ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN – NEW CHALLENGES FOR DIGITAL SUPPLY CHAIN MANAGEMENT

Ivana Martinčević
University North, Croatia
E-mail: ivana.martincevic@unin.hr

Vesna Sesar
University North, Croatia
E-mail: vesna.sesar@unin.hr

Ana Globočnik Žunac
University North, Croatia
E-mail**:** ana.globocnik.zunac@unin.hr

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Abstract

Digital transformation of business is inevitable today, that is, companies include and incorporate new technologies into their business processes, all with the aim of creating added value, securing and achieving competitive advantage. For the purposes of writing this article, new Croatian and world literature has been used and analyzed and authors can be considered as representative authors in the field of interest of this topic. A systematic literature review was undertaken to provide an overview of application and use of new technologies such as blokchain and artificial intelligence in filed of digital supply chain. The papers were selected by searching databases Web of Science and Scopus using the search phrase ("artificial intelligence" OR "blockchain technology") AND ("digital supply chain"). The intention and goal of this research was to make aware logistics organizations about importance of the artificial intelligence and blockchain technology as key factors that can affect and improve logistic process. There are not many studies that explore the application of artificial intelligence and blockchain technology in a field of digital supply chain and its importance and contribution to strengthening supply chain management, so this research contributes to strengthening the awareness of organization about its application. Implementation of artificial intelligence and blockchain technology is relatively new in a field of logistic and specially in field of supply chain so it needs to be strongly and systematically developed further especially with the development of digital supply chain. By analyzing the relevant scientific sources it can be concluded that a strategic approach to the adoption and implementation of artificial intelligence and blockchain technology can provide a numerous of advantages and benefits. The aim of this paper was (1) to analyze and investigate the importance of digitalization and digital transformation and the impact on digital supply chain (2) to analyze and

explore innovation and new technologies in the logistic sector (artificial intelligence and blockchain technology) (3) to provide an overview of the research literature in these areas.

Key words: management, supply chain management, digital supply chain, artificial intelligence, blockchain

1. INTRODUCTION

Digitalization and the associated digital business transformation are changing existing and well-known traditional business models and directing companies towards new, modern and digital business models. New digital technologies create new opportunities and improve business performance by creating recognition but also greater flexibility of organizations. New digital technologies are changing traditional ways of doing business and creating new digital business models through which companies create recognition, flexibility and preconditions for ensuring a sustainable competitive advantage. Without new digital technologies today there is no progress, no innovation so it is crucial to identify appropriate digital technologies that will improve the business processes of the organization and consequently create a sustainable and long-term competitive organization in the market. Industry 4.0. brings new challenges to companies, especially in the field of supply chain, where the contribution of new technologies is pronounced and visible. The key goal of any organization is to ensure sustainability and create sustainable business models where new technologies such as artificial intelligence and blockchain technologies can develop, improve but also facilitate sustainable business models in the field of digital supply chain management. Innovations such as the Internet of Things (IoTs), big data, cloud computing, edge computing, blockchain, and artificial intelligence are just some new digital technologies and are the most remarkable technological innovations of the 21st century.

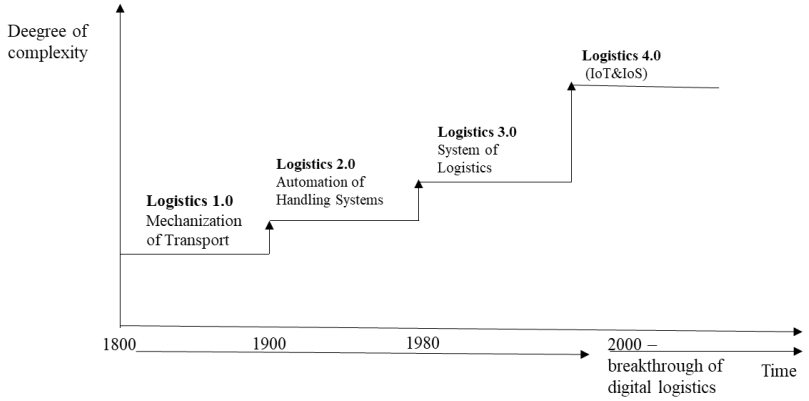
This paper aims to explore the process and importance of digitalization and digital transformation on business and application of new technologies such as artificial intelligence and blockchain technology in the field of digital supply chain management. According to its aim this paper is sectioned into three parts. First part of the paper is dedicated to understanding basic terms related to logistic 4.0 and digital supply chain, digitalization and digital transformation of business. This part gives focus on new digital technologies, artificial intelligence and blockchain technology. The second part of paper, deals with artificial intelligence and blockchain technology and its correlation to supply chain management in terms of its application and implementation, while used methodology and a literature review are presented. The goal of the paper is to present a systematic literature review of papers that present new digital technologies, blokchain and artificial intelligence, and its application and use in the digital supply chain. In our research approach, we focus only on papers in the field of digital supply chain that are linked to blokchain and artificial intelligence. Lastly, the fourth part is a discussion and recommendations about the conducted research and conclusion.

2. THEORETICAL BACKGROUND

2.1. Logistics 4.0 and digital supply chain management

In the last 30 years' logistics and supply chain is evolving rapidly and this development is in accordance with technology development. The process of logistics development according to the degree of complexity can be divided into four periods (figure 1.) First period is related to the process of mechanization and transportation where at the end of the first period capacity for transportation increased. Logistics 2.0 is characterized with many automation system implementations in warehouses and sorting centers and this brought to the replacement of conventional warehouses and use of electrically driven machines in every day operations. During 80's of the last century with computer and IT development, logistics got innovated and systematization of logistic activities started which lead to the increase of logistic management capabilities. Then, during 90's with just in time system implementation, increasing demand for quicker customer response and IT development lead to new ways of delivering good and services to customers. Further, the increasing use of smart devices that use infrastructure services based on cloud computing was one of the significant advances in the last decade (Demir et al., 2020) where industry 4.0 brought new challenges for the logistic industry and supply chain and impacts the development of new paradigms, principles and models in supply chain management (SCM).

Figure 1. Development of logistics according to the degree of complexity

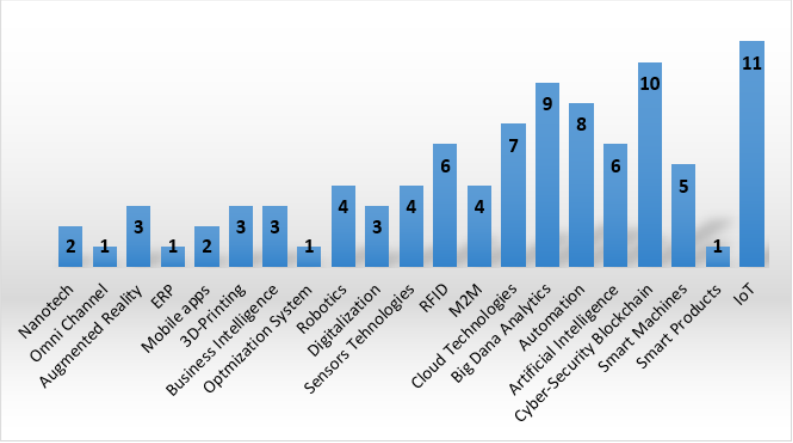


Source: Author's according to Wang, 2016.

Digitalization and fast technological adaptation in everyday business, has even more been driven by corona crises, and has affected almost every industry. This trend has influenced series of processes that involve coordination, planning and controlling of products and services between suppliers and customers, that is supply chain (Büyüközkan and Göçer. 2018:157). Due to new technologies adaptation and the whole new digital movement, organizations have to adapt their organizational structures in order to manage this new processes. In such environment supply chains

are not limited to national territory, in contrary they spread across countries boundaries and become global. The part of the organizational processes in logistic industry, that is constantly changing and evolving (Garay-Rondero, 2019), driven by many factors mentioned above, is certainly digital supply chain. Digital Supply Chain (DSC) can be defined as "a smart, value-driven, efficient process to generate new forms of revenue and business value for organizations and to leverage new approaches with novel technological and analytical methods" (Büyüközkan and Göçer. 2018:157). Also, DSC can be defined as the development of information systems and the adoption of innovative technologies strengthening the integration and the agility of the supply chain and thus improving customer service and sustainable performance of the organisation (Ageron, and Gunasekaran, 2020:133). Some author state that it has the potential to disruptively change how traditional supply chains function (Tjahjono et al., 2017; Muthusami and Srinivsan, 2018; Stevens and Johnson, 2016, Frederico et al. 2020). The research of Frederico et al. (2020) showed that there are limited papers that address supply chain and industry 4.0. They included literature review analysis from 2011, however first articles about using disruptive technologies started to arise in 2016 and later. This review of articles considering disruptive technologies and supply chain can be seen in the figure 1. The most articles published consider the use of IoT (11 articles) and blockchain (10 articles) in supply chain while artificial intelligence includes 6 articles (figure 2).

Figure 2. Number of articles considering each technology

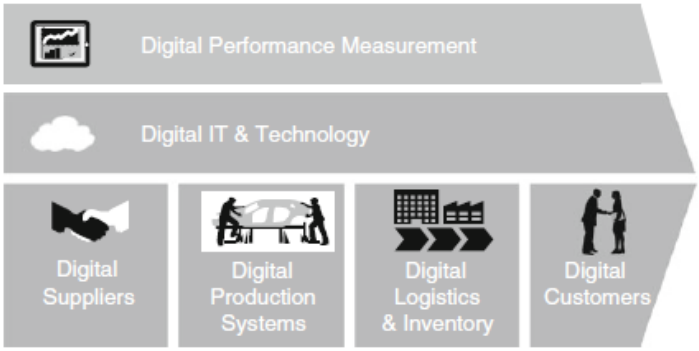


Source: Adopted from Frederico et al., 2020:210

Digital supply chain has five main characteristics. It is customer-centric, interconnected, automated, transparent and proactive. This characteristic is seen through products that are created according to customer requirements with the use of innovative manufacturing technologies where customers, suppliers and partners communicate in real-time through platforms. In this process efficiency is increased since different smart technologies are used which increase visibility in different parts of the supply chain. Also, digital supply chain offers real-time data through data

analytics, machine learning and AI therefore organizations can react faster to new changing conditions (Hoffman et al, 2019). Further, Farhani, Meier and Wilke (2017:161) state that DSC consists of six dimensions based on the Porters value chain and consists of four primary dimensions (customer, logistics and inventory, production, and supplier) and two secondary dimensions (IT and technology and performance measurement) (figure 3.)

Figure 3. Six dimensions of DSC management.



Source: Adopted from Farhani, Meier and Wilke, 2017:162

The benefits of DSC may be seen in greater visibility of the material flows along the value chain as well as the real-time information need for managers to make accurate and on time decisions that correspond to realizing company's objectives (Ageron, Bentahar and Gunasekaran, 2020). Other benefits are seen in cost-efficiency, more responsive supplychain, supply chain lead times efficiency and flexibility of designing the supply chain and sustainability (Korpela, Hallikas and Dahlberg, 2017; Ameri and Patil, 2012; Horenberg, 2017; Strandhagen et al. 2017; Tang and Veelenturf, 2019). The research of Tjahjono et al. (2017) showed that in supply chain, the order fulfilment and transport logistics will have the most impact from introducing new technologies stating that certain technologies may represent both opportunities as well as threats. This is supported by the increase in connections between different areas, where there are no clear boundaries between them. Companies who will adopt new technologies have to transform their traditional processes which includes organizational transformation which is not easy to carry out (Rutkowsky et al. 2015). Transformation of supply chain management will depend on the fact whether the company has already implemented digital business model or has to change its current model to digital. This transformation will bring to the creation of new added value (Mikkonen et al., 2016) and sustainability of companies. Reyes et al. (2021) perceive barriers in the context of organizational, technical deficiencies or deficiencies in supply chain which include little understanding of what new technologies are capable of and what are main limitations, as well as the privacy and security questions.

2.2. Digitalization and digital transformation

Most of contemporary business systems are not efficient enough and do not respond to the needs and demands of the market. Inefficient business systems lead to non-transparency and business errors, which requires great efforts from organizations to solve these problems. Precisely with the emergence of digitalization and the closely related digital transformation of business, business processes are improved through increased efficiency and effectiveness, improved operationalization and productivity growth, with clear business transparency. Coreynen et al. (2017) defines digitalization as the use of digital technology to achieve faster and better connections between people, systems, companies, products and services. Likewise, digitalization is the process of transferring from analog to digital form. Digital business transformation implies the transformation of traditional business models into digital business models through the application of new digital technologies, which affects existing business processes, thus improving business performance and creating and increasing added value of the company (Thomas et al., 2016; Li, F, 2018; Westerman et al., 2014; Sebastian et al., 2017). Vial (2019), on the other hand, interprets digital transformation as "a process that aims to improve an entity by initiating significant changes in its properties through a combination of information, computing, communication, and connectivity technologies". Digitalization is the first step towards the digital transformation of business. The process of successful digitalization and digital transformation of business involves the introduction and use of modern digital technologies and applications with the necessary education and ensuring the necessary business competencies of employees to be able to meet the requirements of new technologies. Digitalization is achieved on two levels, internally and externally. Internally, digitalization affects and changes the current way of working and communication between employees, while at the external level it implies the change of existing traditional business models to digital business models. Digitalization simplifies business processes, provides control and supervision in the work process, and reduces human error. The value of digital technologies and products is invaluable to both manufacturers and customers around the world, which is just visible through the COVID pandemic where digital technologies, ie their implementation and application have proven to be key factors of sustainability and business success. The emergence of new digital technologies (IoT, big data, augmented reality, robotics, blockchain technology, artificial intelligence) requires rapid changes both at the strategic level and at the operational level of the company's business. Recognizing the needs for digitalization and digital transformation of business implies primarily the creation of a digital strategy that leads to the digitalization of products and services and ultimately the digital transformation of business.

2.3. Blockchain technology

Blockchain technology is one of the newer technological innovations, a new digital technology that operates through a platform that enables development and multiple applications in business transactions. Likewise, a blockchain can be defined as a decentralized database in which transactions take place anonymously. Blockchain

is changing the way the business is done as companies that recognize and implement blockchain technology optimize their business processes and create a competitive advantage. Chuen (2017) claims blockchain to be "the main game-changer" in the fourth industrial revolution. Blockchain technology works on the principle of a general ledger in which each transaction remains recorded (Tschorsch and Scheuermann, 2016; Zyskind et al., 2015). The system that uses blockchain technology was developed according to peer-to-peer system (Cunjak Mataković and Mataković, 2018). Blockchain was first mentioned in 2008 under the title "Bitcoin: A Peer-to-Peer Electronic Cash System" and is the result of the actions of one person or a group of people under the pseudonym Satoshi Nakamoto. Further development of the idea and its implementation appear in 2009 by "releasing" the bitcoin network when the first bitcoins (the first cryptocurrency) were created. Private and public blockchain and blockchain consortia are distinguished (Wang et al., 2021). There are no restrictions on public blockchains, anyone can submit a transaction and participate in the mining process without protecting privacy because the transaction data is transparent to the public. A private blockchain has certain restrictions where a certain person or organization has the right to perform transactions, so transaction data is kept private. The blockchain of the consortium is partially decentralized and consists of several organizations with limited access but it requires a significantly better operating environment which improves the efficiency, execution and security of the system. With the development of new digital technologies, the connection between blockchain technology and 5G network is increasingly being explored, with 5G network and blockchain guaranteeing comprehensiveness, reliability, and speed of traceable data transfer (Wang et al., 2021). Decentralization of the blockchain enables data security, authenticity of identity as well as privacy protection (Wang et al., 2021). Blockchain decentralization is its main feature and advantage that makes the system fairer and more secure by emphasizing the most revolutionary quality of blockchain, which is the value of decentralization precisely because of the way data is recorded and processed.

2.4. Artificial intelligence

Any machine that can simulate human cognitive skills is defined as artificial intelligence (AI) and it can be used in every aspect of a human life such as exploring space, self-driving cars, drones, weapons systems, medical diagnosis, etc. (Demir and Paksoy, 2021:158). The term "artificial intelligence" is coined by John McCarthy and it's not a new thing in the IT industry. Its development can be seen in the table 1.

Table 1. The History of AI

Year	Event
1945	Bush's paper "As We May Think" published in the "Atlantic Monthly"
1950	Turing's seminal paper "Computing Machinery and Intelligence" published in the philosophy journal "Mind"

1955	Oliver Selfridge's paper, "Pattern Recognition and Modern Computers", was published in Proceedings of the Western Joint Computer Conference
1956	Arthur Samuel's checker-playing program was able to learn from experience by playing against human and computer opponents and improve its playing ability
1956	John McCarthy coined the term "Artificial Intelligence" in a conference at the Dartmouth College
1966	The first chatbot was developed by MIT professor Joseph Weizenbaum. The program was able to simulate real conversation like a conversation partner.
1972	MYCIN, an expert system that used artificial intelligence to treat illnesses, was invented by Ted Shortliffe at Stanford
1986	Terrence J. Sejnowski and Charles Rosenberg developed a program called "NETtalk" that was able to speak, read words and pronounce them
1997	IBM's AI chess computer "Deep Blue" defeated the incumbent chess world champion, Garry Kasparov.
2011–2015	Powerful processors and graphics cards in computers, smartphones, and tablets led AI programs to spread in everyday life. Apple's "Siri", Microsoft's "Cortana", and Amazon's "Echo" and "Alexa" were introduced to the market.
2018	IBM's "Project Debater" debated complex topics with master debaters, and performed unusually well. Google's "Duplex" called a hairdresser and made an appointment on behalf of a customer while the lady on the other end of the line did not notice that she was talking to a machine.

Source: Adopted from Buchanan 2005; Bosch Global 2018 in Demir and Paksoy, 2021:158

3. CORRELATION BETWEEN BLOKCHAIN TECHNOLOGY, ARTIFICIAL INTELLIGENCE AND DIGITAL SUPPLY CHAIN

3.1. Blockchain technology and digital supply chain

The application of digital technologies and Industry 4.0 in companies and increasingly in the field of supply chain management significantly influences changes within existing business processes, creating faster, transparent and flexible business conditions. Digitalization of business processes in order to influence the quality of products, to reduce production costs and increase the flexibility and efficiency of production is just one of the main goals of Industry 4.0. In order to achieve this within the supply chain management, the application of blockchain technology occurs. Technological progress enables faster development of the organization, opens new possibilities but also brings with it numerous challenges. Digitalization and change of new digital technologies within the supply chain offers solutions on how to face market challenges and how to take advantage of the opportunities available to

businesses (Abdalla and Nakagawa, 2021). The digital transformation of the supply chain ensures better customer service, greater and better integration of suppliers and partners, and affects sales growth and improvement of the overall business of the organization (Agrawal et al. 2019). Relying on the application of new digital technologies, previous studies show an increase in operational efficiency. Transformation from traditional to digital models (application of digital technologies and thus blockchain technology) reduces costs, delivery times, optimizes business processes and increases and improves the already mentioned operational efficiency (Büyüközkan and Göçer, 2018; Calatayud et al., 2019; Du et al., 2016; Gust et al., 2017). Digital transformation is a prerequisite for improved business supply chain performance in terms of efficiency and adaptability (Abdalla and Nakagawa, 2021). Due to the globalization and internationalization of business, companies are facing increasing expectations of customers and business partners, finding new digital technologies to improve the supply chain and to satisfy all parties involved along the way. A number of constraints faced by supply chains such as high operating costs, lack of capacity, low level of operationalization of blockchain technologies can be affected (Tapscott and Tapscott, 2016). "The blockchain allows information to be securely exchanged between producers, suppliers and customers across the supply chain" (Wang et al., 2021). According to Wang et al. (2021:114) important attributes of a blockchain are: (1) immutable, (2) decentralized, (3) trust, (4) transparency and visibility, (5) security and (6) global network. All of the above increases the efficiency and effectiveness of the business and can affect the improvement and increase the efficiency of the supply chain. According to Astarita et al. (2020) immutable as one of the blockchain attributes can improve the traceability in supply chain and logistic operations. Trust is a key prerequisite for the supply chain to function adequately and thus strengthen the relationship between business partners where blockchain transactions within the supply chain make it "trust free" (Beck et al., 2016). Decentralization of blockchain within the supply chain improves visibility and easier access to information. Transparency and visibility are not characteristics of traditional and centralized supply chains, where blockchain technology within the digital supply chain provides all partners with almost instant access to information, faster tracking of information and information transfer where blockchain can reduce data transmission costs and thus facilitate transparency and visibility within supply chain (Wang et al., 2021). Transactions and data passing through the blockchain system are almost impossible to change which creates and ensures a high level of data security for the digital supply chain. As mentioned before, blockchain technology is based on a peer to peer system, and thanks to blockchain, "businesses may no longer need a third party/intermediary to sell the products and/or services" (Wang et al., 2021). Authors' Wanger et al. (2021: 115) "consider the use of blockchain for supply chain collaboration and integration because it provides a conceptual idea to collaborate different nodes / parties / people, and integrates finance, information, and goods flows and technologies in a supply chain". The practical application of blockchain technology within the supply chain is investigated by the authors Wang et al. (2021) and they list several key elements linking the blockchain and supply chain: (1) information sharing, (2) traceability (carrefour), (3) automation in digital transformation. Characteristic of traditional supply chains (especially international

supply chains) is the large number of documents and high costs as well as extensive and long-term communication where blockchain can reduce costs and reduce efforts in communication and document transfer (Benton et al. 2018). Traceability in the supply chain through blockchain can be of great importance through tracking blocks in the network that can have key information about products, processes, shipments and the like and thus blockchain increases the transparency and visibility of the digital supply chain. Blockchain cannot create business autonomy and disruptive changes on its own, but with the interaction and inclusion of IoT, 5G, AI technology can create and gradually develop a smart and digital supply chain network leading to complete business autonomy (Christidis and Devetsikiotis, 2016; Gilchrist, 2016). Blockchain technology changes the way business is done and the way of thinking, and precisely because of a number of advantages it provides, it creates a network of trust between the parties involved but also influences the optimization of goods, information and financial flow in the digital supply chain. The supply chain ensures the flow of goods, services, information and money, while it is necessary to ensure transparency, speed and security, which blockchain technology ensures.

3.2. Artificial intelligence (AI) and digital supply chain

Barlow (2015) said that the future development of organizations will lie on developing organization capabilities for sourcing and distributing relevant data content at every link and life cycle of the value chain. To reach such a demanding task, organizations will have to use new technologies such as artificial intelligence (AI). The use of AI in supply chain has significant impact in parts addressing continuous process change, product lifecycle, real-time monitoring and forecasting future demands, eliminate waste, and achieve error-free production (Dash et al., 2019). Also, Juniper Research (2018) states that organizations invest money in AI to increase trend analysis, logistics planning and stock management (Dwivedi et al, (2021:7). The research of Accenture reports that 85% of C-level managers think that AI is the key to reach organizational growth and the majority think if they don't use this new technology they will be out of the business in the long run (Bersohn and Douglass, 2020). According to the Next Generation Supply Chain Market study, the technology impact of AI until 2025 will be 85% versus the current adaptation of AI at 25%, and by 2030 digital supply chain market will reach more than 100 billion $.[1] AI tehnologies are used to make efficient designs to. Therefore, the importance of adopting AI in business in a such way that gives the new value through the whole supply chain seems to be the matter of a life for many organizations nowadays. Ivanov, Dolgui and Sokolov (2019:838) argue that in the future, the successful supply chain "will be as good as the digital technology behind it". According to Ahmad et al (2019:5), AI will be the part of every technological system such as power system cybersecurity, financial markets, payments, nuclear power plants, electrical grids, IoT, logistics, manufacturing, building construction, etc. Reyes et al. (2021:158) state that the main challenge from implementation of AI in global supply chain management lies in "having the accurate information in order to reduce costs and lead time in the whole supply chain along with improving responsiveness to changing demand

[1] LogisticsIQ, https://www.thelogisticsiq.com/research/next-gen-supply-chain-market/

requirements". Further stating, that the main challenge lies in using the AI to link smart replenishment systems with smart demand planning systems. Ivanov, Dolgui and Sokolov (2019) analysed contributions of digital technologies on disruption risk management and ripple effect in supply chain. The main challenges of SCM in the part of predictive analytics are seen in data transparency and safety regarding complexity which increases in logistics cross-channels. Also, time risk increases because of complexity increase, while demand risk diminishes as well as information disruption risks. Further challenges are perceived in manufacturing process organization, reduction in SC layers, re-qualification of employees, organization re-design, data security and complex control.

4. RESEARCH APPROACH

In our research, we have used the systematic literature review to summarize past findings in a research field, in our case findings about digital supply chain and new digital technologies (blokchain and artificial intelligence) and impact of blokchain and artificial intelligence on supply chain management.

Our selection process of the papers for the systematic literature review is presented in figure 4. First, we identified relevant databases for our research, and we have decided to focus on the peer-review journals that are cited in Scopus and WoS (SSCI and SCI papers). Tables 2 and 3 present our search strategies in WoS (SSCI and SCI) and Scopus, with the period (2017 – 2021). We conducted a search using the scientific databases Web of Science (WoS) and Scopus in August 2021. Through the first part of the search, we checked WoS and Scopus using keywords: "DIGITAL SUPPLY CHAIN" AND "ARTIFICIAL INTELLIGENCE AND BLOKCHAIN". The search was focused on peer-reviewed papers in journals in English language. This approach resulted in 340 hits (305 in Scopus and 35 in WoS).

In the next step, the search strategy was refined. Since digital supply chain and new technologies (artificial intelligence and blokchain) are applied in different areas of scientific research, we decided to limit our research to papers in the fields business and economics and This criterion was related to Scopus subject areas and WoS categories (table 2 and 3). The Following Wos categories were used: Business or Management or Economics or Computer Science Information Systems (Sci-Expanded, Ssci, A&Hci, Cpci-S, Cpci-Ssh, Bkci-S, Bkci-Ssh, Esci, Ccr-Expanded, Ic.). The following Scopus categories/areas are used: Business, Management and Accounting. This approach resulted in 26 hits (18 hits in Scopus and 8 hits in WoS) (table 2 and 3).

Table 2. WoS (SSCI, SCI) search strategy (2017-2021)

Search strategy	Hits	Time span	Indexes
((digital supply chain) AND (artificial intelligence and blokchain)	35	All years	SCIEXPAND., SSCI, A&HCI, ESCI

Refined by: DOCUMENT TYPES: (ARTICLE) AND PUBLICATION YEARS: (2021 OR 2020 OR 2019 OR 2018 OR 2017) AND WEB OF SCIENCE CATEGORIES: (BUSINESS OR MANAGEMENT OR ECONOMICS) AND RESEARCH AREAS: (BUSINESS ECONOMICS)	8	2017-August, 2021 (last five years)	SCIEXPAND., SSCI, A&HCI, ESCI

Source: Authors work, 2021.

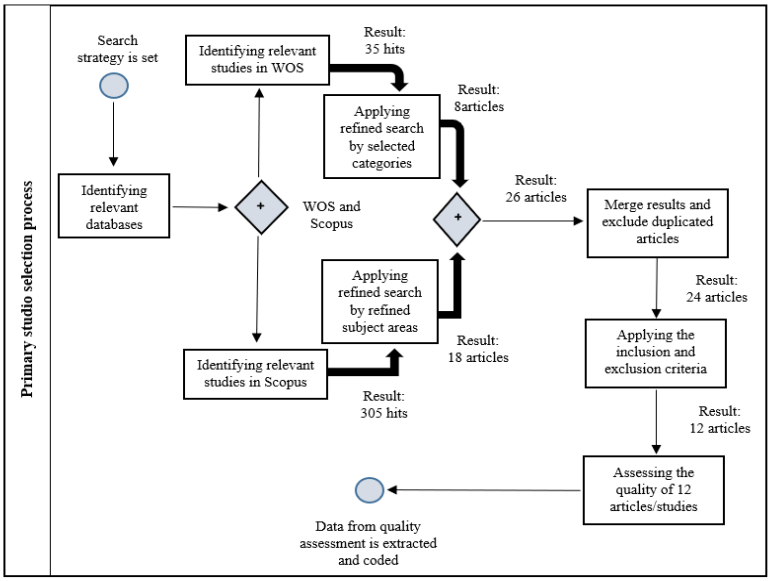
Table 3. Scopus search strategy (2017 – 2021)

Search strategy	Hits	Time span	Indexes
(TITLE-ABS-KEY (digital AND supply AND chain)) AND (artificial AND intelligence AND blockchain)	305	All years	Scopus
AND (LIMIT-TO (OA , "all")) AND (LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (LANGUAGE , "English"))	18	2017-August , 2021 (last five years)	Scopus

Source: Authors work, 2021.

In our analysis, we have included 26 papers (8 from WOS and 18 from Scopus). However, after merging all papers, we excluded 2 papers that were found in both databases. Therefore, 24 papers remained for the analysis. After reviewing the abstracts and keywords of all 24 papers, we eliminated papers that did not report the description of digital supply chain and artificial intelligence and blokchain. We used the following criterion that the paper was considered relevant if it specifically covers the application of artificial intelligence and blokchain in digital supply chain management (figure 4).

Figure 4. The selection process of the papers for the literature review



Source: Authors work, 2021.

Finally, after applying this exclusion criterion 12 publications remained, and they represent the basis for our further analysis. Next, we extracted and coded relevant data of surveys (e.g. authors, title, and journal, year of publication, digital supply chain, artificial intelligence, blokchain) for our analysis (figure 4).

5. RESULTS

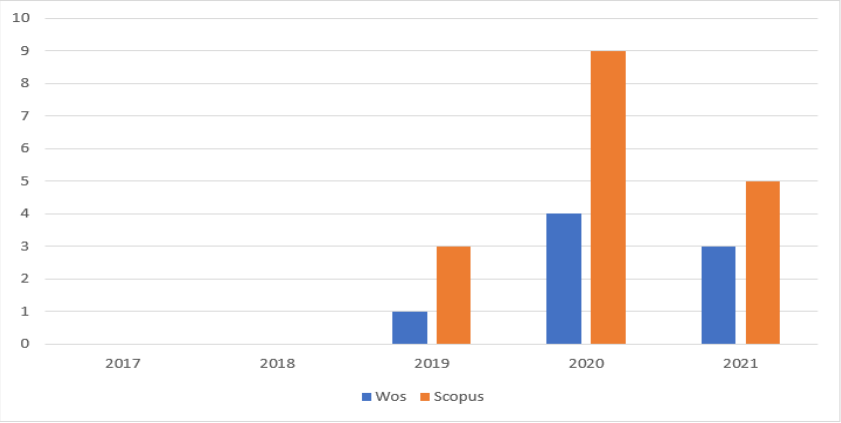
5.1. Analysis of papers with described digital supply chain, artificial intelligence and blokchain

The objective of this work was (1) to study and explore the importance of digital supply chain management and its impact on company productivity and competitiveness (2) to analyze and explore artificial intelligence and blokchain that are connected to digital supply chain management (3) to ensure a systematic review of the research literature in these fields. To achieve the set goals, numerous world literature was analyzed, which explores the field of artificial intelligence and blokchain and its impact on digital supply chain management.

Figure 5 depicts the annual number of publications from 2017 – 2021 in the amount of 24 articles. A growing trend of published papers is revealed. A growing trend in this area is from 2019 until 2021 (in 2017 and 2018 none paper has been published) where 24 articles were published regarding the area of artificial intelligence, blokchain and digital supply chain management where in that period most of the papers (13) were published in 2020. As shown a very small number of

articles deal with implementation and application of artificial intelligence and blokchain in digital supply chain. This shows and proves that this area is insufficiently researched and that a small number of researchers are engaged in research of the application and use of artificial intelligence and blockchain in the field of digital supply chain.

Figure 5. Number of papers published per year from 2017. – 2019. about artificial intelligence and blokchain in field of digital supply chain



Source: Authors work, 2021.

Further, table 4. shows al of 24 papers that were the result of research work within the Wos and Scopus database.

Table 4. Literature review

	Author name, year	**The name of the work**	**Research description**	**Connection between digital supply chain, artificial intelligence and blokchain**
SCOPUS base				
1	Al Hilali, R.A. and Shaker, H., 2021	Blockchain technology's status of implementation in Oman: Empirical study	Authors research new technologies and emphasize blockchain as a very important technology for industry development (case study on its application in Oman's sectors) but does not connect blockchain with digital supply chain	NO

2	Creazza, A. et al., 2021.	Who cares? Supply chain managers' perceptions regarding cyber supply chain risk management in the digital transformation era	Explores risk management and resilience within the digital supply chain but does not link the digital supply chain to artificial intelligence and blockchain	NO
3	Herold, D.M. et al., 2021.	The emergence and adoption of digitalization in the logistics and supply chain industry: an institutional perspective	Explore the development of digitization within logistics and supply chain through a concrete example of selected industry	NO
4	Hallikas, J. et al., 2021	Digitalizing procurement: the impact of data analytics on supply chain performance	Authors explore the importance of digitalization in the supply chain and consider digitalization a key factor in improving business performance within the supply chain	NO
5	Mathivathanan, D., et al., 2021.	Barriers to the adoption of blockchain technology in business supply chains: a total interpretive structural modelling (TISM) approach	Using Total Interpretive Structural Modeling (TISM) and Matrix Cross-Impact Matrix Multiplication Applied to Classification (MICMAC), the authors explore and identify potential barriers to the application and adoption of blockchain technology within the supply chain that they believe has the potential to revolutionize supply chains.	YES
6	Jurčić, V. et al., 2020.	Optimizing the Resource Consumption of Blockchain	Authors research blockchain and consider it applicable in various fields (science, biology, medicine, finance, etc.) and consider it one of the important factors influencing the	NO

			improvement of business processes and cost optimization - no connection between digital supply chain and blokchain	
7	Epiphaniou, G., et al., 2020.	Electronic Regulation of Data Sharing and Processing Using Smart Ledger Technologies for Supply-Chain Security	Authors explore the importance of digitization specifically a digitized platform for data management in the supply chain, exploring the ability to electronically regulate the exchange of data within and between businesses in the supply chain - no connection between digital supply chain and artificial intelligence and blokchain	NO
8	Lohmer, J. et al., 2020.	Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: An agent-based simulation study	Through a simulation study the authors link blockchain and supply chain. They consider that blockchain is a new technology that enables secure and timely data exchange and automation through smart contracts. Likewise, the authors present the impact of blockchain on risk management within the supply chain	YES
9	Filimonau, V., Naumova, E., 2020.	The blockchain technology and the scope of its application in hospitality operations	Authors investigate the existing applications of blockchain technology in different economic sectors and in different consumption markets	NO
10	Ivanov, D., 2020.	Predicting the impacts of epidemic outbreaks on global supply chains: A	Authors investigate the impact of the COVID-19 epidemic on global supply chains and	NO

		simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case	present the results of a simulation study	
11	Kittipanya-ngam, P., Tan, K.H., 2020.	A framework for food supply chain digitalization: lessons from Thailand	The paper explores the importance of digitization within the food supply chain on a concrete example of three companies showing the practice, challenges and opportunities of Thai food producers who apply digitalization of their supply chain	NO
12	Schniederjans, D.G, et al., 2020.	Supply chain digitisation trends: An integration of knowledge management	Authors explore neglected areas of digitalization within the supply chain, explore new areas of top optimization of digital supply chain performance	NO
13	Berawi M.A. et al., 2020.	Digital Innovation: Creating Competitive Advantages	Authors consider new technologies (blockchain, artificial intelligence) to be important factors in increasing efficiency and business performance as well as key factors in meeting customer requirements in product development or service delivery throughout the process chain	YES
14	Martinez, V., 2019.	Blockchain-driven customer order management	The paper explores and connects the blockchain and supply chain by placing emphasis on the understanding and use of blockchain within the supply chain in the	YES

			customer order management process	
15	Hughes, A., et al., 2019.	Beyond Bitcoin: What blockchain and distributed ledger technologies mean for firms	Authors consider blockchain to have great potential in various areas, including within the supply chain, and through the paper they give an overview of its importance and features	YES
16	Calatayud, A., et al., 2019.	The self-thinking supply chain	Authors note that Internet of Things (IoT) and artificial intelligence (AI) technologies have a great ability in resolving the key challenges and opportunities that arise in the supply chain	YES
WOS base				
17	Wang, M., et al., 2021.	Blockchain and Supply Chain Management: A New Paradigm for Supply Chain Integration and Collaboration	Authors present the application of blockchain technology within the supply chain, considering blockchain important for efficient and effective supply chain management	YES
18	Zouari, D., et al., 2021.	Does digitalising the supply chain contribute to its resilience?	The paper investigates the relationship between supply chain resilience and supply chain digitization, defining the degree of digital maturity and digital supply chain tools adopted for supply chain resilience	NO
19	Agrawal, P., Narain, R., 2021.	Analysis of enablers for the digitalization of supply chain using an interpretive structural modelling approach	Through their research, authors prove that new technologies, blockchain and artificial intelligence are the most powerful drivers for digitalization of the supply chain.	YES
20	Schneider, S., Kokshagin	Digital transformation: What we have	The authors explore the process of digital transformation and its	NO

	a, O., 2021.	learned (thus far) and what is next	significance to business and society	
21	Rymarczyk, J., 2020.	Technologies, Opportunities and Challenges of the Industrial Revolution 4.0: Theoretical Considerations	The paper investigates the impact of new technologies and industry revolution 4.0 on the production process of goods and services (effect on supply chain)	YES
22	Chod, J., et al., 2020.	On the Financing Benefits of Supply Chain Transparency and Blockchain Adoption	Authors claim blockchain important for achieving transparency in the supply chain	YES
23	De Bernardi, P.,et.al., 2020.	Innovative and Sustainable Food Business Models	The paper explores the impact of blockchain and artificial intelligence on the food sector	YES
24	Hartley, J.L., Sawaya, W.J., 2019.	Tortoise, not the hare: Digital transformation of supply chain business processes	The paper presents AI and blockchain and the way these new technologies are changing supply chain business processes	YES

Source: Authors work, 2021.

Common to all researched papers is that they emphasize the importance of digitalization on business process, especially on digital supply chain management. As shown, there is insufficient research that connects blokchain technology and artificial intelligence with digital supply chain, which represents the basis for further research in this area. Still, papers that deal with blokchain and artificial intelligence and link it to digital supply chain claim and prove its effect on companies' overall productivity, efficiency and competitiveness in the field of supply chain.

5.2. Influence of artificial intelligence and blokchain on digital supply chain

Our research of relevant data basis on the influence of artificial intelligence and blockchain on digital supply chain found 6 papers dealing with AI in supply chain and 11 papers using the blockchain technology in supply chain (table 5).

Table 5. Correlation between supply chain management and digital technologies

Digital technologies and supply chain - correlation	Paper ID	#of papers
Artificial intelligence	3, 6, 8, 9, 11, 12	6
Blokchain	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12	11

Source: Authors work, 2021.

Further, table 6 represents in detail the used research methodology for every paper analysed.

Table 6. An overview of the methodology, area and industry that deal with blockchain and artificial intelligence within the supply chain management

Research methodology	Paper ID	#of papers
Total Interpretive Structural Modelling (TISM) and Cross-Impact Matrix Multiplication Applied to Classification (MICMAC)	1	1
Agent-based simulation model of a complex supply network affected by disruptions	2	1
Review paper	3, 5, 9, 11	4
Single in-depth case (with direct data collection from primary sources at the company case: interviews, shadowing orders, mapping processes, skills and times, and a validation workshop)	4	1
Systematic literature review	6	1
Case study	7	1
Interpretive structural modelling (ISM approach)	8	1
b_verify (open-source blockchain protocol – new method by authors)	10	1
Interviews	12	1
Research area		
New Zeland	7	1
Industry type		
C Manufacturing	4, 11, 12	3
S Other service activities	12	1

Source: Authors work, 2021.

The emergence of new technologies presents innovative way of managing supply chain. This innovative supply chain will lead to an intelligent supply chain which will represent the integration of processes of ordering storage, production, distribution, and customer on horizontal, and vertical level which will be digitalised, automatic, autonomous, decentralized, and personalised (Rymarczyk, 2020). De

Bernardi et.al., (2020) investigate adaptation of new disruptive technologies in food sector throughout the whole supply chain, from making the products to storage processes. Specially start-ups are beginning to use new technologies to be more customer oriented through customization and offering more safety and healthier products. Such orientation of start-ups is changing the far known business models into innovative business models which leads to quicker and agile response to market demands.

Blockchain technology defined by Wang et al. (2020:113) considers a "decentralised network for supply chain integration and collaboration beyond currency, payment, and economics". The paper discusses the important attributes of the blockchain such as immutability, decentralization, trust, transparency and visibility, security and global network. The focus is on adopting the blockchain technology in companies in order to improve the information sharing as well as material and final products tracing along the supply chain. Also using the blockchain technology in terms of automation in digital transformation which leads to efficiency of the internal and external processes is analysed. The fact is that an integrated and collaborative supply chain creates value for its interested parties (Chen et al., 2017) and the value of using blockchain technology together with other new technologies has a big potential in the future development of digital supply chain management.

Furher, Hartley, J. L., and Sawaya, W. J. (2019) state that the big potential in supply chain digitalization lies in robotic process automation (RPA), artificial intelligence (AI)/machine learning (ML) and blockchain. The potential of adopting blockchain lies in traceability such as documentation flows or food flows from supplier to retailers. Hughes et al. (2019:277) state that blockchain technology has matured enough to disrupt supply chain management. Problems that arise from supply chains handling can be eliminated or reduced since the process handling goods is recorded and this allows monitoring along the whole chain. Blockchain technology ads to purchase security since registered purchase has its authentication certificate and this protects the buyer. Among first case studies to investigate the influence of blockchain in the customer order management process showed that blockchain technology influences process efficiency in terms of reducing the number of operations as well as the average time of orders, workload, increases order traceability and improves visibility along the supply chain (Martinez et al. 2019).

Artificial intelligence is seen as the "enabler of autonomous, predictive supply chain" (Calatayud, et al., 2019:30) and in practice, the use of AI in supply chain is seen in using the autonomous delivery vehicles or in stocking by detecting lack of inventory. Further, using the AI in supply chain increases the capacity for accurate demand prediction and maintenance, can be applies in specific supply chains areas and for optimization of supply chain problems (Calatayud, et al., 2019). Also a great emphasis is on ML in order to gather data and improve decisions to make supply chain more efficient. For instance, ML can be used for route optimization in shipping industry, or predicting time delays in airplane transportation, also for monitoring data on social medias. However, many companies today are not ready to adopt disruptive technologies' but since this is the future yet to come, Hartley and Sawaya (2019:707) state that organizations have to prepare them for that step to come by; "identifying a

supply chain technology visionary, developing a digital technology roadmap for their supply chain processes, and by updating their foundational information systems".

There are many problems companies face when adopting new technologies to make their supply chain efficient. The work of Agrawal and Narain (2021) makes a scientific and practical contribution to this problem by applying interpretive structural modelling (ISM) model for adopting new technologies in sequential mode to make the digitalization of the supply chain more systematic and efficient. Further Calatayud et al. (2019) proposed a self-thinking supply chain model presenting the high level of connectivity between cyber systems and physical objects through the use of IoT and also with the use of AI enormous data can be generated and this can enable monitoring of supply chain performance and early risk analysis in real-time. Therefore, the system becomes agile and resilient. The simulation study of Lohmer et al. (2020) confirmed that the use of blockchain technology in supply chain risk management leads to the increase of the supply chain resilience. This means that applying blockchain technology enables company to respond more quickly and adapt fast to new changes. However, the study showed that resilience to disruption is achievable when company has efficient processes and together with blockchain technology impacts total costs reduction, shortens the time of network recovery and propagation of disruption affects less entities.

6. DISCUSSION AND RECOMMENDATIONS

Most of the papers analysed gave theoretical point of view on the analysed problem. However, there are few cases that applied artificial intelligence and blockchain technologies into their supply chain and business processes, but they are rather the exception than the rule. The practice shows that many managers are still observing what other companies are doing and which technologies they apply. Most often, the barrier to adopt blockchain technology lies in the lack of knowledge about the benefits they get from its application (Mathivathanan, 2021) which often puts managers into the "observing mode" as well as the lack of technology leader in the company (Hartley and Sawaya, 2019). Some evidence from the food sector industry refer that in the future, the synergy between big companies and small companies and dynamic start-ups will occur. Through their cooperation most benefits will occur since start-ups are creative and they easily adopt different logic of conducting a business, nowadays (De Bernardi, P. et.al., 2020).

The findings of our research indicate that the impact of artificial intelligence and blockchain technology on digital supply chain management is on the verge to disrupt current supply chain processes and overall business processes in companies. Also, this is the research area that needs more empirical evidence, theoretical and quantitative evidence and presents a scope for many studies to be carry out in the future.

7. CONCLUSION

Through this paper, the importance of digitalization and digital transformation, digital supply chain and its connection with new digital technologies is highlighted. This paper provides an overview of new digital technologies innovations such as blockchain technology and artificial intelligence and its correlation to digital supply chain.

Traditional logistics is transforming as companies adapt new technologies in everyday business. This brings many challenges to logistics and managing the digital supply chain. In the future, logistic operations will change accordingly with the technology used. At the end this will bring to the establishment of smart logistics systems since with the use of new technologies, company will have agile supply chain and those who adapt faster will gain competitive advantage on the market. The main question for researchers and managers remains how to integrate and manage these new technologies in an efficient and effective way in order to optimize whole supply chain of the organization. The future anticipations about the impact of the use of AI and blockchain are optimistic and fast growing since its use will increase drastically by very near future. In such a context, organizations will have to adapt and implement new technologies in order to gain competitive advantage on market. It is important to combine blockchain technology with other digital technologies (e.g. IoT, smart contract, AI, 5G, big data and others) to achieve the maximum effect of their interaction that will lead to innovation and efficiency gains within the supply chain.

The results of the presented research show that new digital technologies nowadays are imperative in doing business. Blockchain technology and artificial intelligence affect business process and increase efficiency and effectiveness of a company. The idea and the aim of the paper was to present and to show that blockchain technology and artificial intelligence are indispensable elements within digital supply chain that facilitate process of supply chain. As for stating the benefits of this research, we can point out some recommendations for further research. This research deals and explores the areas of blockchain technology and artificial intelligence while other digital technologies are not covered. In terms of future research of this study other technologies and their impact on digital supply chain remains to be analysed. This research gives a brief overview of researched field that is actually insufficiently explored through the scientific literature, and presents a wide area for further researchers.

8. REFERENCES

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Appendix A: List of selected papers

Paper ID	Paper reference
1	Mathivathanan, D., Mathiyazhagan, K., Rana, N.P., Khorana, S., Dwivedi, Y.K. (2021) Barriers to the adoption of blockchain technology in business supply chains: a total interpretive structural modelling (TISM) approach, *International Journal of Production Research*, 59 (11), p. 3338-3359
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6	Calatayud, A., Mangan, J., Christopher, M. (2019) The self-thinking supply chain, *Supply Chain Management*, 24(1), p. 22-38
7	Wang, M., Wu, Y., Evans, M. (2021) Blockchain and Supply Chain Management: A New Paradigm for Supply Chain Integration and Collaboration, *An International Journal*, 14 (1), p.111-122
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