing and utilizing blockchain as a reliable database to share their data and information related to their inventory along with financial transactions and flows among participating firms, do not only gain significant benefits in the area of contracting and supply chain financing, in fact, this approach even enables them to address and resolve a lot of challenges when it comes to conducting their business activities internationally.

When it comes to financing activities, banks usually are faced with a very common problem in their procedures related to the processing of trade credit and working capital to applicant parties. The problem is caused because of the possible inaccuracy in the available or provided information to the bank related to the business of the applicant firm, quality of assets, and incorrect representation of the firm's liabilities. The possibility of a firm requesting a loan from a bank, showing one purpose but then using it for a totally different purpose cannot be neglected. Another possibility is that the firm trying to borrow capital from several banks at the same time against one same asset. Such risks need to be managed and to avoid such scenarios and situations, banks are compelled to take risk management measures in order to control their risks. But such processes often do not only result in slowing down the access to capital, but also a significant increase in the costs of transactions along with reducing the availability of capital to smaller firms. These challenges, if not addressed with suitable measures and solutions, prove to be damaging not only for banks but also for firms that are in need of cheap working capital. Blockchain also has the potential to address such problems and improve

Blockchain Enabling Tracing of Counterfeit Source

Cross-border trade is another area that involves a great deal of manual interventions and efforts in its processes. Not only that, but it also includes physical documentation of goods being traded from one country to another country along with multiple checks, inspections, and verifications of these goods and their documentation at each entry and exit port of countries involved in the route of goods being traded. Additionally, the processing of transactions is not only slow and inefficient but also proves to be much costly. Low to no visibility of the shipment's current status and location is another problem faced when it comes to international trades.

Companies that are included in the study are involved in both types of services such as retailing and financial services. All of these companies have already started the implementation of blockchain technology in all three areas of financing, contracting, and cross-border trades. When it comes to reconciling the process of invoicing, payments and purchase orders, participating firms find it quite comfortable and easy to perform these tasks. Additionally, blockchain also provides them the capability of tracking the status of transactions in process with their counterparties. All of this is possible because of the connecting and sharing characteristic of blockchain which does not only enable participating firms to create connectivity among financial flows, inventory and information but also sharing these details with each and every participant involved in these transactions. Being a participant of transaction, banks have access to the blockchain. This enables banks to provide working capital to suppliers (without any delay or lengthy procedures of verification) as soon as the orders are received. The same applies when it comes to obtaining the payments. As soon as suppliers deliver the ordered goods to buyers, banks are able to obtain their payments immediately. Additionally, automation of reconciliation processes along with audit trail availability also provides the possibility of utilizing such smart applications which are based on blockchain data. This way, it helps a great deal to completely eliminate the possibility of conflicts between any bank and the borrowing party [7].

Utilization of Blockchain in Logistics Operations

MOSOLF is another company in the automotive industry that is utilizing the potential of blockchain technology in collaboration with Etecture GmbH and Lawa Solutions GmbH. This is the first blockchain from MOSOLF and the developed blockchain solution enables MOSOLF to digitally create waybills and other documents such as consignment notes. When it

comes to validation of these digital consignment notes and other digitally created documents in this blockchain solution, smart contracts are utilized for this purpose hence proving to be forgery-proof because of the underlying technology distributed ledger [8].

Such utilization of blockchain technology in the application developed by MOSOLF, makes it forgery-proof and ensures the security for the processes of logistics operations and documents with the help of underlying smart contracts being utilized for the validation purpose. The purpose behind developing a blockchain-based solution to be utilized in logistics operations is to improve the logistics value-added chain of automobile by making the processes more efficient and at the same time improving their security. For this purpose, the utilization of digitalized consignment note is necessary. There are many stages of logistics operations and processes that are covered by this such as loading of the goods, their transportation as well as the handover process. This is the document that generates a fingerprint (hash value) and then this fingerprint is transferred to blockchain. Then it comes to the blockchain network which utilizes smart contracts for the purpose of checking and verification of the transaction by ensuring its uniqueness. Additionally, it also links freight document and vehicle with each other. Once the process is completed, blockchain records the transaction as valid along with its GPS coordinates as well as timestamp. Participants who are authorized to access the blockchain can utilize a web service in order to check and verify the authenticity of the identification number related to any vehicle (VIN) as well as the document of any freight [9].

Conclusion

There is no denying the fact that supply chains in today's era are prone to many risks and vulnerabilities. They need significant improvements especially when it comes to areas such as coordination, end-to-end traceability of products, financing, and speed of product delivery. In this paper, we analyzed use cases and pilot projects of blockchain technology being implemented by companies in logistics and supply chain sectors. The purpose of this research was to find out the capability and true potential of blockchain technology to transform the logistics and supply chain sector and also the current status of this technology around the globe [10]. As per the experience of companies and their use cases included in this paper, it has been established that blockchain is the technology that can play a vital role in addressing these risks and vulnerabilities and can help companies to address and overcome the shortcomings in their logistics and supply chain areas. But as the technology is

new and is still considered to be in its early stages of adoption, there is a need to assess and realize its true potential especially for those on the sidelines. As more and more businesses are going to be involved in the adoption of this technology, it would enable further exploration of the unrealized potentials of blockchain.

But at the same time, this is also to be noted that implementation of solutions based on blockchain technology requires a serious amount of time, effort, technological and human resources as well as investment. This is one of the reasons why most small companies with limited budgets and resources are usually reluctant to be involved in blockchain technology. But once the organizations successfully complete the implementation and testing phase, the advantages and benefits of this technology are huge and also for the long term.

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Ключевые слова: технология блокчейн, логистика, управление цепями поставок, инновации, цифровизация.

ПРИМЕНЕНИЕ И ПОТЕНЦИАЛЬНОЕ ВЛИЯНИЕ ТЕХНОЛОГИИ БЛОКЧЕЙН В ОБЛАСТИ ЛОГИСТИКИ И УПРАВЛЕНИЯ ЦЕПЯМИ ПОСТАВОК

Аннотация

В статье представлен обзор практики применения и потенциального воздействия технологии блокчейн в области логистики и управления цепями поставок. Авторами проанализирован ряд источников для оценки текущего состояния и роли технологии блокчейн в данной сфере. Рассмотрены возможные варианты использования, в том числе пилотные проекты организаций со всего мира. Выработаны предложения по дальнейшему внедрению технологии в систему транспортной логистики.

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