FACTA UNIVERSITATIS
Series: **Economics and Organization** Vol. 20, Nº 3, 2023, pp. 191 - 203
https://doi.org/10.22190/FUEO230517012R

Original Scientific Paper

DIGITAL TECHNOLOGIES IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

UDC 004:62]:658.62
004:62]:658.5

Volodymyr Rodchenko[1,2], Yuliia Prus[3]

[1]Mendel University in Brno, Faculty of Business and Economics, The Czech Republic
[2]V. N. Karazin Kharkiv National University, Karazin Business School, Ukraine
[3]Kauno kolegija Higher Education Institution, Faculty of Business, Lithuania

ORCID iD: Volodymyr Rodchenko https://orcid.org/0000-0003-0298-4747
Yuliia Prus https://orcid.org/0000-0003-0320-0131

Abstract. *The aim of the research is to summarize current trends in the use of digital technologies in logistics and supply chain management, to study the nature of their impact on the development of the logistics system of an economic entity. The article summarizes the main trends in the digitalization of supply chains and logistics in trade and industry. The methodical aspects of digital transformation of supply chains were considered. It is established that the emphasis in the organization and management of supply chains has shifted towards the transformation of traditional chains into the space of the digital economy. The article identifies promising areas and challenges for the use of digital technologies in logistics and supply chain management: the Internet of Things, blockchain, cloud services, augmented reality, robots, drones, and 3D printing. The trends in the development of digital technologies are explored, as their integration into global supply chains can accelerate, simplify and reduce the cost of the supply process at almost all stages. Digital technologies that improve the process of goods movement in supply chains are presented in the article in terms of logistics in the context of managing the relevant flows: material, information, financial, service. The state of development of cooperation between the main types of economic activities that produce technological and digital technologies and types of economic activities that provide logistics and supply management in the European Union was assessed.*

Key words: *logistics, digital technologies, supply chain management, augmented reality, Internet of things, cloud services, blockchain.*

JEL Classification: M21, R41

Received May 17, 2023 / Revised November 11, 2023 / Accepted November 11, 2023
Corresponding author: Yuliia Prus
Kauno kolegija Higher Education Institution, Faculty of Business, Pramones pr. 20, LT-50468 Kaunas, Lithuania | E-mail: yuliaprus@karazin.ua

1. INTRODUCTION

The transition to digital manufacturing and e-commerce defines the focus of changes that should take place in logistics and supply chain management under the influence of the transition to cyber manufacturing. If we consider the changes caused by IT technologies (changes in the structure of companies, a set of key competencies, business models and business strategies), then electronic supply chain management (e-SCM) in such realities becomes strategically important for combining business processes into a single infrastructure of the country's digital economy.

Analysis of reports on trends in the development of logistics and supply chain management (Deloitte, 2021; McKinsey & Company, 2021) for the period up to 2030 by leading consulting, analytical and IT companies allows us to identify global trends that confirm the relevance of the study of digital logistics:

- Big Data together with automated technologies: Blockchain, IoT, AR/VR, ML, AI will be used to improve logistics efficiency.
- The use of big data will change logistics analytics. It will strengthen the role of predictive analytics and forecasting.
- Cloud services will support flexible and dynamic (agile) logistics.
- Chatbots and robots will be used to manage most logistics operations.
- More and more companies will look for their own digital technology solutions for last-mile logistics.
- The challenges of autonomous delivery (driverless cars) will become apparent.
- Logistics security and cybersecurity systems will be top priorities in the field of logistics technology.
- Logistics service providers will increase the adoption of mobile applications.

What is happening today with the digital transformation of individual processes/ operations, business units, enterprises and the entire supply chain in industry, trade, services cannot be called anything other than "digital chaos". Today, many digital technologies are used in any supply chain, but decisions on digitalization are spontaneous, subject to short-term interests and challenges, rather than strategically aligned. In addition, the opportunities to use digital technologies/tools are underutilized, either due to insufficient knowledge and competencies or complexity of technical/software implementation.

At the same time, the method of digital transformation itself, especially with regard to logistics and supply chain management, is not sufficiently developed, despite the work of experts in this field. In particular, the internationally proven methodical approach based on the SCOR model is rarely used.

Given the increase in transaction volumes and the growing demands of customers, logistics service providers are forced to demonstrate increasing flexibility, efficiency and reliability, as well as to produce innovative delivery solutions that meet current customer expectations, such as: guaranteed delivery times, longer working hours, flexible and personalized services, fast processing of returns, etc.

2. LITERATURE REVIEW

The problems of using digital technologies in logistics and supply chain management are currently devoted mainly to foreign publications and research of leading world companies and groups of professionals (Deloitte, 2021; McKinsey & Company, 2021).

Kayikci Y. (2018), based on factor analysis, identifies the following areas of digital business processes of the company: digital logistics focused on internal, external activities of the organization and communication. Nitsche B. et al. (2021) "classified the latest technologies used in logistics and supply chain management into automatic identification technologies, communication technologies, information technologies".

Witkowski K. (2017) classified logistics information systems into the following groups: basic logistics information systems, e-business support information systems, mobile business, supporting logistics information systems. The authors identified the competitive advantage due to innovative information technologies that allow to create a market space for e-business logistics.

Based on empirical research, Grabara J. et al. (2015) found that digital technologies improve the quality of logistics services, the productivity of the organization, thereby providing it with competitive advantages in the logistics services market.

The active use of digital technologies in the provision of logistics services affects customer loyalty in various areas of retail trade (Elke, 2018). Studies have shown that digital capabilities have an indirect positive impact on the financial efficiency ratio, as they provide flow and information management to support operational (real-time), tactical and strategic decisions for both logistics service providers and customers (Ginters, 2019).

Netreba E. (2021) "highlighted the following opportunities of Industry 4.0 in the context of logistics management: products and services are flexibly connected via the Internet and other network applications (blockchain), digital communication allows automation and self-optimization of the production of goods and services, including delivery without human intervention (production systems based on transparency and predictive capabilities)".

At the same time, many aspects of the use of digital technologies in logistics and supply chain management remain poorly understood or even unexplored. In addition, to date, there are few scientific works of researchers that would be devoted to the digitalization of logistics systems and supply chain management processes. That is why this work would like to fill this gap to some extent.

3. Exploring Promising Digital Technologies in Logistics and Supply Chain Management

Digitalization is one of the powerful trends of modern socio-economic development, which has an increasing impact on the economy and society as a whole. This impact is so great that many authors talk about the beginning of another technological revolution – the information technology revolution (Chui et al., 2021). A significant impetus to its development was given by the COVID-19 pandemic: measures of social isolation and social distancing stimulated the use of remote work technologies, which not only transformed some business processes and processes of human interaction in private life, but also led to the development of digital competencies of the population. The latter is an important prerequisite for further development and acceleration of digitalization.

The impact of digitalization processes on different areas is different. The subject of our research in this article is the logistics sector, the development of which in the context of active digitalization depends on the spread of e-commerce. According to a survey by Deloitte in Ukraine (Symonenko, 2021), on the eve of the war, an important trend was observed for the second year in a row: a twofold predominance of online trade growth over offline. A study by

Soul Partners and Baker Tilly on Ukraine shows (Netreba, 2021) that "the e-commerce market grew by 41% in 2020 and reached $4 billion, accounting for 8.8% of the total retail trade in Ukraine. This share was expected to reach 9.2%, or $4.4 billion, in 2021".

Digital transformations have a significant impact on logistics. In particular, business is facing new challenges today, the biggest of which, according to the authors, are the following:

- The rapid development of new digital technologies and their widespread availability, which simplifies many aspects of life, encouraging people to actively adopt and massively apply them. This is forcing businesses and their ecosystems to transform to improve and maintain their competitive position in a digitized world.
- End consumers gain access to more suppliers, solutions and services, meaning that choice is greatly expanded and barriers to change are continuously reduced. Customers are gaining new leverage and competition is becoming fiercer, which in turn is driving businesses to embrace digital innovation as a basis for competitive advantage.

At the present stage, "many logistics professionals involved in planning, executing and monitoring the flow of products from the point of origin to the point of consumption confirm the need to revise existing models and increase the flexibility of business operations to provide omni-channel delivery, reduce costs and meet constantly changing consumer demand" (Abdirad et al., 2020). At the same time, the way to improve operational efficiency and customer satisfaction is through the digitalization of logistics processes.

The digital transformation of the logistics industry is almost inevitable today due to such factors as: significant advances in software development, a growing global economy and fierce competition. As the supply chain is a source of significant amounts of structured and unstructured data, the Internet of Things, artificial intelligence, and blockchain are driving digital transformation in logistics and supply chain management.

The procedure of digital transformation of supply chains should include a number of design solutions related to the formation of a multiparty network and a supply chain control tower.

"By collecting information generated by connected equipment (sensors) and logistics software, and correlating actual data with machine learning models implemented in cloud resources, enterprises can provide greater supply chain transparency and significantly reduce operating costs. Although the pace of cloud computing adoption in the logistics sector has been significantly high over the past few years, so far few industry companies are working with IoT software" (Richnák, 2022). This creates good prospects for further growth of digitalization in the industry.

Consider digital technologies that are expected to have a significant impact on logistics.

3.1. Augmented reality

Augmented Reality is a digital technological trend in logistics associated with the development of robotics, automation of logistics business processes, and the use of artificial intelligence systems, which aims to reduce the number of operations performed by humans, thereby reducing the impact of the human factor. Augmented reality technology allows to increase the efficiency of such operations by reducing the number of errors and speed of decision-making.

The most popular augmented / virtual reality systems are Artoolkit, ARtag, Osgart, Vuforia (Damiani et al., 2018). In systems that support the implementation of warehouse

operations, the task of integrating augmented reality technology with RFID is becoming relevant. Authors of the article proposed a conceptual solution that combines RFID and AR to implement an order picking system (Fig. 1).

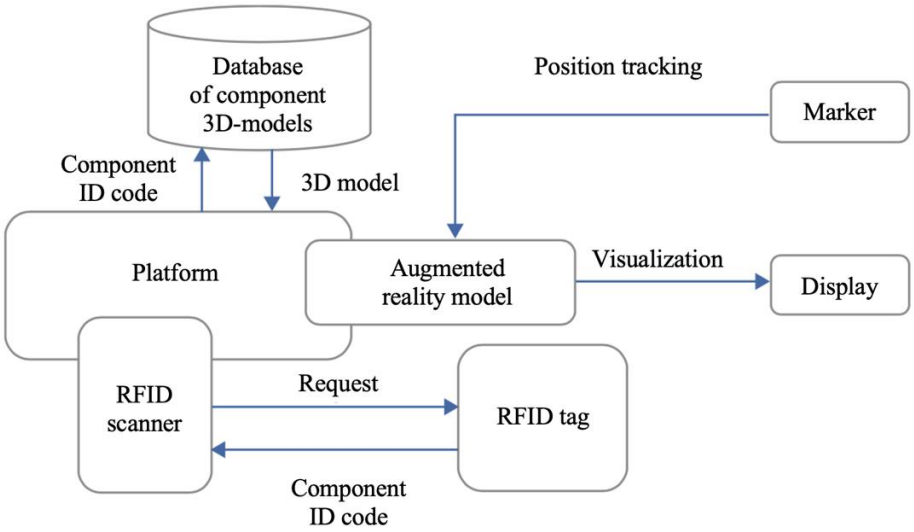

Fig. 1 Diagram of interaction between augmented reality and RFID applications
Source: own study

The RFID scanner reads the identification code of the storage unit / article (SKU) from the RFID tag. In the database of 3D models of articles, the corresponding three-dimensional model is located and visualized on the screen of the augmented reality device in accordance with the positioned object determined on the basis of the marker.

According to the DHL analytical report (DHL, 2021) and research, the promising areas of augmented reality application in supply chains are:

Optimization of order picking. A person sees a "digital pick list" on the display of an augmented reality device. When the person selects an item, the device calculates the most efficient path through the warehouse, and the display directs the person to the item, scans it as "picked" in the warehouse management system, and directs the picker to the next closest item on the list.

Planning of warehouse premises. With the help of virtual/augmented reality technology, a warehouse can be visualized in full scale before construction begins. You can simulate logistics processes in the warehouse, conduct test measurements, redesign zones – all this virtually.

Loading boxes/pallets/containers. Loaders see on the display of the augmented reality device a list of goods to be loaded and step-by-step instructions on how to load the container in the most efficient way, taking into account the size, shape and weight of the goods included in it.

Dynamic motion support. Head-up and frontal augmented reality displays allow drivers of forklifts and other material handling equipment in the warehouse to efficiently redirect loads on the go without taking additional actions that distract the driver. The driver can see critical information on the display regarding the parameters of the route.

Repair and return logistics. Augmented reality technology can be used to transmit a video stream from the consumer to the service department to quickly identify the causes of damage to durable goods and possible ways to repair and restore them.

In addition to proposing new areas and ways of using augmented reality applications, a number of works are devoted to the study and evaluation of the effectiveness of using augmented reality devices.

Studies (Stoltz et al., 2017; De Souza Cardoso, 2020) emphasize the benefits of using augmented reality technology in manufacturing and logistics processes:

- reduction of errors (no need to memorize the sequence of actions, automatic double check can be easily performed);
- increased flexibility (the device leaves hands free, which is convenient for operations, information can be displayed anywhere in the warehouse and at any time);
- increased reliability (work requires less concentration as instructions are easily displayed on the screen);
- increasing the speed of training and adaptation of new employees;
- increase in the speed and safety of operations;
- improving the image of the company through the use of new technologies.

3.2. Internet of things

According to the McKinsey Global Institute, the Internet of Things will annually bring the world economy from 4 to 11 trillion US dollars by 2025. (Chui et al., 2021). It involves equipping various equipment with electronic devices that can interact with each other automatically, without human intervention. The main components of the Internet of Things are sensor-equipped equipment; infrastructure that facilitates data exchange; software. The Internet of Things in logistics blurs the boundaries between the digital and physical worlds, forming a cyber-physical logistics system. As a result, almost any object (vehicles, warehouse equipment, etc.) can potentially be tracked in real time.

"Equipped with IoT software solutions, manufacturing, retail, and transportation companies can track the location of goods in real time and ensure that they arrive on time, at the designated location, and in the appropriate condition. In addition, IoT solutions allow businesses to estimate demand based on data history and automate replenishment processes. In addition to RFID-based tracking and barcoding, applications of IoT technologies in logistics include" (Cichosz et al., 2020):

- "autonomous delivery vehicles. On-board GPS trackers, equipment to detect signs of drowsiness of car drivers and fuel level sensors have already become a reality in modern logistics; further advances in electronics and computer vision will lead to the emergence of unmanned technical delivery devices, including drones and unmanned trucks. Their use will allow the automation of delivery services;
- "smart" warehouse. Unlike traditional warehouse management systems, IoT solutions allow warehouse workers to track goods down to the item level, optimize order processing time with the help of picking robots and significantly improve inventory accuracy" (Cichosz et al., 2020);

- IT-accessories. With the use of IT accessories in logistics, supply chain management and transportation covers the connection of various devices to a single digital system. For example, electronic elements on clothing and hats of employees, the use of which speeds up picking operations in the warehouse, allows you to control the production environment and provide remote management of employees using wireless devices.

The Internet of Things technology is closely related to Big Data analysis, which allows to efficiently process numerous data obtained from the Internet of Things. To reduce the cost of information service and support of these technologies, as well as for more convenient use in business, the Internet of Things is often used in conjunction with cloud services.

3.3 Cloud services

Cloud services is a concept/technology for providing convenient on-demand network access to a set of configured computing resources (e.g., networks, services, data warehouses, applications, and services) that the user can quickly use for their tasks while minimizing interaction with the service provider or their own management efforts. This concept is aimed at increasing the availability of settlement facilities and includes three service models:

1. Cloud Software as a Service (SaaS).
2. Cloud Platform as a Service (PaaS).
3. Cloud Infrastructure as a Service (IaaS).

As a rule, cloud services for small companies are business automation applications that are distributed on the SaaS (Software as a Service) model through the public cloud and are available to a wide range of customers at an affordable price.

Today, cloud services are widely used by IT companies and system integrators (in particular, SAP, Oracle, IBM, Generix) to manage logistics business processes in supply chains.

According to the analysis (De Souza Cardoso et al., 2020), the following advantages of using cloud technologies in logistics and supply chain management can be identified:

- Cloud services make supply chain business process automation more accessible.
- The cost of cloud services is constantly decreasing, and the implementation of such applications is becoming easier and faster.
- Cloud technologies allow supply chain participants to increase the speed and accuracy of the implementation of basic logistics business processes, which is extremely important when fulfilling a customer order.
- TMS-systems provide automated accounting of the current location of vehicles and road conditions, as well as information on delivery and shipment acts.
- Accelerating the turnover of goods, improving the reliability of delivery, thereby increasing the level of service.
- All data and information of the cloud technology user is stored in a single system in the cloud, so you need not be afraid that if you lose a device (tablet, laptop), important information will be lost – it is all securely stored in the cloud and will be available to the owner from any other device.

Among the cloud platforms used for IT support of logistics and supply chain management, the most popular are the platforms of large system integrators – SAP and Oracle.

"SAP Cloud Platform is an open Platform-as-a-Service (PaaS) that provides customers and partners with in-memory capabilities, underlying platform services, and unique business services to build and extend customized, collaborative, mobile cloud applications. SAP Cloud Platform is designed to accelerate digital transformation in business, allowing supply chain counterparties to create an application to support and invest in local infrastructure. Based on open standards, SAP Cloud Platform provides complete flexibility and control over the choice of clouds, frameworks and applications" (Zhan et al., 2020).

SAP Cloud Oracle includes comprehensive, unified business processes that address the supply chain of the XXI century. Whether it is blockchain, the Internet of Things or adaptive intelligence, Oracle SCM Cloud allows you to model a digital supply chain with capabilities including innovative product design, strategic sourcing, outsourced manufacturing, integrated logistics, full-scale fulfillment, and integrated supply and demand planning, making Oracle SCM Cloud the most complete set of SCM functionality in the cloud. Oracle SCM Cloud allows you to deploy functionality incrementally, with minimal risk, lower cost and maximum flexibility – all combined with continuous functional innovation and a more resilient supply chain (Jacobs et. al., 2013).

3.4. Robots

The fourth industrial revolution is characterized by the widespread use of robotics, which has the following advantages:

- Workers are freed from performing low-skilled and dangerous work. Robots perform it faster, more accurately and more economically.
- There is an opportunity to expand production and solve a number of problems, including, for example, the lack of specialists.
- Robotics fundamentally changes our lives and the way we earn money in it.

In addition, robots are more flexible mechanisms that can adapt to the environment and learn to perform new operations.

The areas of application of robots in logistics and supply chain management in terms of operational activities are very diverse. Most often they are used in such functional areas of logistics as warehousing and production logistics. If we talk about warehousing and cargo transportation at logistics infrastructure facilities (cross-docking terminals, distribution centers, etc.), the robotic equipment used in them is very diverse: from fully automatic warehouses to robots that perform individual operations of warehouse.

The transition to robotic (fully automatic) warehouses is a global trend. This is due to the need to speed up logistics processes in large warehouses, where human capabilities have reached their limits. Inventory management (and inventory) using robotic systems is cost-effective, eliminates errors, minimizes accidents and risks to people. Today, this is one of the best examples of the Internet of Things – the potential of such automation is great. According to Markets Research (Market Research, 2022), the "robotization" of warehouses for the period from 2017 to 2022 shows an average annual growth of 11.8%, and the market volume will increase to 4.44 billion US dollars.

Today, the leadership in automatic warehousing systems belongs to vertical warehouses. These are systems of world-known manufacturers such as System Logistics and Modula (Italy), Kardex (Switzerland), Haenel and Vander Lande (Germany), Constructor Group (Finland). The main purpose of these systems is to provide the highest possible storage density per unit of occupied area, that is, these systems are as close as possible to the technological height of the warehouse and always "grow" in height.

Logistics giants (DHL, Amazon.com, Walmart) have long made robotics part of their leadership strategy and are actively promoting their achievements in this area. For example, back in 2012, Amazon acquired Kiva, a manufacturer of production robots for picking and packing goods in the warehouse. According to Deutsche Bank, the use of these robots allowed Amazon to reduce operating costs by 20%, which amounted to 22 million US dollars per distribution center. Today, Kiva is used in 13 such Amazon centers, but if the project is scaled to all 110 centers of the company, it will be able to achieve cost savings of 800 million US dollars.

Such savings are achieved by increasing the efficiency of warehouse processes: with the help of Kiva, the cycle of warehouse operations for a specific product has been reduced from 60–75 to 15 minutes, and the warehouse space has been optimized by 50% due to its more rational use.

3.5. Unmanned aerial vehicles

Unmanned aerial vehicles (UAVs – drones) began to gain popularity in the early 2010s, driven by the development of wireless networks and the emergence of powerful computers capable of controlling complex devices, as well as advanced programming languages. The auditing company PwC estimated the UAV market in 2020 at 127 billion US dollars, most of which (61%) was used in servicing infrastructure projects and in agriculture.

According to experts (Elke, 2018; Richnák, 2022), drones will be playing a supporting role in global logistics for quite some time. Most likely, drones and traditional vehicles will be used together in the near future.

Let us consider some typical examples of the use of drones in logistics. The main manufacturers of drones for use in the civilian sphere, including logistics, are DJI, Flirtey, Project Wing, Matternet. Companies that implement drones in logistics: Amazon, UPS, DHL and others. Drones are used to deliver small parcels (weighing up to 8 kg) over short distances, usually on the "last mile" part of the route. Drones allow logistics services not only to reduce costs for the "last mile" (the most expensive part of the delivery), but also to deliver the parcel to hard-to-reach places.

Amazon's efforts to create new standards for online commerce with the help of drones and attempts to move from "day-to-day" to "hour-to-hour" delivery continue to attract the attention of the world. The consulting company McKinsey expects that in the future drones and unmanned vehicles will deliver up to 80% of all parcels.

The world's largest retailer – Walmart – generally intends to use drones not in delivery, which is associated with regulatory difficulties, but inside large warehouses and logistics/distribution centers: drones can move around the warehouse, taking 30 photos per second, and this information can be used for inventory. If such a process would take about a month when done "manually", then with the help of flying robots, a huge warehouse can be inventoried in one day.

4. Evaluation of Digital Transformation Processes of Logistics Systems

In the modern economy, there is a tendency to transform it into a "real-time economy", in which information about all events and processes comes to decision-making centers very quickly, almost without delay. This opens up new opportunities for improving the quality of logistics. Speed, timely decision-making, and operational data management are key factors for

ensuring the success of logistics companies. Obtaining these competitive advantages is directly related to the development of digital transformation processes.

Assessment of the digital transformation processes of logistics systems in Europe can be carried out using the Input-Output analysis, which is a powerful analytical method.

To assess the trends in the growth of the role and place of digital technologies in logistics, the hypothesis was used regarding the growth of relevant cost items in the intermediate consumption of economic entities of the relevant economic activities.

For the analysis, we used data (Eurostat, 2022) on the volume of trade of companies in two groups of economic activities: the first group is the main producers of digital technology solutions, the second group is logistics service providers. The first group includes the following types of activities:

- Manufacture of computers, electronic and optical products.
- Manufacture of electrical equipment.
- Manufacture of machinery and equipment not elsewhere classified.
- Manufacture of other transport equipment.
- Telecommunications.
- Computer programming, consulting and provision of services in the field of information.
- Scientific research and development.

The total output of products and services of these types of economic activities that were consumed by other types of activities is shown in Fig. 2. We can observe a tendency of constant growth of indicators.

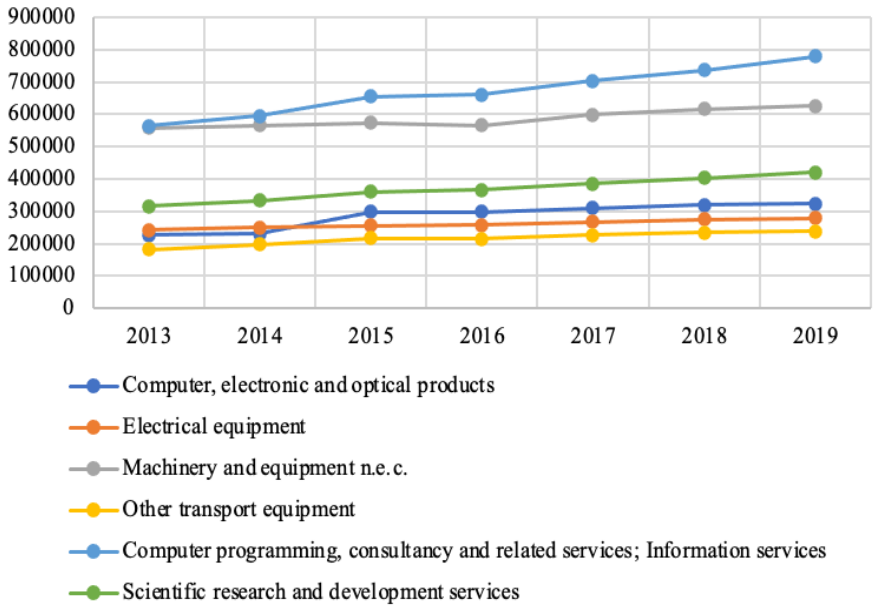

Fig. 2 Total production of goods and services in the EU countries by types of economic activity, EUR million
Source: Own study

The second group includes economic activities that provide supply chain logistics:

- Wholesale trade, except trade in motor vehicles and motorcycles.
- Land transport and pipeline transportation.
- Water transport.
- Air transport.
- Warehousing and auxiliary activities in the field of transport.

Fig. 3 shows the share of consumption of products and services by the second group of economic activities. Thus, it can be argued that the economic activities that provide logistics and supply chain in total consume no more than 3% of products and services of the economic activity Computer programming, consulting and information services, and no more than 2% for such activities as Scientific research and development and Manufacture of computer electronic and optical products.

The above gives grounds to assert the low level of integration of the main sectors of manufacturers of digital technological solutions and sectors of logistics service providers. This, in turn, determines the limited prospects for further rapid spread of digital technologies in logistics and supply chain management.

Also, this trend may indicate multidirectional vectors of technological development of industries due to the development of intra-industry technologies, their possible further encapsulation and the formation of new challenges in the field of system integration of various sectors of the logistics and supply industry.

Perhaps the identified problem will be solved within the framework of the implementation of the EU initiatives "Solidarity Roads", announced in May 2022 (Yermolenko, 2022). The amount of funding for this project is more than 1 billion euros at the expense of EU countries and international partner (Connecting Europe Facility, European Investment Bank).

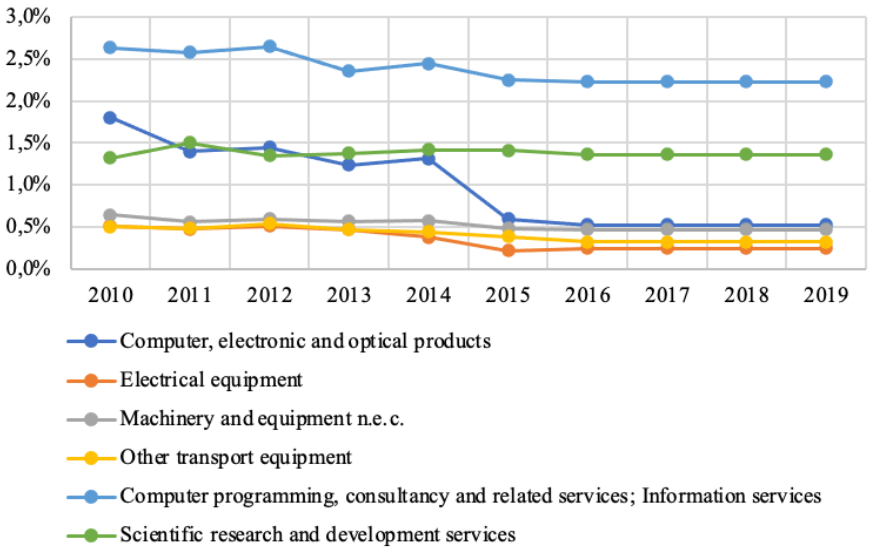

Fig. 3 The share of consumption of products and services by types of economic activity of the second group, %
Source: Own study

5. CONCLUSIONS

As a result of the conducted analytical review and analysis, it can be concluded that the implementation of methods and practical tools for the digitalization of logistics and supply chains of business entities provides benefits and opportunities for supply chain management: from end-to-end visibility to advanced analytics and automation of control and management of processes in the supply chain. Let us summarize the key features:

- End-to-end visibility – visibility across supply chain counterparties, including suppliers, contract manufacturers, carriers, 3PL providers, etc.
- Collaborative information sharing – real-time collaboration among supply chain counterparties based on a multi-layered network structure and blockchain technology.
- Early warning and exception management – eliminating disruptions in the supply chain before they affect the business of chain counterparties.
- Predictive and prescriptive analytics and decision support – using advanced forecasting techniques, artificial intelligence, computer simulation and multi-agent systems.
- Autonomous decision-making and control – reducing routine operations and increasing the productivity of personnel, production and logistics infrastructure through the use of digital technologies: AI, ML, AR/VR, robotics and 3D printing.
- Self-controlled supply chain with optimal decision-making and machine learning.

In such conditions, the possibilities of horizontal cooperation of supply chains in the formation of a digital ecosystem, in particular between different types of economic activity, were expanding. The development of integration, including information integration, initiates the formation of a digital ecosystem that allows offering customers comprehensive services. Digital solutions can help value chain counterparties work together more precisely. Focal supply chain companies can either form and organize a digital ecosystem on their own or focus on a niche service that adds value to customer service and becomes part of an existing ecosystem.

At the same time, the analysis of the economic performance of European Union companies shows a low level of cooperation between the main economic activities that produce technological and digital technologies and the economic activities that provide logistics and supply management.

REFERENCES

Abdirad, M., & Krishnan, K. (2020). Industry 4.0 in Logistics and Supply Chain Management. *A Systematic Literature Review*, 33, 187-201. https://doi.org/10.1080/10429247.2020.1783935

Chui, M., Collins, M., & Patel, M. (2021). The Inter of Things: Catching up to an accelerating opportunity. *McKinsey&Company*. Retrieved from https://goo.su/gd8PgPe

Cichosz, M., Wallenburg, C. M., & Knemeyer, A. M. (2020). Digital transformation at logistics service providers: barriers, success factors and leading practices. *The International Journal of Logistics Management*, *31*(2), 209-238. https://doi.org/10.1108/IJLM-08-2019-0229

Damiani, L., Demartini, M., Guizzi, G. et al. (2018). Augmented and virtual reality applications in industrial systems: A qualitative review towards the industry 4.0 era. *IFAC-Papers OnLine, 51*(11), 624-630. https://doi.org/10.1016/j.ifacol.2018.08.388

De Souza Cardoso, L. F., Mariano, F. C. M. Q., & Zorzal, E. R. (2020). A survey of industrial augmented reality. *Computers & Industrial Engineering, 139*, 106159, 1-12. https://doi.org/10.1016/j.cie.2019.106159

Elke, U. (2018). Industry 4.0, Logistics 4.0 and Materials – Chances and Solutions. *Materials Science Forum, 919*, 307-314. https://doi.org/10.4028/www.scientific.net/msf.919.307

Ginters, E. (2019). Augmented reality use for cycling quality improvement. *Procedia Computer Science*, *149*, 167-176. https://doi.org/10.1016/j.procs.2019.01.120

Grabara, J., Nowak, S., & Ulfik, A. (2015). Application of RFID and ICT in reverse logistic in Poland. *Applied Mechanics and Materials*, *718*, 150-155. https://doi.org/10.4028/www.scientific.net/AMM.718.150

Jacobs, R., & Chase R. (2013). *Operations and Supply Chain Management*. McGraw-Hill Education.

Kayikci, Y. (2018). Sustainability impact of digitization in logistics. *Procedia Manufacturing*, *21*, 782-789. https://doi.org/10.1016/j.promfg.2018.02.184

Moldabekova, A., Philipp, R., Reimers, H.-E., & Alikozhayev, B. (2021). Digital technologies for improving logistics performance of countries. *Transport and Telecommunication*, 22, 207-216. https://doi.org/10.2478/ttj-2021-0016

Netreba, E. (2021). When will online sales replace traditional trips to the supermarket?. *HB Business.* Retrieved from https://goo.su/F9MSAeH

Nitsche, B., Straube, F., & Wirth, M. (2021). Application areas and antecedents of automation in logistics and supply chain management: A conceptual framework. *Supply Chain Forum: An International Journal*, *22*(3), 223-239. https://doi.org/10.1080/16258312.2021.1934106

Richnák, P. (2022). Current Trend of Industry 4.0 in Logistics and Transformation of Logistics Processes Using Digital Technologies: An Empirical Study in the Slovak Republic. *Logistics*, *6*(4), 79. https://doi.org/10.3390/logistics6040079

Stoltz, M.-E., Giannikas, V., & McFarlane, D. (2017). Augmented Reality in Warehouse Operations: Opportunities and Barriers. *IFAC-Papers OnLine*, *50*(1), 12979-12984. https://doi.org/10.1016/j.ifacol.2017.08.1807

Supply table at basic prices incl. transformation into purchasers' prices. Eurostat: Data Browser. Retrieved from https://goo.su/S42ZU

Symonenko, K. (2021). Premonition of war: what changes did Ukrainian retail undergo in 2021 – Deloitte research in Ukraine. Retrieved from https://rau.ua/novyni/ukrainskij-ritejl-u-2021-deloitte/

Warehouse Robotics Market Research Report by Function, Type, Application, Region – Global Forecast to 2027 – Cumulative Impact of COVID-19. 2022. *Market Research.com.* Retrieved from https://goo.su/yL3g

Witkowski, K. (2017). Internet of Things, Big Data, Industry 4.0 – Innovative Solutions in Logistics and Supply Chains Management. *Procedia Engineering*, *182*, 763-769. https://doi.org/10.1016/j.proeng.2017.03.197

Yermolenko, G. (2022). EU to attract €1 billion to develop Ukrainian export routes. *GMK Center*. Retrieved from https://goo.su/o0RKQz2

Zhan, Y., & Tan, K. H. (2020). An analytic infrastructure for harvesting big data to enhance supply chain performance. *European Journal of Operational Research*, *281*(3), 559-574. https://doi.org/10.1016/j.ejor.2018.09.018

DIGITALNE TEHNOLOGIJE U LOGISTICI I UPRAVLJANJU LANCEM SNABDEVANJA

Cilj ovog istraživanja je da rezimira aktuelne trendove u upotrebi digitalnih tehnologija u logistici i upravljanju lancem snabdevanja, da bi proučio prirodu njihovog iticaja na rayvoj sistema logistike ekonomskih entiteta. Rad rezimira glavne trendove u digitalizaciji lanaca snabdevanja i logistike u trgovini i industriji. Razmatrani su metodološki aspekti digitalne transformacije lanaca snabdevanja. Ustanovljeno je da je akcenat u organizaciji i upravljanju lancem snabdevanja pomeren u pravcu transformacije tradicionalnih lanaca snabdevanja ka prostoru digitalne ekonomije. Rad identifikuje obećavajuće oblasti i izazove za upotrebu digitalnih tehnologija u logistici i upravljanju lancem snabdevanja: Internet Stvari, blokčejn, cloud usluge, proširenu stvarnost, robote, dronove i 3D štampanje. Istraženi su trendovi u razvoju digitalnih tehnologija, budući da njihova integracija u globalne lance snabdevanja može da ubrza, pojednostavi i umanji troškove procesa snabdevanja u skoro svim fazama. Digitalne tehnologije koje poboljšavaju process kretanja robe u lancima snabdevanja su u radu predstavljene u smislu logistike u kontekstu upravljanja relevantnim tokovima: materijalnim, informacionim, finansijskim, uslužnim. Procenjen je nivo razvoja saradnje izmedju glavnih tipova ekonomskih aktivnosti koje stvaraju tehnološke i digitalne tehnologije i tipova ekonomskih aktivnosti koje pružaju logistiku i upravljanje snabdevanjem u Evropskoj Uniji.

Ključne reči: *logistika, digitalne tehnologije, upravljanje lancem snabdevanja, proširena stvarnost, Internet Stvari, cloud usluge, blokčejn.*