

Benefits of Blockchain in the Manufacturing Industry

Mufeed Sha¹ and Silpa²

Software Developer, SMIT Solutions¹

Assistant Professor, Vedavyasa Institute of Technology, Malappuram, Kerala²

Abstract: Blockchain technology has started reaching high in the market and also has a huge impact on the manufacturing industry. Blockchain is just one of the technology which supports all cryptocurrencies such as bitcoin but the experts can see that it have a large scope in the future then just meets the needs of bitcoin. On further analysis, we found that it can bring enormous changes in the internet networks itself. Consistently, technology has evolved more and a type of blockchain has grown a lot. So, from today, blockchain is widely being used as a distributed ledger technology. Demand for blockchain has gradually increased a lot and also being noticed in other industries. In short, blockchain can create revolution almost in all the industry. large benefits are in Healthcare, Banking and financial services, Real estate, Security and Manufacturing Industry. Main benefits are currently works in the real scenarios are Amplified inventory management, Upgraded data security, Better traceability and transparency, Automatic Payment Process to Suppliers, Improve Customer Engagement etc. Blockchain technology continues to grow, the supply chain industry is sure to look up the true forms of transparency, accountability, and efficiency. In this paper, I explored this approach, its possibilities and challenges.

Keywords: Blockchain, cost saving, manufacturing industry, real-time transparency, sustainability

I. INTRODUCTION

Blockchain technology has started reaching high in the market and also have a huge impact on the manufacturing industry. In the current days, the world highly gains attention towards terms like cryptocurrency, bitcoin, ethereum token, and blockchain. The reason is nothing that most of the peoples are getting more benefits from those technologies, especially blockchain. When it comes to blockchain technology, it has evolved a lot in the market and has brought more benefits. In this article, I am going to cover blockchain technology, its evolution and how blockchain technology helps in the manufacturing industry. Lets we start a discussion with blockchain and how it has an impact on different industries.

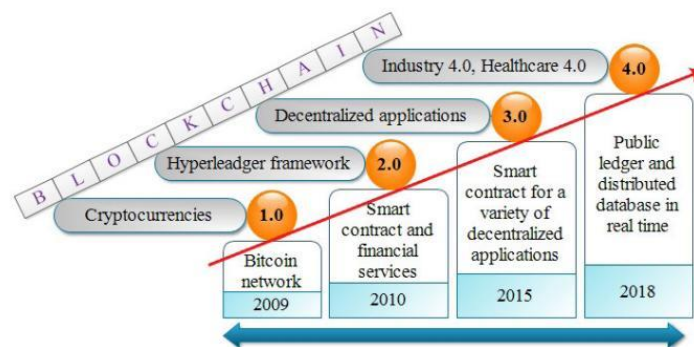


Figure 1: Generations of Blockchain.

- 1. BLOCKCHAIN 1.0:** The first generation of the technology was started with the bitcoin network in 2009, which is known as blockchain 1.0. In this generation, the creation of the first cryptocurrencies was introduced. The idea was all about payment and its functionalities to generate cryptocurrency

2. **BLOCKCHAIN 2.0** In the second level of the blockchain technology, smart contract and financial services for various applications were introduced in 2010. The development of blockchain with Etheruem and Hyperledger frameworks was proposed in this generation.
3. **BLOCKCHAIN 3.0** In this generation of blockchains, the convergence towards the decentralized applications was introduced. Various research areas such as health, governance, IoT, supply-chain, business, and smart city were considered for building decentralized applications [46]. In this level, etheruem, hyperledger, and other platforms were used which having the ability to code smart contracts for a variety of decentralized applications.
4. **BLOCKCHAIN 4.0** This generation mainly focused on services such as public ledger and distributed databases in real-time. This level has seamless integration of Industry 4.0-based applications. It uses the smart contract which eliminates the need for paper-based contracts and regulates within the network by its consensus

II. WHAT IS BLOCKCHAIN TECHNOLOGY?

Initially, Blockchain is just one of the technology which supports all cryptocurrencies such as bitcoin but the experts can see that it have a large scope in the future then just meets the needs of bitcoin. On further analysis, we found that it can bring enormous changes in the internet networks itself. Consistently, technology has evolved more and a type of blockchain has grown a lot. So, from today, blockchain is widely being used as a distributed ledger technology. This technology has created a chain of blockchain where each of the blocks contains information as well as the data stored together and verified. These blocks are further validated and attached to the string of transactions and information in the previous blocks.

In simple terms, let's compare it with google docs. As you know, multiple users can simultaneously use and can edit a single document on google docs. Likewise, even with blockchain technology, you have a distributed ledger. There is a difference here, unlike in google doc, you can't change the previous data. You can only add to the ledger. Some of the features of blockchain technology are blockchain keeps all data records which is referred to as a "ledger". All the data which is exchanged is a "transaction". Once the transaction is verified, it is added to the ledger as a "block". To verify the transactions, blockchain uses a distributed system. ie. a Peer-to-peer network (p2p network). Once the transaction gets completed, the data is verified and added to the blockchain, it can't be changed anymore.

After that, demand for blockchain has gradually increased a lot and also being noticed in other industries. In short, blockchain can create revolution almost in all the industry. But, the most likely ones that can have large benefits from it includes:

- Healthcare
- Banking and financial services
- Real estate
- Security
- Manufacturing Industry

Out of the above-mentioned industries, the manufacturing industry has become more inclined towards blockchain technology. Let us get into deeper that how blockchain technology can have an impact on the manufacturing industry.

2.1 Blockchain Requirements

- **Smart Contracts:** It is a protocol which allows the performance of transactions in absence of third party that makes transactions irreversible and traceable.
- **Tokenization:** It is one of the most important things that must to be included in the blockchain. It facilitates digital representation of the goods, services, and rights with the help of tokens. It allows the exchange of values and trust for different users without involving the central authority.
- **Data security:** Security compliance is a major and essential requirement of blockchain technology with a legal point of view.
- **Decentralised data storage:** It is a basic requirement of the distributed system.

- **Immutability:** All the records on the network should not be modified or tampered in the shared ledger. This enables the integrity of the stored data.
- **Consensus:** Transactions should only be updated when all the verified users in the network agree for the same.
- **Typed Blocks:** It is required for the smart contract and for high speed payment in business transactions. So, data formatting of the different types of blocks include its time, consensus algorithm, number of transaction per blocks, and its content data types.
- **Sharding:** It is required for the separation of content over subsets of nodes in a way, that not all the nodes need to carry all processing load or any burden.
- **Access rights management:** Encryption based private and public key cryptography and distributed databases with user identification is required to assign and manage access rights.
- **Standards used to manage permissioned blockchains:** Immutability of the blockchain network makes the data access in a specific order. The public certificates are available in public blockchain, but without having the private key, authorization cannot be provided to the users. So, all the data should be managed in order of data elements like user's internet protocol (IP) address, name, its code, and extensible markup language. These all are published to the consortium with the communication process.
- **Standard data formatting:** In the blockchain system, it is also needed to standardize the data formats with respect to Application Programming Interfaces (API). Each organization in the blockchain network needs to use the same data format or APIs to communicate in the same network.
- **Updatability:** The need for data updation in the distributed ledger is most important for records. In a peer-to-peer network, data needs to be structured and systematically updated for each node that transacts within the network.
- **P2P encryption between blockchain nodes:** Encryption is needed to secure the transactions between the end nodes that may link together in the blockchain protocol.
- **UX:** One of the major factors in a system is the user interface design that provides an easy and convenient application environment to the users. The main difference between the blockchain-based and non-blockchainbased systems is the manner in which the user perceives it.
- **Development operation:** The main step in the production of the system is the selection of platforms that requires less time and the setup complexity.

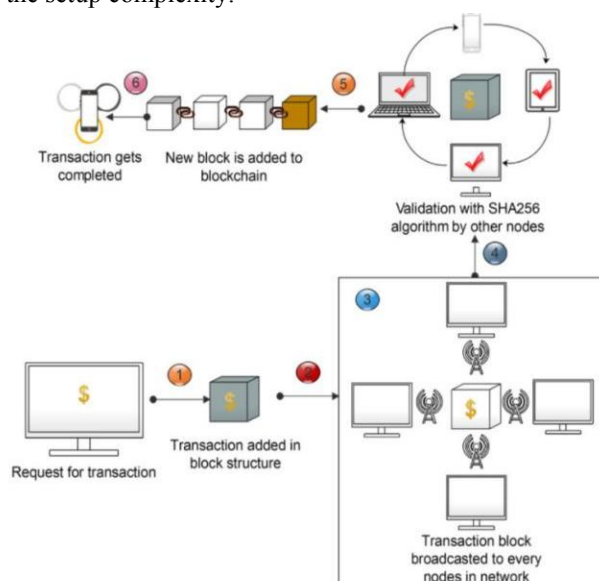


Figure 2: The basic blockchain-based architecture.

III. BLOCKCHAIN ARCHITECTURE AND ITS COMPONENTS

3.1 Basic Blockchain Based Architecture

In the basic architecture of the blockchain, each transaction needs to be verified which can not be altered as shown in Fig. 5.

1. **ADDITION OF TRANSACTIONS IN THE BLOCK STRUCTURE** A blockchain transaction has various steps. First, a network node or user requests for a new transaction. After that, the transaction is recorded in the block format or structure. The block structure consists of the index, time-stamp, data, previous hash, and current block hash.
2. **TRANSMISSION TO PEER NODES** A block of transactions is broadcasted to the peer nodes available in the network.
3. **VALIDATION OF TRANSACTIONS** The blockchain network uses SHA-256 algorithm for creating a unique hash. Each block in the blockchain is linked with the hash of the previous block which makes an unbreakable
4. **BLOCK ADDED TO LEDGER** The new transactions are first verified by the other nodes and then they are added in a new block for the ledger or chain. The existing blockchain is extended by addition of a new block that is unalterable and undeletable for any other users.

3.2 Role of Blockchain in the Manufacturing Industry

When we talk about modern ways of manufacturing industry, the supply chain can work across many organizations, as well as many countries. This can make the system more difficult in the way of finding solutions for increasing efficiency and chasing individual events. Most of the time, the company information in the manufacturing industry flows through the supplychain. They have a uniform way of storing and exchanging data. When it comes to blockchain, it can make smarter as well as secured supplychain whereas you can track the journey of your products within the real-time visibility.

For example, if you are looking for material delivery, you can track the materials which you have ordered on the website and when it will arrive, who receive them and when they transport the material to the next stage and so on. Everything is recorded as blocks in the blockchain. So, you have seen minimalistic details of the supplychain process and there is no chance of any kind of manipulations. There are many benefits that the manufacturing industry can get while using the blockchain technology. If you are the one among them who do experimentation with the blockchain, you must don't miss the opportunity to read the below mentioned five benefits are currently works in the real scenario.

A. Amplified Inventory Management

Blockchain offers a holistic and permanent data of every single transaction details that take place in your supply chain process. Moreover, it opens you to connect to each party in the value chain – be it suppliers, production sites and distribution centers. The records which are store are easily accessible by those who are connected to the network. As everyone in the networks has a copy of the information, so there is no confusion happen in the supplychain process. This, in turn, becomes the intensify inventory management.

B. Upgraded Data Security

Information like Invoices and contract details that are exchange in any supplychain process is highly confidential. Sharing details by the way of traditional methods can be a risk and it can be easily hacked by anyone. Instead of using traditional methods, blockchain keeps the information more secure with the best cryptography techniques. So, if you are looking to build blockchain networks for your manufacturing industry then either choose a freelance blockchain developers (or) **blockchain development company** for solutions in supplychain management to avoid cyber attacks

C. Better Traceability And Transparency

Blockchain Technology in the supplychain can provide the data of all information related to your transaction. For instance, how the products are made, from where they start shipping and how will manage data and much more.

However, if the data is permanent and it can be easily shared with your supply-chain network, it provides you a detailed tracing and tracking abilities.

D. Automatic Payment Process to Suppliers

Blockchain technology has a facility to transfer of the fund to any part of the world. You don't stick it to the traditional banking methods. Money transfers can be made directly between the payers and payee. The whole payment system through blockchain is secured. It can be done quickly. You don't want to wait for a day or even for an hour. Once all the digital secure transactions data becomes a part of blockchain agreements and if your networks agree with the terms and conditions, then the smart contract can begin the commercial process automatically.

E. Improve Customer Engagement

Blockchain is stronger than normal storage technology. Because you can analyse the data to create forecasts and predictions, which can further help you to solve the flaws in your supply chain management. Not only this, but your analytic tools can help to boost your customer satisfaction. You can use the blockchain database to find ways for developing your delivery timeline. Moreover, the customers can also have the ability to access the blockchain data to a certain extent. For Instance, one of the clothing brand provides customer access while showing them an approval form or a labor union sheet. Sharing data will create transparency, which ultimately results in loyalty and also creates ever long-lasting customer relationships.

IV. THE EFFECTS OF BLOCKCHAIN TECHNOLOGY AND INDUSTRIAL APPLICATIONS

A. Distributed System Attained by Blockchain Technology and Real-Time Transparency and Cost Savings:

A distributed system is made up of many single nodes (computers) working together. Each node is indirectly connected, and no single node is directly connected to all other nodes. By contrast, in a centralized system, all nodes are directly connected to a single central node. Distributed systems are preferred to centralized systems because of their faster calculation, reduced maintenance costs, greater stability, and easier upgrades.

The main challenge to maintaining the integrity of a distributed system is interruptions by malicious peers who try to manipulate the distributed system for their own profits. Malicious peers sometimes send virus files to other peers to tamper with transaction information, threatening confidence in the distributed system. Thus, peers may leave the system, leading to the loss of the entire system's functionality, a situation similar to the Sustainability 2018, 10, 4274-4 of 20 Byzantine Generals Problem. This problem hinders the implementation of a useful distributed system. However, blockchain technology has a solution to this problem. Blockchain technology secures the integrity of a distributed system through a consensus algorithm, which elicits the benefit of real-time transparency. The consensus algorithm is the agreement of digital ledger users for the addition of blocks to the blockchain system. A successfully structured consensus algorithm allows a blockchain system to remain a trusted transaction system. A malicious peer must manipulate this consensus algorithm to corrupt the system. However, manipulating the whole consensus algorithm is very costly because of the complexity of finding the nonce, which is an answer for hash values. Hash values are random digits of specific lengths that symbolize the transaction information. Once a blockchain system successfully structures a consensus system, the distributed system becomes dependable. Moreover, during the process of structuring a blockchain system, real-time transparency can be secured. When a new block with new transaction information is uploaded to the blockchain system, all participants can review the information through the shared digital ledger. Thus, users can check the current state of accounts, the quality of goods, and other information in real time while preventing attacks by malicious peers.

In addition, real-time transparency can minimize the need for trusted intermediaries to intervene. For example, when a firm exports goods to a counterparty abroad, an intermediary is needed to ensure that the firm holds sufficient goods or that the counterparty has enough funds. This need arises because these kinds of transactions generally occur sequentially; either one party sends the goods prior to payments or the counterparty pays before the goods are sent. However, if the counterparty's financial affairs utilize blockchain technology, the firm can check its counterparty's

account, allowing it to send the goods with confidence. Conversely, the counterparty can pay first with confidence if the counterparty is provided with the firm's updated inventory information in the blockchain system. Blockchain technology can also solve this trust problem using a smart contract. A smart contract can be enforced using an off-chain technology called a smart-oracle. A smart-oracle comprises data that are not saved in the blockchain but are uploaded to a real-life platform. The smart-oracle can be connected to the blockchain system. In the exporter example described above, the smart-oracle may be data from the importer country's custom clearance. A tamper-proof blockchain contract can be enacted when the exporter's goods successfully clear customs. Thus, as the exporter's goods clear customs in the importer's country, the exporter is automatically paid a certain amount from the counterparty's cryptocurrency account uploaded to the blockchain contract. Consequently, a trusted intermediary is less necessary, and intermediary costs fall.

B. The Effects of Blockchain Technology in the Financial Industry on Manufacturing Firms

Introducing blockchain technology to financial markets, considering its potential for real-time transparency and cost reductions, is tempting to financial firms. However, these innovations are not limited to the financial industry. The application of blockchain technology to the financial industry can also affect manufacturing firms. The effects of blockchain technology in the financial industry can influence manufacturing firms' compensations through real-time transparency and cost savings.

4.1 Security Markets

Goldman Sachs, one of the most powerful global investment banks, is showing great interest in applying blockchain technology to its business. On October 2014, Goldman Sachs files a patent application titled "Cryptographic Currency for Securities Settlement", called SETLcoin, with the U.S. Patent & Trademark Office (USPTO), and on July 2017, the USPTO issues the patent to Goldman Sachs. SETLcoin enables the use of a blockchain platform for securities transactions. It provides a virtual wallet for each user. The user then trades financial assets using SETLcoin, which is saved in the virtual wallet

4.2 Remittance System

Another financial application of blockchain technology was developed by Ripple Labs, which is a leading blockchain company in the field of global payment systems since 2012 (Pilkington, 2016 [7]). Ripple Labs provides a platform for remittances using a blockchain system. It uses three different platforms: "xCurrent", "xRapid", and "xVia". Each platform has a unique function; xCurrent is used for bank-to-bank transactions, xRapid is used for transactions between payment providers and financial institutions, and xVia is used for transactions between corporations, payment providers, and banks and beneficiaries.

4.3 The Effects of Blockchain Technology in Supply Chains on Manufacturing Firms

Applications of blockchain technology to supply chains are being actively developed. Blockchain technology can be adopted in the supply chains of various industries, such as the manufacturing industry and agri-foods (Abeyratne and Monfared, 2016 [21]; Mondragon, Mondragon, and Coronado, 2018 [22]; Tian, 2016 [23]). Firms seeking to apply blockchain technology to their supply chains expect to enhance their systems through two advantages. First, they can cut costs because no additional surveillance on the quality of goods is needed owing to the real-time transparency of blockchain technology. Second, the quality of goods can be guaranteed.

4.4 Supply Chains

Blockchain technology in supply chains works as follows. When the ownership of a product being processed is transferred from one party to another, the new owner becomes the only party who can update the product's status. When the new owner further processes the product, and updates the product status, this new information becomes a block and is uploaded to the shared ledger (blockchain). However, for this information to be uploaded to the shared

ledger, the next recipient of the product must agree with the information. If the receiver agrees, then the correct product status is uploaded to the shared ledger. The recipient of the goods does not agree to the update if the data are inaccurate because they are directly related to his or her profits.

A blockchain system and RFID technology can be combined to support the agri-food industry's supply chain transparency. First, the RFID technology confirms data regarding the current state, such as process, warehouse, distribution, and so on, of a particular agri-food product. This information can be uploaded to the blockchain system instantly through a wireless network. RFID works in the similar way as a smart-oracle does. Blockchain technology's algorithmic irreversibility prevents tampering with the information. Therefore, anyone who needs accurate information about agri-food products can access the data in the shared ledger. For example, consumers or government departments can use this information to check the safety of agri-food products.

In practice, DLTs, such as IBM Fabric, R3 Corda, and Digital Asset Holding, are being used to enhance supply chains. However, blockchain technology-based DLTs enhance trust in transactions. If DLT technologies are implemented under a blockchain platform, they inspire even more confidence owing to the irreversible feature of blockchain technology. This feature implies that the information uploaded to the DLT under blockchain technology cannot be manipulated in the future. Moreover, by using cryptocurrency as a means of transaction, blockchain technology allows for faster transactions and reduces additional fees that may be incurred during.

Blockchain technology applied to a supply chain effectively reduces the verification costs of manufacturing firms and prevents distortions of the quality of goods through real-time transparency. Another application of blockchain technology in the manufacturing industry is found in supply chains of composite materials. Blockchain technology's characteristic of ownership transfer allows the provenance of materials to be traced, thereby reducing verification costs and providing an exact status of the quality of composite materials throughout the long supply chain. Components and structures made up of composite materials are generally utilized in the aerospace and medical. Thus, proof of the actual state and quality of the composite materials, which can be ensured by blockchain technology, is important for safety reasons

4.5 Competition between Manufacturing Firms with and without Blockchain Technology: Effects of Real-Time Transparency and Cost Savings

Real-Time Transparency and Cost Savings of Manufacturing Firms

We focus on manufacturing firms, because, as described in Section 3.2, applications of blockchain technology to the financial industry and supply chains considerably impact manufacturing industries. In particular, applications of blockchain technology to securities markets are being vigorously developed by large investment banks, such as JP Morgan and Goldman Sachs (Ryan and Donohue, 2017 [17]; Walker and Venables, 2017 [18]; Hallam et al., 2018 [19]). Moreover, NASDAQ is also developing a private equity exchange platform using blockchain, the NASDAQ Linq Blockchain Ledger Technology. Supply chains as composite material and agri-food supply chains have scope to employ blockchain technology as well. These applications are expected to have major impacts on the behaviors of owners and managers working in manufacturing firms because of real-time transparency and cost savings.

The effects of blockchain technology on the manufacturing industry primarily arise because of this technology's influence on financial transparency and manufacturing supply chains. Real-time financial transparency allows firms using blockchain technology to reduce verification and surveillance costs. Manufacturing firms implementing blockchain technology can structure confident relationships with their counterparts, thereby eliminating the cost of trust and reducing verification costs. Verification costs are incurred because of a lack of trust between traders (Catalini and Gans, 2016 [15]). For instance, when a manufacturing firm does business with intermediate goods suppliers, the suppliers must consider the potential of default and fraud by the manufacturing firm and require the manufacturing firm to prove that it has sufficient funds to pay for the transaction. Because of this lack of trust and the risk of default, an audit or intermediary is needed, and the manufacturing firm incurs verification costs. These costs can be estimated based on the income of the accounting industry, which is anticipated to surpass 156 billion US dollar in 2018 in the U.S. alone ("Accounting industry in the U.S.—Statistics & Facts," <https://www.statista.com/topics/2121/accounting->

industry-in-the-us/). The effective use of blockchain technology allows a manufacturing firm to provide its true financial status (real-time accounting) to the supplier, rendering verifications by an accounting firm unnecessary. Therefore, the manufacturing firm can save a significant amount of verification costs (Figure 3).

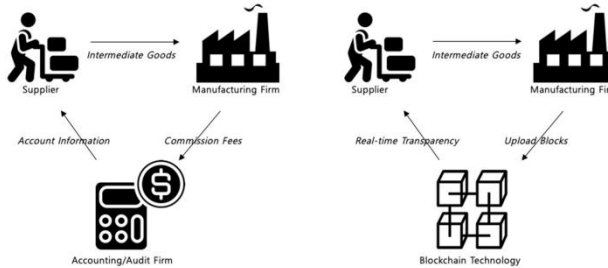


Figure 3: Elimination of a Manufacturing Firm's Verification Costs

In addition, the real-time transparency of blockchain technology allows the owners of manufacturing firms to cut the surveillance costs on managers. A single shareholder (i.e., an owner) may experience difficulty steering a firm because the firm's shares are spread among many shareholders. When a firm has many owners, shareholders' interests generally do not coincide. Berle and Means ("The Modern Corporation and Private Property") explain that the problem of diverse interests among shareholders is solved according to managers' preferences. As a result, manufacturing firms incur additional costs to supervise managers. However, these costs can be reduced through the real-time transparency of blockchain technology. In general, a firm's transparency is divided into two components, financial transparency and corporate governance transparency (Bushman, Piotroski, and Smith, 2004 [31]). However, a blockchain system can provide both financial (Pilkington, 2016 [7]; Underwood, 2016 [8]) and corporate governance transparency (Yermack, 2017 [16]). Thus, the actions of managers can be supervised in real time. As a result, intensive surveillance is no longer needed, lowering surveillance costs. For instance, an owner of a manufacturing firm can monitor the blockchain of a supply chain to observe whether a manager is maximizing profit. She can track the amount of intermediate goods that the manager purchases to estimate the quantity that the manager is planning to produce. Thus, the owner can reduce surveillance costs (Figure 2).

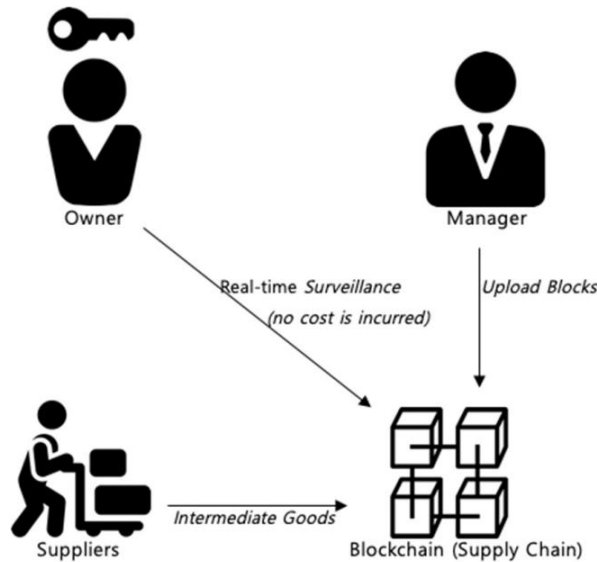


Figure 4: Surveillance Cost Savings in a Manufacturing Firm.

Networking costs can be saved among in-chain manufacturing firms, and the in-chain manufacturing firms with intermediate goods suppliers can develop a new market platform, where in-chain firms refer to the firms within a blockchain system. This process may produce network effects that render in-chain manufacturing firms more competitive than off-chain manufacturing firms. According to Catalini and Gans (2016) [15], firms with blockchain



technology can cut networking costs by bypassing intermediary intervention using blockchain technology participants' new transaction platforms. Extending this argument to the manufacturing industry, manufacturing firms with blockchain technology can develop a new market platform with intermediate goods suppliers and no intermediaries. This new market platform under a blockchain system achieves lower transaction costs by bypassing intermediaries and renders the manufacturing firms within the blockchain system more competitive than the off-chain manufacturing firms. Furthermore, the manufacturing firms in the blockchain system can achieve the benefits of network effects. The more that intermediate goods suppliers engage in the blockchain system, the more that the in-chain manufacturing firms benefit from the excess market information. Thus, the manufacturing firms and their submarkets form even tighter platforms under blockchain technology.

V. CONCLUSION

A lot of new technologies are enhancing the way of manufacturing industries used to work with their supplychain management and blockchain technology is one among them. As blockchain technology continues to grow, the supply chain industry is sure to look up the true forms of transparency, accountability, and efficiency. I am winding this blog that, the manufacturing industries will adopt the blockchain technologies sooner and they will be able to benefit from a better way of running their business.