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# SYNERGY OF VARIOUS DIGITAL TECHNOLOGIES APPLIED IN LOGISTICS

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## Abstract

In today's business environment, logistics activities are being transformed by a multitude of impacts, one of which is digitalization. New market models are modifying the nature of logistics processes and the architecture of chains, reducing the number of links. Nearly all spheres of life are being digitized, requiring people to be flexible, adapt fast to changes and respond to contemporary challenges. Digitalization is a new reality, not an option, but a necessity, not a matter of choice at all. Digitalization needs to be understood as an emerging repertoire of breakthrough solutions in various spheres of human activity: social, political, technological, scientific, educational and economic. Based on current publications and studies, the paper analyzes and clarifies features of a synergetic digital effect in logistics hierarchies. The paper reflects on whether digital technologies have a reciprocal synergetic effect in logistics and builds a schematic representation of synergetic links between digital technologies. Technological innovation is playing an increasingly important role in all sectors of the economy, and logistics and supply chain management cannot remain unaffected by this process either. In recent years, the logistics industry has made significant advances in artificial intelligence, advanced analytics, and automation, just to name a few. Yet, the logistics industry, unfortunately, lags behind in digitalization when compared with the areas of telecommunications, banking services, retail.



*Keywords:* Digital technology, innovations, logistics system, management, synergy effect, transport

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## 1. Introduction

Digital technology has become an integral part of today's world economy and society, and, once spread across the globe, has had a significant share in economic and social processes and given rise to new terms, in particular, "digital economy", "digital society", "digital transformation". The use of digital technologies can significantly increase the competitiveness and investment attractiveness of not only a single enterprise, but also a certain industry and the country at large. In particular, one of the areas where digital technology has long been widely used is logistics.

## 2. Problem Statement

Logistics is a key sector for the global economy; it sets the tone for trade and transport links, amount of imports and exports, profit margin from distribution and transport activities, and environmental risks (Bekmurzaev & Khazhmuradova, 2021). Logistics refers to the overall process of managing a balanced ratio of material, information and financial flows within a company, which follows a phased circulation from an external source to a final destination (Bekmurzaev, 2021).

## 3. Research Questions

Logistics systems might rely on a number of digital technologies that, interacting with each other and with humans, can significantly improve performance indicators, in particular via the synergy effects. Therefore, one of the tasks in logistics management is to combine various digital technologies to improve the performance of a logistics system.

Using digital technologies in logistics systems (including supply chains) is mainly touched upon in foreign publications and studies of international leading companies and organizations (Gish & Laaper, 2016; Kersten, 2017; Logistics Trend Radar, 2018). Various dimensions of some digital synergies are covered, for example, in (Franks, 2016). However, many aspects of digital technologies used in logistics remain understudied or unexplored. With this in view, digital synergy in logistics systems calls for further study.

## 4. Purpose of the Study

The paper aims to analyze, clarify and supplement the current aspects of identifying and evaluating the effects of digital synergy in logistics systems.

## 5. Research Methods

The paper used general scientific methods of comparative, systemic, and statistical analysis in economics. A methodological toolkit involves the publications of domestic and foreign economists, studies of leading world companies, provisions and conclusions by scientists engaged in the issues of the logistics business.

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## 6. Findings

Digitally driven global economic changes are capable of radically transforming the society, in particular, due to interactions between real and virtual environments. This explained a need for the basic performance mechanisms of various economic and social systems to be delineated, in particular, logistics activities, in order to preserve and enhance their viability in the “new economy”.

The following key elements defining the future of logistics (including supply chains) in the digital economy can be highlighted (Logistics Trend Radar, 2018):

1. Customer centricity. For the time being, the client is the “center” of modern business, thus making any company seek to meet their needs. Every year, amount of goods, means and channels for sales promotion grow, demands increase not only for the quality of goods, but also for all processes from ordering goods, delivery and receipt by the end user. One of the progressive ways of interaction is B2B Omni-channel solutions, in which the transition between online and offline channels is considered “seamless” communication, meaning that the client does not need to make additional efforts to toggle between online and offline to buy products and services. “Last-mile” delivery is an increasingly studied field, which in supply chain management refers to the delivery from a transportation hub to a final destination.
2. Sustainability (environmental friendliness). Growing shipments call for more transport, primarily road transport, which, on the one hand, ensures rapid delivery of goods to the consumer, and on the other hand, is a source of harmful emissions into the atmosphere. Nowadays, the logistics industry commits to cut down on CO2 emissions.
3. Digital technology. Global transformation currently underway marks the beginning of a wholly new economy and social relations built on digital technology (Rogers, 2017). Digital technologies that are being used in logistics systems include the Internet of Things, Big Data, cloud computing, wireless networks, next-generation sensors.
4. People. Despite a widespread use of digital technologies (robotics) in logistics, people will continue to remain at the heart of logistics. However, from an active participant in logistics operations, a person will turn into an observer, which will require new approach to training professionals. Digital technology enabling people to process and analyze huge amounts of data may significantly increase the efficiency of management decisions in logistics.

These aspects defining the future of logistics systems are interdependent. In the era of the digital economy, digital technology will be essential for other above-mentioned elements. In addition, digital technology, independently and together, can have a different impact on logistics systems, which can be addressed in the light of synergy effects.

Digital synergy in logistics can be understood as a meaningful, coordinated interaction of two or more digital technologies that are used in a logistics system to produce a joint result as a usual sum of results of a separate action performed by each of these digital technologies. Accordingly, digital synergy in logistics systems is an additional effect produced during the interaction of digital technologies being used in the logistics system.

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The following key trends that could impact the logistics industry in coming years (Kersten, 2017; Logistics Trend Radar, 2018):

1. Big Data is a technology enabling to search, analyze and process a huge amount of structured and unstructured data in order to acquire whole new knowledge that can be used to inform decision making.
2. The Internet of Things is a global network of physical devices that are connected to the Internet and can generate, collect, process and analyze information without human involvement via control, management and information processing centers using various sensors, information transmission media. The Internet of Things is held back not only by Internet speed and connectivity, but also several devices connected, standardization and cybersecurity (Carter & Easton, 2011).
3. Cloud computing is hardware and software used by the user as some kind of service for processing and storing data via the Internet or a local network at convenient times with minimal interaction with the provider.
4. Autonomous Robots are robots that are able to independently perform tasks without recourse to human control.
5. Artificial Intelligence (AI) is a broad branch of computer science that deals with various simulations of human intelligence by machines.
6. Self-driving Vehicles are cars that are capable of moving safely with no human input.
7. 3D printing is the groundwork of additive manufacturing, which uses a 3D printer to create a three-dimensional physical object by successive layers of a certain material in accordance with a targeted virtual 3D model.
8. Low-cost Sensor Technology is various sensors for entering information by touching the screen of a device.
9. Augmented Reality is a technology that enhances real-world environment with virtual elements. Thanks to this digital technology, the boundary between the real and virtual worlds is becoming blurred.
10. Unmanned Aerial Vehicles are aircraft capable of flying, taking off and landing without any human pilot on board.
11. Blockchain is a distributed database technology in which data is distributed in a certain way among computers (servers) in a certain network.
12. Next-generation Wireless, including 5G networks, is characterized by high speed, minimum delay in transmitting and receiving data.
13. Bionic Enhancement are supporting systems that augment capabilities of the body, reduce the number of injuries and damage to people doing various activities.
14. Virtual Reality & Digital Twins is a simulated experience of a real-world environment or an illusion of some real world created using computer systems that provide visual, sound and other perceptions.

These digital technologies of logistics systems can fall into three groups (Logistics Trend Radar, 2018):

1) digital technology that have a significant value for logistics processes and will be widely used in the next five years (Big Data, Internet of Things) and in the next decade (Artificial Intelligence, unmanned vehicles, 3D printing);
2) digital technology that have a not-so-great share in logistics processes and is likely to be widely used in coming years (sensor technology, augmented reality) and in the next decade (unmanned aerial vehicles, Blockchain);
3) digital technology that have a little effect on logistics processes and are forecast to be widely used in 5-10 years (bionic technology, virtual and digital reality).

The first digital technologies that will be used in logistics systems for the next five years, compared to other groups, are assumed to have the greatest contribution to digital synergy effects in logistics systems. The Internet of Things can be considered most promising digital technology connecting all the elements of the logistics system into a single network, which makes data transfers between them much faster. In addition, the Internet of Things interacts with and facilitates almost all digital technologies in logistics systems. However, the IoT is highly dependent on software and hardware. Assumedly, with the development of next-generation wireless networks, the efficiency of the IoT will also increase, and, accordingly, its value for digital synergy will increase.

Big Data a priori requires large data stores and powerful technologies for data transfer and processing. In logistics systems, in particular, due to a growing number of various sensors, controllers, scanners, etc., more and more various structured and unstructured data is being accumulated, which requires the Internet of Things – for transfers and cloud computing – for processing and analysis.

Blockchain is considered as one of the breakthroughs to allow secure data storage. In logistics systems, it is reasonable to use Blockchain, for example, build a data array in which records correspond to transfers and status of material assets. Thanks to Blockchain, it is quite difficult to intentionally damage or destroy records in such an array of data. Assumedly, Blockchain will allow the greatest synergy effect when interacting with Big Data and cloud computing.

Cloud computing, big data, augmented and virtual reality involve the use of powerful modern hardware and software that can operate based, in particular, on various artificial intelligence tools, thereby enhancing their capabilities, which contributes to a synergy effect. In addition, these technologies interact with the Internet of Things and with each other.

Autonomous robots, self-driving vehicles, unmanned aerial vehicles include different means and devices by which a robot performs tasks, vehicles move, and aircraft fly; sensors that provide information about the environment; control system that can be built using artificial intelligence, processes information from sensors and controls robots; navigation system that controls vehicles and suggests alternative directions (Dobrynin, 2006). Moreover, autonomous robots, self-driving vehicles, unmanned aerial vehicles must be connected to the Internet.

3D printing and bionic systems are digital technologies that are not significantly affected by other technologies within the logistics system. However, artificial intelligence can be used to create a 3D model, while the Internet (including the Internet of Things) can be used to transmit data. Hence, the synergy effect is possible when 3D-printing, the Internet of Things and artificial intelligence interact.

For logistics systems, digital synergy should be considered at the level of individual logistics operations; at the level of management of material and information flows – within individual functional logistics subsystems and at the level of their interaction; at the level of holistic management of information and material flows – within the company and at the level of interaction between companies. When it comes to interactions between different subsystems of the logistics system or different companies in the supply chain, the synergy effect also depends on whether the characteristics of some digital technology are the same for different subsystems or companies.

Digital synergy in the logistics system is also influenced by the ability of digital technologies to reinforce each other's capabilities unilaterally or reciprocally. To determine digital technologies that affect other technologies, we can use the method described in (Novikov & Suarez, 2012), adapting it to digital technologies and proposing a mechanism for constructing a matrix of pairwise interactions.

According to the approach proposed in (Novikov & Suarez, 2012), we build a matrix of pairwise interactions (impacts) of digital technologies at a certain level, which are indicated in the paragraph above. In this matrix, the values of its elements are equal to some numbers that correspond to the strength of impact one digital technology have on another. It is quite difficult to assess the strength of impact clearly by a single number. To assess the value of impact one technology have on another, you can use, for example, the Harrington scale that contains a meaningful description of gradations and numerical values corresponding to these gradations: a very high level of impact (0.8–1.0); high (0.64–0.8); medium (0.37–0.64); low (0.2–0.37); very low (0.0–0.2). An expert, in accordance with his own experience and best practices, can choose a single number from the interval, or can take the corresponding average values of each of the intervals: 0.9, 0.72, 0.51, 0.29, 0.1. To relate the digital technology to one of the three groups regarding their impact on logistics processes, the resulting numbers can be aligned in a certain way. Thus, for digital technologies of the first group, the resulting number on the Harrington scale can be multiplied by 3, for the second – by 2, for the third – by 1.

All elements of the main diagonal of the constructed matrix are equal to zero. The matrix is square, the number of rows and columns of which corresponds to the number of digital technologies. For this matrix, the eigenvalues are found, among which the main eigenvalue is selected, for which the eigenvector is calculated. Based on this vector, one can predict the overall strength of impact of each digital technology on others. The highest value of the eigenvector corresponds to digital technology that is able to make the greatest contribution to the overall digital synergy in the logistics system.

The findings can evaluate digital technologies for a particular logistics system in terms of their interaction and reciprocal synergy effect.

## 7. Conclusion

Contemporary logistics systems are integrated economic and social systems that rely on various innovations for effective functioning. These are, in particular, digital technologies, among which a vast majority are technologies that can work in interaction with other technologies. For example, for full-fledged 3D printing of an object, you only need a 3D printer, consumables, and a file with a 3D model of the object. In this case, other digital technologies may not be involved at all, and their use will not produce any additional effect, nor will their absence in any way worsen the outcome. However, when it come to cloud computing, a much better result can be obtained if the data transfer rate is high and without human input (which corresponds to the next generation wireless communication and the Internet of Things), data processing facilities will be built using modern collective artificial intelligence algorithms, and Blockchain technology will be applied to improve the reliability of data storage.

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