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ROLE OF NEW TECHNOLOGIES IN LOGISTICS PROCESSES AND EXPANSION OF LOGISTICS ACTIVITY WITH VIRTUAL COMPONENTS

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Abstract. In improving the organizational structure of industrial activities from an information-logistics point of view, the role of the logistics system is extremely important. Therefore, certain requirements must be met when building effective logistics information systems of a higher class. The purpose of the report is to clarify precisely the role of new technologies in logistics processes and the expansion of logistics activity with the help of virtual components to improve the organizational structure of industrial logistics systems with virtual components.

Keywords: automated logistics systems, E-logistics systems, virtual components.

JEL Classification: L16, L22, O33

Introduction

In modern logistics, the use of modern information technologies is imperative, such as the step-by-step creation of a logistic automated information system with the possibility of system flexibility in relation to the specific requirements of a certain logistic connection or process through the use of hardware and software modules (Caro & Sadr, 2019, p. 49). The system must have the ability to: acceptability of the user in the dialogue "man-machine", with a clear fixation of the interrelationships in the logistics system inside and with the external environment; identification of intersection points of logistics processes with other processes; consistent construction of interfaces for the different subsystems of the automated logistics system; inadmissibility of incompatible solutions at the lowest level of the logistics system, etc.; taking into account the mutual influence of material and information processes, inside the system. All this will lead to the achievement of a synergistic effect by integrating system connections in vertical and horizontal level.

The aim of the study is to clarify the role of new technologies in logistics processes and the expansion of logistics activity with the help of virtual components to improve the organizational structure of industrial logistics systems with virtual components through analysis.

When choosing a methodology for conducting the research, the nature of the set goal and an effective combination of analysis and fieldwork are taken into account. Includes visiting organizations to gather information – such as SMEs (interviews with senior managers). The processing of the obtained data and results is based on research, research and analysis of documents and scientific literature, searches on the Internet and electronic databases.

1. Components of the conventional logistics system

In conventional production and logistics systems, the following general concepts of parallel logistics processes or flows have become established: material flow, financial flow and information flow. The main material flows are goods and raw materials. Next in importance are the financial flows or securing the material flow with financial means. Information is still assigned a secondary role, consisting of supporting the movement of goods from the supplier to the consumer, but only as accompanying information (Zhonga et al., 2017, p. 20). Applied to company activity, information flow is a collection of information components within the company system and also so between the internal system and the external environment necessary for the control and management of the main and auxiliary logistics processes and operations (Glistau & Machado, 2018, p. 38). Of course,

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a predominant role is also played by the auxiliary information system, an element of the main information flow, namely the movement of information in a certain direction, provided that the incoming data have a common source and a common receiver (Abdel-Basset et al. 2018, p. 616) The modules are system blocks for processing logistics information (for example, accepting orders or allocating material stocks to order, etc.). (Kitsios et al. 2018, p. 24). They contain data on the infrastructure and the nature of the information logistics system where the information is stored (e.g. see Figure 1).

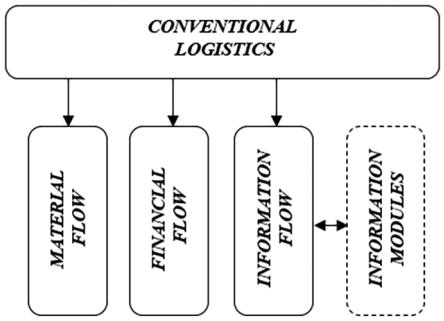

Figure 1. Elements of conventional logistics

The current state of logistics systems is determined by the rapid development and introduction of information and computer technologies in all areas. The implementation of most production concepts and systems would be impossible without the use of high-speed computers, local computer networks, telecommunications systems and information software (Jagersma, 2011, p. 138). The importance of the information provision of these processes is so great that they have an independent meaning in business and logistics information flows and resources (Jabłoński & Jabłoński, 2020, p. 59).

The information system organizes the flow of data accompanying the material flow and is the main link for the firm that connects supply, production and marketing (Starostka-Patyk, 2021, p. 2589). It covers the management of all processes of movement and storage of real goods in the company, which allows to ensure the timely delivery of these goods in the required quantity, package and quality from the point of their origin to the point of consumption with minimal costs and optimal service (Manavalan & Jayakrishna, 2019, p. 931; Nowakowska-Grunt et al., 2018, p. 177).

Information acts as the engine of the logistics system and allows it to adapt to new conditions. In this regard, one of the key concepts is that of information flow. Basically, information flow is the movement in a given environment of data expressed in a structured form (Shin, 2021, p. 57). From a manufacturing perspective, an information flow is a set of data that circulates within the production environment and between the production system and the external environment, necessary for the management and control of production and logistics operations (Stock & Selinger, 2016, p. 537). Apart from it, there are etc. auxiliary information flow, including the auxiliary logistics information operations.

The increasing role of information flows in the modern production environment is due to the following main reasons; for the user, this is information about the status of the order, availability of goods, delivery dates, delivery documents, etc., which is an essential element of the service for users; from the point of view of the management of production, machinery and facilities in this chain, the availability of complete and reliable information reduces the need for inventory and labour resources by reducing the uncertainty of demand; information increases the flexibility of the logistics system in terms of how, where and when resources can be used to achieve competitive advantages (Jurenka et al., 2018, p. 35). There are different types of information flows in the company:

1. Depending on the type of systems that are connected to the logistics flow, they are: horizontal, which belongs to one level of the production system hierarchy; vertical – from the highest level of the system down.
2. Depending on the place of passage: external, which circulates between the production system and the external environment; internal that circulates inside the production system or in an individual element.
3. Depending on the direction related to the production system: incoming; outgoing.
4. Type of information carrier: on paper carriers; electronic media etc.
5. Depending on the purpose: direct (managers); normative – reference; accounting and analysis; facilities.

The information flow is characterized by the following parameters: source of occurrence; the direction of the flow; periodicity; kind of existence; transmission and reception speed; flow intensity etc. (Deckert, 2020, p. 3)

Flow control can be done in the following way: changing the flow direction; limiting the transmission speed to the appropriate reception speed; limiting the amount of flow to the capacity of a single node or section of road (Dimitrov et al., 2012, p. 18).

The following types of information flows are distinguished in logistics systems. Real depending on the type of information carrier – paper, electronic, mixed; depending on the type of flow-related systems – horizontal and vertical; depending on the place of passage – external and internal; depending on the direction in relation to the information system – input and output; depending on the density - low-intensity, medium-intensity and high-intensity flows; depending on the frequency – regular, operational, occasional; virtual depending on the nature of the carrier. Between these flows there is a constant information connection.

2. Interrelationship between material and information flows

In auxiliary systems, material flows are accompanied by a certain amount of information. Their interrelationship

is obvious, since at the heart of the material flow management process lies information processing (e.g. see Figure 2).

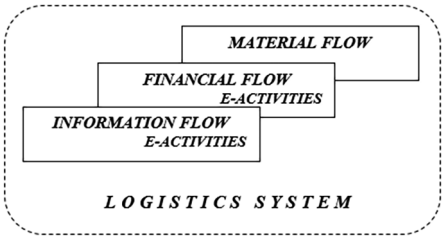

Figure 2. Interrelationship between flows

However, the correspondence of one stream to another is conditional. In fact, the content of the information flow, as a rule, reflects the data of the material flow, but by time parameter they may not match. In practice, in conventional systems, material and information flows are often ahead of or behind each other (Khan et al., 2012, p. 259). In micro-logistics, as well as at the macro-level, material and information flows are formed by a number of components. They can be accumulated from the relevant flows at the stages of transportation, loading and unloading operations, assembly, storage, etc. (Sumah et al., 2020, p. 173)

Correspondence to each other of material and information flows also has a specific feature. It boils down to the fact that they can be both unidirectional and multidirectional. The information flow can be directed in the opposite direction to the material flow (Atzori et al., 2010, p. 2791). For example, in the opposite direction to the material flow, there can be information about the results of the acceptance of the cargo in terms of quantity or quality, confirmation, claims, etc. In general, information flow represents movement in some environment of data expressed in a structured form.

Applied to company requirements, the information flow is a set of circulating messages within the system, and also between the system and the external environment, necessary for the control and management of logistics operations (Kai et al., 2021, p. 3).

The study and management of information flows is carried out in combination with technical means for transmitting, processing and fixing the information. At the same time, the forms of existence of information flows are wider than the possibilities of technical means (for example, direct communication between people). Thus, the forms of manifestation of information flows can be reduced to four types paper document; electronic document; visual document; verbal (oral) messages.

Both material and information flows are characterized by a source of origin, volume and quality indicators, transmission speed, rhythmicity, directionality, etc. (Naskar et al., 2020, p. 1669). With regard to the logistics system, they are divided into: external information flows; internal information flows. According to their purpose, they are divided into: input information flows; output information flows. According to their rhythmicity, they are: constant; discrete or periodic; single (Yin & Peng, 2021, p. 4).

The path along which the logistics information flow moves does not always coincide with the route of movement of the material flow (Nowakowska et al., 2018, p. 177). The formation and management of information flows depend on a number of objective (market conditions, state economic policy, etc.) and subjective factors (the state of the communication infrastructure, the degree of importance, etc.) (Ivanov et al., 2020, p. 3).

Summarizing, it can be noted that the functioning of information flows is an activity to limit the speed of transmission of certain information to a value corresponding to its reception and registration on a medium, and in the field of quantitative indicators – to limit the volume of the information flow to the established parameters of the facility throughput of the distribution facility.

The management of the information flow is also manifested in changing the structure and correcting the direction of the flow. Information flow is measured by the amount of information processed per unit of time (Wang & Luo, 2019, p. 287). In the practice of economic activity, information can be measured by the number of processed or transmitted documents, by the sum of the document lines in them. If computer technology is used for processing and recording the information, then the measurement unit is a byte. The unit of information in this case is the binary unit – bit (Zhou et al., 2017, p. 101).

If the characteristics of the information flow necessary for management are known in advance, then connection resources can be reserved for it, choosing the optimal mode for its movement (transmission), processing and fixation (Ugocukwu et al., 2022, p. 3).

The costs for the formation and processing of the information flow represent an important component of the logistics expenses.

Regarding material and information flows, it should be noted that a large role in establishing their parameters is played not only by sources (suppliers) and receiving points (consumers), but also by intermediate processing systems that transform material and information flows, transforming them in such a way that logistics tasks and functions gain maximum coherence in achieving logistics goals. There is also a certain relationship and interdependence between material, informational and financial flows, which is related to monetary provision of materials and raw materials.

3. Interrelationship between material, information and financial flows

Between the material, financial and information flows in terms of importance, the interrelationship marks the development in the direction and priority of the information flow. The manifestation of this interrelationship is best appreciated if one examines the nature of logistics operations (Huan, 2021, p. 129).

The analysis shows that information flows have a dominant place over others. Thus, in the case of material flows, for their transformation or management, various actions are performed, which in principle have the character of random events (storage of the product using a different complex of technical means at a different moment in time, with differences in the transportation of the product depending on the conditions, etc.). In this regard, it is very important to understand and study the essence of logistics operations and the role of the information component (Liu, 2023, p. 54). This is of particular importance also from the point of view of the fact that it is the most revolutionary component leading to qualitative changes of the entire logistics process. Therefore, we will examine and analyse the functions and influence of information processes in their development and application in logistics.

4. Role of new technologies in logistics processes and expansion of logistics activity with virtual components

In modern logistics, information technology usually means a complex of tangible and intangible tools and methods for the production, processing, transmission and consumption of information that ensure the operation of the process. The main direction in the development of information technologies in logistics is the integration of information flows and communication support for logistics activities (Lei, 2022, p. 896). This direction is focused on the active use of information networks and virtual systems. Development in this direction is associated with a number of problems.

The constant development of information logistics is related both to the growing role of information in this process and to the development of communications and tools for working in a virtual environment. In the modern world, the importance of information is also determined by a number of factors, such as: a high percentage of information resources in the general activity; integrating function of information in the industrial sector, which to a serious extent provides a positive effect. The relevance of the introduction and application of information technologies in logistics is related to the continuous growth of the volume of data to be processed. With the usual, classical methods, it is no longer possible to extract the necessary information and this does not allow it to be used for the management of logistics activities. The most important factor in management is the speed of data processing and obtaining the necessary information. The flow of information increasingly affects the efficiency of the logistics system.

When the necessary information is obtained and in the presence of modern technology for its processing in the logistics system, the company can make a good profit. Therefore, logistics divisions that function successfully put E-logistics in the foreground and consider it as an important source for realizing the potential of and in financial aspects. If electronic networks are used to exchange data with potential users, the enterprise can significantly increase its competitiveness and market share (Thoben et al., 2017, p. 9).

The introduction of information technologies in logistics aims to ensure the flow of tangible and intangible components and the interaction between individual units of the company, as well as between companies in the process of purchasing and distributing goods. Therefore, as the main direction of research, it is necessary to accept the division of logistics systems by material flow phases with characteristics of providing logistics functions (transport, stocks). It is important to note that information technology in itself in the practice of organizing the circulation of goods has no value in itself. In order for the logistics management system to give a positive result, a detailed description of all physical processes is required and only then implementation in the existing program system or the development of effective software. Effective software security occurs only in cases where, during implementation and operation, programmers and consultants collect all feedback and wishes from users, make appropriate analysis, choose appropriate solutions and add the program to a particular company. In logistics, information technology and automation remain key areas at the current stage of development. But, regardless of this, logistics information systems developed on different computing platforms, using different programming languages, are often incompatible with each other and create (without taking into account the requirements) international "givens". As the global Internet is now increasingly used, technologies such as barcoding and electronic data interchange from purely technical equipment are becoming tools for the automatic identification of modern business behaviour. This is why the certification and standardization of supply chain processes and logistics services in industrial sectors play an important strategic role for logistics development (Demirova, 2020, p. 47).

The logistics system in production would be effective only if the necessary conditions were created for its integration into existing production processes. This problem can be solved if an appropriate information base is created. This includes the current review of the fund ie. the existence of actual and planned orders, the content of production, the main and intermediate schedules for storage and delivery, processing, waiting and dwell time, as well as the control of their compliance. In order to realize the data collection of the production system, all companies have sensors and measuring devices that help to control the time of the ongoing processes, their volumes and the transmission of this information for post-processing. To its "measurement" network,, the logistics system has certain requirements such as reliability and fast (manual or automated) collection of the necessary data on the means of production and means of transport.

In warehouse logistics, one of the most important competitive advantages and optimization goal is time – it

is almost the main indicator of the activity of an industrial company that uses warehouses.

Automating all warehousing logistics processes helps to additionally optimize the time and costs associated with maintaining more staff, and yet the automation of the warehousing and storage processes themselves is only the tip of the so-called iceberg. It is necessary to introduce a unified system to optimize the entire process. This system will be able to provide automation of all existing logistics processes for warehouse management, as well as provide the manager with information about the activities of the entire company

The other question is about warehouses for virtual components (e. g. see Figure 3), or storing logistic-informational data in virtual reality.

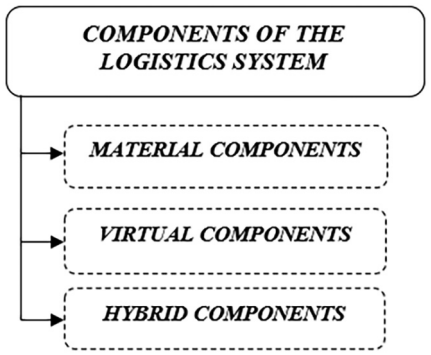

Figure 3. Components of the logistics system

Or, E-Systems will begin to play a major role in the modern logistics environment. Thus, modern information technologies, which are intended for implementation in logistics, offer a number of optimal solutions for various warehouse tasks, starting from the simplest reporting and reaching modern technologies for automatic identification of all stages of the movement of goods. (e. g. see Figure 4).

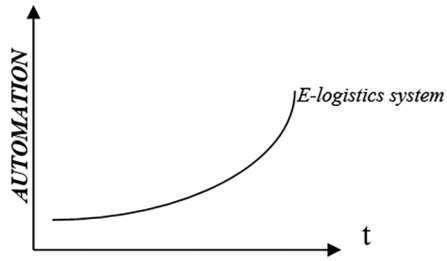

Figure 4. Electronic systems

The experience of implementing warehouse automation systems shows that the basic needs of companies related to warehouse management are almost the same for most market participants. First of all, it is the fastest collection and analysis of detailed information about the goods passing through the company's warehouse, high speed of execution of warehouse operations and accurate identification of goods, control of warehouse workers and the creation of a reasonable system of staff motivation. These problems can be attributed to basic level needs and quite often their solution with the help of automated warehouse management systems could be enough to significantly increase warehouse efficiency.

Highly specialized solutions for warehouse complexes are offered by the WMS class program (Warehouse Management System). But company managers who are interested in the need to use warehouses in one way or another prefer to use the ERP system (Enterprise Resource Planning) – an integrated platform. ERP is able to make business processes transparent for company managers who have to make important management decisions. These products combine extended functional openness to external interaction and flexibility and enable the development of various industrial solutions that represent a new stage in the development of the company's management systems. It is a system that is tailored and adapted to the tasks of the industry, and could help to solve not only standard business tasks, but will also take into account the peculiarities of the company's business processes in a given industry.

It is also important to note the significant role of logistics experts in solving special problems in logistics processes and in creating technical tasks for the improvement of the warehouse information system. For example, when introducing changes in the technological process, logistics experts are able to significantly reduce the company's risks in a short period of time, prepare employees and get the best result.

The information logistics system allows to improve the management of the constantly complicated material and technical supply. For small and highly organized production systems, for example, synchronous production and just-in-time delivery, the ability to qualitatively manage the flow of incoming resources becomes increasingly important. Due to the activity of information logistics in the exchange of supply data, the efficiency of stock management increases. Immediate receipt of information on the movement of goods increases confidence in the rapid delivery of goods and makes it possible to maintain real stocks from information flows. The exchange of supply data, which is distributed throughout the company's network of suppliers and transport companies, allows the manufacturer to reduce the costs associated with ensuring the activities of the entire logistics chain. The manufacturing company receives tangible benefits, increasing its efficiency. These benefits can be divided in certain proportions between the three parties in the process: the supplier, the manufacturer and the transport company, in the form of a recovery of the costs of creating and maintaining modern information systems and creating additional income from their applications. The effect that is obtained as a result of the actions of information logistics stimulates all people who are involved in the logistics process to maintain the reached level of the process, as well as to invest new resources for its further optimization, development and improvement.

Conclusions

The role of new technologies in logistics processes and the expansion of logistics activity with virtual components should be a priority for all organizations, because the digitization of processes will be a leading factor for competitiveness not only now, but also in the future. In the time of fourth and now fifth industrial revolutions, companies will be forced to improve the digitization of their processes, because this will establish them in the market, improve management and synchronize all operations. The trust of the customer should not be underestimated – this is a key point for any organization, because the huge advantage of any company is a short supply chain. This would be possible only if there is digitization of all the main activities in logistics, namely – inbound logistics, production logistics, outbound logistics, marketing and sales, service. New technologies and expansion of logistics activity with virtual components are able to make business processes transparent for company managers who have to make important management decisions. These virtual products combine extended functional openness to external interaction and flexibility and enable the development of various industrial solutions that represent a new stage in the development of the company's management systems.

In this regard, the main conclusions from the upcoming changes in the organizational structure of logistics activity under the influence of new material and virtual components are:

1. Communication and electronic technologies will increasingly be used in the logistics structure.
2. The improvement of logistics activity through automation and virtual components will find an increasingly wide application in modern logistics activities.
3. The influencing factors related to the application of the principles of cyber systems, including and logistics systems begin to show their priority over conventional approaches and methods of improving logistics activity.
4. The efficient functioning of E-logistics systems requires and makes it possible to include more and more virtual components in logistics industrial systems.

References

Abdel-Basset, M., & Manogaran, G., & Mohamed, M. (2018). Internet of Things (IoT) and its impact on supply chain: A framework for building smart, secure and efficient systems. *Future Generation Computer Systems, 86*, 614–628. https://doi.org/10.1016/j.future.2018.04.051

Atzori, L., & Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks, 54*(15), 2787–2805. https://doi.org/10.1016/j.comnet.2010.05.010

Caro, F., & Sadr, R. (2019). The Internet of Things (IoT) in retail: Bridging supply and demand. *Business Horizons, 62*(1), 47–54. https://doi.org/10.1016/j.bushor.2018.08.002

Deckert, C. (2020). Sustainable logistics. *In Encyclopedia of sustainable management*. Springer. https://doi.org/10.1007/978-3-030-02006-4_131-1

Demirova, S. (2020). *Digital logistics.* Tonex.

Dimitrov, I., Makedonska, D., & Milusheva, P. (2012). *Logistics*. Technical University-Varna.

Glistau, E., & Machado, N. I. C. (2018). Logistics concepts and Logistics 4.0. *Advanced Logistic Systems, 12*(2018), 37–46. https://doi.org/10.32971/als.2019.003

Huan, H. (2021). Analysis of enterprise Supply chain management model Innovation based on Internet economy. *Modern Business,* (23), 128–130.

Ivanov, D., Dolgui, A., & Sokolov, B. (2020). Cloud supply chain: Integrating Industry 4.0 and digital platforms in the "Supply Chain-as-a-Service". *Transportation Research Part E: Logistics and Transportation Review, 160*, 102676. https://doi.org/10.1016/j.tre.2022.102676

Jabłoński, A., & Jabłoński, M. (2020). New economy business models in the concepts of, the and the circular economy. In *Social business models in the digital economy* (pp. 51–88). Palgrave Macmillan. https://doi.org/10.1007/978-3-030-29732-9_3

Jagersma, P. (2011). Competitive information logistics. *Business Strategy Series, 12*(3), 136–145. https://doi.org/10.1108/17515631111130103

Jurenka, R., Cagáňová D., & Horňáková, N. (2018). The smart logistics. In *Mobility Internet of things.* Springer.

Kai, L., & Ming, L. X., & Yixuan, L. (2021). Intelligent logistics hardware system based on Internet of Things, VR and AR. *E3S Web of Conferences, 253*, 02081. https://doi.org/10.1051/e3sconf/202125302081

Khan, R., Khan, S., Zaheer, R., & Khan, S. (2012). Future internet: The internet of things architecture, possible applications and key challenges. In *2012 10th International Conference on Frontiers of Information Technology* (pp. 257–260). IEEE. https://doi.org/10.1109/FIT.2012.53

Kitsios, F., Kamariotou, M., Madas, M., Fouskas, K., & Manthou, V. (2018). Strategic information systems in logistics and supply chain management. In *Proceedings of the 4th International Conference on Decision Support. System Technology ICDSST2018)* (pp. 22–25). Heraklion, Greece. Emerald Publishing Limited.

Lei, N. (2022). Intelligent logistics scheduling model and algorithm based on Internet of Things technology. *Alexandria Engineering Journal*, *61*(1), 893–903. https://doi.org/10.1016/j.aej.2021.04.075

Liu, X. (2023). Research on enterprise supply chain management from the perspective of information sharing. *The Frontiers of Society, Science and Technology*, *5*(1), 52–56. https://doi.org/10.25236/FSST.2023.050110

Manavalan, E., & Jayakrishna, K. (2019). A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements. *Computers & Industrial Engineering, 127*, 925–953. https://doi.org/10.1016/j.cie.2018.11.030

Naskar, S., Basu, P., & Sen, A. K. (2020). A literature review of the emerging field of IoT using RFID and its applications in supply chain management. In *Securing the Internet of Things: Concepts, methodologies, tools, and applications* (pp. 1664–1689). IGI Global. https://doi.org/10.4018/978-1-5225-9866-4.ch078

Nowakowska-Grunt, J., Kowalczyk, A., & Wojtaszek, H. (2018). "IT management systems in the supply chain." *World Scientific News, 104*, 175–185. https://doi.org/10.29119/1899-6116.2018.41.9

Shin, S. (2021). A study on the advancement of domestic logistics enterprises to the specialty logistics market in accord-

ance with changes in the logistics industry. *Journal of Korea Port Economic Association, 37*(2), 55–71. https://doi.org/10.38121/kpea.2021.06.37.2.55

Starostka-Patyk, M. (2021). The use of information systems to support the management of reverse logistics processes. *Procedia Computer Science, 192*, 2586–2595. https://doi.org/10.1016/j.procs.2021.09.028

Sumah, B., Masudin, I., F., & Restuputri, D. P. (2020). Logistics management and electronic data interchange effects on logistics service providers' competitive advantage. *Journal of Business and Economic Analysis, 3*(2), 171–194. https://doi.org/10.1142/j_10.36924sbe.2020.3205

Stock, T., & Seliger, G. (2016). Opportunities of sustainable manufacturing in industry 4.0. *Procedia CIRP, 40*, 536–541. https://doi.org/10.1016/j.procir.2016.01.129

Thoben, K. D., Wiesner, S., & Wuest, T. (2017). Industrie 4.0 and smart manufacturing – a review of research issues and application examples. *International Journal of Automation and Technology, 11*(1), 4–16. https://doi.org/10.20965/ijat.2017.p0004

Ugochukwu, N., Goyal, S., & Arumugam, S. (2022). Blockchain-based IoT-enabled system for secure and efficient logistics management in the era of IR 4.0. *Journal of Nanomaterials*, 1–5. https://doi.org/10.1155/2022/7295395

Wang, Q., & Luo, R. (2019). The mechanism and empirical study of intelligent logistics technology improving the efficiency of logistics industry – taking the "Core Area" of the silk road economic belt as example. *Procedia CIRP, 83*, 285–291. https://doi.org/10.1016/j.procir.2019.04.069

Yin, G., & Peng, J. (2021). Prediction of regional logistics heat and coupling development between regional logistics and economic systems. *Discrete Dynamics in Nature and Society, 2021*(1), 1–9. https://doi.org/10.1155/2021/8170234

Zhou, W., Piramuthu, S., Chu, F., & Chu, C. (2017). RFID-enabled flexible warehousing. *Decision Support Systems, 98*, 99–112. https://doi.org/10.1016/j.dss.2017.05.002

Zhonga, R., Xua, X., Klotzb, E., & Newmanc, S. (2017). Intelligent manufacturing in the context of Industry 4.0: A review. *Engineering, 3*(5), 616–630. https://doi.org/10.1016/J.ENG.2017.05.015