

Blockchain Technology in Supply Chain Management: A Review

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Abstract - A supply chain is a system of services and dispersal options that performs the task of acquisition of materials, transformation of these materials into intermediate and finished deliverables and the circulation of these finished products to customers. It is essential in both service and manufacturing sector; however, the complexity of the chain varies greatly from industry to industry. Blockchain technology is revolutionizing the digital world bringing a new perspective to security, resiliency, and efficiency of systems. It offers a secure way to exchange any kind of good, service, or transaction. Blockchain will enable more agile value chains, faster product innovations, closer customer relationship sector. This paper gives an overview of blockchain technology and its potential in making supply chain management more efficient.

Key Words: Blockchain, Supply Chain, Decentralized, Distributed Ledger, Security

1. INTRODUCTION

The Blockchain model is a revolutionary technology for businesses, and it can be particularly useful for cross-border payments, trade arrangements, remittances. This can also allow different new business opportunities in various different sectors like retail & CPG, healthcare and life science and communication. Although it is a relatively technology, blockchain is rapidly advancing and developing. Aside from private firms, there are various government branches which have started using blockchain for administrative purposes at small scale for various uses like land deals [1]. The state government in Kerala has implemented a strategy to use the blockchain technology to modernise purchase and supply network of vegetable, fish and various other small scale retail network. Blockchain technology in yield insurance would help dodge time-lag in the valuation and delivery of compensation to farmers who suffer losses due to natural disasters. It will make the entire process, beginning from creating applications for coverage to the settlement of claims smooth and efficient [2]. The subsequent sections will detail traditional supply chain network, features and benefits of blockchain, and how blockchain can streamline the supply chain.

1.1 Traditional Supply Chain Networks

Supply chains traditionally are linear in nature, with a distinct movement of design, plan, source, make, and deliver. Supply chain management (SCM) is the practice of synchronizing the flow of imports, facilities, information and assets as they transfer from raw materials to parts supplier to manufacturer to wholesaler to retailer to consumer. This route includes order generation, order taking, information

gathering and the efficient and timely distribution of goods and services [3].

Conventionally, supply chain managers strived to achieve volatility, volume, velocity, and visibility as they tried to improve outcome throughout a series of objectives that include total expenditure, service, value, and support for innovation [4]. These conventional goals are not likely to change, but moving forward, supply managers should be able to achieve higher levels of performance with supply chain technologies enhanced with new digital techniques. Furthermore, supply chain managers can help create additional sources of revenue by providing new and faster access to markets, and supporting the creation of smart products. Such openings would add revenue to the existing list of goals for the supply chain.

The function of any supply chain centers on the movement of materials, finished goods, capital, and other assets from place to place, as well as the production of finished goods. At their core, however, supply chains consist of many transactions: the exchange of time, money, information, or physical materials for some other unit of value. Dramatic technological and digital developments, such as greater computing power and lower overall costs, have impacted the traditional supply chain in several key ways, including a reduction in transaction costs and increase in innovation related to the production process itself.

SC network is a series of processes and echelons, which starts with the material/information suppliers and ends with the customer as shown in Figure 1. In the figure an example of a very simple supply chain for a single product is shown. In this case, raw material is procured from vendors, transformed into finished goods in a single step, and then transported to distribution centers, and ultimately to customers. However, the modern supply chains have multiple end products with shared components, facilities and capacities. SCM looks across the entire supply chain, rather than just at the next entity or level, and aims to increase transparency and alignment of the supply chain's coordination and configuration, regardless of functional or corporate boundaries. Traditionally, marketing, distribution, planning, manufacturing, and the purchasing organizations along the supply chain operate independently. These organizations have their own objectives and that are often conflicting. This traditional way of managing is essentially based on a conversion (or transformation) view on production, whereas SCM is based on a flow view of production. Therefore, the traditional supply chain has the following limitations [5]:

- Limited view of supply chain
- Information delayed as it moves through each organization
- Limited visibility to the entire chain hinders meaningful collaboration
- End customer demand distorted as information flows along the material path
- Different planning cycles resulting in delays and unsynchronized responses across multiple tiers

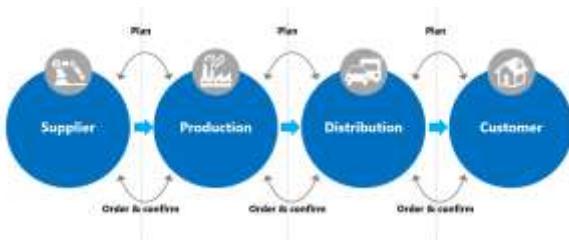


Fig-1: Traditional Supply Chain Network

1.2 Distributed Ledger and Blockchain

Introduction to Blockchain: A Blockchain is a digital, immutable, distributed ledger that chronologically records transactions in near real time. The prerequisite for each subsequent transaction to be added to the ledger is the respective consensus of the network participants (called nodes), thereby creating a continuous mechanism of control regarding manipulation, errors, and data quality. [6] Simply put, blockchain is a protocol for exchanging value over the internet without an intermediary.

Blockchain, by virtue of its design and architecture, offers some inherent benefits which the industry has been looking for quite some time now. The distributed nature of blockchain brings in a lot of transparency in processing and thereby reduces the need for manual verification and authorisation.

Near real time: Blockchain enables the near real-time settlement of recorded transactions, removing friction, and reducing risk.

No intermediary: Blockchain technology is based on cryptographic proof instead of trust, allowing any two parties to transact directly with each other without the need for a trusted third party.

Irreversibility & Immutability: The Blockchain contains a certain and verifiable record of every single transaction ever made. This prevents past blocks from being altered and in turn stops double spending, fraud, abuse, and manipulation of transactions.

Distributed ledger: The peer-to-peer distributed network records a public history of transactions. The blockchain is distributed and highly available. The blockchain does not typically preserve the identities of the parties or the transaction data, only the proof of the transaction existence.

The data is exactly replicated and synchronized across all locations to maintain data integrity, availability and resiliency [4]. Unlike the centralized system, there is no central administrator or single point of control. If a location abruptly fails or stop functioning the remaining location has the data and capacity to maintain the ledger or all transaction details in the absence of the failed location. This way a distributed ledger provides real-time information and reduced error or fail rates of transactions. This also reduces the costs of infrastructure as compared to the centralised system. A distributed ledger uses a peer-to-peer network to communicate with nodes which are spread around the globe.

Additionally, distributed ledger technology give us the opportunity for economies of scale achieved by allowing the transaction to serve simultaneously as agreement, settlement, and regulatory reporting. Instead of building numerous duplicative and redundant services, one master prime record can serve as the source, eliminating the need for reconciliation and increased post-trade processing speed.

Distributed Ledger	Centralized Database
Consensus on data	Internal and external reconciliation required
Append-only (Immutable)	No restrictions
Distributed	Single point of failure
Decentralized	Single point of control
Peer-to-peer	Unnecessary gateways and middlemen
Cryptographic verification	Cryptography must be added as afterthought
Cryptographic authentication and authorization	Actions are done on behalf of others
Resiliency and availability increase with node count	Backups must be set up 'manually'

Fig-2: Difference between Distributed Ledger and Centralized Ledger

In short, the major differences of a centralised and distributed are:

- A distributed ledger system can be implemented using a blockchain system.
- Block chain technology represents the next step for accounting.
- It is a distributed system in terms of technology, and it is a tremendous proof for every transaction completed within this network. [6]

2. ENHANCING SUPPLY CHAIN MANAGEMENT USING BLOCKCHAIN

With the cost of computing, storage and bandwidth plummeting [7] sharply in the recent years. It has become increasingly easier to digitize the supply chain, making it more efficient to use.

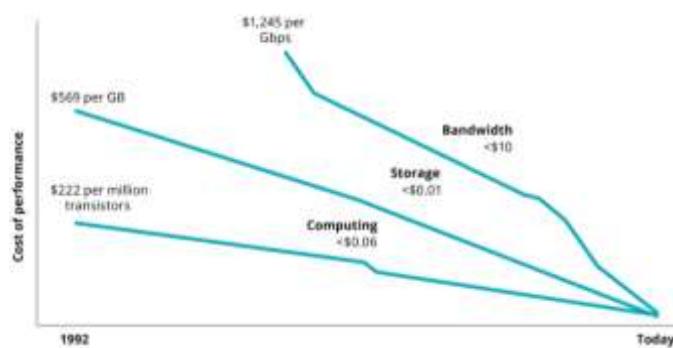


Fig-3: Declining cost of bandwidth, storage and computing

The blockchain technology has entered the world of Supply Chain to make way for better and safer transactions. It can disrupt the way we produce, market, purchase and consume our goods. Brisk execution of purchase orders, easy invoice processing, minimal need of payment reconciliation, eliminating counterfeit or loss of goods are few of the many advantages blockchain promises the supply chain industry. Contracts between parties can now be made digital and automated eliminating the need for voluminous paperwork, associated errors, delays and risks of fraud. Substantial business value can be delivered by increasing transparency, reducing risks and improving efficiency and overall supply chain management using the blockchain. It is a manipulation-proof database which distributes many copies of the same data throughout the overall data bank, such that an unauthorized party would need to change 51% of all instances in order to forge an entry. Blockchain can play a significant role in reduction of production cost as well as increment of customer satisfaction. It works as intervene between manufacturer and customer. Blockchain consolidates transportation as well as warehousing and offers such services to managers who wanted to reduce operation cost [1]. If the business of managing various elements of the supply chain via contract or outsourcing. A blockchain manages all or part of a client's logistical requirements, which may include transportation, inventory optimization, warehousing, order fulfilment, or the integration of these and other functions. moreover, blockchain, providers to offer ten key services, including strategic capacity, logistics expertise, network analysis, mode and load optimization, cost-containment strategies, vendor compliance management, system support, actionable business intelligence, best practice sharing, and risk profile reduction. There are many reasons to switch to blockchain:

- Concentrate on core activities and processes
- Improve customer service level
- Integrate the entire supply chain
- Reduce conflict and reciprocate on mutual goal-related matters
- Increase efficiency, stability and flexibility
- Increase productivity
- Reduce risk, uncertainty and fluctuation
- Leverage resources to the mark. No resources are under or over utilized.
- Improve expertise, market knowledge and data access
- Create a competitive advantage either locally or globally
- Reduce personnel and equipment costs

Additional reasons include:

1. Enhanced Transparency: Documenting a product's journey across the supply chain reveals its true origin and touchpoints, which increases trust and helps eliminate the bias found in today's opaque supply chains. Manufacturers can also reduce recalls by sharing logs with OEMs and regulators (Talking Logistics).
2. Greater Scalability: Virtually any number of participants, accessing from any number of touchpoints, is possible
3. Better Security: A shared, indelible ledger with codified rules could potentially eliminate the audits required by internal systems and processes (Spend Matters).
4. Increased Innovation: Opportunities abound to create new, specialized uses for the technology as a result of the decentralized architecture.

Figure 4 shows blockchain connected supply chain services provided by third party logistics. In earlier period, third party logistics provided some primary services which include transportation and warehousing but nowadays third party logistics shows the provision of many other services which reduces the contact distance between manufacturer and customer. So, blockchain, provides following services:

- Carrier selection- blockchain, helps in the selection of carrier so that damage of the product while transportation can be minimized.

- Development of distribution strategy- According to this function, blockchain, develop the distribution strategy of product in different department so, that firms can supply product in less time to customers.

- Freight bill payment and audit- According to this function, blockchain, reduce the time required for billing of transportation of firm by providing bill payment service. Through such service of blockchain, firm can concentrate of core works.

- Information system- With the help of information technology, blockchain, has developed a service through which a customer can directly contact with a manufacturer. blockchain, transfers information of order from customer to manufacturer.

- Freight distribution- According to this service, blockchain, distributes a transportation of product as per the category. Such kind of function helps to manufacturer to provide the delivery at right time and right place.

- Product returns- Customers can return the products to manufacturer through 'product return service' of blockchain, such service reduces the time of customers of product return because generally blockchain, picks up a product from customer and the handovers it to manufacturer. After that, customer gets a finished new product from manufacturer through blockchain.

- Freight consolidation- According to this service, blockchain, combines the process of freight into one process so that freight services can work together to reduce the time of delivery.

- Product marking- According to this service, blockchain, reduces the time of packaging and labelling of product. Such functions improve the productivity of product.

- Route and network optimization- blockchain, helps to decide a better route for the delivery of a product. So that a firm can reduce cost of freight. With all above functions, blockchain, also provides a service of customer brokerage, Consulting service, customer clearance, cross docking, export operation, export licensing assistance, expedited delivery, transportation, warehousing, EDI capability, selected manufacturing activities, shipment planning, traffic management, product repair, product modification, product marking, product assembly, pickup and delivery, overseas sourcing, overseas distribution, order management, order entry and processing, inventory management, product return, management and performance reports, replenish inventory, rate negotiation, intermodal services, Import operations, export operations.

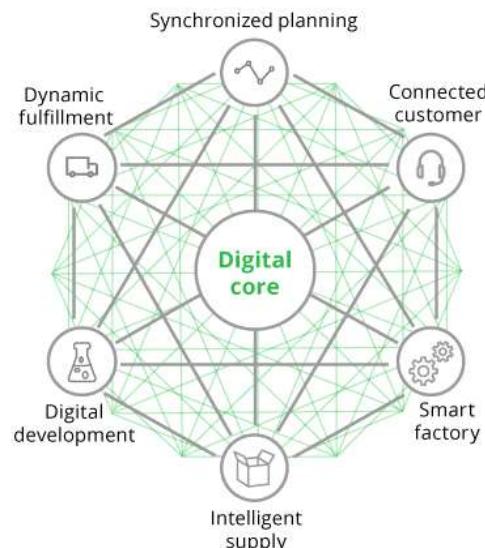


Fig-4: A Supply Chain integrated using Blockchain

3. CONCLUSIONS

To conclude, a decentralized network made possible using blockchain will have numerous advantages for a supply chain network. The blockchain will make all aspects of the supply chain interconnected, make the data more secure, traceable and structured. This will positively impact all stakeholders involved including customers, manufacturers and delivery services.

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