

Application of digital technologies in the logistics sector

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Abstract. In recent years, we have witnessed the growing role and importance of logistics in achieving accelerated economic growth at various levels - company, regional and national. Significant interest in logistics services on a global scale has caused the growth of e-commerce, especially during the period of the Covid-pandemic. The rapid development of digital technologies in recent years has had a significant impact on this process. The logistics sector is among the most strongly influenced by technological progress. The advantages of digitization of logistics operations are associated with cost reduction, process optimization, quality improvement, customer satisfaction and companies' competitiveness. The management of logistics and logistics operations is brought to the highest strategic level in the hierarchy of companies and a mandatory condition for preserving and increasing their market share. The research aims to identify the digital technologies of Industry 4.0, which are about to have the strongest impact on the development of the logistics sector, within the framework of the fourth industrial revolution.

1 Introduction

Logistics is a relatively new management concept that is widely used in various areas of social and economic life. [1] In economic management, it is associated with the integrated management of the movement of material and accompanying (material, informational, financial, human, etc.) flows, which are characterized by a point of origin and a point to which they must reach. This movement requires the execution of multiple logistics operations such as transportation, warehousing, inventory management, demand forecasting, manufacturing operations, quality management, standards development, customer service, etc.

Data shows that the size of the global logistics market is growing annually. For 2022, it is estimated at 10.68 billion dollars (Fig. 1).

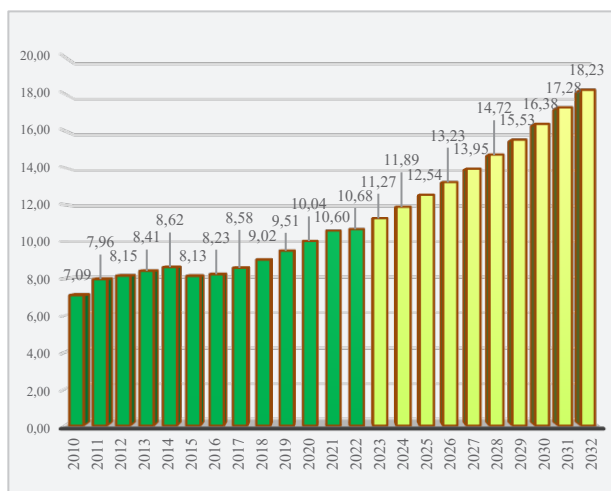


Fig. 1. Logistics market size, billions \$ [2]

Expectations for the sector are that by 2032, the market size will grow to about \$18.23 billion with a compound annual growth rate (CAGR) of 5.48%

Data on the revenue of the logistics market in Europe in the period 2007-2021 shows relative stability. (Fig. 2) Reported revenue growth over a fifteen-year period is 23.66%, which equates to an average growth of 1.6% per year.

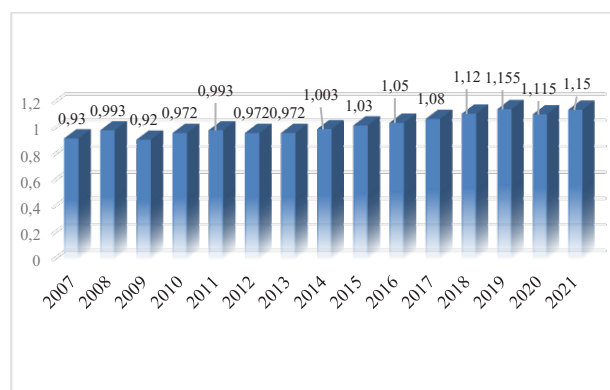


Fig. 2. Logistics market size in Europe, billions EUR [3]

Investor interest in the logistics sector on a global scale confirms its financial attractiveness. Since 2014, there has been a significant increase in start-ups in the sector. (fig.3) For 2021, a growth of 95% compared to the previous year was reported. [4]

The distribution of the global logistics market by geographical regions is presented in fig. 4. The data shows that the largest share of 42% is occupied by North America. [5]

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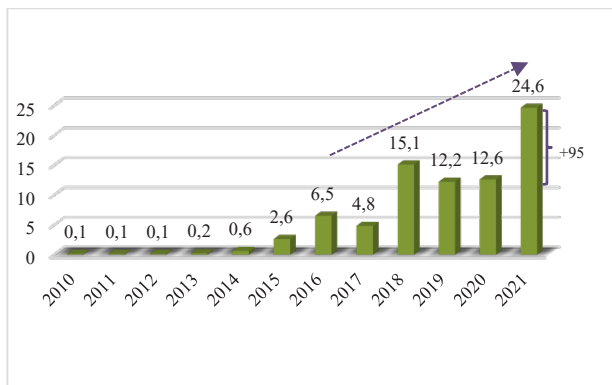


Fig. 3. Globally funding for logistics startups

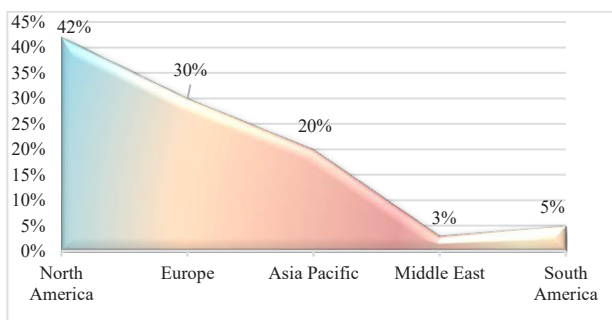


Fig. 4. Global space logistics market by geographic region, 2022

Europe is in second place with a share of 30%. South America and the Middle East account for 5% and 3% of the market share, respectively.

One of the key factors directly influencing the dynamics of the logistics sector is the global e-commerce market. (fig.5) [6]

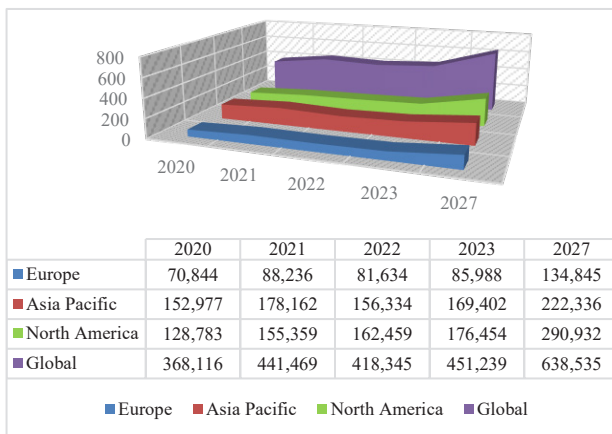


Fig. 5. Global e-commerce logistics market by region 2020-2027, \$ billion

The data from fig. 5 show that the global e-commerce logistics market is growing annually. In 2022, it is estimated to be over \$418 billion. Year-on-year growth projections in 2023 show an increase of 7.9%, and to reach \$638.535 billion by 2027 at a CAGR of 10.3%.

In e-retail, data shows that in 2022, nearly 20% of all retail purchases will be made online, amounting to \$5.7 billion. Expectations are that by 2026 their volume will grow to 24% and reach a volume of \$8.14 billion. (fig. 6) [7]

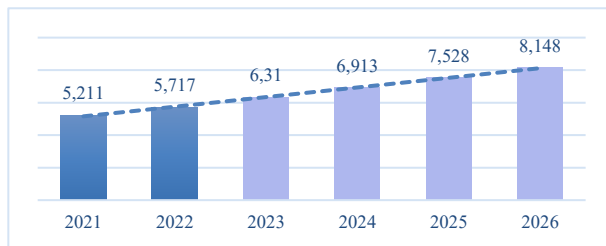


Fig. 6. Global e-commerce retail sales 2021-2026, in billion \$

2 Literature review

The term "logistics" comes from the ancient Greek word "logistike", which means "thinking, calculation, expediency". At the beginning of the 20th century, logistics was recognized as a military science, but after the Second World War, the term entered various areas of life, determining the different directions of its development. According to the order of their appearance, they appear - business logistics, engineering logistics, service logistics, event logistics, city logistics, health logistics. The multiple spheres of application of the term in practice are the reason for the existence of various definitions for the concept, summarized in table 1.

Table 1. Definitions of the concept of logistics

Source	Definition
European Logistics Association (ELA) [8]	Logistics is "part of the supply chain management process and is the planning, implementation and control of the efficiency of the flow and inventory of production, service and related information from the point of origin to the point of consumption in accordance with the requirements of consumers"
Council of Supply Chain Management Professionals [9]	„Logistics is a process of planning, execution and control of the procedures for expeditious and efficient transport and storage of the goods, including services (service) and the accompanying information from the point of delivery to the point of consumption to satisfy the requirements of the users.“
NATO Logistics Handbook [10]	„The science of planning and carrying out the movement and maintenance of forces. In its most comprehensive sense, the aspects of military operations which deal with: design and development, acquisition, storage, transport, distribution, maintenance, evacuation and disposition of materiel transport of personnel; acquisition or construction, maintenance, operation and disposition of facilities; acquisition or furnishing of services; and medical and health service support“
JF Magee, WC Copacino, DB Rosenfield [11]	„Logistics refers to the art of managing the flow of materials and products from source to consumer. The logistics system includes the entire material flow from the supply of raw materials to the delivery of the finished product to the end user, as well as the related information flows.“
Dimov, S., Theoretical Foundations of Logistics, [12]	Logistics is a scientific and practical activity of integrated management of material flows in an economic system, with the aim of optimizing its activity to meet the requirements of consumers

In almost all definitions of logistics, it is noted that its object is material flows, i.e. the set of products in different forms (raw, unfinished and finished) depending on the phases they go through (supply, production, distribution) within a separate economic system, and the subject of logistics is the optimization of the volume of resources in this system.

3 Analysis and discussions

Logistics is extremely important for the development of the economy. [17] Global logistics costs represent about 10-15% of the total world GDP, varying significantly depending on the level of economic development and the orientation of the economy. At the same time, a large share of the working population in the world is employed in the sector - 20-25%.

The relationship between economic development and logistics costs is presented in fig. 7. [13]

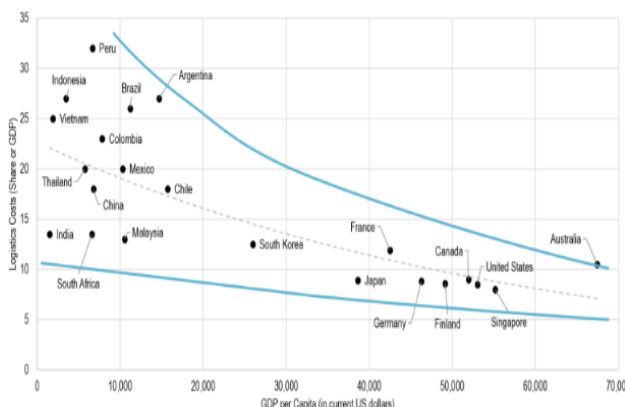


Fig. 7. Relationship between economic development and logistics costs, 2022

The data from fig. 7 testify to the fact that less developed economies (Peru, Brazil, Colombia, Mexico, etc.), relying primarily on the extraction and trade of natural resources, realize higher logistics costs in contrast to economies that are focused on technological manufacturing and digital services (Australia, USA, Singapore, Canada, Germany, France, Japan, etc.)

The influence of logistics on the results of the activity of industrial enterprises is particularly great. It reflects on their competitiveness through its contribution to entering new markets; reaching new sources of raw materials; increasing the level of customer service; the optimization of stocks, transport, warehousing; synchronization of production, procurement and distribution; reducing material costs – by finding more profitable suppliers for procurement.

The technologies from Industry 4.0 that find application in the logistics sector are summarized in fig. 8.

➤ **The Internet of Things.** IoT in logistics is associated with the transfer of data between physical devices over the Internet without human intervention using a variety of applications. This tool improves material flow awareness and increases real-time management efficiency. The integration of IoT provides

monitoring of the status of warehouse operations, transport, stock levels, deliveries to the end customer.

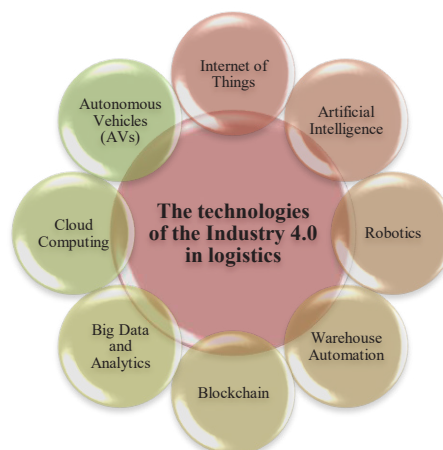


Fig. 8. Technologies from Industry 4.0 in the logistics sector

Through IoT, the status of assets, shipments and people can be tracked in real time. It can automate business processes to eliminate human errors, improve quality, predictability and predictability, contribute to cost reduction. In logistics, IoT is applied to monitor assets in supply chains and make decisions related to processing the huge amount of information.

Expectations for a growing role of IoT in the current decade. If in 2021 more than 10 billion active IoT devices were reported on a global scale, then by 2030 their number is expected to exceed 25.4 billion. According to McKinsey Digital, every second 127 devices connect to the Internet for the first time. The IoT consumer market is expected to reach \$142 billion by 2026 at a CAGR of 17%. According to the latest IoT Analytics report, by 2027, 47% of IoT applications are expected to contain an AI element. This will lead to a change in the interaction between humans and machines that work together and coordinate their actions. [14]

- **Artificial intelligence** - helps to achieve a balance in market demand. AI-based forecasting solutions enable management to plan supply chain processes and uncover opportunities to reduce costs. Through AI, it can provide automation of delivery services, automate administrative tasks, speed up the processing of large volumes of information.
- **Robotics** - integrating robots into logistics increases the speed and accuracy of supply chain processes and reduces human error. Physical and software robots apply. Physical robots are used to pick and transport goods in warehouses or storage facilities, while software robots perform routine human tasks.

Expectations for the impact of robotics on the logistics sector by 2025 are to contribute to a reduction in logistics costs in the range of 20 - 40% and to an increase in productivity in the sector from 25% to 70%. [15] The global logistics robot market in 2022 is estimated at \$7.42 billion. It is expected to grow to \$32.25 billion by 2028, growing at a CAGR of 34.16% (Fig. 9).

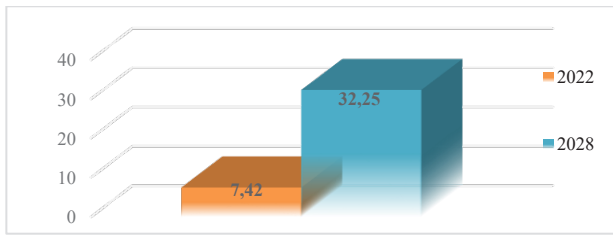


Fig. 9. Global market for logistics robots, billion \$

- **Automation of warehouses.** Through the automation of warehouses in logistics, an increase in activity efficiency, work speed and productivity is achieved by minimizing human involvement. Technologies for picking and arranging goods in the warehouse, automated guided vehicles (AGV), robotic picking, automated storage and retrieval (ASRS) are applied. Warehouses require a combination of effective automation technologies to control their operational logistics costs.
- **Blockchain technologies** - provide transparency of transactions in the logistics process, and smart contracts based on blockchain technology allow for faster correction and subsequent approval. Thus, a reduction in the processing time by the control-pass units is achieved.
- **Big data and analytics.** They are applied to improve warehouse operations and resources, to optimize transport routes, to plan deliveries. Assist in optimization of supplier prices, inventory level, generate reports for better risk management.
- **Cloud computing.** They provide universal accessibility and limitlessness to minimize IT infrastructure maintenance costs. Cloud-based capabilities provide payment with low capital investment. Through them, communication problems are overcome, allowing companies to collaborate and share data in a secure and accessible way. Assist in data collection and analysis of overall logistics processes and systems.
- **Autonomous Vehicles** – Autonomous vehicles, using AI technologies, ensure delivery safety by eliminating the risk of accidents resulting from human error. They contribute to increasing efficiency and flexibility in deliveries. They are independent of working hours. Achieving optimization of the transport route overcome transport traffic, which leads to reduced fuel costs.

The development of the logistics sector in a country depends not only on the economic conditions and the intensive production and trade of the economic organizations in it, but also on the effectiveness of the conditions that the environment provides. In this regard, a study was made of the Logistic Performance Index (LPI) of the World Bank, reflecting the main factors determining the overall efficiency of logistics in a country. The six components of the LPI include: [16]

- The effectiveness of releasing the goods from border control (speed, simplified procedures, predictability of formalities).

- The quality of commercial and transport infrastructure (sea, rail, road transport, information technology).
- Hassle-free organization of cargo at a competitive price.
- Competence and skills of people providing logistics services (transport operators, customs brokers).
- The ability to locate and track shipments.
- Frequency with which the cargo reaches the customer within the scheduled or fixed delivery time.

The data for 2022 put our country in the 51st position (with a score of 3.2) on a par with Romania. (Fig. 10). In the survey conducted among more than 1,000 logisticians from 155 countries, the leading place for 2022 is occupied by Singapore with a score of 4.3. The lag behind the leader in the ranking is in the six components. However, the data show that the conditions in Bulgaria in the logistics sector, in all directions, are above the average for the Europe and Central Asia region. [16]

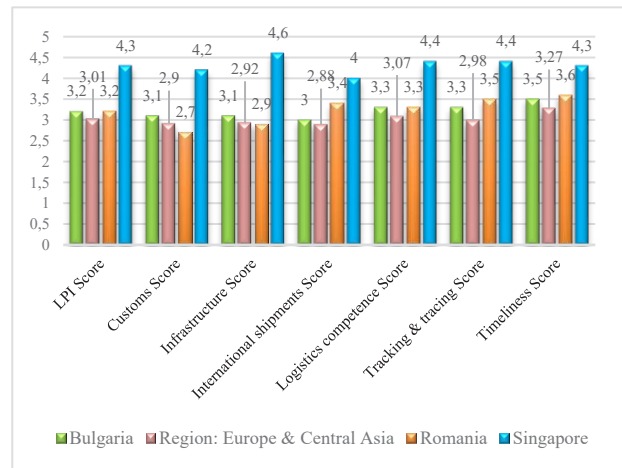


Fig. 10. Comparison of LPI for Bulgaria, Europe and Central Asia, Romania and Singapore, 2023

With a score of 3.2, Bulgaria falls on the border between the group of partial performers and consistent performers. (fig. 11)

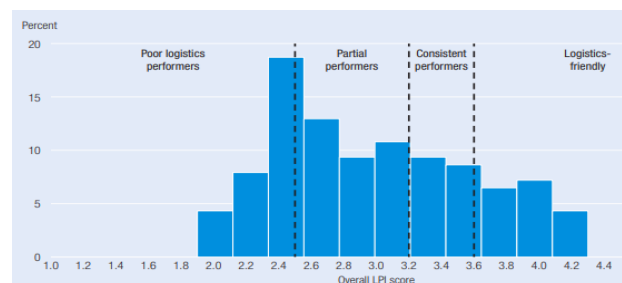


Fig. 11. Distribution of 139 countries into four achievement groups, according to the 2023 LPI [17]

4 Conclusion

The logistics sector is among the fastest growing on a global scale. The data on the growing investor interest in the sector confirms it. The rapid development of technologies from the fourth industrial revolution in

human history - Industry 4.0 - has a significant impact on this process. An additional boost in this development was provided by e-commerce, which recorded record values in the years of the global pandemic of Covid-19. Forecasts for the development of the digital technology market report stable growth in the near future, and this will also affect the logistics sector. Data on the World Bank's Logistic Performance Index (LPI) place our country in 51st position among 155 countries surveyed. According to the 6 factors with a score of 3.2, the country is ahead of the index for Europe and Central Asia on the six indicators, but is far from the leader in the ranking - Singapore with a score of 4.2. Businesses in Bulgaria's logistics sector must make additional efforts and investments to optimize logistics processes.

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