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Blockchain in Supply Chain

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ABSTRACT

Over the centuries, the preservation of valuable assets has made it necessary to store them in a physical space. A secure storage space has been generated with the blockchain technology. Blockchain is a distributed ledger that does not have a single record database in which all Bitcoin operations are performed. Blockchain's database is the most important feature that makes it safe to be distributed, as the community agrees in all actions through this. The application of blockchain to the supply chain has attracted the attention of many business owners as it can be quickly adapted to dynamic market conditions and in the business environment. In this paper, we introduce the integration of blockchain in supply chain.

Keywords: Block chain Technology, Block chain in Supply Chain. Supply Chain, Supply Chain Management.

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1. INTRODUCTION

Processes associated with the transformation of inputs (raw materials, components) into outputs (goods, finished products) and their transport to the place of consumption are an essential part of the modern society. Supply chain plays a critical role in the global economy. It is a set of sequential stages in the manufacturing, transportation, storing, or distribution of a product. It involves various participants and stakeholders and numerous processes in multiple stages. Since supply chains are, at their core, a network of interlinked companies, each business adds value to a product or service before it reaches the end user. Modern supply chain systems are managed using software from the creation of goods and services, warehousing, inventory management, order fulfillment, information tracking and product/service delivery to after-sales services. Today's supply chains are global networks that generally include manufacturers, suppliers, logistics companies, and retailers that work together to deliver products to consumers. They need to be more reliable than ever because disruptions in the supply chain can create significant losses for companies and increase costs for end customers. Figure 1 displays a typical example of the stages of a supply chain [1].

Blockchain technology is an innovation which is regarded as the center of Industry 4.0 revolution and it has become part of our lives. It is a system that stores data in a special way. In most cases, today's supply chains operate at-scale without blockchain technology. Although this technology finds its first application in the financial sector, it has become possible to use it in all sectors which can be integrated with technology today [2]. The blockchain technology has excited the IT and supply-chain worlds.

1.2 OVERVIEW OF BLOCKCHAIN

Blockchain (BC) technology is a permanent record of online transactions. It is a distributed tamper-proof database, shared, and maintained by multiple parties. It is a new enabling technology that is expected to revolutionize many industries, including business. It has the potential for addressing significant business issues. The BC technology allows participants to move data in real-time, without exposing the channels to theft, forgery, and malice.

The term "blockchain" refers to the way BC stores transaction data – in "blocks" that are linked together to form a "chain." The chain grows as the number of transactions increases. Since every entry is stored as a block on a chain, the care you receive is added to your personal ledger. The first Blockchain was conceived in 2008 by an anonymous person or group known as Satoshi Nakamoto, who published a white paper introducing the concept of a peer-to-peer electronic cash system he called Bitcoin [3]. Blockchain is a distributed ledger database that consists of records or transactions or various digital incidents that are executed by the participants. Blockchain technology can assist in achieving the seven objectives of SCM: their cost, quality, speed, dependency, risk reduction, sustainability as well as flexibility. The concept of blockchain is shown in Figure 2 [4].

At its core, blockchain is a distributed system recording and storing transaction records. In a blockchain system, there is no central authority. Instead, transaction records are stored and distributed across all network participants. Rather than having a centrally located database that manages records, the database is distributed to the networks and transactions are kept secure via cryptography. BC eliminates the need for a middleman that traditionally may facilitate such transactions.

Fundamentally, blockchains are distributed digital database that record and maintain a list of transactions taking place in real time. They may also be regarded as decentralized ledgers that sequentially record transactions or interactions among users within a distributed network. They have the following properties [5]:

- Firstly, they are autonomous. They run on their own, without any person or company in charge.
- Secondly, they are permanent. They are like global computers with 100 percent uptime. Because the contents of the database are copied across thousands of computers, if 99 per cent of the computers running it were taken offline, the records would remain accessible and the network could rebuild itself.
- Thirdly, they are secure and tamper-proof. Each record in blockchain is time stamped and stored cryptographically. The encryption used on blockchains like Bitcoin and Ethereum is industry standard, open source, and has never been broken.
- Fourthly, they are open, allowing anyone to develop products and services on them.
- Fifthly, as blockchain is a shared system, costs are also shared between all of its users.

The Blockchain was designed so transactions are immutable, i.e. they cannot be deleted. Thus, blockchains are secure and meddle-free by design. Data can be distributed, but not copied. When it comes to digital assets and transactions, you can put almost anything on a Blockchain. Different scenarios call for different Blockchains. Blockchain is used for different purposes as depicted in Figure 3 [6].

The BC technology currently has the following features [7,8]:

1.*Peer-to-Peer (P2P) Network:* The first requirement of BC is a network, an infrastructure shared by multiple parties. This can be a LAN at a small scale or the Internet at a large scale. All nodes participating in a BC are connected in a decentralized P2P network. Transactions are broadcast to the P2P network. Due to some limitations of P2P networks, some vendors have provided cloud-based BCs.

2. *Cascaded Encryption:* A BC uses encryption to protect transaction data. Blocks are encrypted in a cascaded manner, i.e. the encryption result of the previous block is used in encrypting the current block. The BC is secured by public key cryptography, with each peer generating its own public-private key pairs.

3. *Distributed Database*: A BC is digitally distributed across a number of computers. Each party on a BC has access to the entire database and no single party controls the data or the information. Since BC is decentralized, there is no need for central authorizes such as banks.

4. *Transparency with Pseudonymity*: Each node or participant on a blockchain has a unique 30-plus-character alphanumeric address that identifies it. Users can choose to remain anonymous or provide proof of their identity to others.

5. *Irreversibility of Records:* Once a transaction is entered in the database and the accounts are updated, the records cannot be altered. Records on the database is permanent, chronologically ordered, and available to all others on the network.

As illustrated in Figure 4, a blockchain comprises a peer-to-peer network of participant nodes, a distributed ledger consisting of immutable blocks of data, transactions recorded in the blocks, smart contracts to execute the transactions, and a consensus algorithm that decides the proposer of the next block [1].There are two types of blockchains: public and private. Public Blockchains are cryptocurrencies such as Bitcoin, enabling peer-to-peer transactions. Private Blockchains use Blockchain-based platforms such as Ethereum or Blockchain-as-a-service (BaaS) platforms running on private cloud infrastructure. A private BC is an intranet, while a public BC is the Internet. Companies will be disrupted the most by public Blockchains.

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2. APPLICATIONS

Blockchain technology (BCT) has also received considerable attention outside the financial sector. Over the past few years, the blockchain concept has attracted many industries. Several companies have identified possible use cases that could benefit from blockchain. Several prominent, forward-thinking companies are testing blockchain solutions and investigating blockchain uses for their supply chains. Several applications of blockchain technology in supply chain management are discussed in business practice Some of these applications include the following [1,9,10]:

- *Food Supply Chains:* Because food is essential, food supply chains have attracted more interest in applying blockchain technology than any other industry. The idea of being able to trace ingredients of any food or product back to its origin is very compelling. Food supply chains comprise many stages and they may not be finely monitored and tracked. As a result, end consumers are usually unable to trace their food products' origins. For the most part, the food we eat is the result of a complex global supply chain, comprising a complex web of production, processing, packaging, storage and distribution. In 2017, several leaders in the food industry came together to figure out ways blockchain can be used to improve global food safety. And today, companies like Unilever, Nestlé, and Walmart are using blockchain technology. Walmart has long been known as a leader in supply chain management, and has taken a serious interest in blockchain technology
- *Counterfeit Drugs:* These are a common challenge for the pharmaceutical industry. Recent studies in this industry show the effectiveness of blockchain in tracking and authenticating drugs.
- *Entertainment and Media:* This industry faces transparency challenges in its supply chain because stakeholders need to be assured of the quality of service and compliance of regulations. The complexity of this industry is due to not only the size of operations but also to the vast number of regulations.
- *Postage:* This is an industry that considers blockchain for its supply chain to detect counterfeit stamps as the number of fraud cases continues to increase. Adversaries may take advantage of the variation of currency and counterfeit old stamps. The lack of expiration date of stamps increases the complexity of the challenge.

3. BENEFITS

The blockchain technology has the potential to unlock significant value for organizations by reducing supply chain risk, increasing visibility, and enhancing trust across a complex ecosystem. The supply chain can significantly reduce the risk of unethical sourcing, shipping delays, inadequate storage, or ineffective distribution of your goods, The distributed ledger technology eliminates the need for intermediaries disrupting the ownership model. As shown in Figure 5, blockchain plays a crucial role in addressing supply chain issues transparency, traceability, and trust [4]. Another benefit that blockchain brings to the supply chain is increased data veracity and security. Other benefits of blockchain in supply chain include the following [11,12]:

- *Transparency:* Blockchain technology can provide real-time visibility and tracking of goods and products throughout the entire supply chain, from production to distribution to end consumers. Blockchain enhances supply chain management through process tracking, regulatory compliance, and reporting. This helps to increase transparency and trust between different parties in the supply chain. The implementation of blockchains will bring traceability, transparency, and accountability to the movement of goods and commodities.
- *Traceability:* Tracing the activities along the supply chain allows concerned parties to access price, date, origin, quality, certification, destination and other pertinent information using blockchain. This improves operational efficiency by mapping and visualizing enterprise supply chains. Blockchain helps organizations understand their supply chain and engage consumers with real, verifiable, and immutable data.
- *Tradeability* is a unique blockchain offering that redefines the conventional marketplace concept. Similar to how a stock exchange allows trading of a company's shares, this fractional ownership allows tokens to represent the value of a shareholder's stake of a given object. These tokens are tradeable, and users can transfer ownership without the physical asset changing hands. Recalls become less expensive and more efficient when manufacturers can locate affected products quickly and easily. Blockchain has the unique potential to track ownership records for real estate, automobiles, and digital assets.
- *Automation:* Automated compliance and reporting will reduce friction, reporting costs, and eliminate errors associated with manual activities.

- *Quality Control:* Blockchain can be used to track the quality of products as they move through the supply chain, reducing waste and improving customer satisfaction.

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- *Finance:* Blockchain can be used to facilitate supply chain finance, providing secure and transparent records of transactions between suppliers, manufacturers, and distributors.
- *Smart Contracts:* These are self-executing contracts with the terms of the agreement between buyer and seller being directly written into lines of code. They can be implemented using blockchain technology to automate and streamline supply chain processes, reducing costs and improving efficiency. Figure 6 shows a smart contract [13].
- *Reducing Paperwork:* By digitizing and automating supply chain processes using blockchain technology, administrative costs can be reduced, and paperwork can be eliminated, saving time and resources.
- *Food Safety:* Blockchain can be used to track and monitor food safety, ensuring that food products are safe for consumption. For example, IBM Food Trust is for food supply chain management that enables food producers, distributors, and retailers to track the movement of food products across the supply chain.
- *Compliance:* Blockchain can be used to ensure compliance with regulatory requirements by providing a transparent and auditable record of supply chain processes.

4. CHALLENGES

Supply chains are becoming more complex with the gradual globalization. As the complexity of the supply chain increases, so does the risk of disruption. Although blockchain supports supply chain management by resolving some of the existing concerns, like provenance and quality assurance, it also introduces additional costs for implementation and maintenance and also some security concern. Some challenges remain for making the supply chain more efficient, reliable, and secure. Some of the addressed challenges are transparency, provenance, performance improvement, quality assurance and control, and achieving sustainability.

Supply chains contain complex networks of suppliers, manufacturers, distributors, retailers, auditors, and consumers. It can be highly complex because it may comprise a large number of stages and all the involved parties need to keep track of the development of the product at each stage. The complexity of supply chain management has increased by not only directing the flow of goods but also the flow of information. With a large number of documents, the risk of fraud and forgery has increased and the level of transparency is being lost. The multi-party nature of supply chain tends to result in quite a few inefficiencies and opportunities for fraud. Despite these challenges, blockchain technology is very useful as the driver of digitization in the supply chain.

5. CONCLUSION

Blockchain is an Internet-based technology that is prized for its ability to publicly validate, record, and distribute transactions in immutable, encrypted ledgers. It has emerged as a promising approach to ensuring the traceability and integrity of data. By verifying and adding data in real time, blockchain can increase transparency across a supply chain. The ability to deploy blockchain technologies to create the next generation of digital supply chain networks will be a key element in business success.

Since blockchain technology is still in its infancy, it is governed by various laws in many nations. Blockchain technology is integrated in all sectors and is applied in the supply chain. Forward-thinking companies are now investigating blockchain as a technology that could potentially revolutionize supply chain as we know it. More information about the utilization of blockchain in supply chain can be found in the books in [14-23].

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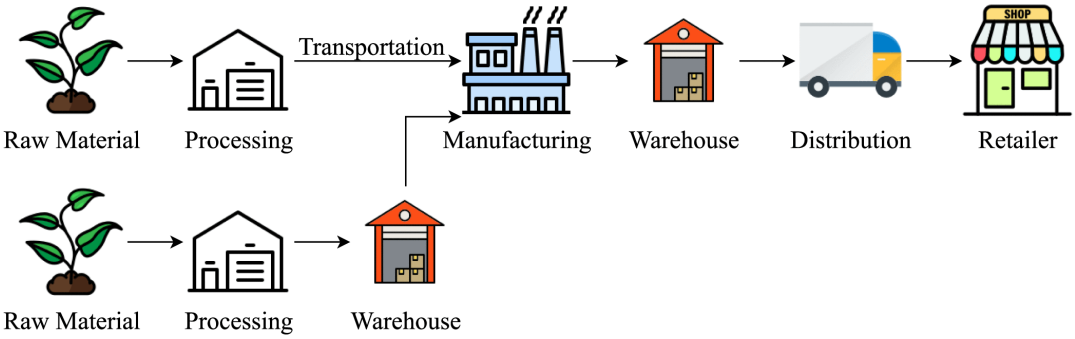

Figure 1 A typical example of the stages of a supply chain [1].

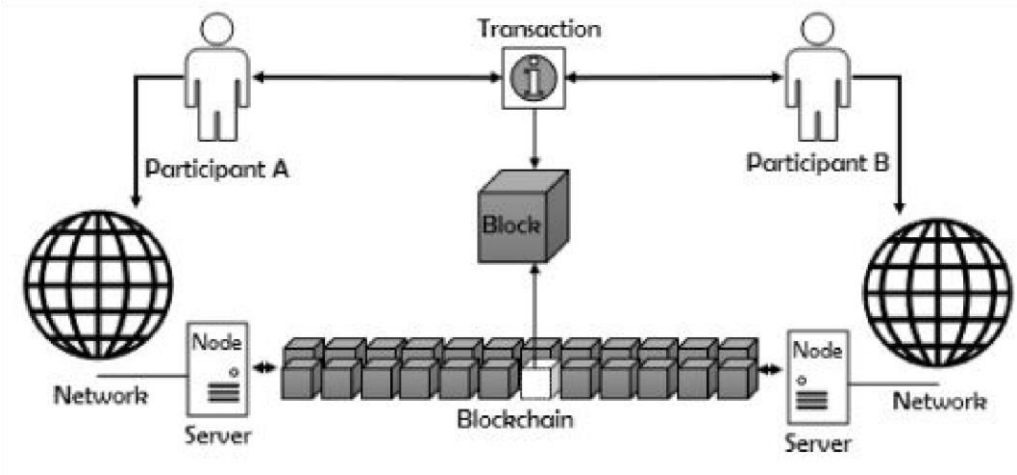

Figure 2 The concept of blockchain [4].

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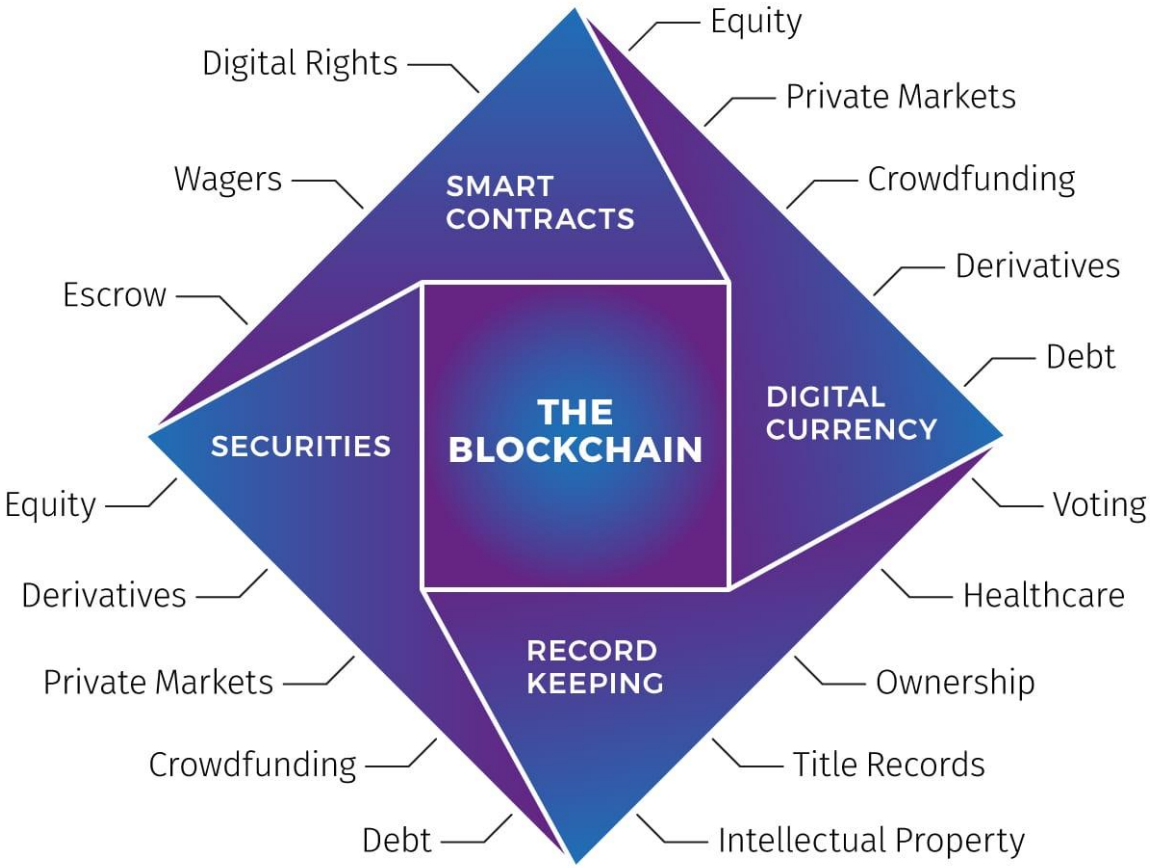

Figure 3 Different purposes of blockchain [6].

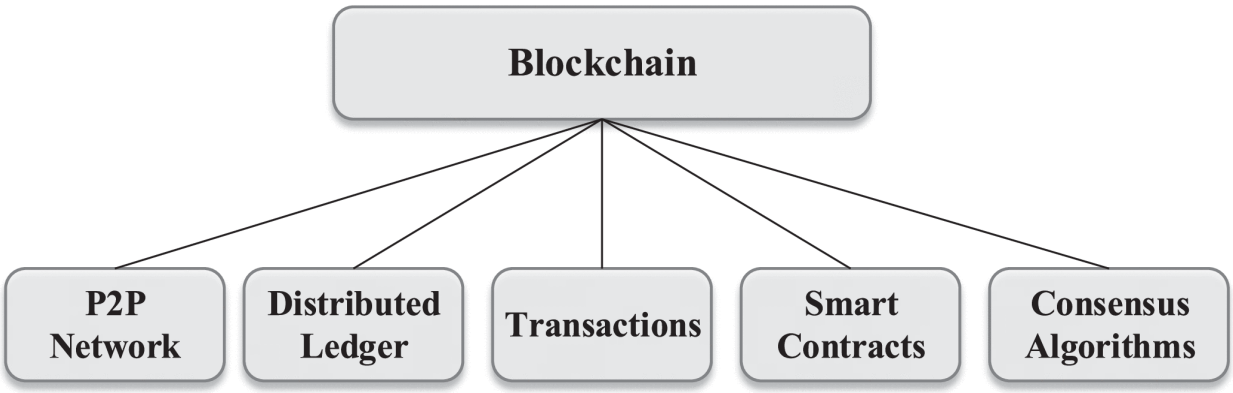

Figure 4 Components of a blockchain [1].

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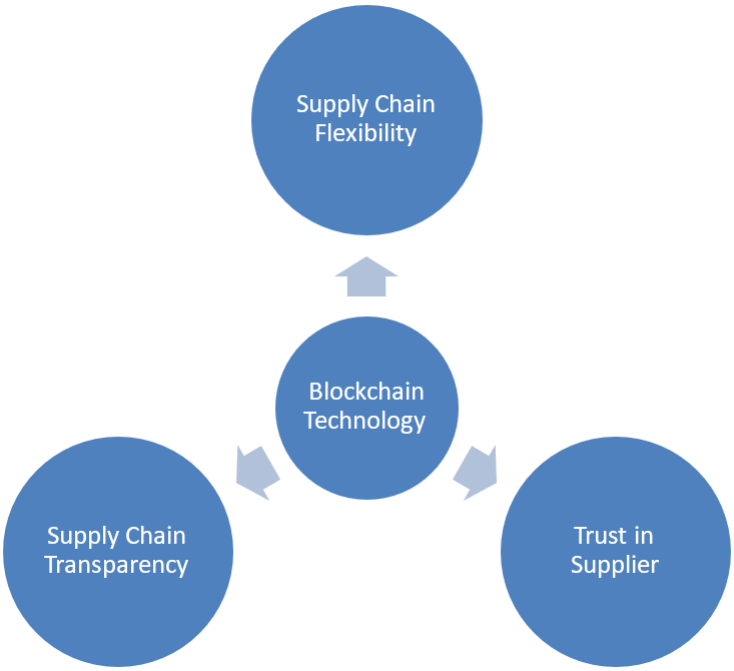

Figure 5 Blockchain utilization in supply chain [4].

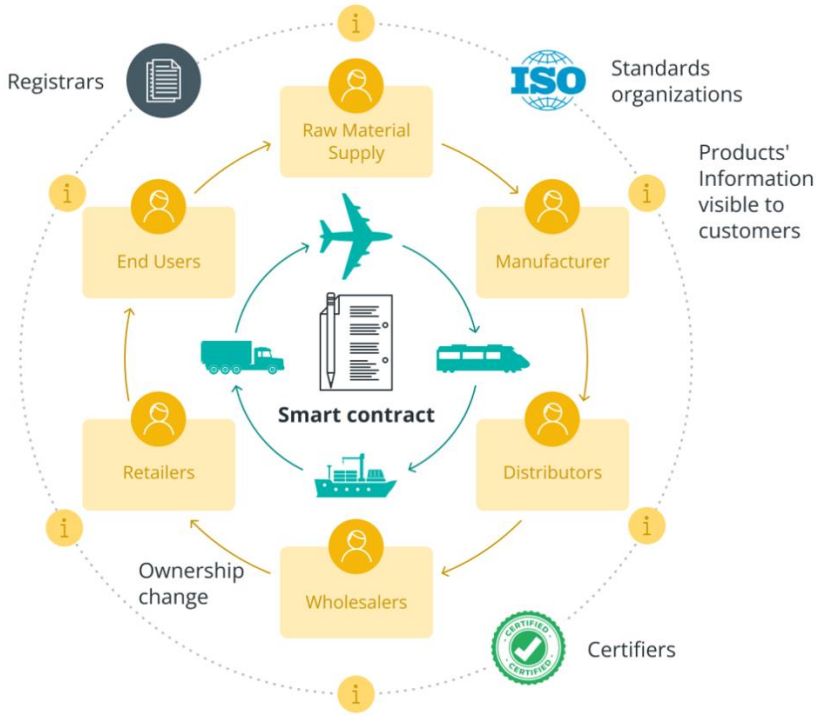

Figure 6 A smart contract [13].

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