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Research Article

The Effects of the Applications of Blockchain Technology on the Logistics Sector

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Abstract

Logistics is a combination of businesses involving various activities and processes which generate value by goods and services. Maintaining track of all transactions is a crucial task in logistics. Logistics 4.0 enables the optimum synchronization of activities inside corporate boundaries; if effective, logistical constraints resulting from industrial sender and receiver channels may be considerably alleviated. Blockchain paves the way for implementation of smart logistics. It served as storage for the transactions after distributed ledger technologies was implemented before the digital cryptocurrency a year ago. It is a decentralized system based on five essential principles: decentralization, P2P, transparency with privacy protection, and algorithmic logic. Some logistics companies are already employing block chain. This paper summarizes adoption of distributed ledger technology in logistics is being investigated. Furthermore, the strengths and weakness of blockchain in logistic industry were extracted from recent scientific literature for readers to overview the application of technology. It is reported that blockchain adoption provides immutability, data security, tracking, storage, dependability, and cost-effective alternatives in logistics industry. However, there are a few obstacles that prevent full-scale adaption by many logistics and transportation sectors, such as throughput, and latency constraints. Nodes aren't monitored by centralized entity to notify security breach, so data security may be compromised. Furthermore, the blockchain is still in its infancy; there's no single standard, theories are difficult to grasp, and even the most basic types of application need programmer assistance.

Keywords: Blockchain Technology, Logistics, Transportation

Blokzinciri Teknolojisi Uygulamalarının Lojistik Sektörüne Etkileri

Öz

Lojistik, ürün ve hizmetlerle değer yaratan çeşitli faaliyetleri ve süreçleri içeren işletmelerin bir kombinasyonudur. Yapılan tüm işlemlerin kaydını tutmak lojistikte çok önemli bir işlemdir. Lojistik 4.0, kurumsal sınırlar içindeki optimum senkronizasyonunu sağlar; eğer etkiliyse endüstriyel gönderici ve alıcı kanallarından kaynaklanan lojistik kısıtlamalar önemli ölçüde hafifletilebilir. Blok zincir teknolojisi, akıllı lojistiğin yolunu açmaktadır ve bir yıl önce dijital kripto para biriminden önce dağıtılmış defter teknolojilerinin uygulanmasından sonra işlemler için depolama görevi görmüştür. Beş temel ilkeye dayanan bir sistemdir. Bunlar merkezi olmayan, uçtan uca, gizlilik korumalı, şeffaflık ve algoritmik mantıkdır. Bazı lojistik firmaları hali hazırda blok zincir teknolojisini kullanmaktadır. Bu makale, araştırılmakta olan lojistikte dağıtık defter teknolojisinin benimsenmesini özetlemektedir. Ayrıca lojistik endüstrisindeki blok zincir teknolojisinin güçlü ve zayıf yönleri araştırmacıların teknolojinin uygulamasını gözden geçirmesi için güncel bilimsel literatürden yararlanılmıştır. Blok zincir teknolojisinin benimsenmesinin lojistik sektöründe değişmezlik, veri güvenliği, izlenebilirlik depolama güvenilirlik ve uygun maliyetli alternatifler sağladığı bilinmektedir. Ancak verimlilik ve gecikme kısıtlamaları gibi bir çok lojistik ve ulaşım sektörü tarafından tam ölçekli uyarlamayı engelleyen birkaç engel vardır. Düğümler güvenlik ihlalini bildirmek için merkezi varlık tarafından izlenemez, bu nedenle veri güvenliği tehlikeye girebilir. Ayrıca blok zincir teknolojisi halen başlangıç aşamasındadır; tek bir standart yoktur, teorileri kavramak zordur ve en temel uygulama türleri bile uzman yardımına ihtiyaç duyulmaktadır.

Anahtar Kelimeler: Blok Zincir Teknolojisi, Lojistik, Taşıma.

1. Introduction

Nakamoto [1] invented blockchain and introduced Bitcoin in 2008, distributed peer-to-peer (P2P) technology is now one of the revolutionary technology in various industries and is predicted to be widely used by many industries and various of its sectors [2]. Recent studies of industry professionals and logistics and supply chain managers have revealed a willingness to adopt blockchain solutions, particularly in the context of distribution networks and transportation and logistics [3]; nevertheless, the world is still at the nascent stages of exploiting this technology's entire promise in economic globalization, logistics, and transit sectors. Although there is considerable hype surrounding blockchain adoption, and people are few decades away from visualizing blockchains industrialized, as the future of this technology is promising.

Academic papers on blockchains in transport and logistics journals continue to be few. However, due to the increased interest in this subject, It is foreseen that there will be an increase in the prevalence of blockchain publications with various technology applications for logistics operations in the coming years. Some publications in the field include Kshetri [4] investigates the influence of blockchain on several supply chain management objectives using a multiple case study technique, offering successful industrial cases as illustrations for each aim. Saberi and co-authors [5] investigate the major roadblocks to blockchain adoption, particularly smart contracts, to achieve long-term logistics management objectives. Babich and Hillary [6] present a complete analysis of blockchain studies in logistics operations, as well as prospective based upon the information within the field, such as inventory control, information extraction, licensing, regulatory compliance, and supplier management, among others.

As blockchain is engraving its claws in smart logistics, improved supply chain accountability, freight monitoring, and carrier onboarding as a service are just a few of the use cases that have already emerged in the sector, revealing the latent revolutionary possibilities of blockchain [3], [6]. This study intends to add to these efforts by collecting recent scholarly discussions, industrial use cases, and potential future developments in this field till. It attempts to fill this research gap related to scientific literature's most recent development in examining the acceptance and use of blockchain in logistics, and transportation.

The current study is structured as follows. First, a brief explanation of blockchain technology and its key characteristics is provided. Following that, the use of distributed ledger technology in logistics is being investigated. Furthermore, the strengths and weakness of blockchain in logistic industry were extracted from recent scientific literature for readers to overview the application of technology.

2. Material and Method

Logistics is a structure of businesses involved in various activities and processes which generate value by goods and services in the hands of consumer through links. Maintaining track of all transactions is a crucial task in logistics. In this profession, keeping track of past activities and performance, and anticipated activities, is critical. Logistics 4.0 enables the convergence and optimum synchronization of activities inside corporate boundaries; if effective, logistical constraints resulting from industrial sender and receiver channels may be considerably alleviated [7].

Blockchain paves the way for implementation of smart logistics. It served as the public information for the transactions after distributed ledger technologies was implemented before the digital cryptocurrency a year ago. It is a decentralized system based on five essential principles: decentralization, P2P, transparency with privacy protection, data impermanence, and algorithmic logic [8]. Among other functionality, blockchain can effectively add value by I) recording all products, transaction (from products to containers) flowing in the distribution network nodes, (ii) tracking purchases, pay stubs, expenses, fees, and any other supporting documentation, and (iii) closely monitoring assets (warranty coverage, accreditations, licenses, product id, bar codes) in a fully integrated with physical assets, and so on. Furthermore, due to its decentralized nature, blockchain could well enable accurate information exchange about the production process, dissemination, maintenance, and merchandise displacements between consumers and suppliers, opening up new frameworks of cooperation in complex assembly lines. [9].

The blockchain consists of five core elements [10], [11]; (1) Distributer ledger technology; (2) P2P network; (3) cryptographic jargon; (4) consensus protocols; and (5) smart contracts

The Blockchain as a common structure of storage: The block's transactions, which are attached to one another in chronological sequence, will serve as a source of confidence for everyone involved. Although Bitcoin has severe shortcomings, such as the limitations of Turing-completeness and interconnected contracts in the Bitcoin blockchain. Ethereum, which was first proposed by [12], was intended to increase the capabilities of distributed ledger technology.

Ethereum is by far the most widely used smart contract framework for developing open protocols, DApps, and tokens. Open protocols are made up of smart contracts, and they may use their own set of rules for identity, transaction forms, and state transitions. [12]. The Ethereum Protocol's built-in programming features enable programmers all over the globe to create DApps that are accessible from anywhere. Tokens are a novel form of application as well. Tokens, according to [13], are digital unit of money that can represent asset ownership or guarantees for the supply of goods or services. The great majority of tokens are created on Ethereum's ERC20 token standards and are based on smart contracts. To facilitate interoperability across tokens on the Ethereum network, ERC20 tokens have adopted a common Application Program Interface (API) [14].

Proof of transactions such as service and product availability, onboarding and deployment, distribution network management is digitally hashed and recorded.

The technology's intrinsic qualities of data integrity, transparency, and decentralization in logistics are projected to give a relative advantage. For example, Author [22] and [18] emphasize the secure, replicated, and synchronization ledger for digitized contract of carriage which can't be covertly altered since the genuine is always accessible. Automated lading bills help to accelerate present operations and cut costs by eliminating or reducing the paperwork involved.

The adoption of possible blockchain applications in the logistics sector may very well be classified based on [15] innovative features, this gives little insights into the repercussions

of individual blockchain implementations on the structures and procedures of firms. A framework to link prospective blockchain solutions in the logistics industry to the various stages, and to help managers understand the success quadrant, thereby assisting managers in understanding the sorts of difficulties it presents, and the level of coordination and consensus required.

Some logistics companies are already employing block chain; for example, the setup of UbiMS (A Logistics and Supply chain Revolution) does so [16]. It's the largest first patent platform as a 3D logistic and transit network for linking numerous sources of commodities with global customers and for completely reinventing the global logistics operations. It's a collaborative distribution network infrastructure for entrepreneurs worldwide networked e-marketplace system for both communications and material commodities delivery. It is basically a platform for information, linking numerous data resources to various knowledge consumers on the Internet. UbiMS is built utilizing blockchain technology for open, decentralized, 3D supplies chain infrastructure that has the potential to revolutionize the entire global logistics business [16].

IBM, Walmart, and Nestle all want to utilize blockchain to make the global food logistics chain more efficient, legitimate, and trustworthy [17]. Given the vast number of potential IoT items in a logistics environment, it's the most attractive domains of use for blockchain, since it is regarded a solution for safely connecting and controlling IoT devices. Walmart wants to improve last-mile shipments by utilizing blockchain to coordinate delivery drones. Furthermore, IoT devices are linked to the blockchain might employ cryptocurrency, allowing them to engage with other participants through smart contracts to pay fees and custom duties such as for prioritized access to limited air corridors [16]. IBM and Samsung collaborated on the technology ADEPT (Autonomous Decentralized Peer 2 Peer Telemetry), which builds a distributed network of sensors, or decentralized IoT, using components of bitcoin's core architecture. BitTorrent, Ethereum, and Tele Hash are the three protocols used by this framework for sharing and storing file [18].

The implementation of blockchains, according to IBM and Maersk, is one approach to achieve improvement; by offering a single overview of all transactions occurring across a complicated network of participants, blockchain may help reduce significant wastage of resources. All parties engaged in shipping may benefit from blockchain technology by increasing sustainability, reducing, or eliminating fraud and mistakes, improving inventory control, lowering courier costs, reducing delays induced by paperwork, reducing waste, and identifying concerns sooner [19].

A study on blockchain in logistics was undertaken by [20]. They ran an online poll to get feedback on the relevant use cases: hurdles, facilitator, and the overall implications of blockchain in logistics. Most of the attendees were enthusiastic about the technology and the advantages it provides. They argue that the advantages of blockchain over conventional ICT solutions should be sculpted precisely. Participants can search transaction records, ensuring the platform's transparency. Furthermore, encryption methods and dispersed data storage secure data in database [21]

3. Results and Discussion

The technology's intrinsic qualities of data integrity, transparency, and decentralization in logistics are projected to give a relative advantage. For example, Author [22] and [18] emphasize the secure, replicated, and synchronization ledger for digitized contract of carriage which can't be covertly altered since the genuine is always accessible. Automated lading bills help to accelerate present operations and cut costs by eliminating or reducing the paperwork involved with today's modern business practices [20]. Furthermore, under the existing logistics system, the capacity to track the origins of items or learn more about them that is severely limited [23]. A safe platform for businesses to communicate and trade data about their commodities is provided by blockchain. The exchange of information and demonstration to customers about where their products are sourced from resilient and secure manufacturers might boost customer loyalty and, as a result, profits. Similarly, there has been an increase in awareness about the environmental effect of freight [24], [25], [26], and logistics firms have developed sustainable choices. But, due to the several layer of contractors engaged in most transportation procedures, it is difficult to certify ecologically favorable requirements [27].

Customer will be able to track items back to primary node in the transportation chain if such data was provided on the blockchain, offering insight into the chosen transit route and operator. Smart contracts can also give a relative advantage since they can remove or significantly reduce operational costs by using the blockchain's recordkeeping and auditing features, and the ability to execute transactions automatically [28], [29].

Three blockchain innovations appear to offer the biggest benefits when implemented in terms of compatibility: validating items, decreasing paperwork, and end-to-end monitoring. Logistics companies transport expensive commodities and confirming paperwork across spatial and temporal, involving several players, and are thus vulnerable to forgery, theft, and manipulation [20].

Since information on the blockchain can't be modified, using blockchain technologies may dramatically limit the likelihood of an item being manipulated. Furthermore, using the technology will enhance the administration of now time-consuming administration paperwork, since shipment validation and inspection are already time-consuming and subject to the possibility of human mistake impacting the operation.

There are various issues involved with blockchain adoption that have obvious implications for network theory. They include inter-organizational connections, trust, dedication, knowledge sharing, and so on. One of the most noticeable flaws is its performance [7]. Every transaction will require the confirmation from every network's node, which might require more time than the centralized technique. Using general encryption cryptography, each user is assigned a personal and system's key, which is conveyed to all other participants in network, blockchain overcomes the double-spend problem [37].

Table 1. Analysis of Major Strengths of Blockchain in Logistics

Parameters	References
Immutability and Inviolability	[30], [20], [31]
Tracking and Storage	[23], [21], [9], [32], [20], [33]
Cost Reduction	[28] ,[29], [24], [34], [25], [26]
Integration and synchronization	[33], [35], [31]
Automated procedure and execution	[36], [20]

The blockchain's fundamental concept is a networked database that contains track of transaction which are distributed among participants. Fraudulent transactions are unable to overcome collective verification since every transaction is validated by the consent of the most of the system's validators. A record can never be changed once it is made and approved by the blockchain [38]. Table I shows Major Strengths of Blockchain in Logistics.

4. Conclusions and Recommendations

Blockchain adoption provides decentralization, immutability, inviolability, data security, tracking, storage, ledger secrecy, dependability, and cost-effective alternatives in logistics industry. Competitive strategies to firms who use this technology enable them to minimize transactional costs, provide extra services, demarcate organizational boundaries, and automate and decentralize decision making. However, proliferation of smart logistics, improved supply chain accountability, freight monitoring, and carrier onboarding as a service are just a few of the use cases that have already emerged in the sector, revealing the latent revolutionary possibilities of blockchain. The study brings the status of adoption of blockchain in logistics industry to light and reveals some challenges faced during commencement of technology in the field. There are a few obstacles that prevent full-scale adaption by many logistics and transportation sectors, such as throughput, and latency constraints. As the transaction volume grows, so do the size and computational power required to authenticate blocks. The most crucial component is to help remove obstacles and problems, to share a protracted vision, and distribute the required resources. Blockchain will take some time to achieve its pinnacle and it's not too far when the logistics and transportation industry will be fully decentralized, automated, and smart.

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