

Infusing Blockchain in Supply Chain Operations of a Public Distribution System

Sini V. Pillai*, Vipin H.**, Anand Mohan***, Shruthi Dileep A.****

*Assistant Professor, CET School of Management, Trivandrum, Kerala, India.
Email: sini.mba@cet.ac.in

**MBA Student, CET School of Management, Trivandrum, Kerala, India.
Email: vipinharikumar15@gmail.com

***MBA Student, CET School of Management, Trivandrum, Kerala, India.
Email: anandanugrah6@gmail.com

****MBA Student, CET School of Management, Trivandrum, Kerala, India.
Email: ashruthidileep@gmail.com

ABSTRACT

The supply chain operations need to be designed to minimize both human and economic losses to assure their effectiveness during a crisis situation. Various mathematical models using optimization techniques and algorithms have been developed to address the problems of supply chains post various disaster phases. Models and techniques developed to overcome various disasters motivate the need to overlook the literature and carry out a systematic review of technological applications supporting the effectual supply chain management. Various technology platforms are evolving which can provide efficient, secure and transparent supply chain operations. The research paper focuses on examining the role of blockchain technology in improving supply chain requirements, improving transparency and visibility among the members of the supply chain for developing holistic and inclusive solutions in a public distribution system (PDS). The theme is to highlight the difference between the conventional supply chain and blockchain technology infused supply chain operations facilitating smooth and transparent transactions in the PDS.

Keywords: Supply Chain, E-Supply Chain Management, Industry 4.0, Blockchain, Public Distribution System (PDS)

INTRODUCTION

Supply chain management (SCM), a key strategic undertaking for organizations, relies upon the sources and abilities of the providers, vendors and enterprise tactics. Supply chain controls have appeared as a vital detail of a hit electronic – business implementation (Croom, 2005). Internet and facts technology permit green inter-organizational facts flows, facilitating SCM. Many studies reported that the inefficiencies in the supply chain can be addressed by transforming the supply chain into a digital supply chain using technology. Developments in technology permit the digital integration of the whole supply chain, facilitating the coordination among special events in a supply chain. The consciousness of this integration within side the context of the web is known as electronic – supply chain management (E-SCM). Improved patron service and expanded pace of performance are principal advantages in the adoption of E-business technology in the supply chain (Wagner et al., 2003). Gime and Lourenco

(2008) outline E-SCM as “The effect that the net has on the combination of key enterprise tactics from end-person through authentic providers that offer products, offerings and facts that add price for clients and different stakeholders.” E-SCM can enhance supply chain operations with the aid of permitting persuasive communication among the groups in the supply chain, lowering the trouble of fact overloading. There are numerous possibilities for blockchain technology where the humanitarian sector is considered to be an emerging one were monitoring the disaster relief fund, materials and information could be made transparent and traceable (Dubey et al., 2020).

Covid 19 brought out the crests and troughs of the existing supply chain. Although it was stable and adequate for normal operations, there were issues in it which were blanketed. Operations and SCM during Covid 19 pandemic is identified to have six perspectives which include adaptation for supply and demand optimization, digitalization in emerging technologies such as artificial intelligence, preparedness with emergency planning,

recovery, ripple effect for controlling the disruption propagations and finally sustainability (Queiroz et al., 2020). When appropriate technology is integrated into the supply chain, it gets transformed into a digital supply chain and works more like an intelligent brain. It facilitates easy real-time monitoring and tracking of where things are, where they came from and to whom it needs to be supplied. Supply of fake products is an issue when demand does not match the supply in the supply chain. This mandates real-time tracking of the movement of materials along a supply chain to ensure that the products supplied are genuine. Both supply chain and blockchain have significant impact on performance through transparency overcoming pressure related to the sharing of knowledge and pressure from trading partners (Wamba et al., 2020). Blockchain technology and Internet of Things build a transparent and traceable relationship between the consumers, improve efficiency, reduce product losses, risk and cost associated with food recalls and fraudulence. Moreover, tracking of consumer engagement can be improved using tracking methods and supply chain analytics (Bumblauskas et al., 2020). The gap which existed between supply chain and blockchain can be reduced by integrating the unified theory of acceptance and use of technology converging the blockchain technology, supply chain network theory and technology acceptance models (Queiroz et al., 2019). The public distribution system (PDS), introduced in India about 70-80 year back handled by central as well as the state government, is a system that handles the distribution of food grains to the public at affordable prices. The Central Government handles the procurement of the food grains, storage and its distribution to the respective states,

and the respective state government handles collection and distribution of the supplies to the fair price shops identified as the PDS outlets. The smooth functioning of the whole system would make sure that the supplies reach the underprivileged but the dearth of accountability down the entire supply chain is a major problem of the PDS, leaving the leakages that arise at unique points completely unaccounted (Dutta & Ramaswami, 2001).

The time period Industry 4.0 stands for the fourth business revolution that defines as a brand new stage of the corporation and consumer requirements (Mosconi, 2015). The length of the fourth business revolution can be marked through the whole automation and digitization processes. The vital goal of Industry 4.0 is a pleasurable consumer wish, which impacts areas such as order management, research and improvement, production commissioning, delivery up to the utilization and recycling of products (Rubmann et al., 2015). Fig. 1 shows the features and technologies applicable to the system of choice-making-Cloud Computing, Blockchain, Artificial Intelligence, Internet of Things (IoT), Big Data and Radio Frequency Identification (RFID) connections. When processing a product, equipment for machining or testing should be grouped and worked together for distributed choice making (Rossit et al., 2018). The features of Industry 4.0 are the extended competitiveness via clever equipment, using facts approximately locations, demographic changes, resources, active performance and concrete production. One advantageous component of Industry 4.0 is the cost introduction consequences from profits in return and new commercial enterprise models (Kane et al., 2015).

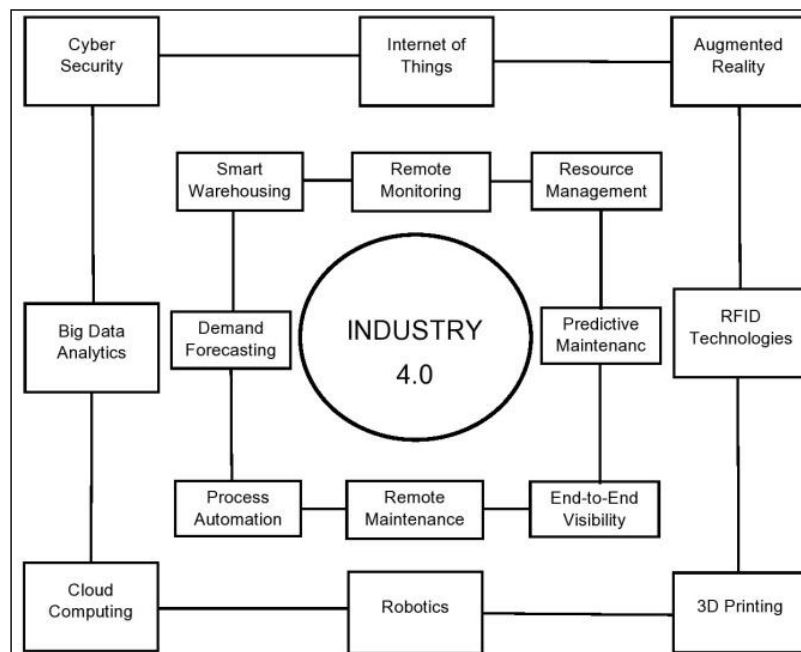


Fig. 1: Features of Industry 4.0

With the revolution of 4th industrial birth, the entire business system in the world-haunted supply chain sustainability. The industries and business models are in progressive change due to the innovations. The need to have clear-cut transparency in understanding the current availabilities of new technologies and concepts introduced in the industry became the strategic objective. The PDS has processes similar to that of the SCM connecting the suppliers with the end-users. By implementing an effective SCM into PDS at each level of operations such as sourcing of the food grains, delivery of the food grain to various destinations accordingly and even identifying and returning the defective items will make the operations more efficient with minimal faults. Even though the government has introduced various technologies to ensure safety and security, the flow of the food grains is more concentrated on urban people. A much more secured data is ensured through SCM platforms which make sure that the data is free from cyber intrusion and hacks. Industry 4.0 will drive operational efficiencies via Smart Factories and Smart Supply Chains as well as develop possibilities via innovation and solutions to boom client value. Heart of Industry 4.0 strategy is blockchain that represents a generation functionality platform that doubtlessly helps all enterprise applications.

BLOCKCHAIN TECHNOLOGY

Blockchain technology involves the peer-to-peer transfer of digital assets without intermediaries with a public ledger, which is shared and agreed upon by all the users in a distributed network (Dinh & Thai, 2018). Each block consists of data related to the transaction along with hash values and time stamp and is connected to the previous block creating a chain. Blockchain is an allotted database infusion that keeps a constantly developing listing of facts information which might be shown through the nodes taking part in it. Every transaction ever finished in blockchain is shared to all nodes and this characteristic makes the technology far more advanced than centralized operations involving multiple intermediaries. In addition, the nodes in blockchain are all anonymous, which makes it more stable for the different nodes to verify transactions (Dinh & Thai, 2018). Bitcoin became the primary utility that added blockchain generation (Huomo et al., 2016). Blockchain technology differs from maximum present statistics structures designs through three key characteristics; non-localization, security, auditability (Steiner & Baker, 2015). Waves of revived digital applications from blockchain to artificial intelligence present innovative and often cluttered business functions. Data analytics on blockchain can extract huge business

values and it can also overcome various challenges faced by blockchain systems (Zheng et al., 2020). A critical capacity of blockchain in supply chain is the disintermediation of monetary intermediaries, consisting of fee networks, inventory exchanges, and cash switch services (Tapscott & Tapscott, 2017). Application of blockchain in the food supply chain is of high importance which enables to store data relating to each product (Kshetri, 2019). One such implication was put forth by IBM with a registration fee for the food supplier that took part in the platform. The future innovation in this platform ensured to create a code which enables the customers to know the complete details about the product right from to origin of the raw materials until it reaches the final customer. There is no chance of attacks that could happen in this platform by the application feature of key encryption in blockchains (Kshetri & Voas, 2018). Blockchain technology can be beneficial in dealing supply chains effectively using distributed ledger technology. Applying such application in the food supply chain industry would assist in predicting and resolving problems in case of a crisis (Kshetri, 2019). Corruption can take place in the food supply schemes as it sometimes does not reach some sectors of society. Distributed ledgers use independent computers known as nodes to record, share and synchronize transactions in their respective electronic ledgers. Entire supply chain beginning from procurement until disbursement may be a part of blockchain and the user can view and verify the transactions at any part of the PDS. A blockchain verification protocol is also implemented on a single centralized ledger to prevent attacks and accidental bugs that can alter and pay ways to access the PDS (Seoyoung & Atulya, 2018).

BLOCKCHAIN APPLICATIONS IN SUPPLY CHAIN MANAGEMENT

Supply chain encompasses the end-to-end waft, inclusive of the physical and correlated flow of raw material, products, information, and money performing a completely unique and vital function in groups, and determines the overall performance of groups. Supply chain manages the sourcing, procurement, manufacturing, distribution, logistics and influences speed-to-market, the value of a product (Kehoe et al., 2017). Evolving purchaser necessities, demanding situations from competition and the adoption of latest commercial enterprise models together with e-commerce make the present-day supply chain an exceptionally complicated system. In the previous few years, traceability has become important for supply chains to address, mainly in regard to customer support and making plans and forecasting in commercial enterprise operations (Chang et al., 2019).

The transparency and traceability feature of blockchain finds application in food supply chain operations (Pal & Kant, 2019). Blockchain captures and records the shipment data from supplier to the manufacturer and from manufacturer to the customer as blocks with respect to the sequence of operations from the supplier to the customer. Whenever items and associated documentation pass from one node within the supply chain to another, objects are faced to counterfeit or theft. To defend this, blockchain entails the advent of a digital token that is related to physical objects while they are created. The very last recipient of the object can then authenticate the token that may comply with the records of the object to its factor of origin (Francisco & Swanson, 2018). The participants in the supply chain will be able to track the shipment data and the role of each participant involved in the operations at each level including the time of transaction, location, price of the materials and payment options to track the movement of the raw materials from the source as they move in the supply chain and get transformed into the components or products and then reaching the exact recorded location. All members in the network can verify the transactions in the block and the block exists only if the members reach a consensus on its validity and then will be added to the chain.

Table 1: Blockchain Applications in Supply Chain Management

Author	Application of BC in SCM
Saberi et al. (2018)	Blockchain based supply chain management allows the introduction of shared, steady, decentralised ledgers, autonomous virtual smart contracts and truthful and stable networks.
Francisco and Swanson (2018)	The Blockchain supports traceability applications in a supply chain.
Sadouskaya (2017)	The public availableness of shared information offers the chance to trace merchandise to the place of origin to the end client.
Sadouskaya (2017)	Decentralized structure supporting power of blockchain offers the power for participation for all parties within the supply chain. Cryptography-based and changeless nature provides the reassurance of security.
Kshetri (2019)	The application enables to understand the complete details about a particular product in a much transparent way which will eradicate false acts by the supplier and intermediaries (Eg: IBM Food Trust).
Di and Variale (2019)	The Italian Airport infrastructure adopted the Airport Collaborative Decision Making (A-CDM) platform which is one of the fundamental blockchain technology applications withinside the airport industry.

Author	Application of BC in SCM
Saberi et al. (2018)	Distributed virtual ledger technology which guarantees transparency, traceability, and security, and showing promise for easing some global supply chain management problems.
Chang et al. (2019)	A blockchain-based BPR framework is established and the technique applied is the supply chain re-engineering.
Kumar and Tripathi (2019)	The enactment of blockchain in supply chain management of medicines using the functionality of encryption and decryption using the respective private key and public key would enable the traceability of illegal drugs being introduced through the intermediaries.
Behnke and Janssen (2020)	BCT (Blockchain Technology) may be utilized in supply chains for traceability of products and may be used to create transparency in the products supply.

INVESTIGATING THE POTENTIAL OF BLOCKCHAIN IN A PUBLIC DISTRIBUTION SYSTEM

The PDS faces excessive issues because of numerous problems and demanding situations that prevent its efficient functioning. Inaccurate identity of beneficiaries implies that food grains aren't accomplishing the focused recipients instead people who aren't entitled to the in-type transfers are taking part in undue benefits (Ghabru et al., 2017). Blockchain technology can empower the PDS with progressed efficacy, efficiency, and transparency with decreased transactional time and fee. With the adoption of blockchain, traceability in the PDS will have significant progress producing a totally auditable path of all material flows via the network. Blockchain has dependable identification control with the aid of allowing all events to realize who's acting what actions, at what time, and where. The transactions of a blockchain-based supply chain are created and recorded primarily based on peer-to-peer interplay that is relied on using virtual signatures. The blockchain-enabled PDS will enable the use of the data that is stored in the blocks to be utilized effectively by the various fellow members in the whole process. The data are being updated at each level in the distribution system. The various participants in the PDS could analyze the various steps involved, the type of seed, quality and level of fertilizer, distribution pattern to various areas, risk involved in the process, details regarding the warehouse requirements, condition of transportation system and so on. This data could be compared with the previous documents in the previous block in resolving the issues associated (Tian, 2018).

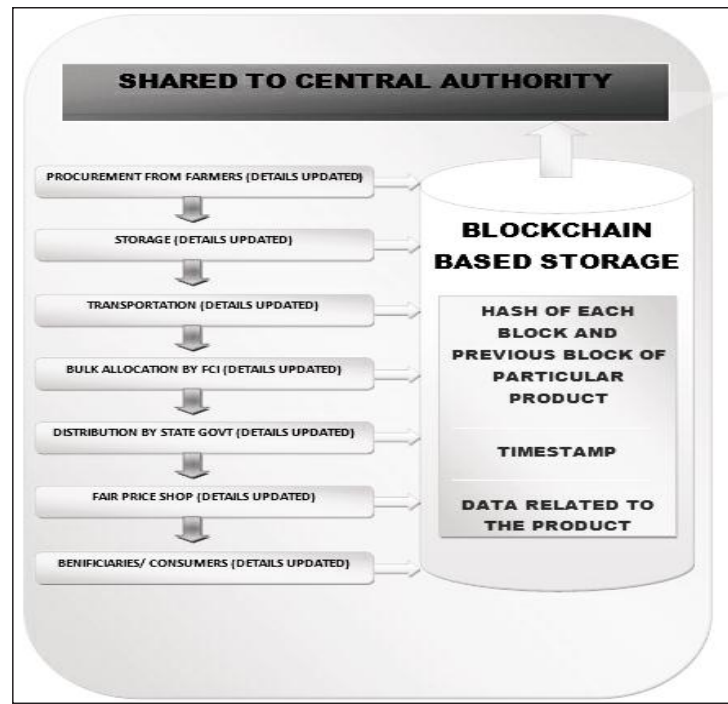


Fig. 2: Blockchain-Enabled Operations in a Public Distribution System

Blockchain technology can be integrated into a PDS to overcome the inefficiencies associated with the transactions. Fig. 2 shows the procurement details from farm, packaging details, logistics and retail details recorded in the blockchain and the supply journey is made visible in the PDS. Every material has a digital identification that stores all the perfect information using blockchain from the

point of origin to the end of retail supplies. The benefits includes uploading transactions details in the blockchain for secure transparent transactions, to identify record the quantity of orders and quality of materials, time and date of transactions, and authentication of beneficiary who receive food materials through biometric sensors linked via National Citizen Identification System shown in Fig. 3.

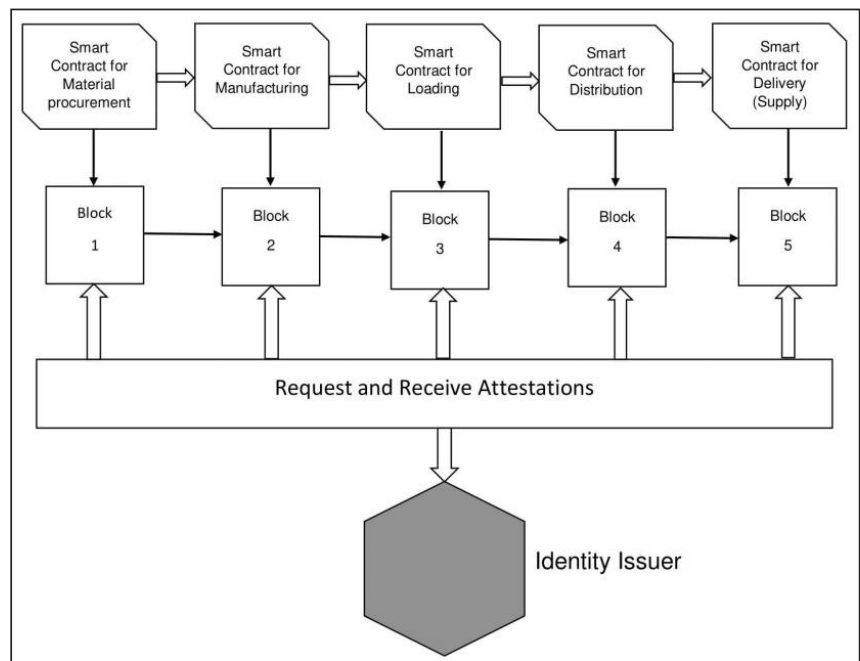


Fig. 3: A Permissioned Blockchain

When a blockchain is managed with the National Citizen Identification System, the users of the chain can be assured that the transactions are originally recorded and are present in the chain for verification and tracking. The most crucial feature of blockchain-enabled supply chain operations in the PDS is that there is no individual resource control, all the parties have equal control over the flow of materials and a secure network is attained. The digital platform will enable each member involved in the supply chain process to virtually monitor the movement of the product. The members would be able to know about any future needs of the products on a real-time basis and are supported by updating information at each level in the PDS. The prime purpose of the system is to closely monitor the safety and quality of the product at each level. The storage at a single spot could enable the transparency and the credibility of the data. The application of encryption and decryption of data using the private and public key will make the data more secure within the hands of the people involved in the whole process. Introduction of such a system reduces the wastage of products, analyses the products that are best demanding as well as the worst moving products. Detecting fraudulent acts that are involved in the system could easily be detected, reduced or rectified. Finally, the optimal level of output could be generated at each level of supply chain operations for performance excellence.

CONCLUSION AND IMPLICATIONS

Supply chains should be able to handle the crisis directing the flow of supplies that makes the supply chain different from the traditional supply chains. Technology platforms lend a hand to recover from crisis and prepare for the future. Convergence of blockchain technology will facilitate smooth transactions between the seller and buyer in the supply chain. The paper highlights the difference between conventional supply chain and blockchain-enabled supply chains in managing smooth flows in the PDS. The information in the supply chain will be entered into the blockchain, sharing data among all members of the supply chain using decentralized ledger in the network which makes it easier to invoke purchases and build blocks for the purchase process using smart contracts. In the paper, an attempt has been made to infuse blockchain technology in a PDS, which will provide an efficient, secure and transparent supply chain performance especially to deal with emergencies. Blockchain can be followed for large-scale deployment on SCM. Blockchain technology additionally has an enormous potential to provide new openings for career within the business industry. Even though blockchain embraces promises, the convergence application in supply chains is still in its infancy as to

accomplish its full potential and can be considered as a scope for future research. Blockchain improvement continues to be in its embryonic stage. Future research work needs to preserve track of blockchain improvement and add further empirical evidence to diverse strands of research opportunities.

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