



A Comprehensive Analysis of Blockchain Applications in Supply Chain Management and Logistics Activities

Tedarik Zinciri Yönetiminde ve Lojistik Faaliyetlerde Blockchain Uygulamalarının Kapsamlı Bir Analizi

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Abstract

Blockchain technology, which is impossible for people and businesses to ignore and brings great changes at the sectors where it is used, contributes to the solution of many problems at businesses. However, it has not been applied in the field of supply chain and logistics to the expected extent and there are the limited number of studies in the literature on this subject compared to other fields. In this context, the aim of the study is to explain blockchain technology in detail, to ensure that the technology is fully recognized, to create awareness on businesses by explaining its benefits with examples of use in supply chain and logistics activities, and to contribute to later researchers by identifying the gaps in the literature by analyzing the literature. As a result of the exploratory research, it was determined that blockchain technology contributes to the solution of many problems, especially reliability, cost, flexibility, delays, transparency, and low performance. Considering the result of the literature analysis, it has been concluded that academic studies on blockchain technology in the field of supply chain and logistics are not sufficient, and the number of these studies should be increased in order for the technology to be learned and used by more businesses in the relevant field.

Keywords: *Blockchain, Blockchain Technology in Supply Chain, Blockchain Technology Applications in Logistics Activities.*

Öz

İnsanlar ve işletmeler için göz ardı edilmesi imkânsız olan ve kullanıldığı sektörlerde büyük değişimleri beraberinde getiren blok zincir teknolojisi, işletmelerde birçok sorunun çözümüne katkı sağlamaktadır. Ancak blokzincir teknolojisi, tedarik zinciri ve lojistik alanında beklenen ölçüde uygulanmamış ve bu konuda literatürde diğer alanlara göre sınırlı sayıda çalışmaya yer verilmiştir. Bu bağlamda çalışmanın amacı, blokzincir teknolojisini açıklamak, teknolojinin iyi tanınmasını sağlamak, faydalarını tedarik zinciri ve lojistik faaliyetlerinde kullanım örnekleri ile açıklayarak işletmeler üzerinde farkındalık yaratmak ve literatür analizi yaparak literatürdeki boşlukları tespit ederek sonraki araştırmacılara katkı sağlamaktır. Yapılan keşifsel araştırma sonucunda blockchain teknolojisinin güvenilirlik, maliyet, esneklik, gecikmeler, şeffaflık ve düşük performans başta olmak üzere birçok sorunun çözümüne katkı sağladığı tespit edilmiştir. Yapılan literatür analizi sonucunda, tedarik zinciri ve lojistik alanında blockchain teknolojisine yönelik akademik çalışmaların yeterli olmadığı, teknolojinin ilgili alanda daha fazla işletme tarafından öğrenilebilmesi ve kullanılabilmesi için bu çalışmaların sayısının artırılması gerektiği sonucuna ulaşılmıştır.

Anahtar Kelimeler: *Blockchain, Tedarik Zincirinde Blockchain Teknolojisi, Lojistik Faaliyetlerde Blockchain Uygulamaları.*

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GENİŞLETİLMİŞ ÖZET

Kripto paralar dışında tedarik zinciri ve lojistik faaliyetlerde de kullanılabilen, birçok şirketin yatırım yaparak kullandığı ve gelecek vaat eden blockchain teknolojisi “farklı amaçlarla verilerin ve varlıkların transferinin yapılmasına, işlem kayıtlarının güvenli olarak dijital ortamda tutulmasına imkân sağlayan bir teknolojidir” (Blockchain Türkiye Platformu, 2019, s. 8). İnsanların ve işletmelerin görmezden gelmesinin mümkün olmadığı, kullanıldığı sektörlerde büyük değişikliklere neden olan blockchain teknolojisi, işletmedeki birçok sorunun çözümüne de katkı sağlamaktadır. Fakat son zamanlarda dikkatleri üzerine çekmesine rağmen işletmeler arası rekabetin yaşandığı tedarik zincirinde ve lojistik faaliyetlerde beklenen düzeyde uygulama alanı bulup kullanımı yaygınlaşmamış ve literatürde bu konuda sınırlı sayıda çalışma yer almıştır. Yapılan akademik çalışmalarda da blockchain teknolojisinin kullanımının lojistik ve tedarik zinciri faaliyetlerine uygun olduğu (Meng vd., 2018; Jain vd., 2020), fakat bu alanlarda yeterli çalışmanın olmadığı, dolayısıyla blockchain teknolojisinin tam olarak anlaşılmadığı ve lojistik ve tedarik zinciri faaliyetlerinde yeterli uygulama alanı bulamadığı belirtilmiştir (Hinckeldeyn ve Jochen, 2018; Hackius ve Peterson, 2017; Tijan vd., 2019; Tandon vd., 2021; Risius ve Spohrer, 2017; Aylak, 2022; Tanrıverdi vd., 2019).

Bu çerçevede çalışmanın amacı, blockchain teknolojisini detaylı bir şekilde açıklayarak, teknolojinin tam olarak öğrenilmesini sağlamak, tedarik zinciri ve lojistik faaliyetlerde kullanım örnekleri ile faydaları belirtilerek işletmeler üzerinde farkındalık oluşturmak ve literatür analizi ile literatürdeki eksikler tespit edilip daha sonraki araştırmacılara katkı sağlamaktır. Blockchain teknolojisi her ne kadar 2008 yılından itibaren literatürde yer almaya başlamış olsa da aslında teknolojinin anlaşılması ve uygulanması konusunda hala birçok alanda sorun bulunmaktadır. Özellikle tedarik zinciri ve lojistik alanındaki bu sorunun giderilmesine katkı sağlamak amacıyla bu çalışma yapılmıştır. Bu amaç doğrultusunda sektörde teknolojiyi kullanan işletmeler belirlenerek kullanım örnekleri araştırılmış ve konuyla ilgili kapsamlı literatür analizi gerçekleştirilmiştir. Böylece, tedarik zinciri ve lojistik alanında kavramın anlaşılabilirliğinin kolaylaşması ile sektörde kullanımının yaygınlaşması ve işletmelere sürdürülebilir rekabet avantajı sağlaması beklenmektedir. Literatür analizi sonucunda da sınırlı sayıda olan akademik çalışmaların hangi alanlarda yapıldığı ve hangi alanlarda eksikliklerin olduğu tespit edilerek bu konuda araştırmacılara da katkı sağlanması amaçlanmaktadır.

Yapılan araştırma sonucunda teknolojinin güvenilirlik, maliyet, esneklik, gecikmeler, şeffaflık ve performans düşüklüğü başta olmak üzere daha birçok sorunun çözümüne katkı sağladığı belirlenmiştir (Zhang, 2018; Tijan vd., 2019, ss. 7-11). Tedarik zinciri ve lojistik faaliyetlerde sahteciliğin önlenmesinde, çevresel duyarlılığın ön plana çıkarılmasında, güvenilirliğin ve şeffaflığın sağlanmasında, ürünün kalitesinin ön plana çıkarılmasında, konteyner ve ürün takibinin yapılmasında Walmart, Cambio, Toyota, Alibaba, Siemens, Samsung, UPS, Amazon, Provenance, Ford, Nestle, Maersk gibi Dünya çapında tanınmış büyük işletmelerin teknolojiye faydalandığı belirlenmiştir (Kshetri ve Loukoinanova, 2019; Kırkan, 2022, s. 399) Türkiye’de ise finans sektöründeki bazı işletmelerin teknolojiyi kısmen kullandığı belirlenmiş fakat tedarik zincirinde ve lojistik faaliyetlerde ise belirtilen küresel işletmelerin dışında kullanan işletmeye rastlanılmamıştır. Yaygın kullanılmamasının sebebi olarak da teknolojinin tam olarak anlaşılabilmesi ve işletmelerin özel bilgilerini diğer üyelerle paylaşmak istememeleri belirtilmiştir. Bu sorunun da teknolojinin kullanımının yaygınlaşması ile ortadan kalkması beklenmektedir (Sert, 2019).

Yapılan kapsamlı literatür analizi sonucunda da blockchain teknoloji ile ilgili akademik çalışmaların genellikle finans sektörü ile ilgili olduğu, tedarik zinciri ve lojistik alanında teknolojinin kullanımı ile çalışmaların daha kısıtlı olduğu belirlenmiştir. Dolayısıyla bu çalışmaların sayısının artırılması gerektiği, böylece bu alanda teknolojinin daha fazla işletme tarafından öğrenilerek kullanılabilmesi ifade edilmiştir. Bu yüzden tedarik zinciri ve lojistik faaliyetlerde blockchain teknolojisinin kullanımı ile ilgili yapılacak akademik çalışmaların sayısının artırılmasıyla sektörde teknolojinin daha fazla kullanılmasına, sektörün rekabet edebilirliğine, sürekliliğine ve gelişmesine katkı sağlaması beklenmektedir. Ayrıca literatürün genellikle teknolojinin işletmelere faydaları ve sektörde kullanılabilirliği üzerinde yoğunlaştığı, farklı konularda sınırlı sayıda çalışmanın olduğu belirlenmiştir.

1. INTRODUCTION

In 2008, after an article written by Satoshi Nakamoto, blockchain technology became popular and it is often confused with bitcoin. Many of supply chain members in different geographies has led to the complexity of the supply chain and the emergence of different problems. To eliminate these problems, blockchain technology has started to be used in sectors such as health, public, insurance, finance, as well as

supply chain and logistics activities. Although, technology has many benefits such as trust in businesses, reduction of costs, increase in speed, prevention of fraud, reduction of returns, blockchain technology, it has not received the expected attention in supply chain and logistics activities. The reason for the lack of widespread use by businesses is often cited as the lack of understanding of blockchain technology by the relevant parties and the lack of sufficient academic studies on this subject. In this direction, in the study, blockchain technology is explained comprehensively, examples of its use in the sector and the benefits it provides to businesses are specified, and the studies in the national and international literature in this field are examined. In the literature, it is generally stated that research and awareness should be increased in order to popularise blockchain applications, and with the study, awareness is created on businesses about the technology. Thus, it contributes to the widespread use of technology in supply chain and logistics activities. The use of such a useful technology in the supply chain and logistics activities where there is competition between businesses contributes to the competition and sustainability of businesses. In addition, there are a limited number of studies in the literature on blockchain technology in supply chain and logistics activities. In this context, it contributes to the literature in this field. With the comprehensive literature study, it is ensured that the researchers who conduct the research on this subject are directed to different subjects and the literature is differentiated. By explaining blockchain technology in all details, the technology is better understood by individuals. In this context, blockchain technology is explained in detail, the benefits and application samples of its use in supply chain and logistics activities are mentioned, and the literature analysis of the studies in the national and international literature is made.

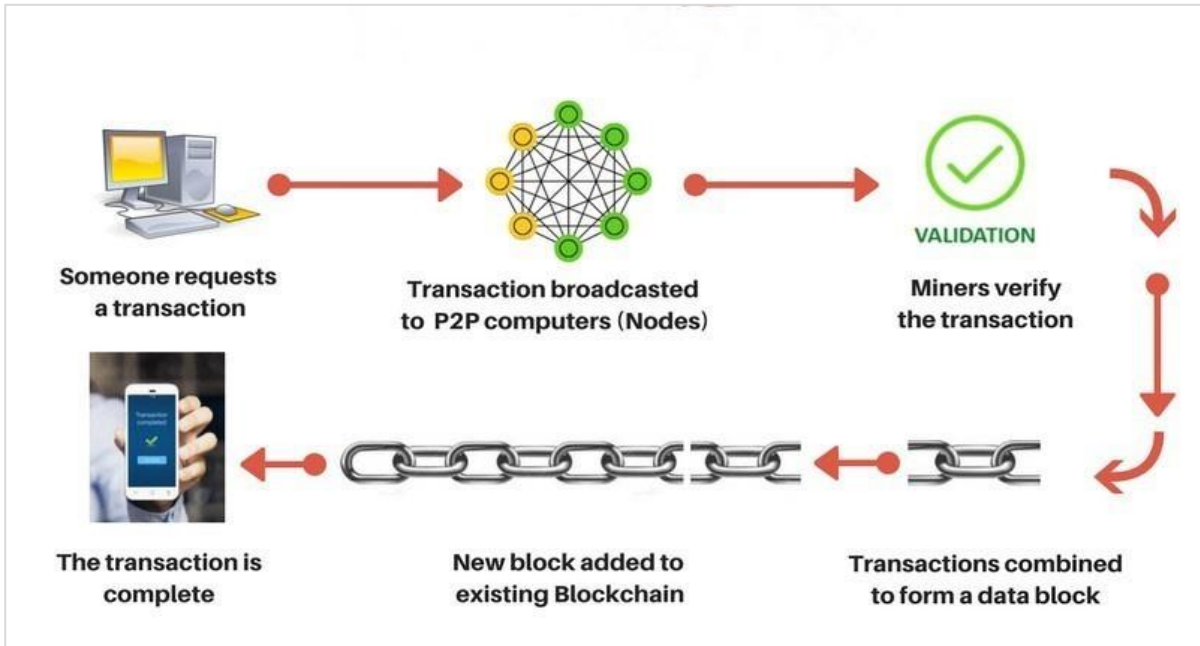
2. STRUCTURAL ANALYSIS OF BLOCKCHAIN TECHNOLOGY

The concept of blockchain, which was first mentioned in an article titled "How to Time-Stamp a Digital Document Block" written by Stuart Haber and Scott Stornetta, became more popular after Satoshi Nakamoto wrote "Bitcoin: A Peer-to-Peer Electronic Cash System" in 2008. The concept of blockchain or blockchain (Ağcakaya and Kaya, 2022, p. 60), is "a unique cryptocurrency system in which data set transactions are effectively distributed" (Jiang et al., 2017, p. 2). In other words, blockchain is "a technology that enables the transfer of data and assets for different purposes and the secure digital storage of transaction records" (Blockchain Türkiye Platform, 2019, p. 8). Blockchain technology, which was mentioned among the top ten emerging technologies by the World Economic Forum in 2016 (Myeong and Jung, 2019, p. 2), is a distributed data storage system that does not allow the data in its network to be deleted, lost and changed (Kırbaç, 2020, p. 6). Because of this system is not under the control of any institution, organization or state, it has a different structure from traditional databases (Notheisen et al., 2017, p. 425).

Blockchain technology, which is stated as one of the most important inventions after the invention of the Internet (Efanov and Roschin, 2018, p. 116), has started to be recognized and expressed by more people, especially after cryptocurrencies such as Bitcoin started to be used by individuals (Myeong and Jung, 2019, p. 2). However, the confusion of the concept of bitcoin with blockchain, which was effective in the rapid spread of the blockchain concept, caused it to be evaluated only as "bitcoin blockchain" (Zile and Strazdiņa, 2018, pp. 12-20). Blockchain technology, which has a supportive structure, can integrate with many other technologies, and cryptocurrencies are only one of them. Therefore, bitcoin and blockchain technology are different technologies (Takaoğlu et al., 2019, p. 260).

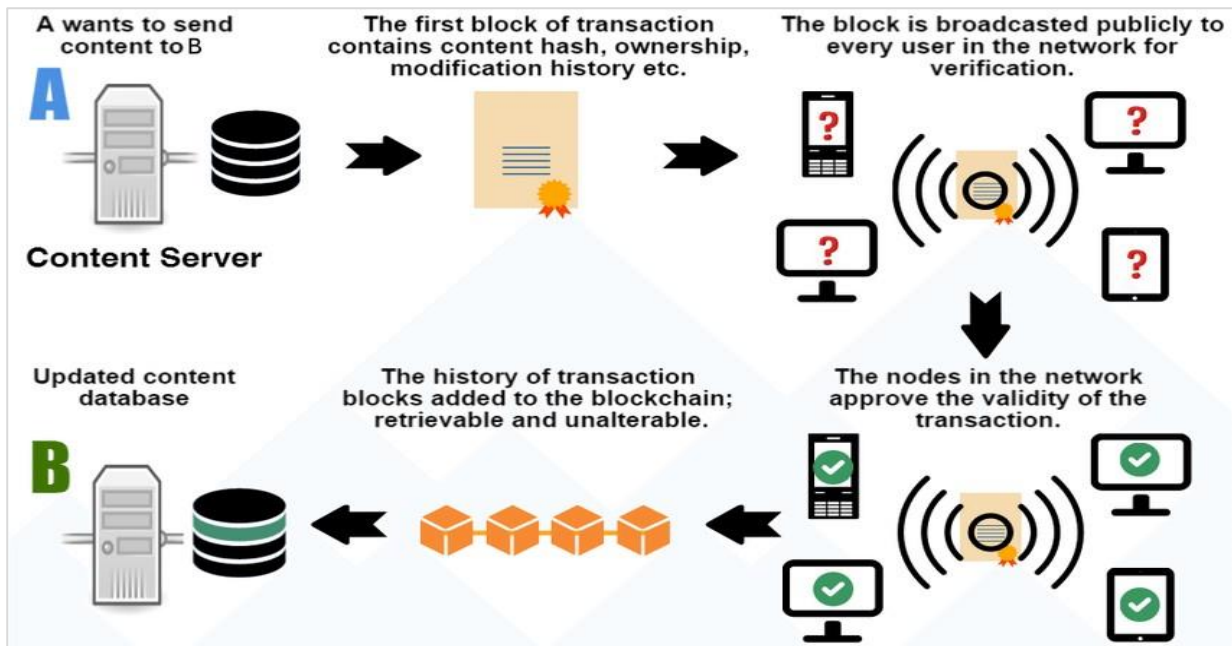
Blockchain serves as a database of transactions in the relevant field (Nebil, 2018, p. 108). There are three different structures in this technology block, chain and network. Blocks consist of a list of transactions recorded in the ledger within a certain time period. The chain is a hybrid structure that allows blocks to be linked and mathematically chained together. The network consists of nodes that make complete records of all transactions in the blockchain (Laurence, 2023, p. 4). The transactions recorded in blocks and encryption is performed here. Transactions made as a result of encryption cannot be changed. Then, thanks to the reconciliation and distributor feature, the data is saved and encrypted on the users' computers with the approval of all users (Nebil, 2018, p. 108). The recording and flow process of these transactions to the network is shown in Figure 1 and the working principle of the technology is shown in Figure 2.

Figure 1. The Process of Adding New Data in Blockchain



Source: Anish, 2017.

Figure 2. Overview of Blockchain Working Principle

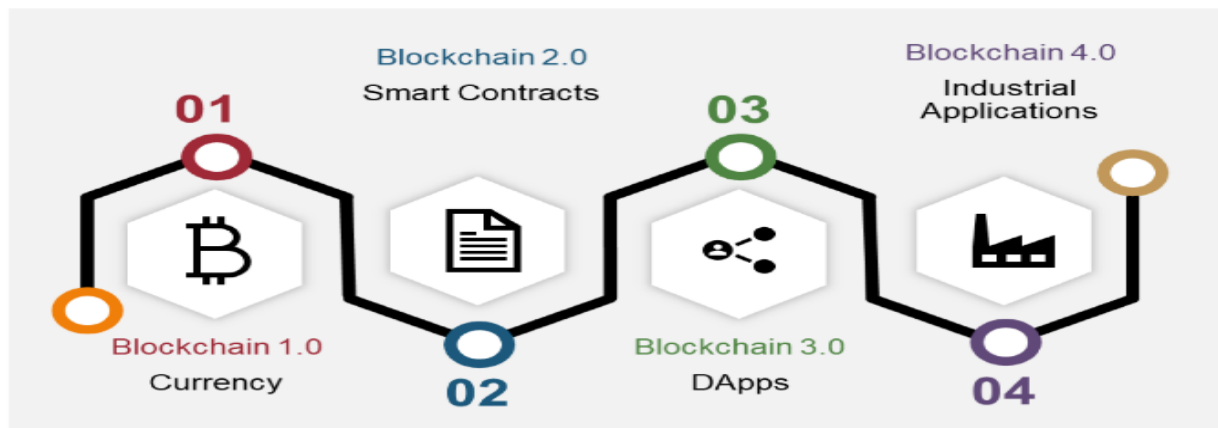


Source: Bhowmik and Fenk, 2017, p. 2.

The development process of blockchain technology, whose usage area in different sectors is increasing day by day, is widely evaluated in 4 stages. These stages are shown in Figure 3. Blockchain 1.0 refers to the currency and includes cryptocurrencies used in related money applications (Swan, 2015). All digital currencies are included in this blockchain (Ceylan and Işık, 2023, p. 136). In Blockchain 1.0, money transfers and electronic transactions made with digital currencies result in much lower transaction fees compared to the methods used in the traditional sense. In addition, since a pseudonym is used in Bitcoin transactions, more privacy is provided compared to credit card transactions. Digital currencies are more effective against inflation since they don't require transactions such as printing money and making financial regulations compared to currencies used in the traditional sense (Moore, 2013, pp. 147-149).

Blockchain 2.0, on the other hand, covers more detailed contracts than simple money transactions and includes financial and economic applications (Swan, 2015). Smart contracts are also recognised with blockchain 2.0 and they are more advanced versions than blockchain 1.0 (Ceylan and Işık, 2023, p. 136). Blockchain 3.0 is a technology that is more reliable than blockchain 1.0 and 2.0 in the fields of health, science, culture, art (Swan, 2015), communication of machines expressed as the Internet of Things, digital identity, cyber security (Tanrıverdi et al., 2019, p. 205). Blockchain 4.0 is a technology that focuses on distributed ledger technology within the framework of industry 4.0 applications (Ceylan and Işık, 2023, p. 136).

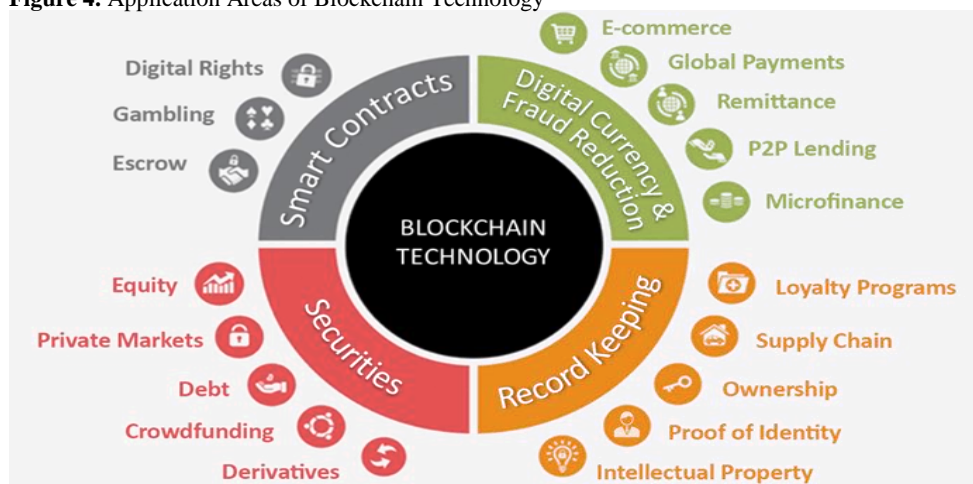
Figure 3. Development Process of Blockchain Technology



Source: Mohanty et al., 2022.

The blockchain applications, which are used in both financial and non-financial transactions (www.businesswire.com), are becoming more and more widespread in many areas such as health, logistics, education, supply chain, insurance, agriculture, automotive and public as well as cryptocurrencies. The usage areas of this technology are shown in Figure 4. International Business Machines (IBM), one of the largest US-based IT companies, stated that blockchain technology is used in the automotive, supply chain, transport, insurance, banking and financial services, public, healthcare and retail sectors (Ceylan and Işık, 2023, p. 142).

Figure 4. Application Areas of Blockchain Technology



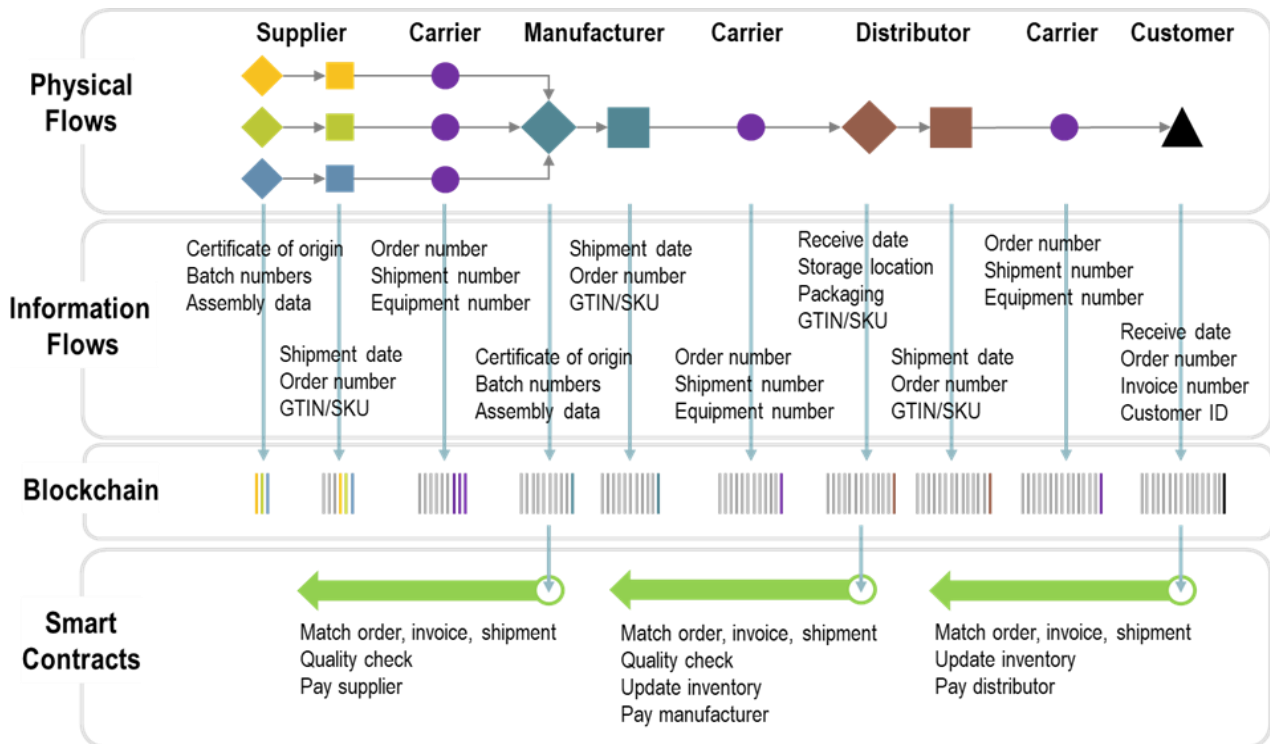
Source: Venkat, 2018.

3. BLOCKCHAIN APPLICATIONS IN SUPPLY CHAIN AND LOGISTICS ACTIVITIES

Factors such as the proliferation of supply chain members, increase in the number and types of documents used, different legal structures, different geographical regions, loss or forgery of documents have caused some problems in supply chain management (Yavuz and Avunduk, 2021, p. 46). Especially in order

to find solutions to such problems, blockchain technology has started to be used in logistics and supply chain activities (Gupta, 2017, p. 30). Although blockchain technology is expressed in cryptocurrencies, the applicability of this technology is not limited to cryptocurrencies (Hawlitschek et al., 2018, p. 50). Supply chain management and logistics activities are suitable areas for the using of blockchain technology (Hinckeldeyn and Kreutzfeldt, 2018). With the widespread use of Internet of Things applications in logistics and supply chain activities, the use of blockchain, which can also be used in integration with this technology, has also increased (Gupta, 2017, p. 30). Since the use of blockchain technology in the supply chain guarantees the quality and reliability of the product and facilitates the transactions between the parties, the use of this technology is expected to increase further than now in the future (Vurdu, 2021).

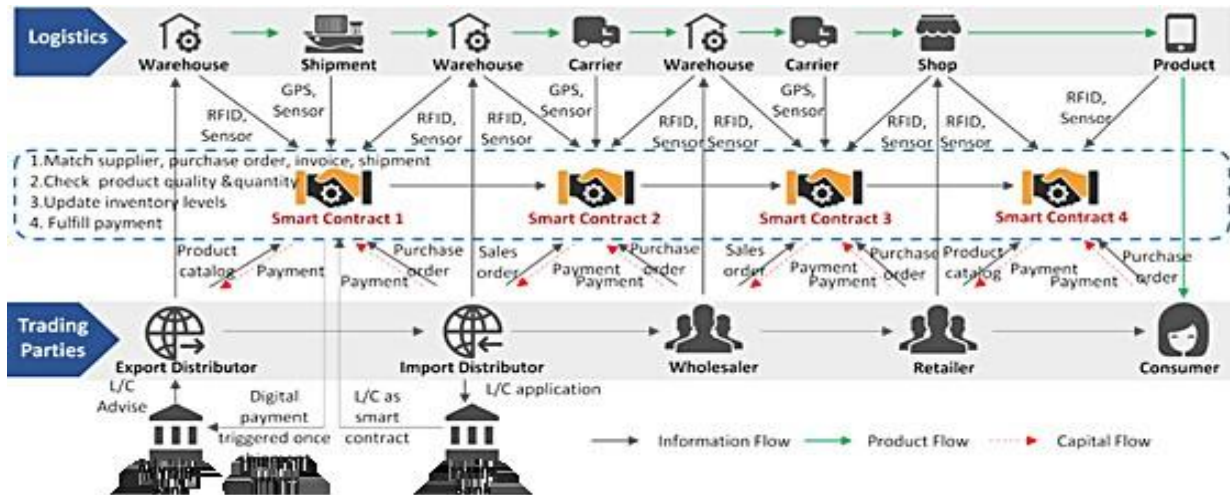
Figure 5. Blockchain Applications in Supply Chain Management



Source: Rodrigue, 2018, p. 22.

Figure 5 shows an example of how blockchain applications can be applied in supply chain activities. In this application, there are four stages: physical flow, information flow, blockchain and smart contracts. In the physical flow phase, there are supply chain members, and in the information flow, different information flows take place between these chain members. In the blockchain phase, the physical flow and information flow along the supply chain records in the blocks in the blockchain and the blocks connect to each other and all transactions that take place until the end which transformed into a chain (Rodrigue, 2018, p. 22). Instead of information and physical flow in the traditional method, encrypted blocks are used in this technology and the necessary information is contained in chains consisting of blocks (Yermack, 2017). The fourth stage, smart contracts, is an important stage for blockchain applications. A smart contract is "a digital contract that allows transactions to take place automatically within the specified conditions, eliminating buyers" (Kimani et al., 2020, p. 5). Smart contracts are realized by automatically generating the contract when the conditions are finalized thanks to the information in the blockchain (Rodrigue, 2018, p. 32). These contracts contain information and codes based on legal judgement between the parties. The code is used to facilitate security monitoring in order to fulfill the conditions specified in the contract (Tasananattakool and Techapanupreeda, 2018). Figure 6 shows an example of distribution activities when smart contracts are used in logistics activities.

Figure 6. Using Smart Contracts in Distribution



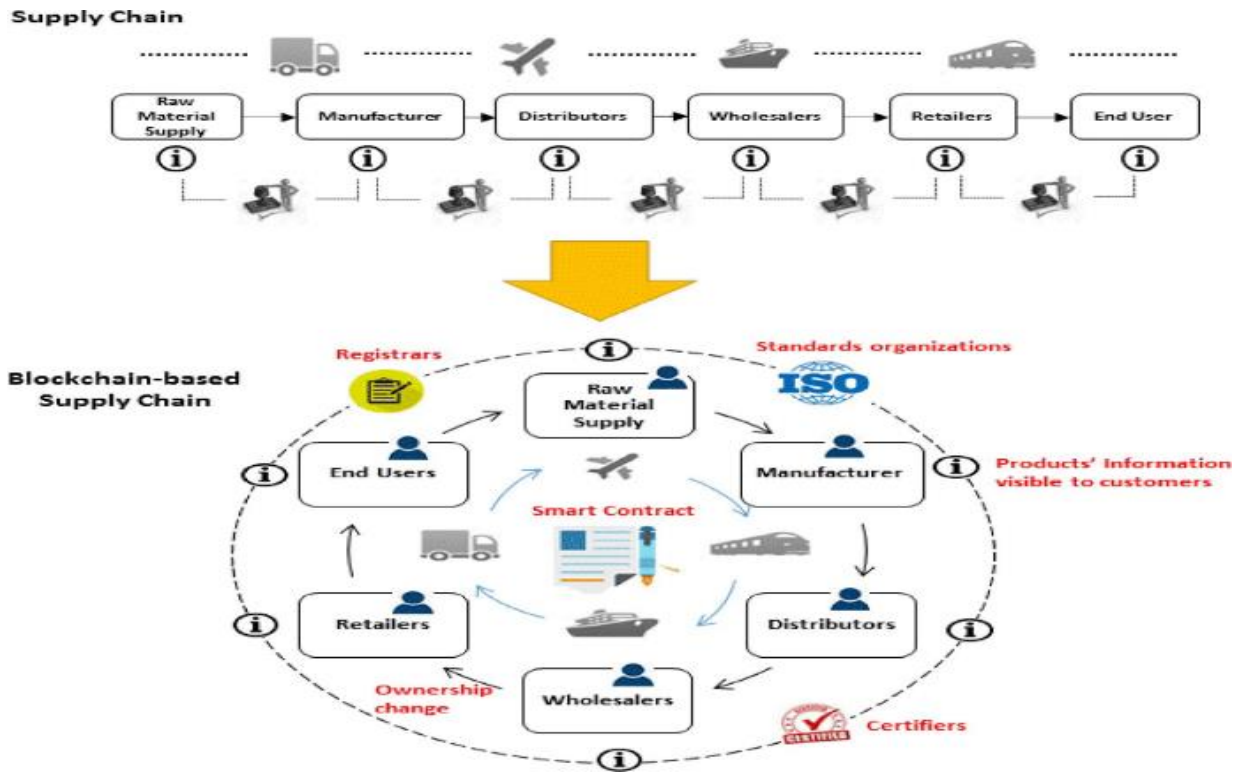
Source: Wang et al., 2019, p. 25.

By the use of blockchain technology, smart contracts have become widespread (Ünsal and Kocaoğlu, 2018, p. 59). Unlike normal contracts, smart contracts are prepared digitally (Yavuz and Avunduk, 2021, p. 44). By using these contracts, all transactions in the supply chain can be both securely recorded and instantly monitored by users (Baygın, 2022, p. 25). The information in the recorded smart contracts cannot be changed without any agreement of the parties in the supply chain. It provides great convenience to the parties, especially in terms of trust in payment transactions. After all the conditions specified in the contract are fulfilled, the payment transaction is carried out automatically (Rodrigue, 2018, p. 23). Interested parties can transparently follow every stage of all transactions thanks to the blockchain (Watanabe et al., 2015). In complex supply chains, if the information that should be shared between the supply chain members is not fully shared with the chain members, insufficient information and data reaches the end consumer, thus the trust in the chain members is negatively affected. However, thanks to smart contracts, full-time traceability is provided and chain members can make quick decisions and thus gain cost advantages (Kırbaç, 2020, p. 37). It also provides advantages in terms of cost and speed as it eliminates third parties such as notaries and banks (Luu et al., 2016, pp. 254-269).

It would be more beneficial for the parties if the people who prepare the contracts are equipped with legal and coding skills. Since these contracts are audited by users (Bilgili and Cengiz, 2022, p. 245) and cannot be changed after the contracts are prepared, it would be useful to be an expert in this field. There will likely be experts who will prepare these contracts in the future with the increase in their use in different fields (Akbulut, 2023, p. 63).

Figure 7 shows the traditional supply chain and the supply chain structure using blockchain technology. While the flow of information and materials is linear in traditional supply chains, this flow becomes cyclical in blockchain technology. The transparency of blockchain technology ensures that all supply chain members in the supply chain process are informed about the process. While in traditional supply chain processes, there may be a disconnection in the flow of materials and information between supply chain members, blockchain technology creates a circularity in the process as it ensures the integrity of this flow. However, this circularity may not be achieved due to the disconnection in the traditional supply chain process.

Figure 7. Transformation from Traditional Supply Chain to Supply Chain using Blockchain Technology



Source: Saberi et al., 2019, p. 2121.

4. STRATEGIC IMPORTANCE AND USAGE EXAMPLES OF BLOCKCHAIN TECHNOLOGY IN LOGISTICS AND SUPPLY CHAIN ACTIVITIES

In an age which globalization and competition are increasing day by day, the competition between enterprises is now experienced between supply chains. In addition, as a result of increasing the number of members in the supply chain and spreading to different geographies, the supply chain has become more complex and has led to the emergence of different problems. In order to gain a competitive advantage and make it sustainable, businesses use different technologies and strategies. In this direction, some businesses have started to use blockchain technology to deal with these problems and gain a competitive advantage. Toyota, Provenance, Walmart, Alibaba, Ford, Samsung, Apple, Amazon, Carrefour, Nestle, Siemens are successful businesses using blockchain technology in their supply chains (Kshetri and Loukoinanova, 2019). US-based UPS, which is also among the major logistics companies, is another important business that uses blockchain technology to monitor cargo and ensure all transport requirements (Kırkan, 2022, p. 399). It is expected that the number of these enterprises will increase in the future and blockchain applications in the supply chain will grow 87% annually and reach \$ 3,485 million in 2027 (Gupta, 2017). Although its use is not as widespread as the financial sector, even the simplest applications of blockchain technology, which has become widespread in supply chain and logistics activities of global businesses, will be able to gain great advantages if they are introduced and used in the field of logistics and supply chain (Sadouskaya, 2018). According to Hackius and Peterson, because of this technology will be more useful than other technologies in the field of logistics and supply chain, this sector must be more interested on this technology and more research must be done on this subject.

IBM is one of the leading companies that has invested in and successfully utilized Blockchain technology. IBM has established the Blockchain Platform to create, operate, manage, and develop this technology. It uses this technology in different areas such as supply chain activities, cross-border payments and food supply. One of the businesses using IBM's blockchain platform to solve problems between buyers and sellers is Home Depot, and one of the businesses using IBM's blockchain platform to solve problems arising in the supply chain is Software. The TradeLens Platform was developed by IBM to increase control in container logistics, which is important in world trade, and to ensure trust between the parties. Maersk, a Danish company, also uses the platform, which includes many exporters, importers and logistics companies, to ensure the traceability of containers (IBM, 2017). Apart from IBM, there are other platforms using

blockchain technology. Hyperledger, Provenance, Skuchain, Robomed, Ripe, Waltonchain, Robob and FastTrack Trade are some of the platforms that are widely used (Özceylan, 2022, pp. 114-117).

Blockchain technology can be used to solve the traceability and reliability problem, which is one of the biggest problems of the globalized and complex supply chain (Yavuz and Avunduk, 2021, p. 33). Trust-based supply chain structure is one of the indispensable elements for the success of the supply chain. Therefore, with the use of smart contracts, the problem of trust between the parties is also eliminated. In order to ensure the transparency of the supply chain, trust must be established between the parties (Koç, 2020, p. 419). Transparency in the supply chain refers to "the ability to track the movement of products, parts and/or components from the manufacturer to the final destination (customer)" (Görsev, 2023). If the supply chain is transparent, access to information will be both easy and fast. With the use of blockchain technology in the supply chain, all transactions within the supply chain structure can be recorded and tracked transparently and securely (Koç, 2020, p. 419). According to Christodoulou et al. (2018), blockchain technology should be used in order to provide a transparent and secure activity in logistics and supply chain activities.

In different studies, it is also emphasized that this technology has a great potential for the development of logistics and supply chain and should be examined in detail (Tijan et al., 2019, p. 10). With the increase in environmentally conscious individuals, businesses can also use this technology to solve environmental problems by utilizing this potential of technology. By using blockchain technology, Provenance can transfer information to its customers about the solution of environmental problems that may arise during the production, distribution and use of products and production conditions (Koç, 2020, p. 430). This will increase the number of environmentally conscious businesses, contribute to the reduction of environmental problems and partially reduce environmental concerns. Similarly, Cambio, a coffee company, uses blockchain technology to record and share with its customers the process from harvesting the products to reaching its customers. Thus, customers' concerns about the products are also reduced. It can also be proved that the products are healthy for the business. Because especially in a period when the number of counterfeit products is rapidly increasing, the side effects of these products on both the national economy and human health constitute a major problem. In order to eliminate these side effects and eliminate fears about human health and prevent counterfeiting, Walimai has developed RFID tags integrated with blockchain technology (Koç, 2020, p. 430). Similarly, blockchain applications which are used too in the pharmaceutical supply chain can provide traceability, transparency and efficiency. In this context, blockchain technology is used in pilot applications for recalling drugs, combating counterfeit drugs and the reliability of clinical trials (Ghatge et al., 2023, p. 6646).

Blockchain technology can be used effectively in the elimination of food waste, detection of the source of food-borne diseases, detection of expiry dates and traceability, especially with the use of food - agricultural products in the supply chain (Antonucci et al., 2019). The IBM Food Trust Platform was also created by IBM in order to increase the reliability of products and the efficiency in the supply chain in the food sector, which has a great worldwide potential. The platform is based on cooperation involving stakeholders in the supply chain such as farmers, wholesalers and retailers (Özceylan, 2022, p. 115). By platform, the information of the products from the farmer to the table is transferred and both profitability is increased and a sense of trust is created between the parties. The technology enables the detection and return of faulty products in the supply chain, the recording of the temperature and quality of the products in the cold chain on the blockchain, and the transfer and tracking of this information to the relevant businesses. In this context, businesses such as Nestle, Walmart, Golden State Foods, McLane, Dole, and Driscoll's which are the important businesses that use this platform for these purposes (Özceylan, 2022, p. 115). Due to the advantages it provides in the supply chain process of food products, blockchain-supported smart supply chain structures are expected to be the supply chain model of the future. Therefore, blockchain supported smart supply chain models are expected to be preferred by more businesses in the future (Kılıç, 2023, p. 361).

Blockchain technology can also offer solutions to reduce the number of buyers in the supply chain, reduce production and logistics costs, and prevent fraud that may arise in documents and processes (Sağlar, 2022). Walmart uses blockchain technology together with the logistics business to manage both invoices and payments from logistics businesses more effectively. Thus, both data are synchronized between the parties and payments are made automatically (Vitasek et al., 2022). Since intermediaries will be disabled in the transactions, costs will be reduced, fraud will be prevented thanks to smart contracts, and transactions will be

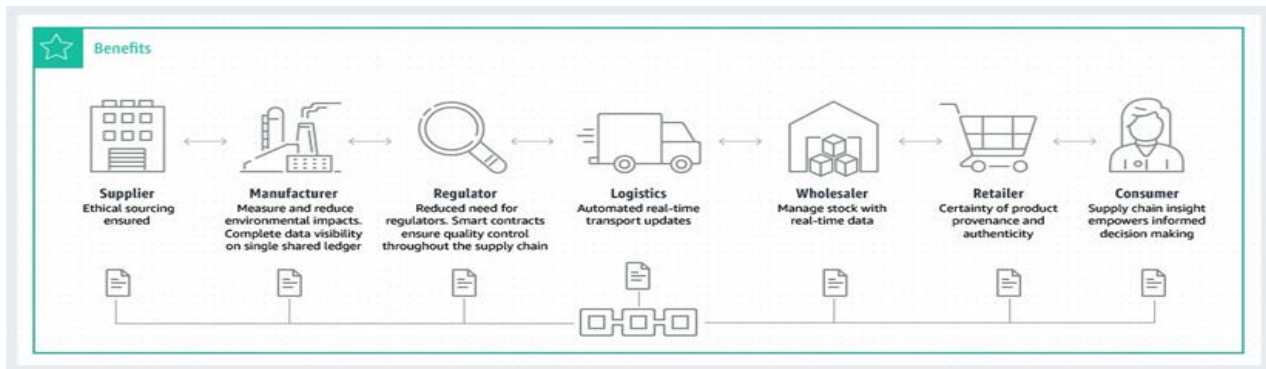
faster. According to Tijan et al., (2019, pp. 7-11), the benefits of using blockchain technology in logistics and supply chain activities are as follows:

- * Every asset along the supply chain will be recorded,
- * All documents related to invoices and payments will be followed up,
- * Delays in deliveries and loss of documentation will be reduced,
- * The trust problem will disappear,
- * Costs will fall,
- * Transparency of the supply chain will be ensured,
- * Human errors will be minimized,
- * Data reliability will increase,

If agricultural products are used in the supply chain, food safety will be guaranteed.

Figure 8 shows the benefits of the enterprises to use of blockchain technology in the supply chain.

Figure 8. Benefits of Blockchain Technology in Supply Chain for Businesses



Source: Chang et al., 2022, p. 196.

Although the use of such a useful technology has become widespread in global businesses, its use is not widespread at businesses in Türkiye yet. As a result of the studies, it has been determined that some financial institutions benefit from the technology, but there is no enterprise that uses it in supply chain and logistics activities. The reason why it is not widely used despite the stated benefits is the problem of trust. As a result of the use of technology, enterprises don't have full confidence that all members of the supply chain will record accurate information. There is also the effect of the fact that businesses don't want a third party to see private information about them. However, these thoughts will change as the use of technology becomes widespread and the studies on this subject increase, and thus businesses will begin to adapt to technology (Sert, 2019).

In addition to all these benefits, it is stated that blockchain applications also cause some difficulties for businesses. Although blockchain technology provides advantages to businesses in supply chain and logistics activities, its suitability for business strategies must firstly be analysed. If the use of blockchain technology increases in the supply chain, it will create a domino effect and all members in the chain will have to adapt to blockchain technology (Koç, 2020, pp. 433-434). Therefore, all businesses in the chain need to invest in technologies that connect physical and digital operations (Sağlar and Nakıpoğlu, 2022, p. 322). Since it is an energy-intensive technology, investment costs will be high as powerful computers will be needed.

In some studies (Casino et al., 2018; Hou, 2017; Wang et al., 2019a), it is mentioned that there are concerns about the possibility of hacking in terms of technological security of data and information if blockchain technology is used. In addition, some studies (Angelis and Silva, 2019; Sayogo et al., 2015; Mangla et al., 2017; Luthra et al., 2016) emphasize that the using of blockchain technology in the supply chain requires technical expertise and there is not enough information on this subject. For this reason, it is stated in the studies that the state does not provide sufficient support for the use of blockchain technology and there is no guidance on its use (Biswas and Gupta, 2019; Morkuas et al., 2019; Wang et al., 2019b).

Blockchain is an important application that will contribute to the digital transformation of public institutions (Duman, 2023, p. 207). Therefore, it will be useful to carry out the necessary activities for this technological development.

5. LITERATURE ANALYSIS ON BLOCKCHAIN TECHNOLOGY

By conducting an effective literature study, the information obtained will have a solid basis and a broad perspective on the subject. For this reason, a detailed literature analysis has been carried out in the study and a limited number of studies in the field of supply chain and logistics have been included among the many articles written on blockchain.

Most of the studies about the use of blockchain technology in logistics and supply chain activities are related to the advantages that technology will provide to businesses. As a result of the use of blockchain technology, which is sometimes referred to as disruptive technology, significant progress will be made in solving the problems of enterprises. In the study conducted by Tijan et al. (2019), it was stated that the problems encountered with the use of blockchain technology in the logistics sector will be minimized. Tektaş and Kırbaç (2020) concluded that as a result of the use of this technology, which is effective in solving problems, together with other technologies such as the Internet of Things, smart contracts and artificial intelligence, there will be a sustainable increase in productivity and a decrease in costs and delays. This technology, which can work in integration with other technologies, will also be effective in eliminating delays, which is an important problem for the sector. Sundarakani et al. (2021) stated that as a result of the use of blockchain technology in a logistics company serving the oil industry, there was a 25% increase in revenues, paperwork and carbon emissions decreased. In most of the studies on this subject, it has been concluded that technology provides cost advantages in enterprises. Aylak (2022) investigated the results of the application of blockchain technology in the logistics sector and concluded that data security, traceability and cost advantage will be provided as a result of the use of blockchain technology in the sector. A similar result was obtained in the results of the study in which Kshetri (2018) investigated the effect of blockchain technologies on the achievement of enterprises' goals in the supply chain, and Perboli (2018) investigated the use of blockchain technology in the foreign trade sector where logistics and supply chain activities are intensive. According to Kshetri (2018), using of blockchain technology causes a decrease in cost and risk, increase in quality and speed and flexibility, and also contributes to sustainability. Perboli (2018) reported that the using of blockchain technology, increases transparency and reduces logistics costs. Although blockchain technology is not used at the expected level in international trade (Tüfenk, 2023, p. 41), it is stated that blockchain technology will be effective in solving the problems experienced in letter of credit and remittance transactions in imports (Alsalm, 2023).

Supply chain and logistics performances are very important for the continuity and competitiveness of businesses. Nowadays, businesses measure their performance at certain intervals and strive to improve their performance by using different strategies and technologies. In the results of the studies conducted by researchers such as Rubio et al. (2018), Yang (2021), Sheel and Nath (2019), Tektaş and Kırbaç (2020), Wamba et al. (2020), Park and Li (2021), Taşçı (2023), it was concluded that blockchain technology increases supply chain and logistics performance. Therefore, businesses can also benefit from blockchain technology to improve their performance.

In supply chain and logistics activities, the multiplicity of members and their location in different geographies cause reliability problems. The fact that the parties don't recognize each other in international trade also leads to the use of intermediary institutions. The presence of intermediaries in the supply chain also negatively affects the speed and cost of operations. In the literature, it is reported that, trust problem is eliminated by using blockchain technology, so that enabling an intermediary-free supply chain; and using of smart contracts can provide more security environment by using fewer resources (Alvarez et al., 2017). In their study, Meng et al. (2018) reported that if blockchain technology is used in supply chain activities, it will be even more beneficial than the systems used in terms of cyber security. Yıldızbaşı and Üstünyer (2019) concluded that by using blockchain technology in the supply chain of products in the agricultural sector, all supply chain members can reach all information more easily by being protected from cyber-attacks. Yang (2018) reported that, with the use of blockchain technology in logistics activities, all documents used in that area will be streamlined and transaction reliability will increase. According to Sadouskaya (2017), blockchain technology will provide consumers with reliable information about the product, reduce counterfeiting and returns, and facilitate payment transactions. Karlı and Tanyaş (2020) stated that with the

use of smart contracts in the logistics sector, transactions such as tax, customs and insurance will be both in a little time and more transparent.

Although Blockchain technology has been talked about since 2008, there are still problems in many areas in understanding and applying the technology. This study has been done to contribute to the elimination of this problem, especially in the field of supply chain and logistics. This case has been expressed in different studies in the literature. Tandon et al. (2021) reported in their study that, there are a limited number of studies about how blockchain applications will contribute to businesses in sectors instead of the financial sector. Similarly, Risius and Spohrer (2017) reported that studies concerning using of the technology in sectors are not sufficient. Aylak (2022) concluded that in his study, the use of technology is still at the beginning stage, and that not all logistics enterprises can use this technology, since an expert will be needed due to the difficulty of comprehending this technology in the absence of a standard application. Similarly, Tanrıverdi (2019) concluded in his study that researchers and businesses do not understand the structure of blockchain technology and make mistakes to satisfy their needs.

At some studies, it is reported that this technology is new and it can be used in both supply chain and logistics activities. In this context, as a result of the study by Mendi (2021), it was determined that the technology is new and this technology will be used more widely and developed further in the future. Meng et al. (2018) also found that blockchain technology can be used in supply chain activities, while Jain et al. (2020) found that the technology is a hopeful technology that can be used in the logistics sector. In addition, Tekin et al. (2020) reported in their study that, as a result of the using of blockchain technology in the logistics sector, there will be innovations in different areas in the sector, transactions will be made faster and the number of intermediaries will decrease. Blossey et al. (2019) concluded that blockchain technology in the logistics sector is more secure and cost-effective than the current use of technologies in the logistics sector. Takaoğlu et al. (2019) also conducted a study to determine the applications of blockchain technology in Turkey and concluded that it will be possible to use this technology in 18 different areas such as supply chain, internet of things, insurance, voting process, smart cities, legal applications, public transport, online data storage, smart contracts.

As a result of the literature review, it was concluded that studies on blockchain are generally related to the finance sector. The number of academic studies in which technology is used in the field of supply chain and logistics is less than others. This case has also been expressed in some studies. It is emphasized that at these studies, the increase of the studies concerning blockchain technology will increase the using of blockchain technology. Studies in the literature have generally focused on the benefits of the using technology in supply chain and logistics activities. Then, encountering more frequently studies are regarding the usability of blockchain technology in the sector and its impact on the supply chain and logistics performance of enterprises. As a result of the studies to be carried out on subjects other than these issues, both the literature will be contributed to the literature and businesses will gain a new perspective on this issue.

6. CONCLUSION

The importance of blockchain technology is increasing day by day. The technology, which causes many changes, has become more widespread in the finance sector because it was first expressed and used with cryptocurrencies. However, its use in the supply chain and logistics activities, which are closely related to many sectors and where competition between businesses is experienced, is not very widespread. In these activities, which are critical in terms of competition and sustainability between businesses, it is just important to popularise the use of a technology that provides great advantages to businesses. Therefore, in this study, it is aimed to explain blockchain technology comprehensively, to provide better awareness of the technology, to specify the benefits to businesses with examples of use in supply chain and logistics activities, and to raise awareness of businesses. In addition, by analyzing the literature on this subject, deficiencies in the literature were identified and this contribution will benefit subsequent researchers. For this purpose, the technology has been explained in detail, literature analysis has been made and the application areas in the sector have been expressed with examples in order to create awareness on the enterprises and to expand its use and to obtain the expected benefits.

As a result of the research conducted in this context, it was determined that the technology can be used in logistics and supply chain activities and this is a promising technology. In fact, it has been stated that blockchain technology is more useful technology than other technologies used in supply chain and logistics

activities. It has been determined that if this technology is used in the supply chain and logistics activities of enterprises, it will contribute to enterprises at important issues such as transparency, cost, reliability, performance and speed. In addition, it has been concluded that it is used in the fight against counterfeit products in practice, in the tracking of products, in increasing sensitivity to the environment, in highlighting product quality and in ensuring trust between the parties; especially used by sector leaders of large enterprises which are recognized worldwide.

UPS in cargo tracking; IBM in cross-border payments, food supply; Maersk in container tracking; Cambio is healthy of products; are some of the important businesses that use blockchain technology to prove to their customers. Apart from these businesses, businesses operating on a global scale such as Toyota, Walmart, Alibaba, Samsung, Apple, Nestle, Dole and Golden State Foods also use these technologies in an effective way. While using Blockchain technology, these businesses benefit from different platforms such as Food Trust, Hyperledger, Provenance, Skuchain, Robomed, Ripe and Waltonchain. In Turkey, it has been determined that some enterprises in the finance sector partially use the technology, but in the supply chain and logistics activities, no enterprises other than these global enterprises have been found. The reasons for the lack of widespread use of the technology by more enterprises are stated as the unwillingness of enterprises to share their private information with other enterprises, insufficient knowledge of the technology, the high investment cost and the low level of awareness. These problems are expected to disappear by using technology and increasing of the number of studies on this subject and increasing of the level of awareness.

As a result of the literature review, it has been determined that the number of studies regarding the use of technology in supply chain and logistics activities is less and the use of technology in supply chain and logistics activities has not been investigated as much as the other sectors. It was concluded that the studies focused on the benefits of technology to businesses and its usability in the sector. It was emphasized that increasing the number of studies on blockchain applications in supply chain and logistics activities will increase the applicability of the technology and that the technology has not become widespread because of its less understanding.

In the study, since blockchain technology is explained in detail, the technology is considered better by individuals and the level of awareness can be increased. By including application examples in supply chain and logistics activities, it is expected to contribute to the popularisation of technology in supply chain and logistics activities. In addition, the literature can be enriched by enabling researchers to focus on topics that are not included in the literature. Thus, competitive advantage can be gained in supply chain and logistics activities by using technology by more enterprises where competition between enterprises is experienced. In future studies, different studies can be conducted on these individuals in order to increase the level of awareness on supply chain and logistics managers. In addition, conducting different studies by researchers other than the benefits and usability of blockchain technology in supply chain and logistics activities will contribute to the enrichment of the literature.



This study does not necessitate approval from an ethics committee.

Notes on the Article

The article has been meticulously crafted in adherence to the principles of research and publication ethics. There is no conflict of interest among the authors.

In the conducted study, each author contributed equitably to all stages and processes of the research, signifying equal and shared involvement in the project's execution.

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