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Review

Blockchain Technology Implementation in Logistics

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Abstract: This paper researches decentralized data storage represented by blockchain technology and the possibility of its development in sustainable logistics and supply chain management. Although the benefits of blockchain technology have been most widely researched in the financial sector, major challenges in logistics, such as order delay, damage to goods, errors, and multiple data entry can also be minimized by introducing blockchain technology. This paper presents a comprehensive review of the current and rising trends of blockchain technology usage in logistics and supply chain management.

Keywords: blockchain; logistics; internet of things; big data

1. Introduction

The supply chain is tied to the complex processes of creation and distribution of goods. Depending on the product, the supply chain can include many phases, multiple geographic locations, several accounts and payments, several individuals, entities, and means of transport. Therefore, procurement of supplies can be extended over several months. Because of the complexity and the lack of transparency of traditional supply chains, it is of great interest for the stakeholders involved in the logistics process to introduce and develop blockchain technology to enhance the logistics processes in the supply chain, making them more sustainable [1]. Blockchain technology is most often mentioned and used in crypto currencies, but the extent of possible applications is significantly larger. Blockchain is a distributed book (ledger) with many potential applications. It can be used for any data exchange, whether it is contracts, tracking of shipments and financial exchanges (payments). Each action is captured in the block and the data is distributed over many nodes (computers), making the system transparent. Every block connects to the one before and after, which makes the system safer. Blockchain can increase the efficiency and transparency of the supply chain and positively affect all logistic processes, from storage to delivery and payment. In addition to increased transparency and security achieved through blockchain, it is possible to speed up the physical flow of goods [2]. Tracking goods through blockchain can improve the decision-making process with end result being a more satisfying service for the end user. Blockchain technology possesses the potential for creation of new logistics services, as well as new business models. As a relatively new technology, blockchain is designed to achieve decentralization, real-time peer-to-peer operation, anonymity, transparency, irreversibility and integrity in a widely applicable manner. However, there are still vulnerabilities and challenges related to this technology that should not be neglected [3]. One of the limitations that stand out is its performance. The verification of every transaction requires the acknowledgement of every node in the network, which will take substantially more time than the centralized system.

This paper researches the possibilities of blockchain technology and its applications, with special emphasis on blockchain technology in logistics. It should be emphasized that no available literature sources have been found that comprehensively explain the exclusive application of blockchain technology principles in logistics. The goal of this paper is to explore possible use of blockchain technology in logistics processes, to identify impact of blockchain technology on business transparency and why it is important to implement blockchain technology in every part of the supply chain.

2. Blockchain Technology

The blockchain technology is based on a method by which previously unknown parties can jointly generate and maintain practically any database on a fully distributed basis where transaction correctness and completeness is validated using consensus of independent verifiers. The idea behind blockchain technology can be traced to 1991, when Stuart Haber and W. Scott Stornetta published their work on cryptographically secured chains of blocks. In 1992, they incorporated Merkle trees into the design allowing several documents to be collected into a block. Blockchain technology gained significance in 2008 when the pseudonymous Satoshi Nakamoto published the Bitcoin white paper [4–6].

The system works in a way that a copy of the database or its partial copy is distributed to each party, and such party may then make changes to the database subject to collectively accepted rules. The changes made by the various parties are collected and stored in the database at regular intervals as bundled packets called 'blocks' [7].

There are three main advantages of blockchain compared to other cover mediums: (1) it is anonymous and free to join, meaning that the communication parties have free access; (2) submitted data cannot be altered and, in particular, the integrity guarantees are not provided by any centralized party, but rather the consensus of the entire network; and (3) published data cannot be removed, meaning that no authority can apply censorship to already published data. Since the blockchain is immutable, alteration of the covert messages is virtually impossible, and the embedding of covert information is free to be fragile [8].

For better understanding of this paper, blockchain is defined as follows: "blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding time stamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity" [9,10].

Once the block is full, nodes simultaneously perform Proof-of-Work—mathematical operations that are difficult to solve but whose correct solution is easy to verify. These mathematical operations are indispensable to the operation of the system, as they force the verifying nodes to expend processing power which would be wasted if they included any fraudulent or invalid transactions. The first node that succeeds in solving a Proof-of-Work problem broadcasts the solution, along with the block of transactions, to all other nodes. Nodes can quickly and cheaply verify the accuracy of the transactions and solutions, and when 51% of the processing power of the network votes to approve a block, nodes begin recording new transactions to a new block, amending them to all previous blocks [11].

The blockchain technology solves double-spend problem with the help of public-key cryptography, whereby each user is assigned a private key, and a public key is shared with all other users. The main idea of the blockchain is a distributed database comprising records of transactions that are shared among participating parties. Every transaction is verified by the consensus of most of the participants in the system, making fraudulent transactions unable to pass collective verification. Once a record is created and accepted by the blockchain, it can never be altered [12].

This allows for the creation of a jointly generated electronic time stamp that all participants can trust, even if they do not trust one another. In this manner it is easy to verify the origin and accuracy of the information whatever its source. No external intermediary (such as a centralized server) trusted by all the parties is required to validate the data [10].

This mechanism of work includes the three most important properties of the blockchain: it is decentralized, verified, and immutable, as shown in Figure 1.

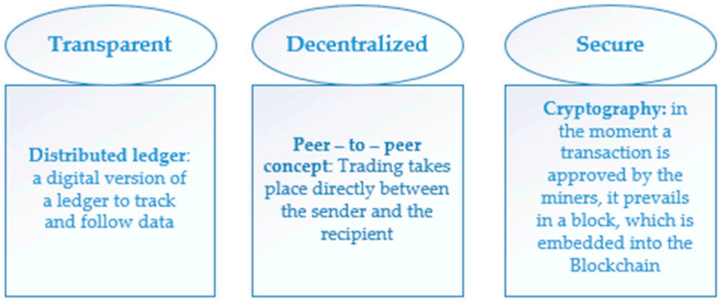

Figure 1. Basic properties of blockchain (authors and [13]).

The system is decentralized because the network is entirely run by its members, without relying on a central authority or centralized infrastructure that establishes trust. To add a transaction to the ledger, the transaction must be shared within the blockchain's peer-2-peer (P2P) network. All members keep their own local copy of the ledger. It is verified because the members sign the transactions using public-private key cryptography before sharing them with the network. Therefore, only the owner of the private key can initiate them. The members can be both transparent and stay anonymous because the keys are not linked to real-world identities. It is immutable through its consensus algorithm; one or more transactions are grouped together to form a new block. All members of the network can verify the transactions in the block. If no consensus on the validity of the new block is reached, the block is rejected. Likewise, if consensus exists that the transactions in the block are valid, the block is added to the chain. A cryptographic hash is generated for each block. Each block not only holds transaction records but also the hash of the previous block. This creates a block interdependency linking up to a chain—the blockchain. Altering a transaction on the blockchain would retroactively require not only to alter the local records on most of the networks members' devices but also altering the cryptographic hash of every block down the chain [13].

Generally speaking, it has become evident that the decentralized transaction ledger functionality implemented through the blockchain technology can be used not only for cryptocurrencies, but to register, confirm and transfer any kind of contract and property. Clearly, such an approach can be profitably adopted in many application scenarios and industry sectors, from logistics to finance, in healthcare, or even as a communication framework for supporting Artificial Intelligence (AI) applications. For example, public records such as vehicle registrations or marriage certificates could be migrated to suitable blockchains. Blockchain technology enables indeed the creation and management of *smart contracts* and *smart properties* [14]. Smart contracts represent the implementation of a contractual agreement, whose legal provisions are formalized into programming code and verified through a network of peers [15]. Indeed, these contracts are defined through the code and executed or enforced by the code, without the need for a trusted third party. An example of a smart contract is the enforcement of a bet between two users about the maximum humidity level tomorrow. On the following day, the contract is automatically completed by a software program checking the humidity levels provided by a qualified weather service or some given sensors, as stated by the contract itself, reading and transferring funds from the loser's to the winner's account [16].

Blockchain tackles an elusive networking problem by allowing for transactions that do not rely on a centralized authority. Values, goods and rights can be exchanged without central institutions. Such transactions are verified, monitored and enforced by means of the blockchain technology [17]. It offers confidence to everyone involved in the process.

This kind of technology changes the way transactions are conducted—a decentralized system, without using centralized system (banks, companies, etc.). In industry, blockchain technology transactions can be initiated and carried out directly "from peer to peer". As a result, industry companies can cut costs and speed up processes; they become more flexible, as many previously manual work tasks are carried out automatically through smart contracts [18].

One major promise of blockchain is to create transparency—every member of the network has access to the same data, providing a single point of truth. This can be the most important benefit of blockchain technology in logistics industry. The blockchain could be applied in many sectors in the future [19].

3. Possibilities of Blockchain Technology Usage

The blockchain technology can be utilized advantageously in different domains, from finance to more general societal applications [20].

Zyskind et al. [21] propose a decentralized personal data management system that ensures the user ownership of their data. This system is implemented on blockchain. They improved the efficiency of blockchain by using off-chain data storage and heavy processing where blockchain has the potential to improve the security of privacy sensitive data. The authors have proposed a decentralized personal data management system that ensures the user ownership of their data. For the first time, users can share their data with their privacy being cryptographically guaranteed. Only references to data and lightweight processing tasks are handled in the blockchain. The system can protect the data against these privacy issues using three safeguards: (1) data ownership, (2) data transparency and auditability, and (3) fine-grained access control [22].

The first blockchain was applied in the financial sector to serve as the basis for the cryptocurrency Bitcoin. Bitcoin uses P2P technology, and it operates without any trusted third-party authority that may appear as a bank, a chartered accountant (CA), a notary, or any other centralized service [5]. An owner has full control over owned bitcoins, can spend them at own discretion and without geographical constraints or involvement of any centralized authority. Bitcoin design is open-source, nobody owns or controls it. Moreover, it is a cryptographically secure electronic payment system, and it enables transactions involving virtual currency in the form of digital tokens called Bitcoin (BTC or bitcoins) [22].

Although Bitcoin is one of the most famous blockchain applications, blockchain can be applied in diverse applications far beyond cryptocurrencies [23]. The spectrum of blockchain applications ranges from cryptocurrencies, financial services, risk management, Internet of Things to public and social services [23]. Since it allows payments to be finalized without any bank or intermediary, blockchain can be used in various financial services such as digital assets, remittance and online payments [24,25].

Reputation is an important measure of the community trust. There is a rising number of cases of personal reputation records falsification. For example, in e-commerce, many service providers enroll a huge number of fake customers to achieve a high reputation. Blockchain can potentially solve this problem [23].

Blockchain can improve the security in distributed networks. Charles [26] proposed a novel anti-malware environment named BitAV, in which users can distribute the virus patterns (signatures) on blockchain. Blockchain technologies can also be used to improve the reliability of security infrastructure.

In addition to the increasing risk of the exposure of private data to malwares, various mobile services and social network providers are also collecting sensitive data. For example, Facebook has collected more than 300 petabytes of personal data since its inception [27]. Usually, the collected data are stored on the central servers of service providers, which might be susceptible to malicious attacks. Blockchain has the potential to improve the security of privacy sensitive data.

Blockchain technology includes several preventive mechanisms (e.g., distributed consensus and cryptography) to reduce risks of cyber-attacks. It has also been proposed as an innovative solution for areas such as clearing and settlement of financial assets, payment systems, smart contracts, operational risks in financial market, etc. [1,28].

Mattila et al. [29] contributed, in 2016, a new understanding on design patterns for managing product life-cycle information through blockchain technology. An effort is made to analyze how blockchain technology could be applied to overcome the digital trust and data synchronization issues related to the product-centric information management architectures.

In 2015, Nasdaq developed a cloud-based platform (Figure 2) called LINQ (Language-Integrated Query), built on a private blockchain, which stores information on current shareholdings and related changes, the prices of shares issued in each investment round and information on available stock options. The platform records individual steps before and during transactions. Users can thus keep track of who purchased shares of a particular company and how they were later sold. At the end of 2015, this system replaced the previous manual process based on documents and records maintained by lawyers, accountants and consultants, as well as those based on spreadsheet data provided by the start-ups themselves, which used to be prone to errors [30].

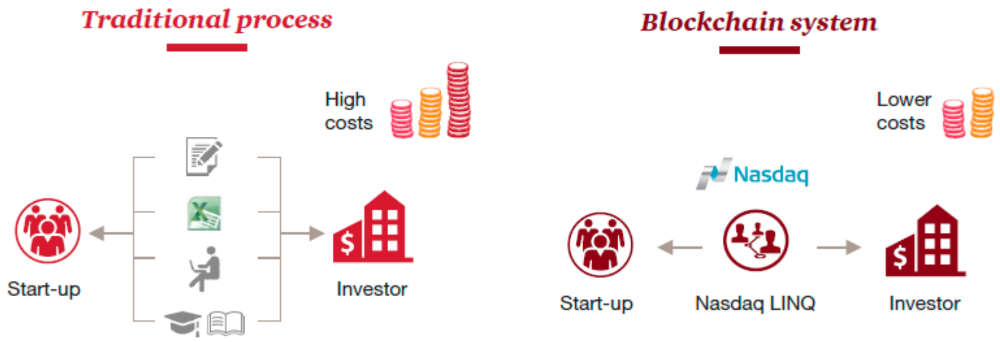

Figure 2. Nasdaq's LINQ platform [30] (p. 18).

According to Nasdaq, the first transactions carried out for a total of 6 start-up companies and their investors have been successful, subsequently the application being migrated also to other areas. Other than improving transparency and providing record keeping functionality, the platform delivers additional user benefits by reducing costs and accelerating the process. Nasdaq does not pass on the entire cost savings to customers as a benefit, but continues to charge a fee in exchange for service provision [26].

Blockchain technologies can potentially improve the IoT (Internet of things) technology. Internet of things (IoT), one of the most promising information and communication technologies (ICT), has been ramping up recently [23]. IoT is proposed to integrate the things (also named smart objects) into the Internet and provides users with various services [31,32]. The typical applications of IoT include logistics management with Radio-Frequency Identification (RFID) technology, smart homes [33], e-health [34], smart grids [35], the maritime industry, etc. [36]. The maritime industry is part of a complex and information-intensive maritime supply chain comprising a set of organizations that are globally connected and distributed, including other critical infrastructures that support world trade, such as transport and port structures. Although the maritime industry is technologically advanced, innovations in the maritime sector have been primarily related to ship construction, oil and gas exploration, seabed exploitation technologies, and other—mainly engineering-based—innovations. The industry lacks innovations related to operations procedures and logistics, which represent both a challenge and an opportunity. One of the most promising areas of maritime innovation is related to digitalization, including the development of smart ships, smart fleet and smart global logistics [37].

Blockchain is still a rather complex technology/concept for the majority of people/institutions that have been just keeping up with the current well-established systems. It may take many years before reaching its full potential and gradually seeping into the economic and social infrastructure, especially considering that a comprehensive replacement is required for the existing systems due to the nature of blockchain as a foundational technology [38].

4. Perspective of Blockchain Technology in Logistics

The supply chain is the network of organizations that are involved, through linkages, in the different processes and activities that produce value in the form of products and services in hands of the final customer [39].

Development of Industry 4.0 creates opportunities processes improvement in the supply chain. Industry 4.0 is holistic, with a (partial) transfer of autonomy, intelligence and autonomous decisions to machines. It improves the flexibility, speed, productivity and quality of the production process, greatly increasing sustainability. It lays the foundation for the adoption of new business models, production processes and other innovations. This will enable a new level of mass customization as more industrial producers invest in logistics 4.0 technologies to enhance and customize their offerings [10]. Logistics 4.0 enables integration and optimum alignment of processes within corporate boundaries; when it is successful, logistical issues relating to input and output streams of materials, can be significantly simplified. When it comes to transport, smart trucks, containers and pallets are opening up for new approaches to monitoring. Internet of things and big data are the basis of Industry 4.0 development. Sensors and the Internet of Things (IoT) are enabling goods containers to report when a value limit has been exceeded, e.g., temperature, tilt or incoming light intensity. The freight being forwarded remains in clear view across the entire supply chain.

To make full use of Logistics 4.0 and Industry 4.0., it is necessary to a apply big data approach. The term 'big data' encompasses the large volume of structured and unstructured data, which is growing exponentially and is analyzed using data analytics and warehousing. Big data analytics makes it possible to ensure better decision making [40]. Big data is the basis for the development of blockchain technology. Data analysis provides accurate information, through the use of which timely decisions can be made. The blockchain technology allows more secure tracking of all types of transactions, for example money transactions, data transactions, information transactions, etc. In the supply chain this technology could dramatically reduce time delays, added costs and human errors. With blockchain technology in the supply chain every time a product is exchanged between sides, the transaction could be documented, creating a permanent history of the particular product, from manufacture to sale (from suppliers to customers).

Logistics and supply chain management are regarded as domains where blockchains are good fits for a series of reasons. During the lifecycle of the product, as it flows down the value chain (from production to consumption) the data generated in every step can be documented as a transaction, thus creating a permanent history of the product. Among things, blockchain technology can effectively contribute to: (i) Recording every single asset (from product to containers) as it flows through the supply chain nodes, (ii) tracking orders, receipts, invoices, payments, and any other official document, and (iii) track digital assets (such as warranties, certifications, copyrights, licenses, serial numbers, bar codes) in a unified way and in parallel with physical assets, and others. Moreover, the blockchain can contribute effectively, through its decentralized nature, to sharing information about the production process, delivery, maintenance, and wear-off of products between suppliers and vendors, bringing new modalities of collaboration in complex assembly lines [41]. The challenges in logistics parameters, such as delays in delivery, loss of documentation, unknown source of products, errors, etc., can be minimized and even avoided by blockchain implementation. Benefits of integrating the supply chain with blockchain are the following: increased sustainability, reduced errors and delays, minimized transport costs, faster issue identification, increased trust (consumer and partner trust) and improved product transport and inventory management. Blockchain technology enables complete supply chain visibility. Under full visibility, it is considered to show the movement of goods both spatially and temporally throughout various phases and processes of the supply chain, from the physical condition of the consignment at any given moment, through various variations of the goods (e.g., temperature deviations) and to support the decision making of logistics operators. This way of doing business or developing a business process would fulfill the main task of logistics, which is to bring the goods to the right place at the right time in the right amount and in the original state.

The main features of blockchain could be very useful for application in the supply chain [42]; public availability gives the opportunity to track products from the place of origin to the end customer, the decentralized structure provides the ability for participation for all parties in the supply chain, and its cryptography-based and immutable nature gives the assurance of security.

Supply chain transparency is one of most important (and hardest to achieve improvement in) areas for logistics. Abeyratne S.A. and Monfared R.P. [43] provided a review of the current status of this technology and some of its applications. They discussed the potential of such technology in manufacturing supply chain and proposed a vision for the future "blockchain ready" manufacturing supply chain. Manufacturing of cardboard boxes is used as an example to demonstrate how such technology can be used in a global supply chain network.

Whenever goods and related documentation (e.g., bills of lading or ship notifications) pass from one actor in the supply chain to another, items are subject to counterfeiting or theft. To protect from this, blockchain technology involves the creation of a digital "token", which is associated with physical items when they are created. The final recipient of the item can then authenticate the token, which can follow the history of the item to its point of origin. End users have more confidence in the information they receive, since no one entity or group of entities can arbitrarily change the information contained within the blockchain. Due to most goods' linear flow from material origin to final consumer, blockchain is a suitable technology to enable supply chain traceability. Since goods and their associated "tokens" usually are not traded between competitors within in a given blockchain, this operational facet helps maintain anonymity. As such, participant confidentiality may be maintained [9].

Logistics and supply chains processes can be significantly improved by introducing the blockchain technology. Even the simplest application of the blockchain technology could bring the supply chain great benefits. Registering the transfer of products on the digital ledger as transactions makes it possible to identify the main data relevant for the supply chain management [44].

5. Benefits and Challenges of Blockchain Applications in Logistics

Companies in the logistics and manufacturing industries can implement decentralized concepts for goods and transport containers tracking. Driven by the demand for greater transparency in the supply chain, which allows traceability from start to finish, comprehensive technical solutions are required. This is often a challenge for IT solutions that focus on centralized solutions with complex access rights. Blockchain or derived concepts can provide a remedy because they have already addressed these issues [45,46].

Some supply chains are already using the blockchain technology, for example, the start-up UbiMS (A Global Supply Chain Revolution), is using blockchain technology [47,48]. UbiMS is the world's first patented, cloud-based meta-platform as a 3D (three-dimensional) supply chain process system for connecting multiple providers of goods with worldwide consumers and for a complete reinvention of the global supply chain process. It is a shared supply chain infrastructure for entrepreneurs and SMEs, modeled as a 3D globally interconnected e-marketplace and e-supply chain process system both for communication and distribution of material goods. The most obvious example of a 3D network is the Internet, in the sense that it is simply a meta-platform for information, connecting multiple information sources to multiple information recipients. Moreover, UbiMS will be developed using blockchain technology. UbiMS is the first decentralized open supply chain infrastructure system. Therefore, it is possible that UbiMS 3D process platform with blockchain technology will disrupt the whole global supply chain industry [47].

As blockchain is considered to be a solution for connecting and managing IoT devices reliably, logistics might be one of the most promising fields of application, given the large amount of possible IoT objects in a logistics environment (such as vehicles, shipments, etc.). For example, Walmart aims at improving last mile deliveries through coordinating delivery drones using the blockchain. Moreover, IoT devices connected to the blockchain could also make use of cryptocurrencies, enabling them to interact autonomously with other parties through smart contracts in order to pay fees and duties by themselves, e.g., for priority access to restricted air corridors [48].

In the paper "An agri-food supply chain traceability system for China based on RFID & blockchain technology" [49], the authors analyzed the advantages and disadvantages of using RFID (Radio-Frequency Identification) and blockchain technology in building the agri-food supply chain traceability system. They demonstrated the building process of this system. It can achieve the traceability of trusted information throughout the entire agri-food supply chain, which would effectively guarantee the food safety, by gathering, transferring and sharing the authentic data of agri-food in production, processing, warehousing, distribution and selling links.

IBM has tried to streamline the leverage of blockchain in the supply chain [42]. IBM, in partnership with Samsung, developed the platform ADEPT ("Autonomous Decentralized Peer to Peer Telemetry"), which uses elements of the bitcoin's underlying design to build a distributed network of devices, or decentralized Internet of Things. ADEPT uses three protocols in the platform: Bit Torrent [50] (for file sharing), Ethereum (for Smart Contracts) and TeleHash (for Peer-To-Peer Messaging) [51].

Blockchain can help digitally trace and authenticate food products from an ecosystem of suppliers to store shelves and ultimately to costumers (Figure 3). IBM, Walmart and Nestle are aspiring to use blockchain for more transparent, authentic and trustworthy global food supply chain [52]. Several existing applications combine blockchain and food technology, with the primary idea being to solve food safety issues. Their motivations are consistent with the objective of building a safe, sustainable and transparent food supply chain [53].

The cloud-based IBM blockchain platform delivers end-to-end capabilities that clients need to quickly activate and successfully develop, operate, govern and secure their own business networks. IBM and Maersk see the adoption of blockchains as one way to achieve this improvement; by providing a single view of all transactions taking place among a complex network of parties, blockchain can help eliminate considerable resource waste. Blockchain can help all parties involved in shipping to increase sustainability, reduce or eliminate fraud and errors, improve inventory management, minimize courier costs, reduce delays caused by paperwork, waste and identify issues faster. This could increase worldwide GDP by almost 5% and total trade volume by 15% [54].

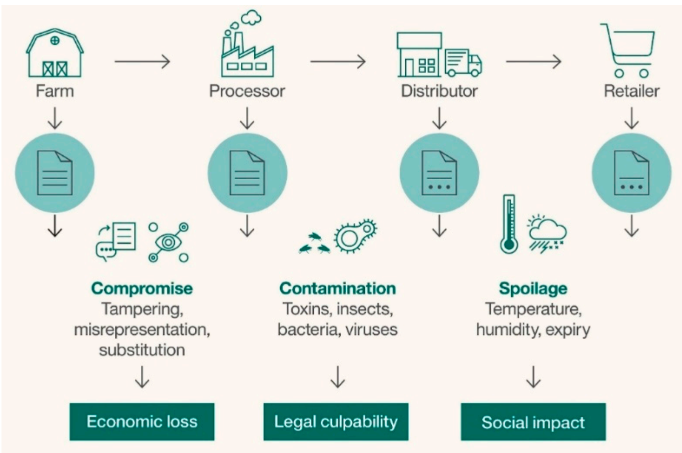

Figure 3. IBM blockchain supply chain [52].

Hackius and Peterson [13] conducted a research about blockchain in logistics. They conducted an online survey and asked logistics professionals for their opinion on the following use cases: barriers, facilitators, and the general prospects of blockchain in logistics and supply chain management. Most of their participants were positive about blockchain technology and the benefits it offers. They reason that the benefits over existing ICT solutions must be carved out more carefully and use cases must be further explored to get a rather conservative industry, like logistics, more interested in blockchain. Participants can query transaction data in the blockchain, which ensures the transparency of the whole platform. Additionally, data in the system is protected by encryption algorithms and distributed data storage [55]. They concluded accordingly the following about the blockchain's potential (Figure 4):

1. EASE PAPERWORK PROCESSING (global container shipping involves a lot of paperwork—costing time and money. Also, freight documents are prone to loss, tampering, and fraud);

2. IDENTIFY COUNTERFEIT PRODUCTS (counterfeit medicine is a growing problem for pharmacy supply chains. This especially pertains to expensive, innovative medicine like cancer drugs. Pharmacies must make sure to sell "the right thing" to the consumers);
3. FACILITATE ORIGIN TRACKING (in the food supply chain, foodborne outbreaks are a challenge for retailers. They must get a quick overview of where the food came from and which other products are also affected and must be removed from the stores);
4. OPERATE THE INTERNET OF THINGS (logistics objects are equipped with sensors that generate data along the supply chain—e.g., about the status of a shipment. This data must be stored in an immutable, accessible way).

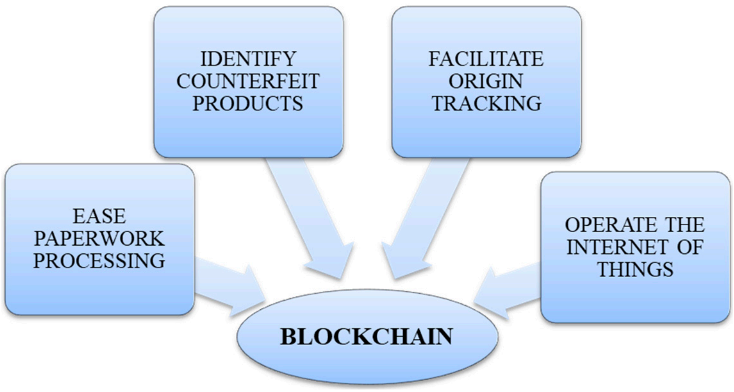

Figure 4. The potential of blockchain technology in logistics [13].

In this case, the study authors have identified business processes that are part of logistics. They presented a study of the current state and knowledge of blockchain technology in logistics and supply chain. The research and analysis were conducted by examining the opinions of owners and employees in logistics industry about implementation of the blockchain technology. According to their analysis, based on the data collected during the testing, implementing the blockchain technology into logistics activities was considered very positive [13].

According to information published on official DHL Web pages, up to 10% of bills of lading contain incorrect data that may lead to litigation and disputes [56]. Blockchain technology might have a significant role in the improvement of processes in logistics and, consequently, in mitigating these issues. This will be especially apparent with further implementation of blockchain technology in creation of smart contracts. Such type of contracts could digitize commercial services and improve underlying business processes. One of the first startups that used smart contracts in maritime logistics was ShipChain [57]. ShipChain is a company that has envisaged a system based on blockchain to track goods from the moment they leave the factory until delivery to final destination (customer). Process automation is based on digital currency (so-called "SHIP tokens"). Stakeholders of the ShipChain platform purchase tokens to pay for the cargo and transactions executed using ShipChain platform. This business model enables data and transaction permanence and facilitates information sharing, thus elevating platform transparence to the highest possible level.

Generally speaking, several weaknesses and threats related to blockchain technology are identified. Blockchain technology suffers from scalability and performance issues. All nodes in the chain must process all transactions, and this presents an issue with large and especially global scale roll-outs. The technology is very energy intensive, and proof calculations expend significant amounts of processor power. Users' privacy might be reduced, because all nodes contain a full copy of the ledger, and there is no central authority to contact in case of evident security breach. Furthermore, the technology is still very immature, there is no single underlying standard, concepts are difficult to be mastered and there is need for programming intervention even in the simplest forms of implementation. Threats to blockchain implementation are complementary to identified weaknesses. The novelty of the technology still means the reluctance of the main technology players to adopt it. With various levels of merit, the technology can be perceived as unsecure and unreliable. Also, lack of regulation creates insecurity, because some facets of smart contract technology might be adopted by the logistics market, just to be overregulated, or even to be considered illegal [58].

6. Conclusions

Blockchain technology offers an innovative platform for a new decentralized and transparent transaction mechanism in industry and business. Features of this technology increase confidence through transparency within any transaction of data, goods, and financial resources. Blockchain technology can easily provide secure business operations in logistics. The technology platform is based on a decentralized system, and it creates a permanent record that can be shared and publicly accessible. In the second paragraph, "blockchain technology", a brief overview of the underlying decentralized ledger technology was given, along with basic properties of the protocol.

Aside from financial services (such as digital assets, remittance and online payment) and cryptocurrency, blockchain technology can be used for applications in risk management, Internet of Things (including the logistics management with RFID, smart homes, e-health, smart grids, maritime Industry, etc.) and in public and social services (for example, in e-commerce blockchain technology can potentially solve the problem of fake customers).

The blockchain technology allows more secure tracking of all types of transactions (money transactions, data transactions, information transactions, etc.). In the logistics sector, blockchain technology could dramatically reduce time delays, added costs and human errors.

The use of RFID and blockchain technology in building of the agri-food supply chain traceability system can enable the traceability with trusted information in the entire agri-food supply chain, which would effectively guarantee the food safety, by gathering, transferring and sharing the authentic data of agri-food in production, processing, warehousing, distribution and selling links. Some supply chains are already using the blockchain technology. In the Section 3, "Possibilities of blockchain technology usage", an overview of ongoing implementation projects and applications of the blockchain technology is described with examples in financial and logistics sectors.

Blockchain can help digitally trace and authenticate food products from an ecosystem of suppliers to store shelves and ultimately to end customers. IBM blockchain platform delivers end-to-end capabilities that clients need to quickly activate and successfully develop, operate, govern and secure their own business networks. Blockchain technology can be the solution for overall improvement of logistics, it can help reduce or eliminate fraud and errors, minimize costs, reduce waste and delays, improve inventory management and it can help to identify issues faster. The Section 4, "Perspective of blockchain technology in logistics", is a central part of the paper, where various facets of implementation of the distributed ledger technology in logistics are described.

Finally, by using blockchain technology, the challenges encountered by the logistics sector can be minimized or even eliminated, and sustainability can be greatly increased. In the final, Section 5, based on previous research, appropriate conclusions are derived about possible obstacles and advantages in blockchain technology implementation. This technology can facilitate logistics tasks: it can be used to track purchase orders, order changes and freight documents, and it can help in information sharing about manufacturing process and delivery. The blockchain technology has huge potential for development and application in the logistics sector and supply chain, presenting challenges for further research.

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